Assessing Conventional Army Demands and Requirements for Ultra-Light Tactical Mobility

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Preface

For over a century, the conventional Army has formally and informally used relatively small and light ground vehicles to meet tactical mobility needs in circumstances where standard tactical vehicles were too heavy, too large, or otherwise inappropriate. These platforms are smaller than the Army's standard light tactical vehicle fleet and are therefore informally referred to as ultra-light tactical mobility (UTM). As used in this report, UTM refers to ground mobility platforms intended and/or employed for tactical functions that, with a maximum combined vehicle weight of 4,500 pounds in combat configuration and internally transportable by a CH-47 in combat configuration, are smaller, lighter, and more transportable than the standard service vehicles (SSVs) that make up the Army's light wheeled vehicle fleet.

To better understand the conditions that have precipitated UTM needs and the capabilities required to meet current mobility needs, the Asymmetric Warfare Group (AWG) asked RAND to investigate historical and recent usage of ultra-light tactical transportation capabilities, such as motorcycles, all-terrain vehicles (ATVs), and quadrupeds to understand how these capabilities might best be used by Army forces in current and future operations.

This report presents the analysis, key observations, and recommendations from this AWG-sponsored study. It identifies how the Army has developed and employed UTM capabilities and describes key requirements and recommendations for *conventional* Army development and sustainment of UTM capabilities to meet its mobility needs. This report includes some discussion of Special Operations Forces (SOF) UTM employment primarily to identify and illustrate its key implications for conventional Army consideration, development, and employment of UTM. This report's findings should be of interest to those commands responsible for identifying requirements for, developing, sustaining, or employing vehicles for mobility and support of ground forces.

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Summary

The U.S. Army owns and operates a large fleet of wheeled combat and support vehicles, which it divides into three distinct fleets: heavy, medium, and light tactical vehicles. It also frequently uses wheeled vehicles that are not formally identified in any of the three fleet categories. These are such vehicles as all-terrain vehicles, motorcycles, and, on occasion, pack animals. These vehicles are informally classified as ultra-light tactical mobility (UTM) vehicles (commonly referred to as simply "UTM") and, if they were classified in the Army's vehicle taxonomy, they would be part of the light tactical vehicle (LTV) fleet.

An examination of the Army's history shows that UTM vehicles have been used since the early days of motorized forces. Most recently, forces in Afghanistan have used several types of UTM, and in April 2014 Army Forces Command (FORSCOM) initiated a plan to develop established sets of UTM vehicles for airborne forces.[1] Yet Army use of UTM has been sporadic enough that the Army has not formally identified them within its vehicle classification system. Given the persistent use of UTM currently and throughout the Army's history, they warrant a more detailed examination to determine whether the Army should formally classify and adopt such vehicles. This report assesses the Army's unvalidated needs (demands), validated needs (requirements), current capabilities, and key considerations for developing and sustaining Army UTM capabilities.[2]

Why Army Units Keep Using UTM

The repetitive use of UTM across a range of different conflicts raises the question of why this occurs. The answer is straightforward. Army tactical units acquire UTM capabilities for three reasons. First, the Army's family of standard vehicles cannot meet all the needs of units at the

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1 U.S. Army Forces Command, XVIII Airborne Corps, and 82nd Airborne Division, "Expeditionary Warfare Operating Concept," January 21, 2014. As part of a wider discussion of the required concepts and capabilities for expeditionary and entry operations, this presentation identifies "tactical wheeled mobility" as a key enabling initiative and describes the battalion-sized UTM vehicle set recommended to meet this need.

2 For the purposes of this analysis, the term *requirement* is used to refer to a capability which is required to meet an organization's roles, functions, and missions in current or future operations, as validated by the appropriate authority (Joint Requirements Oversight Council [JROC] or designated validation authority in a service, combatant command [CCMD], or other Department of Defense [DoD] component). The term "demand" refers to a desire for a proposed capability to meet identified operational gaps that, while identified by the demanding unit, is not explicitly articulated in a formally validated "need" or "requirement."

lowest tactical level.[3] Typically, this failure occurs because the vehicles available are too large and heavy to operate where units need them to operate due trafficability limitations, to include terrain, vegetation, surface, or infrastructure restrictions. Moving equipment and supplies over mountainous terrain in Afghanistan where only footpaths exist is one example. Dense jungle is another. In some areas of the world, the roads and bridges cannot handle even the Army's current LTVs. Second, the military operation is so austere that the facilities to sustain the heavier vehicles are unavailable or infeasible. When standard LTV cannot meet unit needs at the tactical level, the best available alternative is usually manpower; that is, soldiers carry the load. UTM vehicles fill the gap between backpacking loads and the smallest LTV, the M998 High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) family of vehicles. Third, there are instances where the utility of UTM employment for an Army unit outweighs the associated risks. For example, remotely operated carriers are used to haul weapons, ammo, and other important capabilities for a dismounted infantry squad despite the potential for attack and destruction of the materiel hauled.[4]

Mobility Trends Affecting Need for and Use of UTM

Two types of mobility trends create the demand and requirement for UTM and affect how they are used: mounted and dismounted. The emergence of improvised explosive device (IED) employment has exerted an enormous influence on the design of Army vehicles. The result has been the addition of heavy armor plating and bulletproof glass to LTV and the development and fielding of vehicles that provide greater crew protection, such as the Mine Resistant Ambush Protected (MRAP) vehicle. Protection comes at a cost, and in this case the most noticeable cost is weight. These MRAP vehicles' advantage in reducing the severity of impacts from attack simultaneously greatly degrades their capability of varied avenues of approach and reduction of signature to lessen the *probability* of attacks. The up-armored HMMWV weighs about a ton more than its unarmored counterpart, and an MRAP can weigh more than 20 tons. The increased weight and corresponding size limits the places these vehicles can go, either because the roads or bridges would crumble under their weight or because they are too big to move through restricted terrain such as narrow city streets. Although these vehicles clearly provide better protection in areas with significant IED threats, they also drastically limit the ability of forces to access and use more constrained terrain for maneuver. While this increased mobility from UTM could potentially influence the distribution and lethality of IED attacks, no identified analysis exists to validate this argument, posited by some UTM proponents.[5]

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[3] XVIII Airborne Corps, "Operational Statement of Need for Enhanced Tactical Mobility of Airborne Infantry Forces in Support of the Global Response Force Mission," December 4, 2013. This Operational Needs Statement (ONS) provides explicit discussion of Army airborne forces' need for UTM.

[4] While autonomously controlled UTM vehicles do not currently exist within the Army force structure, recent field experiments and prototype systems have demonstrated this capability is technically viable.

[5] Some proponents of UTM have posited that the UTM vehicles offer safer mobility alternatives because of their ability to negotiate more terrain than MRAPs and therefore confound enemy attacks with less predictable movement. However, the research team did not identify any existing analysis to support this assertion.

Trends in dismounted mobility mirror those in mounted. In spite of advances in materials that make equipment lighter and stronger, the load soldiers carry has increased steadily, while the load a soldier can carry has remained essentially constant. A soldier in WWII carried a combat load weighing 60 pounds; a soldier in Afghanistan carries over 80 pounds. The full load can exceed 100 pounds. The toll exacted by these heavy loads is high, especially in hot or high-altitude locations.

Following the completion of this analysis, the growing need for lighter mobility options to enhance the mobility of otherwise dismounted formations motivated a formal request for acquisition of UTM capabilities for some conventional Army units. In March 2014 the Joint Chiefs of Staff published the *Joint Concept for Entry Operations* (JCEO) that amplifies a requirement for the Global Response Force (GRF) Infantry Brigade Combat Team (IBCT) to conduct an airborne assault at an offset drop zone and adds a new requirement for the GRF IBCT to immediately maneuver to seize a lodgment or complete assigned missions at extended ranges.[6] Based on these new requirements, the 82nd Airborne Division submitted an updated ONS for "enhanced tactical mobility for the GRF" with a requested IBCT-sized set of UTM vehicles consisting of Polaris MRZR4s and Polaris DAGORs.[7] Currently FORSCOM is pursuing a rapid evaluation and fielding initiative to address this validated requirement for UTM.

The Case For and Against UTM

A number of arguments support the case for adding UTM capabilities. One is that an analysis of Army operations identifies eight basic Tactical Activities performed during execution of the many Army Universal Tasks that involve tactical mobility and for which UTM have been consistently used:

- maneuver force security/reconnaissance
- local patrolling and engagement
- coordinated maneuver
- immediate pursuit
- troop mobility
- traveling support
- casualty evacuation
- internal/ferry support.

Most, if not all, armies everywhere have performed these activities since the distant past, perform them today, and almost certainly will perform them in the foreseeable future. These tasks do not hinge on a specific type of vehicle. Circumstances will dictate, for example, whether the vehicle needs armor protection. However, in many circumstances, UTM vehicles can carry out these activities and, most important, can do so in constrained environments where standard service vehicles (SSVs) cannot.

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6 Joint Chiefs of Staff, the *Joint Concept for Entry Operations* (JCEO), 2014.

7 U.S. Army Forces Command, 82nd Airborne Division, "Update to Operational Needs Statement—Enhanced Tactical Mobility for the Global Response Force (ONS 14-19635)," March 26, 2014. This memorandum updates the original ONS submitted in December 2013 based on additional operational requirements associated with the newly released JCEO.

Other arguments for using UTM include the following. The recent *Joint Concept for Entry Operations* and corresponding 82nd Airborne Division ONS identify the ability of UTM vehicles to reduce operational risk to the Joint force by reducing the delivery resources required through use of vehicles with smaller transportability requirements than those associated with the current SSV. When the terrain is constrained, such as in cities or mountainous areas, UTM can provide mobility where SSVs cannot. Furthermore, UTM vehicles can be moved by a wider range of transportation assets such as CH-47 or UH-60 helicopters compared with SSVs and take up less space when shipped. They can also operate on transportation arteries that cannot accommodate SSVs, such as narrow trails and low-capacity bridges. And, as mentioned, they can maneuver in extreme terrain used by asymmetric adversaries, such as along mountain paths. Another advantage is that they are more compatible with partner militaries we train and support. Their agility enables them to use routes that SSVs cannot and thus avoid certain threats, such as IEDs, set up in restrictive terrain. They also have a lower operational signature, and they can navigate surface conditions such as mud or sand that would bog down SSVs. Lastly, experiments have demonstrated that increased mobility could make up for a lack of protection in some missions, so long as the forces could stay on the move, evade the enemy, and avoid decisive engagements or requirements to hold a defensive line.[8]

Arguments on the negative side of the ledger largely revolve around the vulnerability of UTM vehicles to tactical risks from threats and hazards. The Army properly wants to avoid as many casualties as possible, and UTM vehicles are both vulnerable and, under some conditions, hazardous. They are vulnerable simply because they do not provide much physical protection from attack. They are hazardous in some instances because they tip over easily, and the operator has little protection. There are a number of other potential liabilities of UTM vehicles when compared with mounted or dismounted alternatives:

- The noise signature of UTM platforms is higher than that from dismounted movement.
- The level of concentration often required for safe operation of UTM vehicles can detract from other sensory requirements, such as looking for signs of threat activities.
- UTM platforms, as currently nonstandard vehicles, often do not have common parts or standardized maintenance procedures.
- While UTM platforms are often used for nonstandard casualty evacuation (CASEVAC), they generally do not enable stabilization of casualties as well as larger vehicles.
- On a more technical note, field experiments have shown that it is difficult for operators of UTM vehicles to stay in contact with other elements of the unit.

Why the Army Has Avoided Formal UTM Capabilities in the Past

On multiple occasions the Army has pursued development and fielding of UTM capabilities that did not make it to or remain in sustained operational use. UTM applications focused on combat-related activities, such as maneuver force security and reconnaissance, have succumbed to reasonable, but not always validated, concerns about exposure of UTM occupants to threats

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8 Steven L. Bowman, John M. Kendall, and James L. Saunders, eds., The Motorized Experience of the 9th Infantry Division 1980–1989, Fort Lewis, Wash.: [Department of the Army, 9th Infantry Division (Motorized)], 1989, pp. 33–34.

and hazards. Incorrect assumptions about future operating environments and their freedom from constrained operating conditions has led the Army to discount the continuing need for UTM support for operations facing constrained terrain and/or delivery capacity. In sum, the Army has founded decisions about wholesale avoidance of UTM primarily on assumptions about the ability of HMMWVs and larger vehicles to address all legitimate mobility needs in future combat environments, underappreciating the continued need of forces to maneuver in spite of constricted terrain and delivery capacity.

Current Trends in UTM Capabilities

A number of conventional Army units have developed UTM capabilities, in many cases on their own initiative to meet their specific needs. Looking across the units that have done so, we find several trends, and these are presented in Table S.1. It indicates which applications have been most successful, what capabilities they provide, what the supporting capabilities for these systems are, and the key challenges and limitations.

The upshot is that several different types of units have acquired UTM capabilities. However, these have largely been gained outside of the standard Army procurement mechanisms, so institutional support for them is, largely, lacking. For example, little exists in terms of doctrine, and what does exist tends to be spotty and focused narrowly, e.g., how to rig certain items for airlift or airdrop. Acquisition occurs largely through commercial off-the-shelf (COTS) or modified COTS (M-COTS) purchases. The latter enables the procuring unit to do some tailoring of commercial vehicles for military use. Funds are typically overseas contingency (OCO) funds or command discretionary funds, which do not provide a stable source of funding to support these vehicles. Since the systems are acquired outside of normal acquisition

Table S.1
Overarching Trends from Conventional Army UTM Cases

Category	Description
Key UTM applications	• Most successful and sustained UTM applications are for internal ferry/support, traveling support, and casualty evacuation activities • Current experimentation is primarily evaluating utility of UTM platforms for recon/security activities.
Key DOTMLPF capabilities	• Relatively common M-Gators from congressionally mandated procurement and subsequent unit purchases • Some unit-specific COTs platforms • Specific mention of UTM platforms as mobility options in various Army manuals and technical publication • Contractor-provided training on UTM operations and basic maintenance
Supporting capabilities	• Instruction on basic planning considerations in Army Mountain Warfare School instruction • Limited evaluation and experimentation as part of the NIE
Key challenges and limitations	• No Armywide ability to manage or support current UTM capabilities • Current repair and replacement executed primarily with rapidly declining OCO funds • No basic guidance or concepts for tactical UTM employment • Limited consideration of hazards and threats associated with operational UTM employment

processes, they often are not accounted for in normal materiel management documents such as property books. There are procedures to enter UTM vehicles into the system, but not all units do so. One result of the ad hoc procurement processes is that the support and sustainment systems do not recognize the UTM vehicles; thus, such things as replacement parts are not available in the normal supply channels. The burden then falls back on the units to get the parts, for which there is no institutional funding. Nor is there robust institutional training.[9] Some contract training has been provided, but this is normally episodic. After the original training, the unit must again assume responsibility for maintaining proficiency.

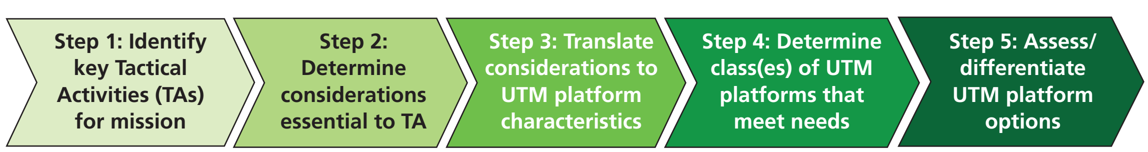
Both the Marines and Special Operations Forces (SOF) have greater institutional support for UTM capabilities. This support has translated into better access to platforms that are better tailored to meet specific requirements, as well as more robust training and sustainment resources. While conventional Army units may not need SOF's platform diversity or robust UTM program, the conventional Army can likely draw useful lessons from SOF and Marine Corps overlapping requirements and existing programs to develop appropriate UTM capabilities.

A Process for Assessing UTM Alternatives

Based on the demonstrated reoccurrence and persistence of conventional Army units' UTM needs over time and across operational environments, conventional Army units are likely to have demands for UTM capabilities in the future. Therefore, a more methodical approach to determining the specific type of capabilities would be useful. The researchers developed one based on contemporary unit experiences and used a Unified Quest scenario to illustrate how such a process would work and what elements it should contain.[10] The process developed, called the UTM Selection Process (UDAP), contains the five steps indicated in Figure S.1.

It begins by identifying the most important Tactical Activities associated with the scenario that will need some sort of mobility asset. It does not focus on UTM at this point; rather, it simply identifies the mobility requirements associated with the mission. The second step identifies, in priority, the mobility considerations most important in accomplishing the mission. For example, if the ability to move across diverse types of terrain is important to accomplishing the mission, that would be an important consideration in choice of vehicles. The third step of the

Figure S.1
UTM Demand Assessment Process (UDAP)



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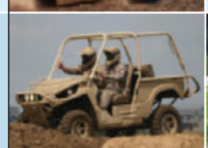
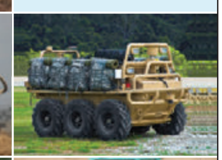
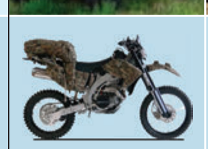
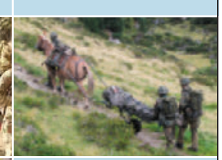
[9] The Army does have institutional training on pack animals at its Mountain Warfare School.

[10] As described by the Army Capabilities Integration Center, Unified Quest is the Army Chief of Staff's annual future study program that is a key element in the Army's efforts to identify the challenges and opportunities that will test future Army forces. The Army uses the Unified Quest program to examine a variety of plausible mid- to long-range strategic settings and explore a broad set of ideas about future conflict.

UDAP focuses on identification of desired platform characteristics based on the identified considerations from UDAP Step Two. Those characteristics would include vehicle range, training of personnel to repair and maintain vehicles, cargo volume, and weight. These characteristics are relatively quantifiable and, thus, useful in ruling a particular vehicle in or out by comparing characteristics with key mission considerations. The next step focuses more narrowly on UTM platforms, determining which ones meet the specific demands of the scenario. As depicted in Table S.2, the analysis determined that track width, carrying capacity, and psychological stress on operators were most important for differentiating suitable options. (Operating motorcycles is more stressful than driving four-wheel vehicles with padded seats and power steering.) This step involves trade-offs among types of capabilities. For example, a donkey can go just about anywhere, but at the cost of speed and endurance. A subcompact platform can negotiate difficult terrain but lacks speed and cargo capacity. The final step involves assessing different platforms to determine which ones best answer the unit's needs. While this analysis explicitly included a scenario with a demand or opportunity for employment of UTM vehicles, applica-

Table S.2
Categories of UTM Alternatives Based on Differentiating Characteristics

UTM Platform Class	Track Width	Max Carrying Capacity (soldier equivalents)	Physiological Limitations	Examples
Full-duty	Dual (+) (70″)	3,000 lbs (12>)	Low	
Midsize	Dual (60″)	1,600 lbs (6.5>)	Moderate	 
Compact	Dual (-) (48″)	750 lbs (2.5>)	Moderate	 
Subcompact	Single (+) (36″)	375 lbs (1.5>)	High	
Quadruped	Single (+) (36″)	375 lbs (1.5>)	High	 
Human-enabled	Single (30″)	375 lbs (1.5>)	High	

tion of the UDAP to other scenarios could support a determination that no UTM alternative is appropriate based on terrain, threat, and/or other specific factors.

This five-step analysis would not necessarily have to begin from ground zero each time, because different unit types have common characteristics that would influence UTM choices. For example, air assault units have organic helicopter capabilities that would tend to favor one type of UTM capability over another. They could sling-load some UTM vehicles under UH-60 helicopters or transport them internally in CH-47 helicopters. Airborne units have organic capabilities to rig vehicles for airdrop.

Observations and Recommendations

Observations

Our research leads us to the following observations:

- Contemporary operations and operating environments present "bundles" of factors that can favor or discourage UTM employment.[11]
- The *tactical* threat is the most difficult factor to offset, and it has routinely outweighed the potential benefits of UTM in the judgment of operational commanders.
- UTM capabilities provide a validated alternative to reduce *operational* risks and increase operational flexibility through reduction of requirements for delivering an "operationally significant force."
- Despite a threat environment that has generally precluded formal Army consideration of UTM capability development, other militaries, services, and individual Army units have found appropriate and tactically beneficial methods for employing UTM.
- While UTM requirements do exist for conventional Army units, an apparent lack of tactical unit participation in formal requirements validation processes, such as ONSs, has left UTM requirements undervalidated, underrepresented, and not fully understood.
- There is insufficient data to assess UTM employment and operational effectiveness or to assess the impact on conducted operations from not having UTM capabilities.[12]
- The growth in size and weight of the Army's SSV has resulted in unmet tactical mobility requirements that UTM can address under some limited circumstances.
- While individual Army units maintain ad hoc UTM capabilities, coordinated Army UTM capabilities are generally nonexistent.
- The Army can develop the basic UTM capability needed with some limited foundational investments.

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[11] For example, constricted terrain, minimal direct fire or IED threat, extensive use of dismounted forces with rotary wing lift, and limited infrastructure would represent a bundle of factors that, taken together, would generally present an opportunity for UTM employment. Conversely, a mature operating environment with pervasive direct fire and IED threats, numerous improved roads, and widely dispersed combat arms maneuver would present a bundle of factors that would likely minimize the opportunity for UTM employment.

[12] However, the absence of widespread UTM can also suggest an implicit decision by some units to not pursue alternatives for acquisition and employment of UTM vehicles. Multiple factors could have influenced commanders' implicit decisions not to use UTM vehicles, to include an implicit consideration of risk associated with UTM employment, lack of knowledge about possible UTM alternatives, and unwillingness to contest established command policies.

The Army Cost of Not Having Coordinated UTM Capabilities

While individual Army units have realized immediate benefits from ad hoc development of UTM capabilities, there are long-term costs to the Army from not pursuing a coordinated UTM capability development program. We identify four costs associated with the Army lacking a coordinated UTM capability:

- **Loss of tactical flexibility.** Without vehicles smaller than the SSV, the Army does not have the vehicular flexibility to use alternate routes in or tailor unit mobility to many operational environments when terrain, threat, and tactical capabilities create an opportunity for beneficial UTM employment.
- **No opportunity to reduce the burden on dismounted soldiers.** Without UTM, rucksacks are the only other options when terrain and operational constraints do not permit SSVs.
- **Loss of the opportunity for improved fire and maneuver for ground forces in some circumstances.** UTM platforms provide the ability for dismounted forces to carry or maneuver with mounted heavy weapons (mortars, heavy machine guns, recoilless rifle, etc.) in spaces too constrained for SSVs.
- **Loss of the opportunity to subject UTM alternatives to the Army's rigorous development and assessment processes**, to include development of broader operational concepts and capabilities. While there are challenges and inefficiencies associated with current Joint Capabilities Integrated Development System (JCIDS) and acquisition processes, they entail rigorous needs validation and performance assessment that are valuable for the Army to understand and address long-term UTM requirements. The JCIDS provides the ability to test potential UTM options in benign environments in advance instead of ad hoc application in operational settings.

Four UTM Strategies for Going Forward

This research identifies four potential strategies that the Army can pursue to address current and emerging UTM requirements based on current and previous experience:

- **Status Quo—Unit-Specific UTM Capabilities:** This approach requires little resource commitment for the Army and relies on units employing informally available resources to meet UTM needs. This approach assumes that units with legitimate UTM capability needs can and will find locally available resources and methods to meet their needs. This is the approach that the Army is, by default, currently pursuing.
- **Minimal Investment in Foundational UTM Capabilities for Selected Units:** This approach generally entails limited and carefully considered investments in training, doctrine, support programs, and a limited number of appropriate UTM platforms, like dual-track all-terrain vehicles (ATVs) and other motorized vehicles. This resource-conscious strategy ensures presence of foundational UTM capabilities while remaining flexible as the operational demands change.
- **Procurement of Optimal UTM Platform or Mix of Platforms for All Army Needs:** This approach requires the Army to identify a common UTM capability and outfit major formations, such as battalions or brigades, with it, to include materiel, training, doctrine,

and support. This approach requires potentially significant resources and may not meet all key UTM requirements.

- **Procure a UTM Capability for Each Potential Need:** This approach entails considerable investment in time and money to develop, test, field, train, and support a wide range of UTM capabilities. However, there is no evidence that this is a reasonably efficient approach or even possible given the variety of ways UTM platforms have been used.

This report identifies the second strategy, minimal investment in foundational UTM capabilities for selected units, as the most appropriate strategy for the Army to pursue given current demand for UTM capabilities. This approach is cost conscious but preserves the capability to scale up UTM capabilities if needed. This approach would enable the Army to institutionalize the UTM capability and establish the doctrine, training, experimentation, and support capabilities through limited investments. The report provides specific recommendations for the Army to execute this strategy.

Recommendations

We offer recommendations to the Army in the following areas: doctrine, organization, training, materiel, leadership, and facilities.

Doctrine

Refine Army doctrine to provide sufficient concepts and technical information for effective and safe tactical UTM employment. A number of doctrinal documents provide limited discussion of UTM platforms as a potential option. However, these documents do not necessarily align with the most prevalent applications of UTM abilities demonstrated by historical and recent operations. The Army Doctrine 2015 structure provides a suite of publication types to support discussion of appropriate UTM capabilities for potential tasks and operating environments. The Army should refine existing doctrine to discuss UTM platforms as potential mobility options, planning considerations for their use, and guidance for operational employment capabilities at appropriate levels of Army doctrine.

Develop an Army Techniques Publication (ATP) or comparable resource that specifically addresses training, planning, employment, and support considerations associated with UTM employment. Information collected and analyzed for this report suggests that UTM capabilities can be and are being applied to a wider range of activities and unit types than previously considered. Additionally, user experiences and emerging technologies suggest significant differences between UTM capabilities and LTV platforms. Therefore, a dedicated ATP or comparable resource is likely required to capture the unique knowledge and skills required for safe and effective tactical employment of UTM platforms.

Organization

Develop planning conferences and workshops with other services and SOF to determine common UTM needs and take advantage of economies of scale for resource-conscious sustainment of UTM capabilities. USMC and SOF have UTM needs that are similar to those in conventional Army units. Additionally, USMC and SOF maintain UTM materiel, training, experimentation, and support capabilities that the Army can exploit to develop and sustain required UTM capabilities. The Army should use memoranda of agreement (MOAs) and regular conferences with the USMC and SOF to coordinate UTM capability development and sustainment efforts.

Use specialized National Guard units to maintain low-density UTM competencies and experience. Currently, the Army uses the 86th IBCT (Mountain) and associated Army Mountain Warfare School (AMWS) to lead Army development, sustainment, and promulgation of mountain warfare competencies. National Guard soldiers often remain in a given unit much longer than their conventional Army counterparts, giving them the ability to develop and refine the low-density skills required to conduct technical mountain warfare operations. These soldiers also provide the Army with a valuable method to export mountain warfare expertise to other Army units through resident courses at AMWS and Mobile Training Teams (MTTs). Similarly, the Army should consider identifying an appropriate National Guard unit to lead long-term development and refinement of UTM-related expertise. Finally, use of a National Guard unit in this capacity would take advantage of the extensive utility of UTM capabilities to support Title 32 Defense Support to Civil Authorities (DSCA) operations that National Guard personnel routinely conduct.

Training

Develop training resources to establish and maintain basic UTM knowledge that units can flexibly apply to develop and employ UTM capabilities. Safe and effective UTM employment requires specific knowledge and skills that do not readily exist in most Army units that do or could require UTM capabilities. While these skills are specific, they are sufficiently transferable that required expertise could likely be developed primarily through unit-level training supported by MTTs, limited resident course instruction, and field exercises.

Coordinate training programs and resources with the USMC and SOF to develop UTM training strategies to meet common UTM expertise requirements. For example, the Marine Mountain Warfare Training Center (MWTC) offers programs of instruction (POIs) that can accommodate Army needs for such training on employment of pack animals. Through coordination with the USMC and SOF, the Army can provide or gain access to training programs and resources.

Materiel

Formally recognize the Army need for some UTM materiel capabilities and define ultra-light tactical vehicles (ULTVs) as a distinct category of equipment in Army materiel strategy documents such as the *Army Tactical Wheeled Vehicle Modernization Plan*. Current Army materiel strategy documents do not identify UTM capability as a specific need for development and procurement. Discussion of the existence of UTM needs in key materiel strategy documents will support formal consideration of the continuing need for UTM development, evaluation, and acquisition.

Test and evaluate UTM platforms to identify common materiel alternatives that can be tailored to meet requirements across a range of mission profiles for conventional Army units. Technological improvement of civilian recreational vehicles has increased the potential options to meet Army UTM platform needs. However, thorough testing and evaluation are required to determine the most likely UTM applications and the performance characteristics required for each. Due to the potential for UTM employment to increase effectiveness of Army units (especially dismounted activities) significantly, the Army should focus resources on developing and evaluating concepts through experimentation for the most effective employment of UTM platforms in accordance with operationally realistic use profiles.

Identify one or a small set of UTMs that meet most Army-wide needs. Based on the significant commonality of UTM need characteristics across conventional Army units, one or a small set of UTM platforms can likely provide a basic solution that, in various configurations, can optimally meet most Army UTM needs. With information from testing and evaluation, the Army can identify a common platform or small set of platforms that units can readily adapt to meet most priority UTM requirements. Initially, these platforms should likely be UTM models that are already authorized for testing and evaluation, such as the military Gator (M-Gator) and lightweight tactical all-terrain vehicle (LTATV).

Develop a UTM support program that enables authorized units to satisfy sustainment requirements, especially repair materials and replacement parts. The lack of coordinated sustainment resources is the most significant challenge for conventional Army units that currently have UTM capabilities, requiring them to acquire parts through informal means and reducing the usability of existing UTM platforms. Previous attempts to develop UTM capabilities have procured platforms without considering long-term sustainment or replacement. The Army needs a coordinated method to ensure sustainment of both current and future UTM materiel capabilities.

Leadership

Provide training and doctrinal resources to enable leader consideration of UTM capabilities as an option and to enable planning for UTM capability employment. Through training and doctrine resources, provide basic guidance for leader planning for and employment of UTM capabilities. One potentially significant limitation for UTM employment is lack of leader knowledge of UTM capabilities or concepts for employing them in coordination with other capabilities. For UTM capabilities to constitute a beneficial option, leaders must understand the benefits and limitations associated with each specific type of UTM, as well as the key planning considerations that should precede UTM use.

Facilities

Provide information and guidance for leader identification of terrain features and training areas required to enable home station or deployed training on key UTM training requirements. As described by current practitioners and subject-matter experts, operationally realistic UTM training requires training operators on a broad range of potential terrain and conditions they may encounter in operations. Leaders and practitioners require some basic guidance to identify key training requirements and coordinate for appropriate training areas to meet UTM-specific training needs.

Prioritizing Army UTM Investments

The various potential UTM capability investments and applications do not provide equal opportunity to realistically improve current and future Army operations. Furthermore, the significant threats and risks associated with some UTM applications make their execution in combat operations less likely and, consequently, make investments in them harder to justify. The Army should consider the following when prioritizing Tactical Activities to address with UTM program investments:

- **Likely Impact:** The total number and importance of Army units that can potentially benefit from UTM development for a Tactical Activity
- **Associated Risks and Threats:** The appropriateness and justifiability of investing in UTM capabilities to perform Tactical Activities based on expected risks and threats they will encounter in combat operations
- **Impact of Emerging Technologies:** Opportunity for technologies like optionally manned control or autonomous robotic control to drastically change UTM appropriateness for a Tactical Activity by improving performance, increasing protection, or eliminating the need for human operators and the associated vulnerability concerns.

Acknowledgments

This yearlong research was sponsored by Col. Patrick J. Mahaney as the commander of the AWG. COL Mahaney's leadership and intellectual engagement in the issue of improved mobility options for soldiers made this study possible. At AWG, Major Timothy O'Sullivan, Dwight Umstead, and MAJ Jeffrey Brewster provided invaluable assistance and coordination for the RAND study team.

Understanding the nature and extent of informal and generally undocumented development and employment of ultra-light tactical mobility (UTM) required the RAND study team to spend extensive time engaging with and collecting information from current Army leaders and practitioners in tactical units. A number of Army and Marine units provided valuable input to the study, including the 86th Infantry Brigade Combat Team (Mountain); the U.S. Army Mountain Warfare School (AMWS); 1st Squadron, 38th Cavalry Regiment (Long-Range Surveillance Troop); 1st Battalion, 6th Infantry Regiment, U.S. Marine Corps Mountain Warfare Center; and 159th Combat Aviation Brigade (Air Assault). Personnel from each of these units provided invaluable information on their immediate needs and recent experiences with UTM, as well as access to their current UTM capabilities.

In addition to the help from the numerous personnel from the units visited by the RAND study team, a few other individuals provided particularly valuable assistance identifying current UTM capabilities and sharing pertinent and recent combat experience with UTM that would not have been available otherwise. MAJ Geoffrey Farrell facilitated study team access to the Vermont National Guard and AMWS that provided extensive information and experience to inform and help guide the study design. MAJ Paul E. Roberts, the former commander of Headquarters, Headquarters Company (HHC) 6th Squadron, 4th Cavalry Regiment provided first-person insights on recent combat employment of UTM capabilities, to include their use in establishment of the now infamous Observation Post Bari Alai. The experience of Major-Roberts in the rugged mountains of Kunar Province, Afghanistan illustrated the continuing imperative for appropriate mobility capabilities for soldiers who must continuously operate and sustain operations in unimaginably rugged terrain. These and other Army personnel provided detailed and balanced assessments without which this report would be much less detailed and insightful for Army audiences. Our appreciation for their service in combat and for the study team cannot be overstated. Lastly, Ted Macubia, Deputy Director of Mounted Requirements at the Maneuver Center of Excellence (MCOE), and his staff provided specific and useful input on current and emerging programs to provide UTM capabilities to Army units.

Within RAND, a number of people helped the authors make this report a reality. The research team especially appreciates the direct, honest, and wise input of our communications analyst, Jerry Sollinger. Also, Theresa Dimaggio and Martha Friese spent countless hours ensuring this report was well crafted and ready for publication.

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Abbreviations

9th ID	9th Infantry Division
AAE	Army Acquisition Executive
AAFARS	Advanced Aviation Forward Area Refueling System
AAMDC	Army Air and Missile Defense Command
AFSB	Aviation Forward Support Battalion
AAR	After Action Report
AASLT	air assault
ABN	airborne
ADP	Army Doctrine Publication
ADRP	Army Doctrine Reference Publication
AETF	Air Expeditionary Task Force
AFSB	Army Field Support Brigade
AGS	Armored Gun System
AMSA	Army Materiel Systems Analysis Activity
AMWS	Army Mountain Warfare School
AOI	area of influence
APOD/SPOD	aerial point of debarkation/sea point of debarkation
APPs	applications
ARCG	Arctic Response Company Group
ARSOF	Army Special Operations Forces
ASL	above sea level
ATGM	antitank guided missiles
ATP	Army Techniques Publications

ATTP	Army Tactics, Techniques, and Procedure
ATV	all-terrain vehicle
AUTL	Army Universal Task List
AWG	Asymmetric Warfare Group
BCT	Brigade Combat Team
BDA	battle damage assessment
BOIP	Basis of Issue Plan
C2	command and control
CA	Civil Affairs
CAB	Combat Aviation Brigade
CAS	close-air support
CASEVAC	casualty evacuation
CAV	cavalry
CBIRF	Chemical Biological Incident Response Force
CCMD	Combatant Command
CDS	Container Delivery System
CDU	critical dual use
CENTCOM	U.S. Central Command
CFV	Cavalry Fighting Vehicle
CIA	Central Intelligence Agency
CID	Criminal Investigation Command
C-IED	counter–improvised explosive device
CJFLCC	Combined Joint Forces Land Component Command
CJSOTF-A	Combined Joint Special Operations Task Force–Afghanistan
CMO	Civil Military Operations
CMSE	Civil Military Support Element
COIN	counterinsurgency
COTS	commercial off-the-shelf
CQB	close quarters battle
CREW	Counter-RCIED Electronic Warfare

CSAR	Combat Search and Rescue
CSG	Corps Support Group
CSSB	Combat Sustainment Support Battalion
CSV	Combat Support Vehicle
CTV	Combat Tactical Vehicle
DA	Department of the Army
DARPA	Defense Advanced Research Projects Agency
DART	Downed Aircraft Recovery Team
DoD	U.S. Department of Defense
DOTMLPF	doctrine, organization, training, materiel, leadership, education, personnel, and facilities
DRAS	Dual-Row Airdrop System
DSCA	Defense Support to Civil Authorities
EFP	Explosively Formed Penetrator
EN	engineer
ESG	Expeditionary Support Group
FARP	Forward Arming and Refueling Point
FAV	Fast Attack Vehicle
FM	field manual
FMTV	Family of Medium Tactical Vehicles
FOB	Forward Operating Base
FORSCOM	U.S. Army Forces Command
FOV	Family of Vehicles
FSOV	Family of Special Operations Vehicles
GCC	Geographic Combatant Command
GMV	Ground Maneuver Vehicle
GRF	Global Response Force
GVW	gross vehicular weight
G-Wagen	Mercedes Benz Geländewagen Family
HA/DR	humanitarian assistance/disaster relief

HEMTT	Heavy Expanded Mobility Tactical Truck
HMMWV	High Mobility Multi-purpose Wheeled Vehicle
HQDA	Headquarters, Department of the Army
HRF	Homeland Response Force
HTLD	High-Technology Light Division
HTTB	High-Technology Test Bed
HTV	Heavy Tactical Vehicle
IAW	in accordance with
IBCT	Infantry Brigade Combat Team
IBD-A	Integrated Base Defense—Austere
ID	infantry division
IDF	Israeli Defense Forces
IED	improvised explosive device
ISR	intelligence, surveillance, and reconnaissance
ITV	Internally Transportable Vehicle
IVO	in vicinity of
JAPCC	Joint Air Power Competence Centre
JCEO	Joint Concept for Entry Operations
JCIDS	Joint Capabilities Integration Development System
JFACC	Joint Force Air Component Commander
JFE	Joint Forced Entry
JFMCC	Joint Force Maritime Component Commander
JFSOCC	Joint Forces Special Operations Component Commander
JIEDDO	Joint Improvised Explosive Defeat Organization
JLTV	Joint Light Tactical Vehicle
JLTV-A	Joint Light Tactical Vehicle–Assault
JLTV-CCWC	Joint Light Tactical Vehicle–Close Combat Weapons Carrier
JLTV-T	Joint Light Tactical Vehicle–Companion Trailer
JLTV-GP	Joint Light Tactical Vehicle–General Purpose
JLTV-UTL	Joint Light Tactical Vehicle–Utility

JORD	Joint Operational Requirements Document
JP8	Jet Propellant 8
JROC	Joint Requirements Oversight Council
KPP	Key Performance Parameter
LIN	line-item number
LRAS3	Long Range Advance Scout Surveillance System
LRS	Long Range Surveillance
LRSC	Long Range Surveillance Company
LMAMS	Light Miniature Aerial Munitions System
LMTV	Light Medium Tactical Vehicle
LOSV	Light Over Snow Vehicles
LRS	long-range surveillance
LRSU	Long-Range Surveillance Unit Operations
LS3	Legged Squad Support System
LTATV	Light Tactical All-Terrain Vehicle
LTV	Light Tactical Vehicle
MANPAD	Man-Portable Air Defense missile
M-ATV	MRAP all-terrain vehicle
M-COTS	modified COTS
MEB	Marine Expeditionary Brigade
MEDCOM	Medical Command
MEDEVAC	medical evacuation
MEU	Marine Expeditionary Unit
MFP-2	Major Force Program 2
MFP-11	Major Force Program 11
M-Gator	military Gator
MILMO	military motorcycles
MIS	Military Information Support
MISO	Military Information Support Operation
MOA	Memorandum of Agreement

MOST	Mobile Over Snow Transport
MP	military police
MRAP	Mine Resistant Ambush Protected
MRE	Meal Ready to Eat
MRDC	Military Research and Development Center
MTN	mountain
MTOE	Modified Table of Organization and Equipment
MTT	Mobile Training Team
MWSS	Marine Wing Support Squadron
MWTC	Mountain Warfare Training Center
NATO	North Atlantic Treaty Organization
NDAA	National Defense Authorization Act
NEO	noncombatant evacuation
NIE	network integrated enterprise
NSCV	nonstandard commercial vehicle
NS-NSN	nonstandard National Stocking Number
NSTV	Nonstandard Tactical Vehicle
NSW	Naval Special Warfare Command
NTC	National Training Center
NVG	night vision goggle
OCO	overseas contingency operation
OEF	Operation Enduring Freedom
OEM	original equipment manufacturer
ONS	Operational Needs Statement
OPFOR	opposition force
OPs	observation posts
OT&E	Operational Test and Evaluation
OTO	Operations Training Officer
PBO	Property Book Officer
PEO	Program Executive Officer

POI	Program of Instruction
POL	petroleum, oils and lubricants
PR	personnel recovery
PSI	pounds per square inch
PSYOPS	psychological operations
PVL	priority vehicle listing
RAF	Regionally Aligned Force
RAI	Rural Access Index
RCI	Rotating Cone Index
RCIED	remote control improvised explosive device
REF	Rapid Equipping Force
ROPS	Roll-Over Protective Structure
RPG	rocket-propelled grenade
S&T	Army Science and Technology
SAS	Special Air Service
SBCT	Stryker Brigade Combat Team
SB[SO][A]	Sustainment Brigade (Special Operations) (Airborne)
SEAL	U.S. Navy's Sea, Air, Land
SECEL	Security Element
SF	Special Forces
SFA	Security Force Assistance
SFG	Special Forces Group
SLAMIS	SSN-LIN Automated Management and Integrating System
SMTV	Special Mission Terrain Vehicle
SOAR	Special Operations Aviation Regiment
SOF	Special Operations Forces
SOFM	Special Operations Forces Management
SOP	standard operating procedure
SOTF-N	Special Operations Task Force North
SOTF-S	Special Operations Task Force South

SPAWAR	Space and Naval Warfare Systems Command
SSV	standard service vehicle
STAMIS	Standard Army Material Information System
SUB LIN	Subordinate Line Item Number
SUSV	Small Unit Support Vehicle
TA	Tactical Activity
TACOM	Tank Automotive Command
TDA	Table of Distribution and Allowances
TIOG	Theater Information Operations Group
TOC	Tactical Operations Center
TOE	Table of Organization and Equipment
TOW	Tube Launched Optically Sighted Wire Guided
TPE	Theater Provided Equipment
TRADOC	Army Training and Doctrine Command
TSE	Tactical Site Exploitation
TTP	Tactics, Techniques, and Procedures
TWV	Tactical Wheeled Vehicle
UAH	up-armored HMMWV
UAS	unmanned aircraft systems
UDAP	UTM Demand Assessment Process
ULTV	Ultra-Light Tactical Vehicle
UNMEE	United Nations Mission in Ethiopia and Eritrea
USASOC	United States Army Special Operations Command
USMC	United States Marine Corps
USR	Unit Status Reporting
USSOCOM	United States Special Operations Command
UTM	Ultra-Light Tactical Mobility
VCI	Vehicle Cone Index
VSO	Village Stability Operations
VTOL	Vertical Take-Off and Landing

CHAPTER ONE

Introduction

Background and Purpose

Currently, conventional Army equipment authorization documents make no allowance for ground mobility platforms smaller than the basic M998 High-Mobility Multi-Purpose Wheeled Vehicle (HMMWV). Yet, a review of the Army's history shows periodic reliance on what are often referred to as ultra-light tactical vehicles. Most recently, U.S. ground forces deployed to Afghanistan have used all-terrain vehicles (ATVs), motorcycles, small, diesel-powered work vehicles, and, on occasion, pack animals to help move equipment and supplies over difficult terrain.

In April 2014, following the completion this analysis and release of the draft report, Army Forces Command (FORSCOM) established a battalion-sized set of ultra-light tactical mobility (UTM) vehicles for Army airborne forces.[1] This program responds to an Operational Needs Statement (ONS) submitted by the 82nd Airborne Division and XVIII Airborne Corps in late 2013. The ONS included the following recommendation:

> We [82nd Airborne Division] should immediately purchase the Global Response Force (GRF) Infantry Brigade Combat Team (IBCT) Enhanced Tactical Mobility Set (Phase I & II) now because it will provide an immediate capability to address an urgent operational need against an identified increased threat capability.

FORSCOM's UTM acquisition effort is in coordination with the initiation of Joint Capabilities Integration Development System (JCIDS) documents by Maneuver Center of Excellence (MCOE) to comply with the acquisition process that enables the Army to implement a long-term Program of Record solution.[2]

Given the Army's recent and more established history that shows a continuing demand and need to validate requirements for UTM vehicles, these vehicles and associated capabilities warrant a more detailed examination than they have yet received. This report provides the foundation for such an examination. This report assesses the demands, requirements, current capabilities, and key considerations for developing and sustaining a coordinated Army UTM capability.

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1 U.S. Army Forces Command, 2014. As part of a wider discussion of the required concepts and capabilities for expeditionary and entry operations, this presentation identifies "tactical wheeled mobility" as a key enabling initiative and describes the battalion-sized UTM vehicle set recommended to meet this need.

2 MCOE Capabilities Development and Integration (CDID), "Information Paper and Recommendations for RAND Study: Assessing Conventional Army Needs for Ultra-Light Tactical Mobility (UTM)," draft dated May 2013.

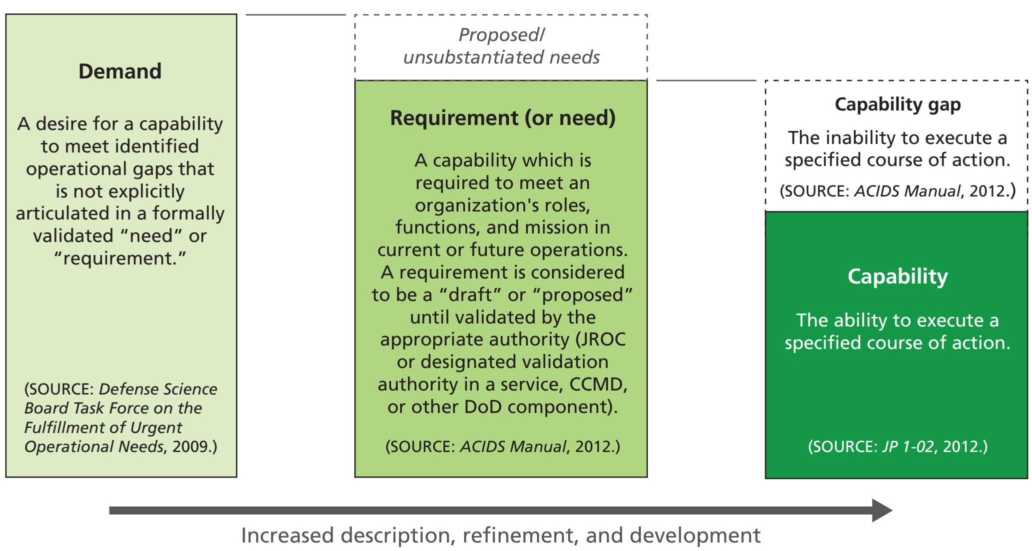
Currently, Joint and Army commands do not necessarily equate "demands" for UTM capabilities by Army units with UTM "needs" or "requirements" that, by Joint acquisition parlance, are explicitly validated capabilities required to execute assigned tasks, activities, or missions. To clearly and accurately discuss existing, required, and potentially required capabilities, this report uses the capability-related terms "gap," "requirement," and "demand" as defined in Figure 1.1.

What Is Ultra-Light Tactical Mobility?

UTM platforms are not explicitly identified or considered by Army tactical wheeled vehicle (TWV) strategy or guidance, but they currently fall within the broad light tactical vehicle (LTV) category. The Army's TWV strategy identifies the LTV category as including any vehicle capable of being transported by a CH-47F, having a cargo capacity equal to or less than 5,100 pounds, and consisting of armored and unarmored variants for the following three specific mission sets:[3]

- Force application (armament carriers)
- Battlespace awareness (reconnaissance, command and control [C2], and general purpose mobility)
- Focused logistics (light cargo utility vehicles/shelter carriers/casualty evacuation vehicles)

Figure 1.1
Key Capability-Related Terms Used in This Report



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3 Department of the Army, *The Army TWV: Tactical Wheeled Vehicle Strategy*, 2010.

The Army LTV category currently consists of the HMMWV family of vehicles (FOV),[4] vehicles as large as the prototype 15,600-pound Joint LTV (JLTV), and those as small as a bicycle or pull cart. The broad range in potential scale and weight of platforms within the LTV category does not delineate a category of platforms to meet operational requirements that the default TWV used for combat operations, referred to in this report as the standard service vehicle (SSV), is simply too large to carry out. While the "strategy" description of an LTV does not specify a lower limit with respect to weight and size, the strategy consistently associates the LTV with the lightest vehicle mentioned in the document, the basic HMMWV. UTM platforms, as defined by this report, are generally lighter than the HMMWV and, thus, smaller than all the LTVs that currently exist. UTM refers to a currently informal category of transportation platforms most commonly associated with ATVs, motorcycles, snowmobiles, and pack animals. While the UTM category of vehicles is not formally defined by the Army, the term "ultra-light tactical mobility (UTM)," as used in this report, refers to ground mobility platforms defined by the following distinguishing characteristics:

- A subset of the Army LTV category is described as "any vehicle capable of being internally/externally transported by a CH-47F with a cargo capacity equal to or less than 5,100 pounds."[5]
- externally transportable by a UH-60 in high-elevation and high-temperature conditions, constraining the vehicle to a maximum combined vehicle weight (CVW) of 4,500 pounds in combat configuration
- internally transportable by a CH-47 in combat configuration
- intended and/or employed for tactical employment (rather than administrative applications).

This report considers the full range of vehicle options that fit within the general description of UTM regardless of their intended application. As this report's description of Tactical Activities (TAs) indicates, the general category of UTM includes options for executing combat, mobility, and support activities. As depicted in Figure 1.2, this broad spectrum includes recent capability development efforts, such as the MCOE's ultra-light combat vehicle, that are focused only on UTM vehicles for maneuver applications.

UTMs fill the gap created by the increasing size of the SSV, which has become too large to satisfy many tactical mobility requirements for infantry forces. UTM platforms generally enhance tactical mobility by providing two key benefits:

- lighter, more mobile alternatives with improved trafficability over the SSV
- additional, lightweight mobility through enhanced load carry capacity for dismounted elements.[6]

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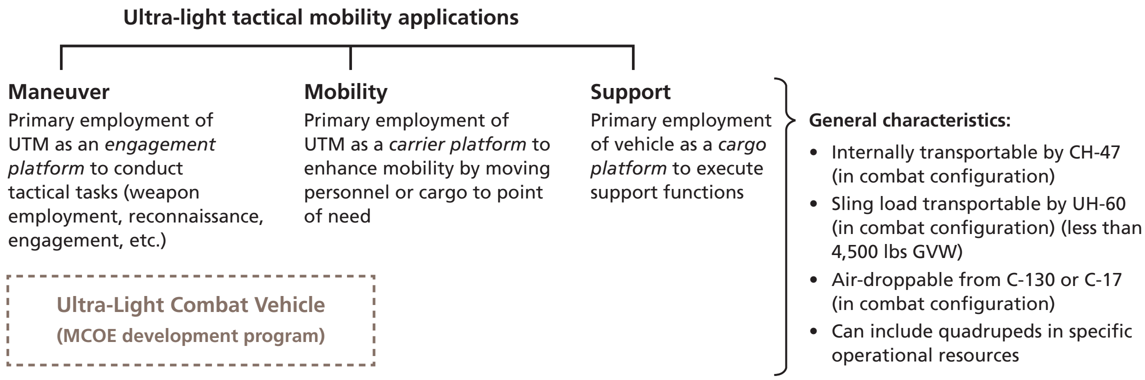
[4] U.S. Government Accountability Office, *Issues to Be Considered as DOD Modernizes Its Fleet of Tactical Wheeled Vehicles*, Washington, D.C., GAO-11-83, November 2010.

[5] Army PEO Combat Support and Combat Service Support, "Aligning the Tactical Wheeled Vehicle Fleet for the Future," February 7, 2012.

[6] Recent examples of UTM platforms as substitutes for SSVs include the use of motorcycles and ATVs in Village Stability Operations (VSO), and the use of pack animals to resupply remote observation posts in mountain terrain where narrow paths, altitude, and vegetation preclude the use even of LTVs. Examples of UTM platforms as enhancers of dismounted infantry capabilities include dismounted patrols' use of M-Gators to carry supplies, ammunition, or weapons such as mor-

Figure 1.2
Spectrum of UTM Applications



RAND *RR718-1.2*

There are two general approaches to developing such vehicles: the "top-down" and the "bottom-up." The top-down approach builds many of the characteristics of SSVs into a smaller and lighter vehicle that meets the major UTM requirement. In the "bottom-up" approach, UTM platforms enhance the capabilities of dismounted infantry who would otherwise be limited to their physical capacity for mobility performance and carrying capacity. This "bottom-up" UTM approach is a matter of expanding soldiers' capabilities, usually their ability to go farther, faster, and take more with them. These two approaches are defined by the next best available alternative that potential users are seeking to improve upon, as described in Table 1.1. This fundamental distinction defines the basic assumptions about the UTM platform charac-

Table 1.1
Comparison of Top-Down and Bottom-Up Approaches to UTM Employment

Category	Top-Down Approach	Bottom-Up Approach
Objective	• Enhance the mounted formation	• Enhance the (otherwise) dismounted formation
Applicable forces	• Mounted forces equipped with access to SSV or larger vehicle	• Light/airborne/air assault/mountain infantry formations • Otherwise dismounted forces
Next best alternative (in absence of UTM)	• SSV or larger vehicle	• All equipment and supplies carried as dismounted soldier load • Limited by combined carrying capacity of formation
UTM implications	• Improved trafficability, transportability, and/or stealth over SSV or other mounted platform • Generally less protection and firepower than existing vehicle alternative	• Improved speed, endurance, and carrying capacity over dismounted soldier • Accepts risks inherent in dismounted formations (i.e., exposure to direct fire, IEDs, and other attacks)

tars and MK-19 grenade launchers. Marine Corps After Action Reports (AARs) from Afghanistan describe having to operate on narrow trails at altitudes of 8,000–15,000 feet, where HMMWVs and Mine Resistant Ambush Protected vehicles (MRAPs) cannot operate. Units rely on a combination of Toyota Hi-Lux trucks and pack animals to transport supplies from valley floors.

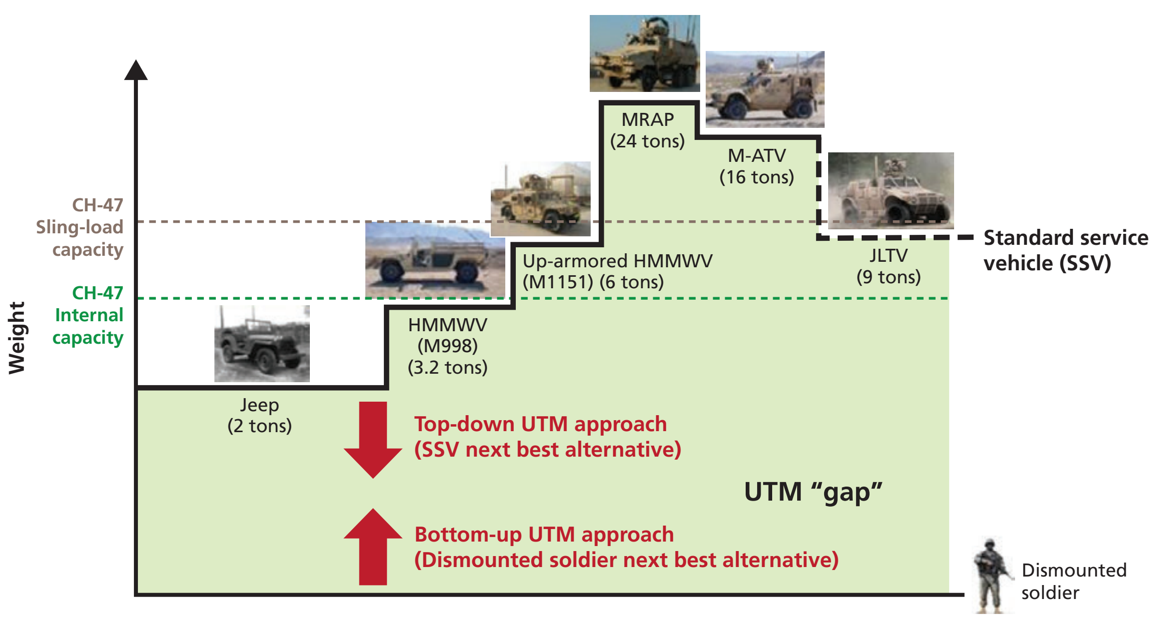
teristics required for the UTM vehicle to provide a relative improvement over a user's existing mobility alternatives, such as protection and speed, to provide a distinguishable improvement over the unit's *next best alternative* in absence of UTM.

The distinction between UTM platforms and SSVs is particularly important given the flux over time with respect to the vehicles constituting the Army's SSV fleet and the state of LTVs in general. For example, quarter-ton trucks ("Jeeps") and similar vehicles were once part of SSV fleets in the U.S. and major Western militaries. After their removal from the American inventory in the early 1980s, Jeep-class vehicles such as Mercedes G-Wagen variants have effectively become UTM vehicles for general-purpose forces.[7] Moreover, the Army and Joint SSV fleets have been steadily growing in size and weight, as protection has become a greater priority. As shown in Figure 1.3, true LTVs such as the basic HMMWV variants became operationally rare, and Mine Resistant Ambush Protected (MRAP)-type vehicles—though most could not be considered LTVs—are taking LTVs' place as the SSV for combat operations. As Figure 1.3 indicates, at the lighter end of the total "tactical wheeled vehicle" fleet, SSVs in effect are increasing in weight, creating a larger space for UTM platforms.

Trends in Army Mounted Mobility Affecting UTM Demands and Use

Since 2001, the persistent and often pervasive improvised explosive device (IED) threat to security forces has grown in sophistication and frequency of use as more threat groups realize

Figure 1.3
Growth of the SSV Weight and Corresponding UTM Gap over Time



SOURCE: U.S. Army.

[7] For example, Norway and Sweden use the Mercedes G-Wagen as their primary light tactical vehicle.

the potential physical, psychological, social, and political impact of this weapon.[8] The current threat has also shaped U.S. strategic perceptions about the Army's future operating environment and the TWV capabilities required to operate in it, as summarized in the statement to Congress by the director of the Joint Improvised Explosive Device Defeat Organization (JIEDDO):

> Today and in the future, U.S. forces will operate in an IED environment. . . . The IED and the threat networks that employ this asymmetric weapon are a reality of 21st century warfare and we must plan accordingly. . . . During the Cold War we trained to conduct operations in a nuclear, biological and chemical environment. Moving forward, we must train to conduct operations in an IED environment, which includes an agile networked enemy.[9]

Threat trends and their expected permanence have significantly influenced authorized TWV platforms and other capabilities available to conventional Army units. Tactically effective trends in TWV development include

- **increased armor protection:** In response to the rise of asymmetric threats, the Army and Department of Defense (DoD) have significantly increased the amount of armor for the SSVs used in Afghanistan, Iraq, and future conflicts.[10] In 2005, combatant commanders identified an urgent operational need for armored tactical vehicles to increase crew protection against IEDs, rocket-propelled grenades, and small arms fire, resulting in the up-armored HMMWV (UAH) as the initial solution and the MRAP as a long-term solution. As result of this transition, SSVs went from little or no armor with the M998 FOV used in 2003, to some IED protection with the UAH, to robust and fully enclosed vehicle protection with the MRAP FOV currently employed.[11]
- ***dramatically* increased platform size and weight:** The increase in the amount and integrity of armor protection on SSVs has required a significant increase in the curb weight (complete vehicle, no cargo) of SSVs with minimal increase in overall carry capacity. The SSV has grown from the M998's curb weight of 5,380 pounds to the M1151 UAH's 7,000 pounds to the MRAP all-terrain vehicle's (M-ATV's) curb weight of 27,500 pounds and total height of almost 11 feet. The prototype JLTV has an objective goal to reduce the SSV platform weight to a sling-loadable 15,600 pounds.[12]

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8 Department of the Army, *Fiscal Year 2012 Budget Estimate: Joint Improvised Explosive Device Defeat Organization,* November 2011.

9 Michael D. Barbero, "Statement by Director of the Joint Improvised Explosive Device Defeat Organization Before the U.S. House of Representatives," September 20, 2012.

10 Matthew Sablan, "Encounter Avoidance—Protecting and Sustaining the Tactical Wheeled Vehicle (TWV) Fleet," 2010. Sablan captures the prevailing Army and DoD attitude toward the vulnerability of tactical vehicles to asymmetric threats, stating,

> For the past 50 years, Army tactical trucks have been under-protected compared to their combat vehicle brethren. In conventional warfare, this shortcoming was rarely an issue. On today's ever-changing battlefield, however, military trucks face threats similar to those sustained by combat vehicles, but without the same armor-enhanced protection. Underbody blasts, improvised explosive devices, explosively formed penetrators, rocket-propelled grenades (RPGs)—even direct and indirect artillery fire—all pose threats to military trucks and their crews.

11 GAO, 2010.

12 GAO, 2010. This weight would not include the additional armor package or any combat cargo. The program faces significant risk of not meeting this objective criterion.

- **decreased mobility:** While the addition of armor protection increased survivability of HMMWVs against IEDs and other asymmetric threats, the additions pushed the HMMWV well beyond its original purpose and capabilities.[13] According to DoD officials and a survey of over 300 soldiers interviewed in the field, the development of the MRAP further diminished the mobility of tactical forces, especially for mounted patrols in constrained urban areas or extensive off-road operations.[14]
- **decreased transportability:** The weight of the M-ATV and the MaxxPro Dash also makes them unsuitable for transportation by C-130 Hercules aircraft,[15] CH-47 and CH-53 Chinook helicopters, and most amphibious ships.[16] While the prototype JLTV is being designed for strategic and operational transportability by ship and aircraft, there is a significant risk that the JLTV currently under development will exceed the CH-47 transport weight limit of 15,600 pounds.[17]
- **increased sustainment requirements/decreased efficiency:** With significantly increased weight, the newer SSVs have significantly less fuel efficiency, with observed fuel efficiency for the MRAP as low as three miles per gallon. Additionally, the current SSVs require significant infrastructure to repair and maintain.[18]
- **increased reliance and adverse effect on local road infrastructure:** The weight of the current MRAP SSVs, which varies from 19 to 37 tons, makes them too heavy to go over 72 percent of the world's bridges.[19] The significant weight, limited off-road performance, and excessive width for many roads have almost completely limited use of MRAP FOVs to primary and improved routes. Even the relatively lighter M1114 UAH, with its significantly diminished performance compared to the M998 HMMWV,[20] cannot use most secondary and tertiary routes.
- **increased operational signature:** The MRAP FOV, with their larger engines and tires, produce a noise signature that, while localized and temporary, is greater than that of the HMMWV or smaller platforms.[21] More importantly, the mass, profile, and noise patterns associated with the MRAP and medium tactical vehicle vary significantly from the visual and audible patterns of life in almost all operational settings, precluding the ability for stealth, camouflage, or concealment of these vehicles.

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[13] GAO, 2010.

[14] *Defense Acquisitions: Rapid Acquisition of MRAP Vehicles*: Statement of Michael J. Sullivan, Director Acquisition and Sourcing Management, Before the House Armed Services Committee, Defense Acquisition Reform Panel, Washington, D.C., GAO-10-155T, October 8, 2009..

[15] However, the C-130 can transport the M-ATV with a waiver.

[16] Raymond Longabaugh, "Incorporating MRAPs into the Army Force Structure," *Army Sustainment*, September–October 2011.

[17] GAO, 2010.

[18] Joint Program Office Mine Resistant Ambush Protected Vehicles, "MRAP Program Overview," 2010.

[19] Jacques S. Gansler, William Lucyshyn, and William Varettoni, "Acquisition of Mine-Resistant, Ambush-Protected (MRAP) Vehicles: A Case Study," May 12, 2010.

[20] GAO, 2010.

[21] Department of the Army, "Programmatic Environmental Assessment for Fielding and Use of the Mine Resistant Ambush Protected Vehicles at Army Installations in the United States," September 2009.

- **decreased interaction with/awareness of the immediate tactical environment:** The enclosed cab required for protection of occupants from threats also serves as a significant obstacle to the "fundamental and complex duty of a land force" to operate among and engage local audiences.[22] Additionally the aggressive appearance and extra-human scale of M-ATVs and other MRAPs are reported as significant barriers to building rapport with local populations during stability-related operations such as counterinsurgency (COIN), humanitarian assistance/disaster relief (HA/DR), and stability operations.
- **increased platform costs:** The significant increase in protective armor and the associated vehicle performance requirements have resulted in a consistent and exponential growth of vehicle platform costs. As Table 1.2 shows, the largest UTM platform is less than one tenth of the cost for a basic M-ATV. Because many UTM platforms are available for well under $25,000, these are mobility platform options that Brigade Combat Team (BCT) and lower units can pursue and are commonly acquiring with their own unit funds through local purchase, Government Purchase Card transactions, and other nonstandard methods.[23]

Table 1.2
Per-Unit Platform Costs for Current Army Tactical Vehicles and UTM Platforms

UTM Platform	Platform Type	Example	Estimated Per-Unit Cost ($)
Standard Army platforms	MRAP	MaxxPro Dash	720,000
		M-ATV	438,000
	Up-armored vehicle	M1151 HMMWV	140,000
	Unarmored tactical vehicle	M998 HMMWV FoV	65,000
Representative UTM platforms (by UTM class)	Full-duty	Dept. of Army full-duty truck	24,000
	Midsize	LTATV	27,000
	Compact	Polaris RZR	14,000
	Subcompact	HDT M1030 military motorcycle	18,500
	Quadruped	Mule	2,000
	Human-enabled	Mountain bike	1,250

[22] Army Field Manual 3-13, Inform and Influence Activities, defines s*oldier engagement* as interpersonal interactions by soldiers with audiences in an area of operations. Doctrine explains that soldier engagement can occur as an opportunity, a face-to-face encounter on the street, or a scheduled meeting. Soldiers and leaders conduct this engagement to provide information or to influence attitudes, perceptions, and behavior. Effectively integrating soldier and leader engagement into operations increases the potential for commanders to mitigate unintended consequences, counter adversary information activities, and increase local support for friendly forces and their collective mission.

[23] 2nd Brigade, 82nd Airborne Division, "Priority Vehicle Listing for Forcible Entry," December 10, 2013. For example, 82nd Airborne IBCTs have purchased Kawasaki Mules and currently airdrop them as part of their initial entry forces to rapidly establish command and control on the drop zone and execute nonstandard casualty evacuation (CASEVAC).

In addition to specific changes in SSV characteristics in response to the IED threat, other trends in tactical operations have also widened the gap between current capabilities and mission requirements that units have employed and are employing UTM capabilities to address:

- **no meaningful improvement in mobility options for support to dismounted forces and activities:** While stress on the dismounted soldier has continued to grow, there are currently no fielded systems to increase the mobility of dismounted soldiers to provide them with increased speed, lethality, and survivability in rugged or constricted terrain where SSVs cannot readily operate.[24] While IEDs militate against SSVs and UTMs, some leaders argue the increased maneuverability and multitude of routes can increase uncertainty of enemy targeting and decrease the probability of enemy attack. However, this potential benefit has not been clearly assessed and has generally not outweighed the potential impact of catastrophic attacks against UTM vehicles for commanders with access to them.
- **increased diversity of alternatives for execution of tactical tasks:** Development and use of improved tactical intelligence, surveillance, and reconnaissance (ISR) and strike capabilities, such as the Switchblade lethal unmanned aircraft systems (UAS) and unattended ground sensors, have provided tactical alternatives for gathering intelligence and executing strikes that were previously done primarily by manned ground reconnaissance elements. This increase in tactical capabilities has reduced the need for manned elements to conduct some combat activities in certain situations such as reconnaissance and surveillance.

These trends, as described and illustrated below, have motivated increasing and changing demands for UTM capabilities as part of a portfolio of mobility alternatives to adapt to changes in the tactical environment as they occur over time and across a single operation.

Trends in Army Dismounted Mobility Affecting UTM Demands and Use

Because of mission requirements or the limited transportation assets of almost exclusively dismounted formations, such as light infantry, soldiers must carry all personal and unit equipment required. Despite advancements in soldier equipment since World War II, the total weight and bulk of soldier loads have continued to increase.[25] As illustrated in Figure 1.4, the average infantryman's load has grown over time. The addition of body armor and larger small arms systems have driven further increases in the average dismounted soldier's load. As described in Figure 1.5, this trend has continued during recent operations, with the average squad automatic rifleman carrying almost 80 pounds of fighting load and over 110 pounds for

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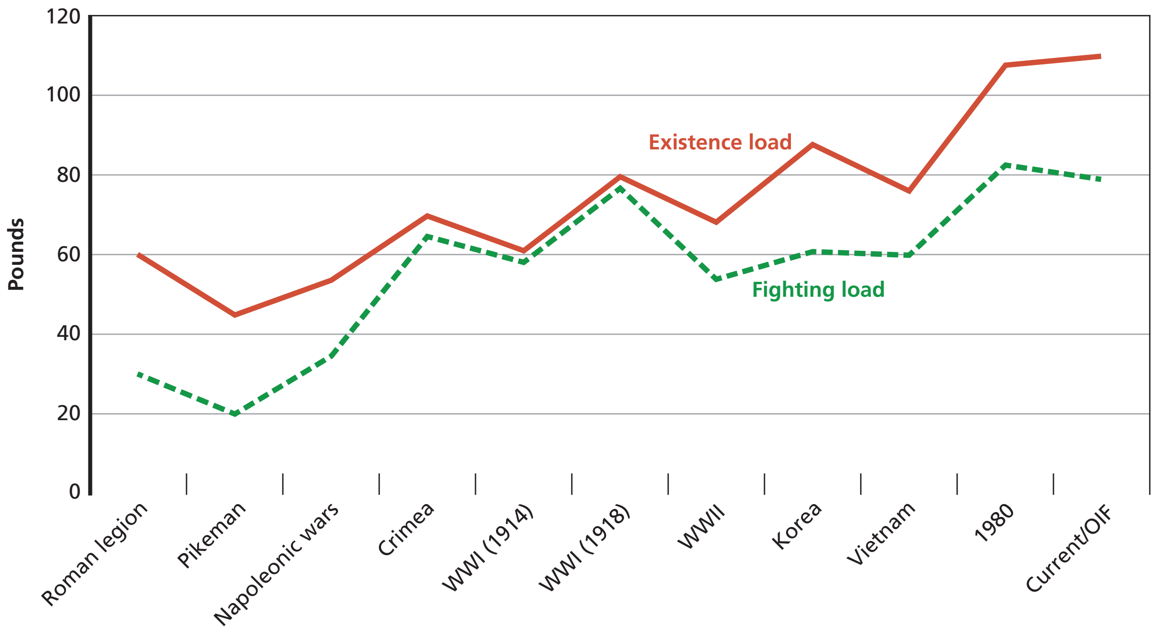
[24] Steven T. Holste and Dominic A. Ciccimaro, *Increasing the Mobility of Dismounted Marines: Small Unit Mobility Enhancement Technologies: Unmanned Ground Vehicles Market Survey,* SPAWAR Systems Center Pacific, October 2009.

[25] Joseph Knapik, "Physiological, Biomechanical and Medical Aspects of Soldier Load Carriage," paper presented at the RTO HFM Specialists' Meeting on "Soldier Mobility: Innovations in Load Carriage System Design and Evaluation," held in Kingston, Ontario, Canada, June 27–29, 2000, and published in RTO MP-056.

Figure 1.4
Growth of Infantryman's Load over Time



SOURCES: Knapik, 2000; U.S. Army Center for Lessons Learned, 2003.
RAND *RR718-1.4*

Figure 1.5
Average Squad Automatic Rifleman Individual Load

Fighting load = A+B
Approach march load = A+B+C
Emergency approach march load = A+B+C+D

Average mission duration: 48–72 hours
Resupply items: Soldiers were resupplied with 2–3 MREs per day and up to eight liters of water per day. When under fire, soldiers could expect a resupply of their basic load of ammunition each day.

Duty Position	Average Fighting Load (lbs)	Average FL % Body Weight	Average Approach March Load (lbs)	Average AML % Body Weight	Average Emergency Approach March Load (lbs)	Average EAML % Body Weight
Squad automatic rifleman	79.08 lbs	44.74%	110.75 lbs	62.71%	140.36 lbs	79.56%

SOURCE: U.S. Army Center for Lessons Learned, 2003.

the approach march.[26] However, the soldiers' physiological weight-carrying capacity is a fixed maximum that has been well established by field experience and science. As the total load increases, soldiers' capabilities in terms of speed and endurance disproportionately decrease.[27]

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[26] U.S. Army Center for Lessons Learned (CALL), "The Modern Warrior's Combat Load," 2003. Values are based on data collected during light infantry operations in August 2003 as part of Operation Enduring Freedom.

[27] Knapik, 2000.

UTMs can be, have been, and are employed by otherwise dismounted formations to meet the increasing amount of terrain that SSVs cannot access and to reduce the physical burden on dismounted soldiers who must operate in locations SSVs are denied access to.[28]

UTM platforms provide a valuable weight-bearing alternative to increase the speed, endurance, and capabilities of light forces that must remain primarily self-contained and self-sufficient during operations. The UTM platform's ability to cover more of the terrain that dismounted formations are required to transit, clear, and control provides it increased utility over the SSV for support to dismounted formations. Vietnamese local defense forces using U.S.-supplied bicycles, for example, were able to patrol larger areas using fewer people than they could on foot.[29] More recently, dismounted units in Afghanistan have sought and employed UTM vehicles to carry additional engagement systems (i.e., Long-Range Advance Scout Surveillance System [LRAS3], Mk-19, 60-mm mortar)[30] and additional supplies to lengthen their operational endurance. Lastly, UTM platforms have also provided a valuable asset for reducing troop-to-task requirements and potential for short-term and long-term injury of soldiers when moving bulky or heavy materials.[31] One example, as currently executed by the 82nd Airborne initial entry forces, is the ability to use a UTM for "nonstandard CASEVAC" rather than having to assign several people to carrying a litter.

The Army's Persistent Demands and Requirements for UTM Capabilities

While the Army has generally viewed UTM capabilities as having an occasional utility to meet extraordinary operational needs, analysis of previous, current, and potential Army experience suggests a more consistent and sustained demand for UTM capabilities. As this report demonstrates, the demand for UTM, when viewed over time since the mechanization of the Army, may appear sporadic in the short term but is, in fact, perennial. Army units keep turning to them largely because the Army

- has tactical mobility requirements that have remained relatively constant and consistent over time and across operations
- continues to face tactical environments that fundamentally preclude the use of the current SSVs and larger platforms, to include airborne delivery, air assault operations, densely vegetated terrain, and constricted urban terrain.

These trends suggest the basic demands for UTM platforms will likely continue to increase as SSVs continue to bulk up in size and weight—as indicated by Figure 1.5 and as operations require infantry soldiers to do more and to carry more.

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28 Heidi Shyu, Assistant Secretary of the Army (Acquisition, Logistics, and Technology), "Army Science and Technology (S&T) Path Ahead," October 3, 2012. Reducing the load on the dismounted soldier has become a priority for the Army in light of both the growth in that burden and the increasing importance of doing more with fewer soldiers.

29 Stephen T. Tate, "Human Powered Vehicles in Support of Light Infantry Operations," thesis, U.S. Army Command and General Staff College, 1989, pp. 92–93.

30 Recent and often unauthorized employment of available UTM vehicles as described in interviews with personnel with recent combat experience.

31 Department of the Army, Army Techniques Publication (ATP) 5-0.1: *Commander and Staff Officer Guide,* 2013. The troop-to-task figure is the number of soldiers required to execute a tactical task.

To be clear, this report does not argue for the Army to replace SSVs with UTM platforms, or necessarily buy vast amounts of UTM platforms. The combinations of protection, mobility, and firepower provided by the contemporary SSV fleet are significant and clearly cannot be matched by UTM platforms. Contemporary experience proves that in the majority of scenarios commanders would and should opt for SSVs over lighter, less armored alternatives if only for the greater protection they offer.[32] UTM platforms come into play primarily when certain constraints preclude the use of SSVs, or—to refer to the "bottom-up" approach discussed above—when UTM is simply the most appropriate choice for enhancing the capabilities of dismounted infantry. Army units have successfully taken advantage of UTM when and where the risk was tolerable and when it provided a useful alternative to either foot or larger vehicle movement. As part of an expanded and scalable portfolio of mobility options, UTM can provide units a temporary or as-needed capability that addresses the gap between the operational limitations of SSVs and dismounted soldiers.

Why the Army Has Avoided Maintaining Formal UTM Capabilities in the Past

On multiple occasions the Army has pursued development and fielding of UTM capabilities that did not make it to or remain in sustained operational use. These development programs included the 9th Infantry Division's High-Technology Test Bed (HTTB) and other efforts that featured use of all-terrain motorcycles and dune buggy–based Fast Attack Vehicles (FAVs). Most of these programs focused on employment of UTM capabilities to execute maneuver force security and recon for a larger force or coordinated maneuver with UTM vehicles alone. The majority of Army attempts at UTM development efforts, by focusing on maneuver-related activities that are particularly exposed to threats and hazards, fell victim to legitimate (though not always validated) concerns by Army leadership.

While much of the formal Army effort to employ UTM has focused primarily on maneuver functions, Army units have applied UTM to support-related activities with more success. For example, the M-274 Mule remained in the Army for over two decades, being phased out as the HMMWV family of vehicles was fielded based on the assumption that the HMMWV could meet all tactical requirements previously addressed by the Mule. Additionally, the phasing out of the Mule occurred as Army assumptions about likely combat environments shifted from jungle and dismounted warfare to mounted major combat operations against a Soviet force in Central Europe. Like the phasing out of pack animals before, the Army decided to divest UTM for support activities based on a shortsighted assessment of likely combat conditions and expected disappearance of the need for lighter, smaller support mobility options.

Sustained consideration of UTM use routinely demonstrated the vehicles' vulnerability to both threats from enemy fires and nonthreat risks, such as operator injuries and coordination challenges during UTM operation. However, these same attempts at UTM employment also demonstrated that enhanced mobility could make up for a lack of protection in some missions, so long as the forces could stay on the move, evade the enemy, and avoid decisive engagements or requirements to hold a defensive line.[33] This Army's experience demonstrated the UTM vehicles' ability to generally decrease the *probability* of successful attack versus more

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[32] This assertion was made and widely supported by practitioners and commanders from motorized and mechanized combat arms units, such as 1-6 Infantry Battalion, 1st Armored Division, as well as by historical Army experience with UTM platforms.

[33] Bowman, Kendall, and Saunders, 1989.

Figure 1.6
Risk Factors for UTM Employment Compared to Current SSVs (MRAP, M1114 UAH, M-ATV)

	Probability of Attack/Damage (versus current SSVs)	**Severity of Attack/Damage** (versus current SSVs)
Increasing factor	• **Perceived as a "softer" target (i.e., easier to inflict casualties)** • **Operated primarily in reduced trafficability areas (i.e., broken terrain, thick vegetation, etc.)** • Usually requires more physical and mental stamina to operate – Generally less opportunity to delegate key functions (navigation, C2/reporting, observation, etc.)	• **Little/no protection against attacking fires (IEDs, direct fire, etc.)** • Generally fewer physical restraints to manage impact from accidents
Decreasing factor	• **Generates more enemy uncertainty about presence, number, and location of forces** – Allows opportunity to use a wider variety of available routes • **Has reduced signature; less likely to attract detection and/or attention** • Increased sensory connection with environment (observation, hearing, etc.) • Enables improved access to and rapport building with populace • **Reduces number of aircraft required for delivery and sustainment of mobility for Airborne IBCT**	• **Generally fewer personnel per vehicle** • **UTM vehicles/equipment cheaper to replace**

NOTE: The factors listed in this figure are based on risk factors identified in numerous interviews with Army personnel who are employing, have employed, or decided not to employ UTM vehicles.
RAND *RR718-1.6*

armored vehicles, as often highlighted by UTM advocates. Army experiences have also demonstrated the likely increased *severity* of successful attacks on UTM vehicles when they occur, as consistently noted by UTM skeptics. The lack of clear evidence to assess the composite risk (the probability of risk multiplied by the severity of the risk) of the various risk factors identified by Army leaders and listed in Figure 1.6 has fueled perpetual Army debate over UTM vehicles.

In total, the Army has founded decisions about wholesale avoidance of UTM primarily on expected risks due to severity of attacks on UTM vehicles and assumptions about the lack of continued need. However, the recent ONS submitted by the 82nd Airborne and supported by XVIII Airborne Corps and FORSCOM identified that the absence of UTM capability will require the GRF to accept higher tactical, operational, and strategic risks associated with the additional resources required to deliver the larger and heavier SSVs that will face rapidly advancing antiaccess/area denial (A2AD) threats during initial entry operations. While skeptics of UTM utility point to platform risks as the primary reasons they are not appropriate, validated requirement documents highlight the tactical, operational, and strategic risk from not having UTM as key motivators for their acquisition.[34]

[34] U.S. Army Forces Command, March 2014.

About This Report

This report is organized into five chapters and four appendixes. Chapter Two of this report describes the Army's UTM demands and requirements based on analysis of previous and contemporary UTM employment and how the opportunities for UTM capabilities are likely to persist in future operations based on current Army planning scenarios. Chapter Three of this report provides a summary of selected UTM capabilities that currently exist within Army units, as well as those developed and maintained by other U.S. military services and special operations forces, that can inform Army opportunities, demands, validated requirements, and potential UTM programs. Chapter Four of this report identifies, based on analysis of demonstrated UTM employment patterns and practitioner experiences, key considerations for assessing potential UTM alternatives and their implications for defining specific Army UTM demands and requirements. Chapter Five of this report identifies key observations and recommendations from this study, describing some potential resource-conscious strategies for Army prioritization, development, and sustainment of appropriately scaled UTM capabilities.

This report also includes an appendix of UTM case studies capturing UTM employment over time and across militaries, as well as additional technical information that supports and further explains key issues and considerations summarized in the report.

CHAPTER TWO

Defining the UTM Demand

Because no authorized ground mobility platforms smaller than the basic M998 HMMWV currently exist within conventional Army forces, there are few defined terms or relevant concepts for delineating or describing UTM platforms, considering their appropriate role in the Army's "portfolio" of mobility options, or analyzing the specific demands and requirements they address. To better support Army identification and consideration of UTM requirements, this chapter accomplishes the following three tasks:

- defines UTM as a distinct category of platforms
- identifies and describes the types of Tactical Activities that have been consistently executed by UTM platforms
- identifies the key operational factors and constraints that have motivated and hampered previous and current development and operational employment of UTM capabilities.

Taken together, the information in this chapter illustrates the consistency of Army tactical mobility requirements over time and across operations. The historical and contemporary examples of UTM use provided here are explored in greater detail in the case studies included as Appendix A at the end of this report.

Defining the Requirement

UTM platforms employed by conventional Army forces have generally provided two distinct types of benefits:

- UTM platforms fill the gap created by the inability of standard Army vehicles, especially SSVs, to meet all of the Army's tactical mobility requirements. SSVs cannot meet all tactical mobility requirements, usually because terrain, transportability restrictions, or insufficient sustainment capacity preclude their use. Sometimes LTVs or other usable platforms are simply unavailable. Thus, there is rarely a specific or independently defined "requirement" for UTM. Units tend to employ UTM platforms because they cannot employ the SSVs that would ordinarily be their first choice for the job, and specific conditions warrant UTM employment.
- UTM platforms boost the capabilities of dismounted elements who otherwise would not have vehicles and who would be limited by their physical abilities. UTM platforms help dismounted elements carry more, faster and farther. In this regard, they not only meet

tactical mobility demands and requirements that LTVs cannot meet but also respond to the additional needs of dismounted infantry.

While the available technologies have evolved, the demands for Army units to use smaller mobility systems to offset the limitations of the SSV have persisted and actually grown over time. Indeed, the capabilities gap filled by UTM essentially has existed since motorized transport began to replace horses and other harness, pack, and riding animals. The motor vehicles that have become common in military inventories can do most things better than animals but not everything. UTM platforms provide specialized mechanical solutions for dealing with the remaining demands and requirements. For example, SSVs cannot replace dogsleds, but snowmobiles and other UTM platforms do; and SSVs cannot meet all the demands that perhaps horses once met, but today motorcycles and ATVs can. As operations in Afghanistan and elsewhere illustrate, some activities remain for which animals still are beneficial options.[1] Indeed, for Army purposes, harness, pack, and riding animals should be regarded as UTM platforms because they, too, fill the niche created by the limitations of LTVs and are used on a strictly exceptional basis.

While the demand for UTM may appear sporadic to Army commanders and planners—thus justifying the ad hoc, as-needed approach to UTM acquisitions and deployment—the demands for UTM when viewed over time since the mechanization of the Army appear constant. The Army does not require UTM continuously, but it keeps needing them and returning to the same UTM technologies. Army planners have repeatedly believed that they no longer needed UTM platforms because they were finished with certain demands or because they thought that new LTVs met all the demands relevant to their plans.[2] Yet battlefield exigencies have consistently made the Army pay for its optimism: Seemingly anachronistic demands remain relevant (e.g., a need for donkeys in Afghanistan), and troops find that they need mobility platforms that can do things or go places that the SSVs cannot.

Tactical Mobility Demands

UTM platforms have been employed repeatedly to execute a set of platform-agnostic tactical "activities."[3] As depicted by Table 2.1, analysis of current and historical Army operations indicates eight basic *Tactical Activities* performed during execution of the many Army Universal Tasks that involve tactical mobility and for which UTM options have been consistently used.

[1] MAJ Paul E. Roberts, discussions with authors, January 26, 2012. For example, Army units have temporarily or permanently procured pack animals to enable resupply of remote outposts in Afghanistan. In early 2009, elements of 6/4 Cavalry Squadron, 1st Infantry Division "rented" local donkeys and their handler to move heavy barrier materials up narrow and rugged paths accessible only to foot traffic during construction of the Bari Alai outpost in Kunar Province of Eastern Afghanistan.

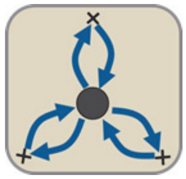
[2] U.S. Army Transportation Museum, "Mechanical Mule," May 27, 2013. For example, in 1978 the U.S. Army retired the M274 "Mechanical Mule," designed to keep pace with foot soldiers, from service in the belief that the newly developed HMMWV would meet all the Army's light mobility requirements. However, in 2000 the John Deere M-Gator was introduced into service to meet unmet requirements for ultra-light mobility.

[3] These activities are not specific collective "tasks" as defined by Army Field Manual 7-15, *Army Universal Task List (AUTL)* but are activities that are inherent to the execution of multiple AUTL tasks.

Table 2.1
Overview of Tactical Activities with Demonstrated Use of UTM Platforms

Tactical "Activity"	Conceptual Sketch	Description	Comparative Advantages of UTMs
Maneuver force security/recon		Tactical Activities enabling a larger element to maintain freedom of movement and maneuver, to include execution of flank security, overwatch, and reconnaissance and surveillance tasks for the supported unit.	Rapidly carry recon/security personnel and equipment through areas that may be constrained or impassible for larger vehicles to gain rapid access to key terrain for execution of recon and security missions.
Local patrolling/ engagement		Sustained and potentially persistent traversing of permissive and semi-permissive environments to execute stability, security, and engagement activities operations.	Carry personnel and engagement systems (speakers, etc.) through crowded or constricted developed areas; enable improved interaction with populace and environment.
Coordinated maneuver		Conduct of tactical movement and maneuver independent of a larger force to achieve a decisive end state as part of defensive, offensive, or other operations.	Carry personnel and weapons systems for rapid insertion, maneuver to/through the objective, and exfiltration when constraints preclude SSV use.
Immediate pursuit		Hasty movement and maneuver to exploit an offensive opportunity, react to enemy actions, or other nondeliberate, short-duration missions to react to emergent threats or opportunities.	Rapidly pursue fleeing attackers or other targets through restrictive urban or natural terrain.
Troop mobility		Use of mobility platforms to increase the approach speed, endurance, and/or effectiveness of otherwise dismounted troops to execute subsequent close-combat operations.	Transport soldiers with associated equipment and supplies to initiation point for close combat operations when constraints preclude SSV use.
Traveling support		Use of a mobility platform to augment the range, foot speed, and/or carrying capacity of dismounted formations.	Carry crew-serve weapons, unit supplies, or individual soldier loads to support and enhance a dismounted element.
Casualty evacuation		Use of a mobility platform to conduct CASEVAC of wounded or injured soldiers to a location for collection, transfer, and/or treatment.	Carry casualty over rugged or high-elevation terrain to location suitable for MEDEVAC pick-up (below 8,000 ft. AGL) or transfer to larger ground platform.

Table 2.1—Continued

Tactical "Activity"	Conceptual Sketch	Description	Comparative Advantages of UTMs
Internal/ ferry support		Use of a mobility platform inside a relatively established and secured area to move troops, equipment, and/or supplies.	Conducting multiple trips to move equipment or other material with an enclosed assembly area or operating base. May be more efficient than larger vehicles.

The eight identified Tactical Activities executed with UTM platforms are by and large universal across time and geography: They are activities that most, if not all, armies everywhere have performed since the distant past, continue to perform, and almost certainly will perform in the foreseeable future. These tasks are, moreover, vehicle agnostic, meaning that they may be performed with any of a large variety of vehicles available ranging from horse-drawn chariots to snowmobiles to the latest M-1 Abrams. Specific circumstances, of course, are not vehicle agnostic: Commanders in the field are not indifferent as to whether they have horses or tanks at their disposal. In different circumstances, they may require more or less protection, more or less firepower, more or less carrying capacity. Operational circumstances create the requirements for UTM by constraining commanders' choices and precluding or significantly limiting use of SSVs or larger platforms. These operational circumstances also inform choices regarding which UTM platform to employ.

As illustrated in Table 2.2, these Tactical Activities are inherent in the execution of numerous tactical tasks identified in the AUTL. Indeed, critical to understanding the role played by UTM historically and in contemporary operations is an appreciation for the constancy of two things: tactical mobility demands and the operationally specific constraints that sometimes preclude using LTVs for these Tactical Activities and create the immediate need for lighter alternatives—UTM platforms.

Maneuver Force Security/Reconnaissance

Maneuver force security/reconnaissance activities support another maneuver element by enabling the main element to maintain freedom of movement and maneuver. Tactical tasks that include these activities often require the security/recon element to reconnoiter, clear, or utilize key terrain, such as ridgelines, hilltops, and other dominant features.

UTM platforms are often sought for these activities because of their speed and off-road capabilities, which enable them to navigate quickly key operational terrain for observation and other reconnaissance tasks. Additionally, UTM platforms are often beneficial for reconnaissance/security activities that exploit smaller size and reduced operational signature (compared to current Army SSVs) to reduce likelihood of detection or that require greater speed or work capabilities than dismounted reconnaissance elements provide. (See Figure 2.1.) During the Second World War, the German army used motorcycles for this purpose (see case study in Appendix A). In the 1980s, the U.S. 9th Infantry Division (Motorized) HTTB employed motorcycle-based recon elements to support HMMWV-based maneuver forces.[4]

[4] Shane Burkhart, email correspondence with authors describing experiences as an infantry officer in 9th Infantry Division (Motorized), October 17, 2012.

Table 2.2
Example Army Unified Tasks That Include Execution of Identified Tactical Activities

ART	Task	Subtask	Maneuver Force Security/Recon	Local Patrolling/Engagement	Coordinated Maneuver	Immediate Pursuit	Troop Mobility	Traveling Support	Casualty Evacuation	Internal/Ferry Support
1.2.2	Conduct tactical maneuver	Employ combat formations	×	×	×	×	×			
1.2.3	Conduct tactical maneuver	Employ combat patrols	×	×	×		×			
1.3.2	Conduct tactical troop movements	Conduct tactical road march	×				×	×		
1.3.4	Conduct tactical troop movements	Conduct an approach march	×		×		×	×		
1.5.3	Occupy an area	Occupy and establish a battle or defensive position	×		×					
1.6.2	Conduct assured mobility	Enhance movement and maneuver	×		×		×	×		
1.6.3	Conduct assured mobility	Negotiate a tactical area of operations	×	×	×	×	×		×	
1.6.5	Conduct assured mobility	Conduct nontactical movements								×
4.1.2	Provide logistics support	Provide transportation support					×	×	×	×
5.4.6	Conduct civil-military operations	Conduct civil affairs operations		×				×		
5.7.3	Integrate, inform, and influence activities	Conduct soldier and leader engagement		×						
6.5.5	Conduct operational area security	Conduct response force operations	×		×	×		×		
7.1.1	Conduct offensive operations	Conduct a movement to contact	×		×			×		
7.1.4	Conduct offensive operations	Conduct a pursuit			×	×		×		

More recently, some Army elements in Afghanistan have used ATVs and motorcycles to conduct flank security for SSVs maneuvering along primary roads.[5]

Local Patrolling/Engagement

These activities include traversing permissive and semi-permissive environments to conduct engagement and security tasks as part of stability or security operations. These Tactical Activities are characterized by an overt presence and by the lack of expected sustained enemy contact and the need to observe the environment and/or engage the population.

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5 86th Infantry Brigade Combat Team (Mountain), discussions with authors, November 6, 2012.

Figure 2.1
Marine Corps Element Using UTM to Conduct Recon in Afghanistan

SOURCE: United States Marine Corps, photo by Cpl. Kyle McNally, 2011.
RAND *RR718-2.1*

UTM platforms, especially those requiring less sensory capacity for operation,[6] are often beneficial to such activities because of the ability to access areas with only narrow alleys or paths, as well as their relative slowness and open form, which facilitates interacting with people and making detailed observations—the same argument that is commonly made for deploying urban police on bicycles, horses, or Segways. UTMs have been employed in this capacity in numerous conflicts, to include in Southeast Asia and,[7] more recently, by SOF as part of VSO.[8]

Coordinated Maneuver

Coordinated maneuver activities include use of mobility platforms to execute close combat tasks, such as fire-and-maneuver or assault. While UTM platforms are generally not the best alternative for close combat due to their lack of armor and firepower, they have been used when constraints preclude other options or simply to increase the capabilities of nonmechanized infantry that otherwise would be on foot. European armies in the First and Second World Wars, for example, used bicycles and motorcycles to perform coordinated maneuver in a variety of different contexts (see case studies in Appendix A). More recently, the U.S. and other militaries have employed a variety of motorized, usually dual-tracked UTMs including Toyota pickup trucks and dune buggy-like Fast Attack Vehicles (FAVs) in a variety of contexts that

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6 For example, UTM vehicles like motorcycles often require consistent balancing and create significant noise that can obscure operator ability to collect detailed information, while stabilized and quieter UTM platforms can allow detailed observation of the environment by occupants.

7 Joint Thai-U.S. Military Research and Development Center (MRDC), "Stage II Motorbike Test," April 1969. This document reports the MRDC and Thai Border Patrol Police efforts in the Stage II motorbike user evaluation test to determine the appropriate two-wheeled vehicle for use by the latter organization.

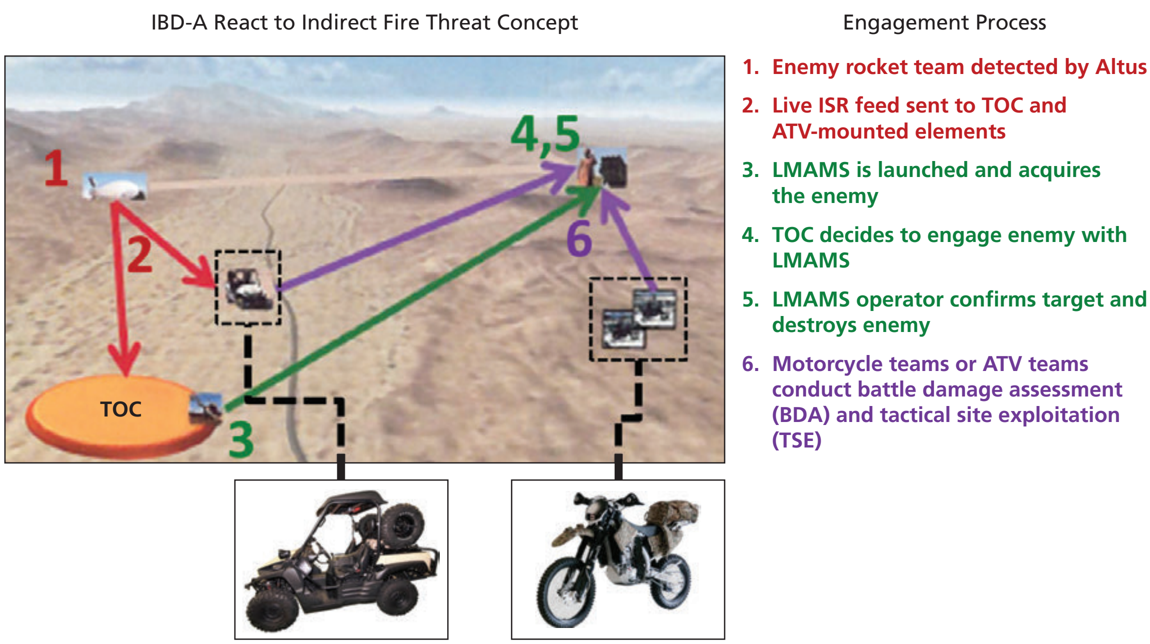
8 Seth Robson, "Soldiers on Motorcycles Might Be Most Effective in Afghanistan," *Stars and Stripes*, June 6, 2013.

made them preferable to SSVs.[9] They can also be deployed readily by air. For example, troops in Afghanistan have lifted ATVs and motorcycles by rotary-wing aircraft to locations from which they have been able to perform blocking maneuvers.

Immediate Pursuit

Immediate pursuit activities are efforts to engage fleeing targets or exploit a perishable tactical opportunity. Historical examples (including bicycle-mounted troops pursuing infantry) outnumber contemporary ones, probably because the threat in current engagements makes using UTMs in this capacity too dangerous. That said, recent operational concepts, such as the Integrated Base Defense—Austere depicted in Figure 2.2, have included UTM capabilities because of their presumed ability to pursue fleeing targets rapidly through the constricted terrain often used to launch attacks and enable flight.[10] Successful UTM-based execution of these activities would likely stress Army forces' ability to negotiate constricted terrain rapidly and the ability to receive, use, and transmit environmental or targeting information on the move. However, these activities appear particularly vulnerable to the risks associated with hasty pursuit, to include baited ambushes and other attacks. Mitigating these risks to make immediate

Figure 2.2
Integrated Base Defense—Austere (IBD-A) Employment Concept for Employing UTM Platforms to Conduct Immediate Pursuit of Threats



SOURCE: Rapid Equipping Force, 2011.
RAND *RR718-2.2*

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[9] For example, the U.S. Army's 9th Infantry Division employed FAV and motorcycle UTM platforms as part of its role as the Army's HTTB in 1981–1986.

[10] U.S. Army Rapid Equipping Force, "13.1 Candidate SUE Evaluation: Integrated Base Defense—Austere (IBD-A)," March 26, 2012. While there are few documented examples of execution for this tactical concept, the REF developed concepts for employing LTATVs and Christini motorcycles as part of an IBD-A package of capabilities.

pursuit a viable alternative would likely demand rigorous coordination and integration of close air support, fire support, and ISR.

Troop Mobility

Troop mobility activities include movement of soldiers to a location to execute assigned tactical tasks. Tactical vehicles used for troop mobility, such as the Light Medium Tactical Vehicle (LMTV) or HMMWV, include armament and protection sufficient to survive initial contact with hostile forces but are not intended as close combat platforms. Similarly, UTM platforms are used to increase the speed of troops and preserve their physical capacity to perform tactical tasks at an intermediate or final objective. During these activities, UTM platforms are primarily employed in permissive or semi-permissive areas where strict tactical movement is not required or efficient. For troop mobility activities, the ability of a UTM to fit within delivery and terrain constraints are advantages over SSVs. UTM platforms are most often used to execute these activities by airborne, air assault, dismounted, and light motorized forces, such as Downed Aircraft Recovery Team (DART) operations, that face delivery constraints precluding SSVs or larger platforms.[11]

Traveling Support

For these activities, a mobility platform is specifically used to increase the foot speed, endurance, or carrying capacity of dismounted formations. For this activity, the mobility platform operates within the limits of the dismounted force it is used to support. The inclusion of a mobility platform augments the total carrying capacity of the formation, reducing individual load on each soldier or increasing the total amount of equipment and supplies the formation can carry. (See Figure 2.3.) Within this activity, the UTM platforms meet delivery demands faced by airborne, air assault, or other dismounted units better than the SSV. Their ability to cover more of the terrain traversed by dismounted soldiers than the SSV is key. Formations using UTM platforms for this activity often use the UTM platform to increase the time before they need resupply by carrying additional supplies or increase the lethality of the dismounted formation by carrying weapons systems, ammo, or capabilities not otherwise suitable for dismounted operations (i.e., .50 machine guns, 81mm mortars, and LRAS systems).

Casualty Evacuation (CASEVAC)

For Army forces, CASEVAC involves the unregulated movement of casualties using tactical or logistic aircraft and vehicles.[12] By definition, any available vehicle than can carry a casualty or tow a platform that can carry a casualty is suitable for these activities. Just about every UTM can and has been used for CASEVAC, and Army CASEVAC doctrine explicitly calls for using UTMs such as ATVs to fill the gap created by the withdrawal of the Jeep and the Mechani-

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[11] For example, 160th Special Operations Aviation Regiment (SOAR) and other units have employed UTMs because of the transportability inside a CH-47 and ability to move heavy repair equipment required for their DART from landing zones to downed aircraft over rough terrain.

[12] Department of the Army, *ATP 4-25.13: Casualty Evacuation,* 2013. Doctrine describes the vehicles used for CASEVAC as ground vehicles or rotary-wing aircraft that are not staffed with medical personnel for en route care (unless augmentation is planned for in the operation plan). These vehicles/aircraft do not have organic medical equipment.

Figure 2.3
UTM Use for Traveling Support Activities

SOURCES: National Archives, 2005, and USMC Mountain Warfare Training Center, 2012.
RAND *RR718-2.3*

cal Mule from service, a gap that the doctrine notes the HMMWV is too large to fill.[13] Using UTMs for CASEVAC also frees infantry of the burden of having to dedicate considerable resources to evacuating casualties by carrying them physically (see Figure 2.4). Indeed, the Army Mountain Warfare Center specifically teaches the use of UTM platforms in this role for high-altitude environments where casualties must be moved down steep terrain to a suitable air MEDEVAC landing zone.[14]

Internal/Ferry Support

Internal/ferry support activities are generally conducted within an enclosed and secured area to execute or support internal operations. UTM platforms are used for these activities to efficiently perform multiple short-distance movements of small quantities of troops, equipment, or supplies when an SSV or larger platform is impractical or precluded by delivery, terrain, or other constraints. (See Figure 2.5.) Operations such as conducting a Forward Arming and Refueling Point (FARP) or operating a field artillery battery firing position can require movement of heavy, bulky equipment over significant distances within a relatively confined and secured area.[15] Army doctrine describes the potential value of smaller mobility platforms in

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[13] Department of the Army, *ATP 4-25.13*, 2013. This doctrine specifically identifies UTM platforms as potential CASEVAC options, stating "[t]he family of small all-terrain vehicles such as the John Deere M-Gator military utility vehicle, the Polaris MVRS800 and MV800 as well as other all-terrain vehicle variants currently in service, provide a capability as light capacity tactical vehicles. In this role they fill the gap created with the phasing out of the 1/4-ton truck M-151 (Jeep) and M-274 mechanical mule that the HMMWV is too large to fill."

[14] U.S. Army Mountain Warfare Center (AMWC) and U.S. Marine Mountain Warfare Training Center (MWTC), interviews with authors. November 6, 2012 and January 25, 2013. Due to air density and weather restrictions, air MEDEVAC pickup can generally not be performed above 8,000 feet above sea level (ASL). Casualties suffered at higher altitudes must be evacuated down generally rugged terrain to a suitable location below 8,000 feet ASL.

[15] Department of the Army, *Field Manual 5-50: Counterinsurgency Approaches*, 2005.

Figure 2.4
UTM Use for Execution of CASEVAC Activities

SOURCES: German Army, 2010, and U.S. Army, 2003.
RAND *RR718-2.4*

support operations like FARPs, citing their increased mobility, maneuverability, and ease of concealment.[16]

Key Factors and Constraints Motivating Operational UTM Demands

Given the platform-agnostic nature of the Tactical Activities discussed above, a variety of mobility platforms can be and have been used to perform them based on the tactical mis-

Figure 2.5
UTM Use for Execution of Internal/Ferry Support Activities

SOURCES: British Army, 2009, and U.S. Army, 2004.
RAND *RR718-2.5*

16 Department of the Army, ATP 3-04.94, *Forward Arming and Refueling Points*, 2012. In FARP support operations where SSVs or larger platforms are precluded because of delivery constraints, terrain, or other limitations, a UTM platform can provide an extremely mobile refueling capability that is light enough to be transported inside a CH-47, transport ammunition from the cargo truck to the armament pad, or enable efficient movement of personnel during FARP operations.

sion, environment, and available resources. All things being equal, both historical and contemporary operations demonstrate that commanders generally prefer armored vehicles, such as the current SSV, that can carry more and offer greater protection and firepower when they are available. However, some key factors and constraints preclude SSV use, establish UTM demands and requirements, and, in some instances, militate against UTM use. Table 2.3 lists the key factors and constraints that, based on historical and contemporary operations, have motivated UTM demands, while the primary factors that argue against operational UTM use are discussed later in this chapter. These factors are discussed in greater detail below.

Constrained Operating Space

Both natural and built terrain pose challenges in the form of narrow streets and other tight spaces that can preclude the use of SSVs, including HMMWVs, simply because the vehicles are too large and unwieldy.[17] Operations in densely vegetated areas, such as jungles or forests, can drastically limit the track width of usable mobility platforms as illustrated in Figure 2.6.[18]

Table 2.3
Key Factors Motivating Operational UTM Employment

Factor	Description
Constrained operating space	Natural and/or built terrain precluding mobility platform options
Constrained transport/ delivery capacity	Internal dimensions and/or lift capacity of transport platforms, such as aircraft or trailers, precluding mobility options due to size or weight
Insufficient road infrastructure	Limited quality, structural integrity, and/or width of roads and bridges precluding options due to size, weight, and/or mobility
Extreme terrain	Inclines, declines, or undulation of terrain precluding mobility options due to performance limitation
Partner capabilities	Ability to use mobility platforms that can readily operate with partner forces and leverage partner force support capabilities when needed
Threat avoidance	Ability to avoid, bypass, or confound enemy attack through mobility and use multiple potential routes
Operational signature	Ability to reduce the potential for observation, identification, tracking, or engagement by reducing observable platform traits
Platform availability/support limitations	Limited access to the type or quantity of sustainment and repair of supplies, precluding vehicle options due to efficiency and/or availability
Surface conditions	Uneven, soft, or inconsistent soil or ground covering, such as mud or snow, precluding mobility options due to trafficability and/or weight distribution

[17] Army Tactics, Techniques, and Procedure (ATTP) 3-06.11, *Combined Arms Operations in Urban Terrain*, describes the potential impact of street patterns and widths on maneuver, stating "Street patterns influence all warfighting functions. Knowledge of street patterns and widths gives commanders and leaders a good idea of whether or not mounted mobility corridors permit movement and maneuver of wheeled or tracked vehicles, facilitate mission command, and facilitate sustainment."

[18] Joint Thai-U.S. "Military Research and Development Center, Stage II Motorbike Test," 1968. This evaluation report provides a detailed description of the impacts of dense vegetation on cross-country mobility. The heavily forested or jungle areas present the greatest deterrent to transportation, and in some areas, prevent any movement at all by vehicles. Both seen and concealed obstacles such as tree stumps, fallen trees, holes, and soft spots slow up trafficability even during the dry season. During the wet season there is flooding to varying depths, and some low places are under water for weeks at a time. Even at times when these heavily forested or jungle areas are passable, vehicle speeds will be limited to less than 6 or 7 miles per hour.

The adverse impact of vegetation on use of SSVs is especially acute in jungles, dense forests, and dense undergrowth where the width of the trafficable area along unimproved roads or trails is limited, and deadfall vegetation blocks trails.[19] Currently, Army forces intending to operate in areas with vegetation too adverse for SSV employment are almost completely limited to dismounted operations and the human limits they entail. While this absence of UTM against similar forces is not necessarily a disadvantage, UTM's relatively inexpensive capability can improve reach, duration, and lethality over normal dismounted formations in these environments.

Like operations in constricting terrain or vegetation, Army maneuver in urban areas too constricted for SSVs, as illustrated in Figure 2.7, must currently be executed by dismounted forces. Urban or developed areas in many current and potential operating locales include alleys, paths, and crossing points that, while potentially useful for movement, maneuver, mission command, and sustainment, are too narrow at one or more points to allow for maneuver with SSVs or larger Army platforms. U.S. forces have used UTM platforms, when available, to maneuver through these areas independently, supporting both mounted and dismounted forces.

Constrained Transport/Delivery Capacity

For modern militaries, mobility demands and suitable platform alternatives are most often driven by the size and weight limitations of the delivery methods at their disposal, to include fixed-wing aircraft, rotary-wing aircraft, amphibious ships, and trucks. For airborne, air assault, and other light forces, CH-47 and UH-60 aircraft are often their primary means for tactical infiltration and movement, making these aircrafts' internal carrying and external sling load capacities key constraints for suitable mobility options. For airborne forces, the maximum carrying capacity of the 18-foot dual-row airdrop system (DRAS) platform and the Container Delivery System (CDS) bundles are key constraints for delivery of mobility platforms. For

Figure 2.6
French Army Soldiers Operating ATVs During Jungle Operations in Maripasoula, French Guiana

SOURCE: Armee de Terre (French Army), 2013.
RAND *RR718-2.6*

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19 Army Field Manual 5-33, *Terrain Analysis*, describes the potentially adverse impact of tree spacing and other vegetation on the mobility of wheeled and tracked vehicles.

Figure 2.7
Vehicle Space in Narrow Alleys and Passages in Developed Areas

SOURCES: International Charter Space and Major Disasters, 2013.
RAND *RR718-2.7*

ground movement, existing SSVs and armored vehicles, especially MRAPs, require movement on Heavy Tactical Vehicles (HTVs), while standard methods including shipping containers and palletized load system (PLS) flat racks can accommodate multiple UTM platforms. Due to their relatively light weight and dimensions, UTM platforms include mobility alternatives that easily fit the constraints associated with most delivery platforms and methods. As illustrated by Figure 2.8, delivery constraints largely rule out the MRAPs and other armored vehicles in favor smaller and lighter vehicles that can efficiently meet delivery constraints.

Insufficient Road Infrastructure

The condition or absence of local road networks and supporting infrastructure, especially bridges, in rural and austere locations often precludes the tactical use of SSVs or larger vehicles for tactical mobility. These limitations are usually due to an insufficient maximum width, height, and/or weight bearing capacity to accommodate SSVs or larger vehicles at the most restricted segments of a given route, such as bridges, tunnels, or narrow sections of navigable road. While military analysis on road networks is often country- and operation-specific, the Rural Access Index (RAI) developed and measured by the World Bank estimates the suitability of local road infrastructure for access to and by the local population globally. The RAI measures the portion of rural population that lives within 2 kilometers of a road that is navigable all year round by the "prevailing means of rural transport." This prevailing means usually corresponds to a two-wheel-drive pickup truck as illustrated in Figure 2.9 (left photo).[20] While SSVs or larger vehicles can often negotiate more challenging road surface conditions than the RAI's prevailing means, military usability of these local routes is often limited due to segments constrained by a narrow road width, insufficient weight-bearing capacity of roads (e.g., soft road shoulders), and bridges with insufficient load capacity, as illustrated in Figure 2.9 (right photo).

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[20] Peter Roberts, "Rural Access Index: A Key Development Indicator," *World Bank Transport Papers*, 2006.

Figure 2.8
Transportability of Standard and UTM Platforms by Various Platforms and Methods

Delivery Platform/ Method	Transportability at Combat Weight (with estimated number of vehicles)										
	Army SSVs					Example UTM Platforms					
	Maxx Pro Dash	M-ATV	JLTV-A	M1151 UAH	M998 HMMWV	Toyota Hilux 4 x 4	LTATV	M-Gator A1	Polaris ATV	Christini Motor-cycle	Pack Animal (mule)
C-130J		1[a]	2	2	2	2	4	4	10	20	[h]
Advanced Low Velocity Airdrop System (ALVADS)		1[d]	1[d]	1[d]	1[d]	1[d]	1[d]	1[d]	n/a	n/a	[h]
PLS Pallet			1	1	1	1	4	2	4	12	[h]
CH-47 Sling load			1[b]	2	2	1[e]	2[f]	2[f]	4[g]	12[g]	n/a
CH-47 Internal				1[c]	1[c]	1	3	3	4	12	[h]
Dual-Row Airdrop System (DRAS)				1	1	1	1	2	4	8	n/a
UH-60 Sling load					1	1[e]	2[f]	2[f]	4[g]	12[g]	n/a
20 ft Shipping Container					1	1	2	2	4	12	[h]
463L Pallet									2	4	n/a
UH-60 Internal									1	2	n/a
Container Delivery System (CDS) A-22 Container									1	2	n/a

[a]Only with waiver
[b]This is the objective; criteria for current prototypes indicate transportability only possible without supplemental armor and combat load, with a significant assessed risk that final model will not make this threshold (GAO, 2012).
[c]Cannot be carried in combat configuration.
[d]Vehicles dropped individually.
[e]Standard Toyota Hilux does not have sufficient hardware for standard rigging and would require nonstandard rigging techniques.
[f]Based on standard sling load procedures (Army Field Manual 4-20.199, *Multi-Service Sling Load Procedures*).
[g]Transported in a 20-foot shipping container.
[h]Not authorized, but possible through nonstandard loading methods and adaptation of the transport platform.

RAND *RR718-2.9*

Based on World Bank measurement, as depicted in Figures 2.10 and 2.11, a significant portion of rural populations live over 2 km from even the most austere all-weather routes. This suggests potentially significant demands for U.S. Army forces to navigate along these routes and on even smaller and more restricted tertiary routes (i.e., paths and trails), especially in more population-centric operations such as counter-insurgency (COIN), stability, humanitarian assistance/disaster relief (HA/DR), and noncombatant evacuation (NEO) operations.

Extreme Terrain

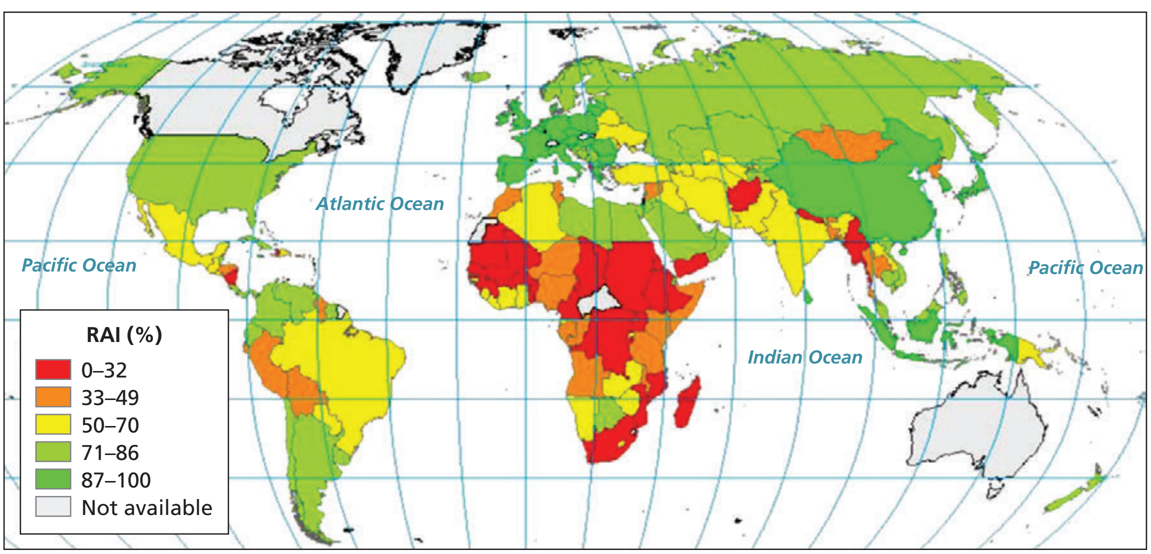
While UTMs present few advantages and consistent disadvantages over larger vehicles in open and moderate terrain, restricted terrain presents a specific case where the significant size and

Figure 2.9
Examples of "Prevailing Transport Method" and Bridge Crossings for the RAI's Minimum "All-Season Road"

SOURCE: U.S. Agency for International Development (USAID).
RAND *RR718-2.9*

weight of SSVs, MRAPs, and other armored vehicles eliminate or significantly reduce their utility. Regardless of their ability to protect and provide power, the heavy vehicles simply cannot operate. Due to the growth in size of the SSV from the M998 to the MRAP, the current SSV is much less capable of negotiating extreme terrain due to significant size, weight, and diminished all-terrain performance characteristics.[21] Troops operating in mountainous areas, for example, routinely have to resort to UTM capabilities including pack animals to occupy or

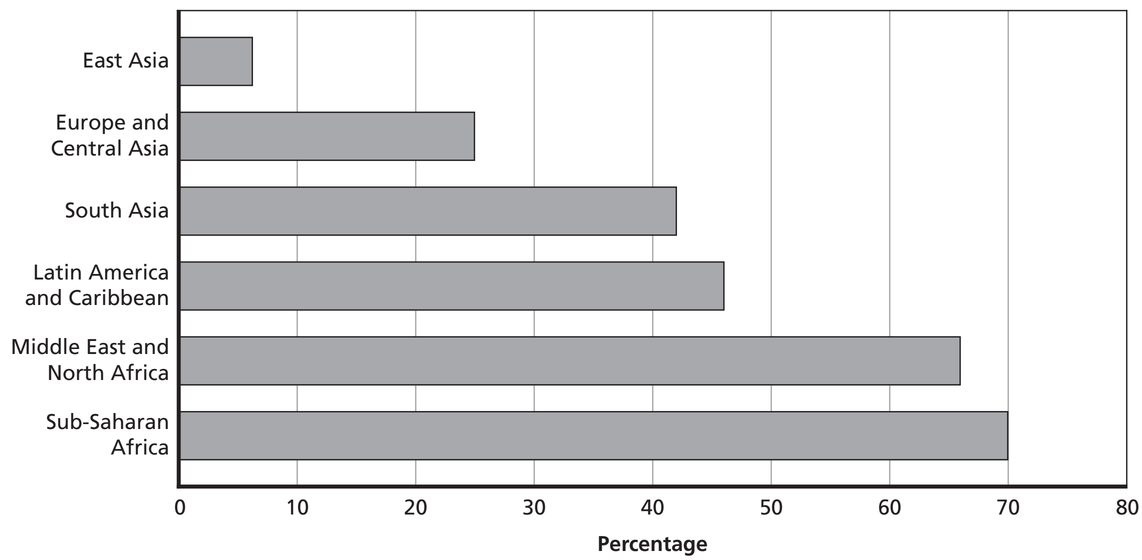
Figure 2.10
RAI for the Rural Population Within 2 km of an All-Season Road



SOURCE: Roberts, 2006.
RAND *RR718-2.10*

[21] The diminished performance characteristics include elevated center of gravity and reduced maximum angle of approach, maximum angle of departure, and maximum side slope angles.

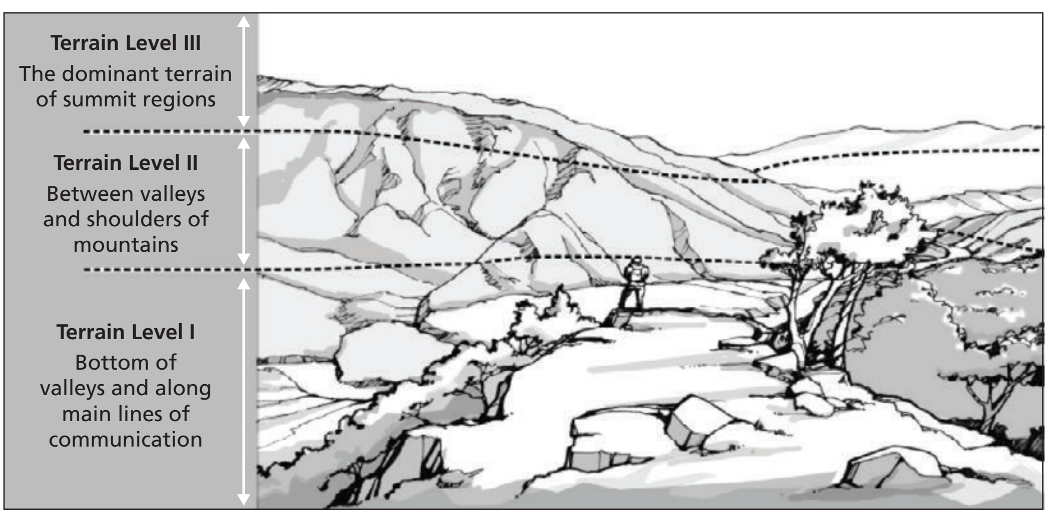
Figure 2.11
Percentage of Rural Population Without Access to All-Season Road



SOURCE: Roberts, 2006.
RAND *RR718-2.11*

to supply positions that cannot readily be reached by trucks or even helicopters. As illustrated in Figure 2.12 and described in Table 2.4, ATTP 3-21.50 classifies terrain in three general categories. Especially with the increasing size and weight of SSVs, mounted Army forces are often limited to maneuver in Level I terrain and improved areas in Level II terrain. Maneuvering

Figure 2.12
Army Terrain Classification Levels I, II, and III



SOURCE: ATTP 3-21.50, Infantry Small-Unit Mountain Operations, 2012.
RAND *RR718-2.12*

Table 2.4
Army Terrain Classification Levels and Their Impact on Mobility

Terrain Level	Description	Impact on Mobility
Level I terrain	• Terrain is located at the bottom of valleys and along the main lines of communications. • Most civilian population is found at this level. • Vital lines of communication usually follow the valley highways, roads, and trails.	• Mounted forces can operate, but maneuver space is often restricted. • Need to maneuver through restricted spaces motivates employment of UTM.
Level II terrain	• Level II terrain lies between valleys and shoulders of mountains. • Narrow roads and trails, which serve as secondary lines of communication, cross this terrain. • Ground mobility is difficult in this terrain.	• Since small forces can easily influence operations at level I from level II terrain, they often expend great effort to utilize and control level II terrain. • Use of SSVs is precluded or significantly limited, and UTM platforms are used to increase the speed and carrying capacity of otherwise dismounted forces.
Level III terrain	• Level III includes the dominant terrain of summit regions. • Narrow foot paths requiring mountaineering and/or climbing • Although summit tops may contain relatively gentle terrain, mobility along summit approaches in Level III is usually the most difficult to achieve and maintain.	• Soldiers with proper skills and equipment can infiltrate to attack lines of communication and key locations. • Mobility often limited to single track or pack animal UTM platform with similar ability to negotiate uneven and rocky terrain as humans.

and sustaining operations in Level II and Level III terrain where current SSVs are precluded, as routinely illustrated during combat operations in Afghanistan, are left almost completely to dismounted forces and the maximum loads they can carry.

While restricted natural and urban terrain challenge all movement, modernized maneuver forces have routinely faced asymmetric adversaries who explicitly operate from and in constricted terrain to negate the general firepower and protection advantages of the U.S. forces. Recent operations demonstrate that use of constricted terrain is a reoccurring feature of asymmetric and hybrid warfare. Center for Naval Analyses research on insurgent tactics in Southern Afghanistan in the mid-2000s suggests Afghan insurgent use of rugged terrain helped insurgents outmaneuver and defend against coalition forces as they had Soviet armored forces. Examples from previous operations include

- use of narrow roads and canal crossings by Iraqi insurgents to limit potential pursuit by U.S. forces in wider and heavier HMMWVs and MRAP
- egress along narrow, cluttered alleys by Iraqi insurgents in Sadr City to prohibit mounted pursuit by U.S. forces[22]
- Taliban use of single track trails through mountain passes along the Afghanistan-Pakistan border to avoid checkpoints and patrols along improved roads
- establishment of Afghan insurgent bases in rugged and remote mountainous areas to avoid incursion by coalition forces
- use of small bridges as ad hoc obstacles by Afghan insurgents to dissuade maneuver and pursuit by MRAP vehicles too wide and heavy to cross

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[22] David E. Johnson, M. Wade Markel, and Brian Shannon., *The 2008 Battle of Sadr City*, Santa Monica, Calif.: RAND Corporation, OP-335-A, 2011.

- Viet Cong operations from densely vegetated areas to prohibit U.S. incursion by armored vehicles.

Ground vehicles' performance characteristics significantly impact their ability to access and navigate extreme terrain, especially the platform wheelbase, ground clearance, and center of gravity. Figure 2.13 shows these and other performance characteristics for standard Army platforms and a representative set of UTM platforms.

Partner Capabilities

As witnessed by both conventional forces and SOF in Afghanistan, Iraq, and elsewhere, U.S. forces must often train, support, and operate along with foreign military forces that lack the United States's robust platforms and support capabilities. These types of operations are expected to continue with the Army's Regionally Aligned Force (RAF) concept that will require mission-tailored Army forces to focus on a specific region within their normal training program and deploy to select locations to support small-scale security cooperation activities and annual military exercises. Based on current Army guidance, RAF brigades will align with each Geographic Combatant Command (GCC) in order to provide GCCs with "scalable, tailorable capabilities to enable shaping the environment."

RAF demands will likely include the need for mobility and support capabilities in austere and temporary locations that are relatively permissive. As seen in other recent operations, local infrastructure limitations can preclude the use of the larger, less transportable, and less efficient standard Army mobility platforms like MRAPs and armored HMMWVs in favor of platforms that are more easily transported and operated alongside foreign partner forces.[23] While the Army's limited RAF-specific planning and operational experience does not clearly indicate how and to what extent RAF elements will need various mobility options, the Army Vice Chief of Staff's *Army Equipping Guidance 2013–2016* recognizes the likely need for non-MTOE and nonstandard capabilities to meet RAF mission demands, stating

> As we move to regionally aligned and mission tailored forces, we expect units to need unique equipment . . . These forces may need only their MTOE equipment or could be provided mission specific equipment. This approach requires us to adapt forces from the lowest levels and will create unique challenges in aligning equipment needs, non-standard equipment, and training specifically tailored to the mission on what could be very short timelines.[24]

Without significant RAF operations completed, insufficient information exists to validate and quantify the demand for UTM within these operations. However, previous experience by both SOF and conventional units demonstrates the interoperability challenges that U.S. forces face when attempting to operate beside more rugged and locally appropriate forces.[25] The UTM capabilities developed, maintained, and provided by the Family of Special Opera-

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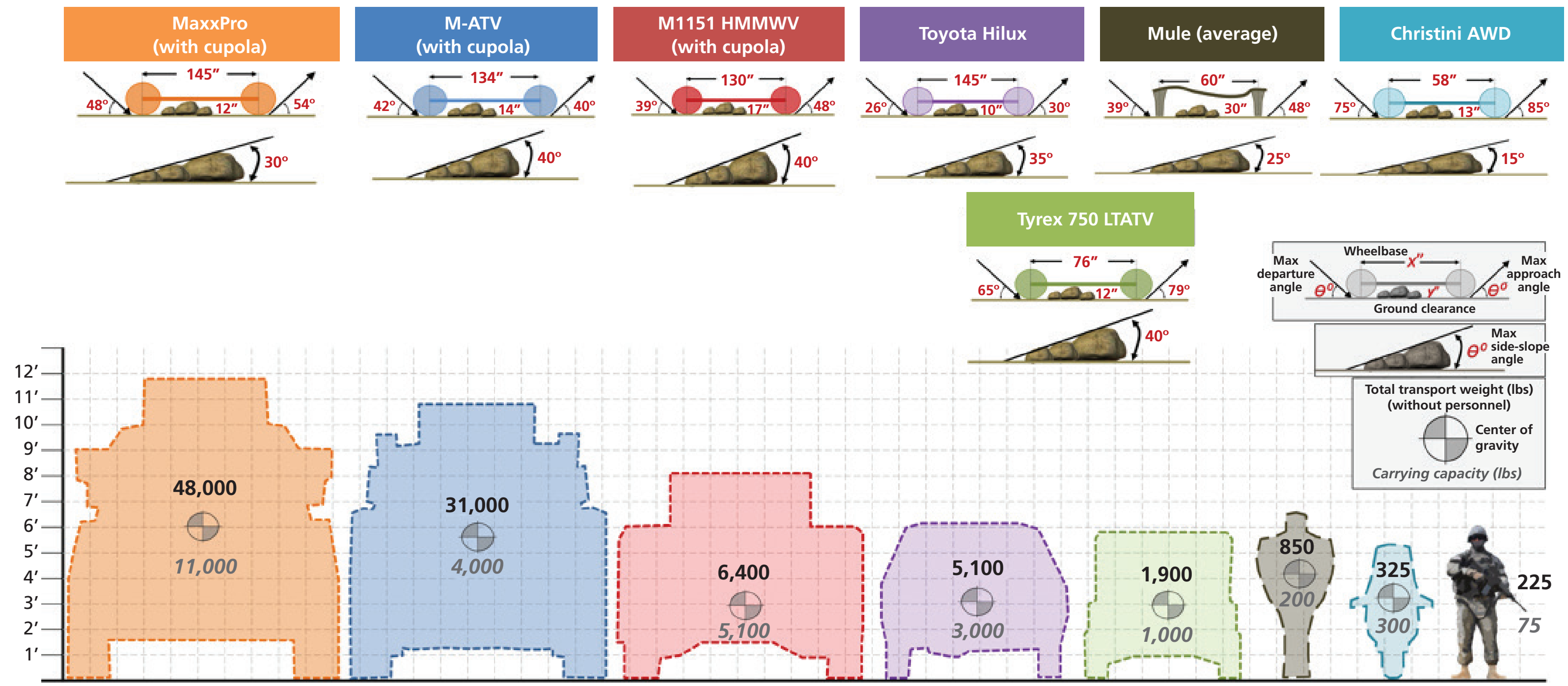
[23] U.S. Army Forces Command (FORSCOM), "US Army Forces Command Regionally Aligned Forces (RAF) Training Requirements," February 11, 2014.

[24] Department of the Army, "Army Equipping Guidance 2013–2016: From Afghanistan Through Sequestration Toward Regionally Aligned and Mission Tailored Forces," 2012.

[25] Joint Thai-U.S. Military Research and Development Center (MRDC), 1969. This report discusses the importance of having appropriate mobility platforms to operate with local security forces along narrow trails through dense vegetation.

Figure 2.13
Performance Characteristics of Army SSVs and Example UTM Platforms



Total width	102″	98″	87″	69″	59″	42″	32″	28″
C-130J internal capacity	0	1	3	8	12	12*	24	92
CH-47 internal capacity	0	0	1	1	3	6*	12	55
CH-47 sling load capacity	0	0	2	2	2	n/a	12	n/a

*Estimated capacity. Would require nonstandard rigging and exception to current aircraft loading regulations.

RAND *RR718-2.13*

tions Vehicles (FSOV) are used extensively by SOF to conduct the security force assistance (SFA) and foreign internal defense that the Army intends the RAF to execute. The absence of a basic capability to provide and support appropriate UTM capabilities for RAF elements on a temporary and non-MTOE basis significantly limits the Army's opportunity to provide truly tailorable, scalable, and locally appropriate forces.

Threat Avoidance

One significant advantage of UTMs posited by some observers is their ability to avoid threats based on their access to a much broader range of potential routes than current SSVs that are primarily limited to main routes due to their size and weight.[26] This assertion assumes that UTMs, through access to more routes than larger vehicles, can more easily vary their maneuver patterns and therefore create more uncertainty and reduce the ability of would-be attackers to predict UTM location and target deliberate attacks. With little or no protection, safety of UTM occupants in these instances is almost completely dependent on their ability to confound and avoid enemy attacks. While these assertions have some conceptual merit, no testing or evaluation has validated the potential benefit of UTMs in an asymmetric threat environment with IEDs, point ambushes, and other highly adaptive forms of enemy contact. Previous Army evaluations of reconnaissance forces have identified the ability of smaller military motorcycles (MILMO) to avoid decisive engagement when operating with larger HMMWVs and M3 Cavalry Vehicles in simulated combat at the National Training Center (NTC), noting,

> HMMWVs accounted for the majority of losses in 10-vehicle platoons while the MILMO and M3 CFV experienced low loss rates. . . . Due to the MILMO's inherent stealth, mobility, and maneuverability, it extended the platoon's survivability and increased the capability to conduct reconnaissance and security missions.[27]

However, assumptions about the long-term ability of UTM platforms to trade protection for mobility and confound employment of IEDs by adaptive and observant enemies are not clearly validated by analysis, evaluation, or combat experience. As discussed below, units employing UTM platforms have encountered significant threats in previous and current combat operations. More recently, the NATO Joint Air Power Competence Centre (JAPCC) has identified the potential value of air mobility in reducing exposure of ground forces to IED threats through air movement and by "leveraging air power's inherent agility, speed and reach" to provide the rapid movement of capabilities and personnel to attack the IED network in depth.[28] The use of aircraft, especially rotary-wing and Vertical Take-Off and Landing (VTOL) platforms, can reduce the need for ground movement. However, the delivery constraints associated with aircraft, as discussed above, will generally preclude use of SSVs and demand ground

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[26] Kyle Stockwell, *Motorcycles in the Conventional Military: A Doctrinal Approach to Achieving Operational Success*, September 1, 2012. Stockwell advocates for leveraging the all-terrain capabilities of motorcycles to enable forces to operate on tertiary roads and trails rather than the primary routes often targeted by enemy IEDs.

[27] U.S. Army Directorate of Combat Developments, *Proponent Evaluation Report for the Concept Evaluation of the Maneuver Battalion Scout Platoon*, 1990.

[28] Joint Air Power Competence Centre, *NATO Air and Space Power in Counter-IED Operations*, 2011.

mobility platforms that are transportable and can be rapidly inserted by aircraft in combat configuration and ready for immediate use.[29]

Operational Signature

Operational signature includes all the characteristics, traits, or patterns of an individual, platform, or activity that can enable observers to identify the actor's presence, actions, and intent. Over the history of UTM employment, the most commonly identified advantages over SSVs and combat vehicles is their ability to operate with diminished operational signature through speed and stealth. Forces have sought to employ UTM platforms because their small size and increased speed relative to armored vehicles enabled them to avoid detection while executing reconnaissance, security, and courier missions.

An Army evaluation of military motorcycles at the NTC in 1990 demonstrated the operational signature implications for Army recon units. The OPFOR was impressed with the motorcycle's mobility and stealth, observing that the motorcycle was difficult to acquire and subsequently destroy due to its "stealth, small silhouette, and minimal thermal signature." The overall survivability rate of the MILMO exceeded that of all other vehicles.[30] The relatively small stature of UTM platforms also allows them to be more readily hidden when not in use than the larger HMMWV or much larger MRAP.[31] In addition to their relatively small physical profile, UTM platforms provide other advantages to help reduce operational signature. Examples of these advantages include the nonmilitary appearance of Nonstandard Tactical Vehicles (NSTVs) like the Toyota Hilux and the more common audible signature of motorcycles in rural Afghanistan than MRAPs.[32]

Platform Availability/Support Limitations

SSVs might simply be unavailable for any of a number of reasons. Historically the problem was often one of industrial capacity: The German army in World War II, for example, was never able to supply its forces with adequate numbers of cars, trucks, and VW Jeeps (Kübelwagen), obliging it to rely on draft and pack animals to a much greater extent than the U.S. Army. German industry could provide large numbers of motorcycles, so the German army fielded motorcycles, mostly with sidecars, in large numbers (see Appendix A for a further discussion of German motivations for wide use of UTMs). For a well-resourced military force like the U.S. Army, unavailability of SSVs will more likely occur as a short-term issue dependent on delivery capacity or an inability to sustain them at the point of need. Indeed, recent planning in Africa, Asia, and other areas has identified the inability to rapidly deliver and effectively sustain heavily armored SSVs as a key concern.[33]

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[29] While the HMMWV is capable of internal transport by a CH-47 and the prototype JLTV is capable of CH-47 sling load, both would require significant time and effort at or near the landing zone to prepare platforms for operations and for subsequent extraction if required.

[30] U.S. Army Directorate of Combat Developments, 1990.

[31] 1-38 CAV Long Range Surveillance (LRS) Troop interviews with noncommissioned officers, January 25, 2013.

[32] Based on author experiences supporting SOF Village Stability Operations (VSO) in Afghanistan during 2011.

[33] Tom Vanden Brook, "MRAP Trucks Near the End of the Road in Military Strategy," June 16, 2012, *USA Today*. The article quotes Mark Barbosa, the Army MRAP Program Director, as saying, "[The MRAP] is too heavy, breaks down too often and is too unwieldy to have a future. Thus it becomes a truck that fits niches not an overall mission."

The need to operate in austere conditions with limited sustainment resources also sometimes dictates the use of UTM rather than an SSV or larger platform, which typically requires more sustainment and repair support.[34] While these and other factors are generally less prevalent and influential in selection of UTM platforms, in some operations these factors converge to make UTM platforms a very beneficial utility.

Surface Conditions

Surface conditions can also significantly limit the usability of SSVs and other wheeled platforms and favor use of specific UTM capabilities. Surface conditions, to include deep mud, snow, and sand, are a significant challenge for most wheeled vehicles due to their concentrated surface pressure. For example, snow forced mechanized armies including the U.S. Army to operate dogsleds during the Second World War and subsequently snowmobiles, ATVs, and specialized all-terrain vehicles, such as the BV-206, that benefit from an extremely low surface weight distribution.[35] At maximum gross vehicle weight, the M1151 HMMWV exerts a surface pressure of 23 pounds per square inch (PSI) and the M-ATV exerts 25 PSI, while the tracked BV-206 exerts less than 5 pounds per square inch fully loaded. Similarly, tracked UTM platforms such as snowmobiles and tracked ATVs provide units with greater ability to maneuver over adverse surface conditions. (See Figure 2.14.)

Key Factors Discouraging Operational UTM Employment

A range of factors has motivated demands for ground mobility alternatives that are smaller, lighter, and otherwise more appropriate than SSVs. However, concerns over threats, risks, and interoperability have negated the vast majority of attempts to develop and employ UTM

Figure 2.14
Air Force Personnel Test the Rubber Track Conversion System for ATVs and the Hagglunds BV-206

SOURCES: U.S. Army, U.S. Marine Corps.
RAND *RR718-2.14*

[34] For example, the ATVs employed by 1-38 CAV LRS Troop have a fuel efficiency of about 20 miles per gallon (mpg), while a basic HMMWV gets about 12 mpg and an RG-33 MRAP gets about 4 mpg.

[35] Arctic Tracks, "The Hagglunds BV206," web page, undated. The BV206 exerts less than 2 PSI of pressure at curb weight.

capabilities. While only limited analysis has been conducted to assess the motivating and contravening factors for UTM employment, commander concerns and some highly visible UTM calamities have precluded their use and in many instances increased the burden on the next best alternative—the individual soldier. However, emerging technologies, such as remote operation and automation, are offering the potential for UTM platforms that meet demands while significantly reducing the threat from enemy forces and risk of accidental damage to operators. Table 2.5 lists the most significant dissuading factors for potential UTM employment based on case studies and contemporary experiences. These factors are described in detail following the table.

Threat Vulnerability

The single most influential factor weighing against UTM employment in previous and current combat operations is commanders' respective assessments that UTM operators and occupants are too exposed to enemy fires. The decisions to forgo the potential tactical advantages of UTM platforms are based on both reality and perceptions. For example, although the German army experienced success using horse and motorcycle cavalry in Poland in September 1939, the motorcycles were phased out by 1943 because of their "battlefield fragility."[36] More recently, the Canadian army discontinued use of the M-Gator outside of secured areas in Afghanistan after losing three soldiers in an IED strike. Similarly, SOF doctrine on UTM employment stresses the importance of premission analysis and planning prior to UTM employment to identify, assess, and react to enemy patterns of attack.[37]

One key rebuttal offered by proponents of UTMs is that, while UTM platforms are more vulnerable than armored MRAP SSVs, they disperse personnel and reduce the probability of successful attacks and resulting catastrophic losses. Additionally, UTM proponents argue that while UTM occupants would sustain some casualties, forces would suffer fewer overall casualties than in attacks on current SSVs. However, this analysis did not identify any substantial analysis to demonstrate and quantify the potential benefit of this widely held assessment. As indicated in interviews with current Army leaders and by the 2007 Canadian army decision to

Table 2.5
Key Factors Dissuading Operational UTM Employment

Factor	Description
Threat vulnerability	Exposure of occupants and materiel to injury, death, or damage from hostile capabilities (e.g., IEDs and direct fires)
Hazard vulnerability	Exposure of occupants and materiel to injury, death, or damage during the course of vehicle operations (e,g. vehicle rollover)
Lack of interoperability	Insufficient ability to readily transfer information between cooperating platforms through communication during operations, such as intelligence, location, or maneuver plans
Sensory capacity demands	Operation of some UTM platforms, especially single-track vehicles like motorcycles, requires more sensory capacity than SSVs to manage, leaving less for collection of information from the environment.

[36] John J. McGrath, "Scouts Out! The Development of Reconnaissance Units in Modern Armies," 2008.

[37] Navy Special Warfare Command, *NTTP 3-05.9: Naval Special Warfare Tactical Ground Mobility,* 2011, not available to the general public.

discontinue use of the M-Gator, the potential perceptions associated with UTM-related casualties are as much a negative factor as the potential cumulative losses.[38] The historical tendency across militaries is either not to use lightly equipped units for fear of their destruction or to reinforce them, making them heavier and less stealthy.[39] Regardless of the actual probability and effect of threats to UTM occupants, the specter of threat vulnerability has made manned UTM employment for direct combat activities by conventional Army forces unlikely for the foreseeable future.

Hazard Vulnerability

Even in the absence of immediate threats, expected and actual hazards played a significant role in dissuading conventional Army forces to adopt and employ UTM platforms. For example, the 9th Infantry Division HTTB evaluated motorcycles in the 1980s and experienced some significant injuries due to "clotheslined" motorcycle operators and injuries associated with operating motorcycles at night with night vision goggles (NVGs).[40] Recently, an Army SOF soldier suffered a fatality during training in Kenya due to head and chest injuries sustained in an ATV crash.[41] Because of the lack of restraints, roll cages, and other protective equipment on many of the nonstandard UTMs in use, collisions and vehicle rollovers are a significant concern for both administrative and tactical use of UTM platforms. One result of the Army units' unsupervised approach to UTM employment has been inconsistent materiel and training measures to ensure safe operational employment of UTM platforms. While the growing recreational vehicle industry has assessed many ATVs and associated innovations on a variety of performance characteristics, such as safety, endurance, and maintenance dependability, the Army has not provided coordinated resources for units to apply these advancements to tactical mobility needs.

Lack of Interoperability

While the UTMs' relatively small size and weight make them useful alternatives for dealing with some factors, these characteristics can also present challenges for forces attempting to employ multiple UTM platforms or employ UTM platforms with larger tactical vehicles, like MRAPs, M-1 tanks, and M-3 Bradley Fighting Vehicles. Some UTM platforms, like the motorcycle, require almost all of the operator's faculties to safely operate, leaving few opportunities for the operator to safely communicate, navigate, or coordinate maneuver plans with other platforms when on the move.

Sensory Capacity Demands

Due to the terrain commonly navigated with UTM capabilities, exposure to environmental conditions, and their intentionally rugged design, UTM employment often imposes significant

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[38] 1-38 CAV Long Range Surveillance (LRS) Troop, 2013. Leader comments indicate a perceived sensitivity among senior Army, DoD, and civilian personnel to public pressure to protect soldiers to the greatest extent possible, precluding acceptance of the potential risks associated with UTM employment.

[39] McGrath, 2008.

[40] Burkhart, 2012.

[41] U.S. Army Combat Readiness and Safety Center, Army Preliminary Loss Report 13072, "ATV Crash Claims One Soldier's Life," June 12, 2013. The loss report indicated that a soldier died from injuries sustained in an all-terrain vehicle crash that occurred on June 12, 2013, at Camp Simba, Kenya. The staff sergeant sustained head and chest injuries when the Army-leased ATV he was operating overturned. The soldier was not wearing a helmet.

and continuous physical and sensory demands on the operator. At a minimum, the operator must continuously collect sensory information on terrain, visibility, and other environmental factors while operating the vehicle. The physical characteristics of UTMs, especially motorcycles, often require the operator to closely monitor (or "feel") and adjust vehicle position and balance while in motion. During Tactical Activities, operators must also execute tactical tasks that impose significant sensory demands, such as

- identification of potential threats (ambushes, IEDs, obstacles, etc.)
- collection of information through observation and reconnaissance
- communication of key information to other friendly forces
- coordination of movements with other force elements
- employment of auxiliary sensor, designator, and/or engagement systems.

The requirements to continuously monitor the broad range of sensory inputs, physically manage the vehicle position, and execute additional sensory tasks significantly increases the potential challenges and risks for UTM employment, especially during continuous operations, as during forced entry or other high-tempo operations.[42]

Key Observations from UTM Case Studies

The key constraints and factors for UTM use, such as tactical mobility requirements, are remarkably constant in the sense that modern Western militaries have been grappling with them since mechanization and are likely to continue to do so. Even the newest of these constraints, the carrying capacity of CH-47s and other cargo aircraft, have remained fairly constant since the 1960s (the CH-47's lifting capacity has more than doubled since it was first introduced, but the cargo bay's dimensions remain the same). Armies continue to operate in difficult terrain, face availability problems, and use aircraft rapid delivery. Due to the consistent presence of these factors in determining the decision to employ or not employ UTM platforms over time, the presence or absence of the factors are applicable for determining the potential demand and validated requirements for UTM capabilities in future operations.

Future Operational Scenario Illustrating Factors Motivating UTM Demand

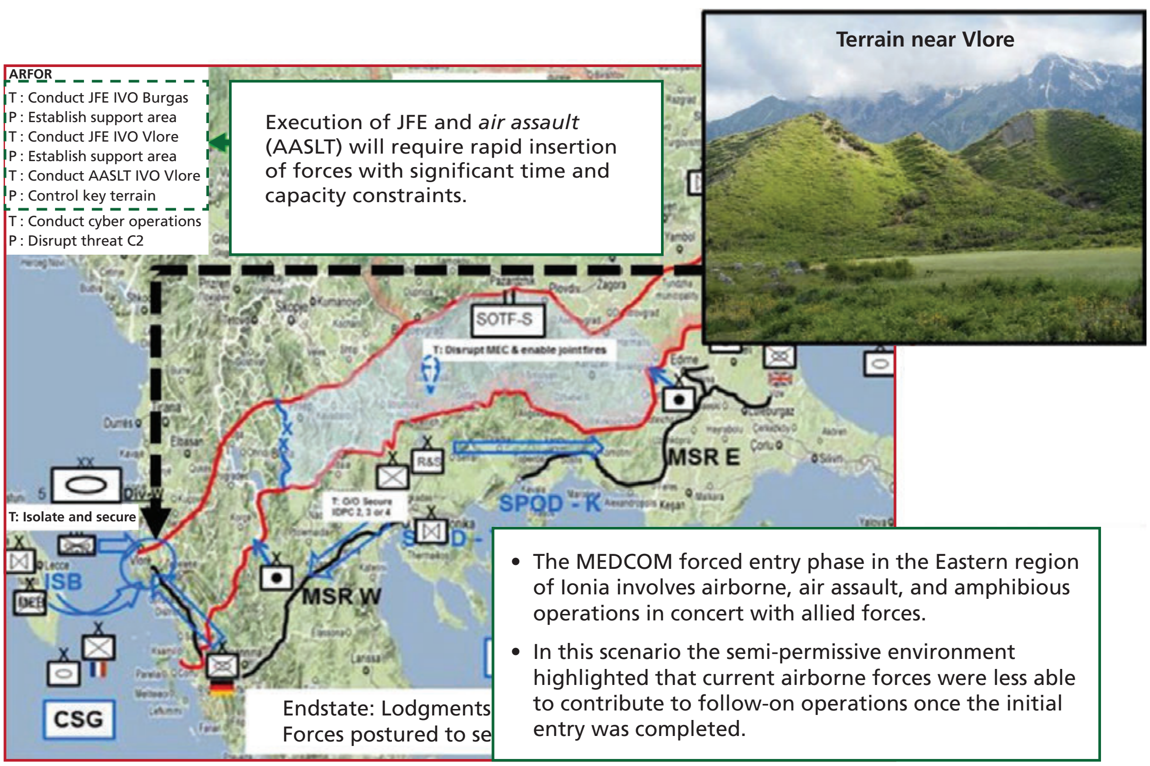
As demonstrated by the UTM employment examples provided above and in greater detail in the case studies, military operations commonly include aspects of missions and environments that preclude or significantly limit the use of SSVs. While the confluence of mission and environmental characteristics in operations will likely not preclude the use of SSVs for most forces, historical experience strongly suggests that some elements will face delivery or terrain constraints precluding SSVs and larger vehicles. Army planners might not have forecasted the requirement for UTMs, yet with striking frequency units in the field discover that they have

[42] For example, one interviewee described the experiences of Army Special Forces units operating with motorcycles during Operation Desert Storm. The units commonly suffered accidents due to the demands of continuously balancing the motorcycle while operating at night, across featureless desert, and with little sleep or rest.

a compelling demand for them. Similarly, the U.S. Army Medical Command (MEDCOM) future operational scenario used by the Army for strategic consideration of required capabilities illustrates how the motivating and discouraging factors for UTM influence overall UTM demand (see Figure 2.15). While the MEDCOM scenarios provide a useful context for illustrating how UTM demand can occur, this single scenario is not a sufficient substitute for an analysis of potential UTM demands across a broad collection of scenarios. The need for this type of follow-on analysis to this study is discussed specifically in the Recommendations section of this report.

Using the MEDCOM scenario, the UNIFIED QUEST 2012 Army future game for senior leaders presented a complex operating environment with notional forces superimposed over southeast Europe.[43] In the scenario, which was imagined to take place in 2020, U.S. and coalition forces must conduct airborne Joint Forced Entry (JFE), air assault, and follow-on expeditionary operations against near peer, paramilitary, and militia forces as illustrated in Figure 2.16. Adversary concept of employment includes use of operational depth and anti-access, area denial (A2AD) to frustrate U.S. attainment of objectives, such as antiaircraft to deny U.S. ISR and strike options. These factors would increase to drop zones and landing

Figure 2.15
Concept of Operations for MEDCOM Wargame Scenario



SOURCE: U.S. Chief of Staff, "UNIFIED QUEST 2012: Army Future Game Senior Leader Discussion," June 8, 2012.
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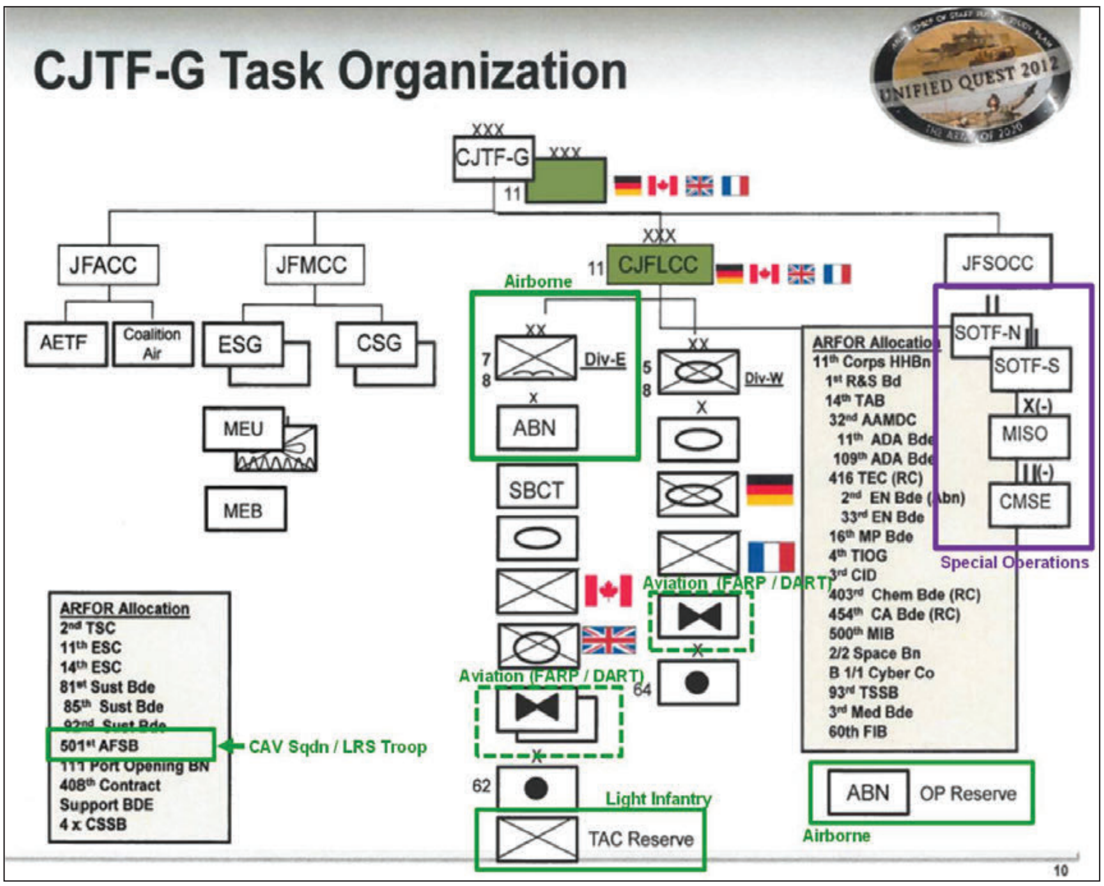
[43] U.S. Joint Chiefs of Staff, "UNIFIED QUEST 2012: Army Future Game Senior Leader Discussion," June 8, 2012.

zones for air assault and airborne forces, further constraining the amount and capacity of airlift available to transport vehicles.

Both airborne JFE and air assault operations, as employed in this scenario, are fundamentally constrained by aircraft capacities, which would significantly limit or preclude the delivery of SSVs that are likely to be available in 2020.[44] Additionally, the rugged terrain of the scenario's Greece and Southeast Europe setting would significantly limit SSV ability to operate off of improved roads. The scenario almost certainly would also require engaging in Tactical Activities for which SSVs would be incapable of participating or undesirable, placing a considerable burden on otherwise dismounted formations.

As listed in Figure 2.16, execution of the MEDCOM scenario would involve a number of Army units that would need ground mobility at the same time that there were significant

Figure 2.16
Task Organization for Army MEDCOM Wargame Scenario



SOURCE: U.S. Chief of Staff, "UNIFIED QUEST 2012: Army Future Game Senior Leader Discussion," June 8, 2012.
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[44] The airborne and air assault operations, as conceived by the MEDCOM scenario, are "offset" insertions up to 20 km from the final objective due to the significant air defense posture around key objectives (the "offset" insertion is a key feature of current 82nd Airborne Division Global Response Force (GRF) concepts of employment). While fixed- and rotary-wing delivery can deliver forces over distance much faster than UTM, the postulated air defense threat precludes their use with 20 km of the final objective.

constraints on the delivery and subsequent transport of that mobility. For example, because of potential antiaccess threats near many potential lodgment airfields (or *airheads*), this scenario considers the feasibility of dropping airborne maneuver forces (top center) up to 20 km from the airhead for rapid ground movement to secure the objective.[45] This type of "offset" operation would occur in an antiaircraft threat environment precluding use of fixed- or rotary-wing aircraft to deliver forces close to the objective and would place significant emphasis on the ability of airborne forces to airdrop mobility platforms for rapid movement and maneuver.

Additionally, the air assault operations would include a number of Army aviation and aviation support units (bottom center) that would require and be involved in FARP and DART operations, which also require mobility capabilities that could be delivered by rotary-wing aircraft, especially the CH-47. Lastly, light infantry forces (below center) are slated for follow-on expeditionary operations that would likely be constrained by initial delivery and sustainment capacity.

The Joint Concept for Entry Operations (JCEO) published in March 2014 explicitly describes the environment, operations, and capabilities illustrated by the type of operation depicted in the MEDCOM scenario. The JCEO describes the joint vision for how joint forces will enter onto foreign territory and immediately employ capabilities to conduct entry in the presence of armed opposition characterized by increasingly advanced area denial systems as well as where the environment and infrastructure may be degraded or austere.[46] The JCEO lists 21 required capabilities to execute these operations, to include two required capability areas that form the basis of the validated need for UTM for 82nd Airborne IBCT forces. These two required capability areas and the associated specific required capabilities are listed in Table 2.6.

As illustrated above, the MEDCOM scenario includes operational tasks that will likely encounter many of the factors for and against UTM described above. Table 2.7 identifies the factors and associated operational tasks that could motivate and/or dissuade employment of UTM capabilities. While the MEDCOM scenario presents only one specific bundle of operational factors that would likely motivate demand for UTM capabilities, the scenario demonstrates how a range of operational factors can converge to significantly limit SSV employment and generate significant demand for lighter, more deployable, and more mobile UTM capabilities for some units and TAs.

Summary

As demonstrated by the UTM case studies (see Appendix A), the operational factors favoring and militating against use of UTMs have remained relatively constant over time, across operations and militaries. The types of Tactical Activities executed with UTM platforms are relatively consistent and well defined based on the advantages and limitations of UTMs compared with the next best alternative, which is often dismounted soldiers. The tactical tasks discussed above represent constants of military operations. Moreover, militaries invariably face constraints that prevent them from using SSVs to meet mission requirements as they grapple with the problem of assisting overburdened infantry. From this perspective, UTMs appear not

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[45] Joint Publication 3-18, *Joint Forcible Entry Operations,* 2012.

[46] Joint Chiefs of Staff, 2014.

Table 2.6
Joint Concept for Entry Operations Required Capability Areas Support Validated Requirements for UTM Capabilities by 82nd Airborne Division

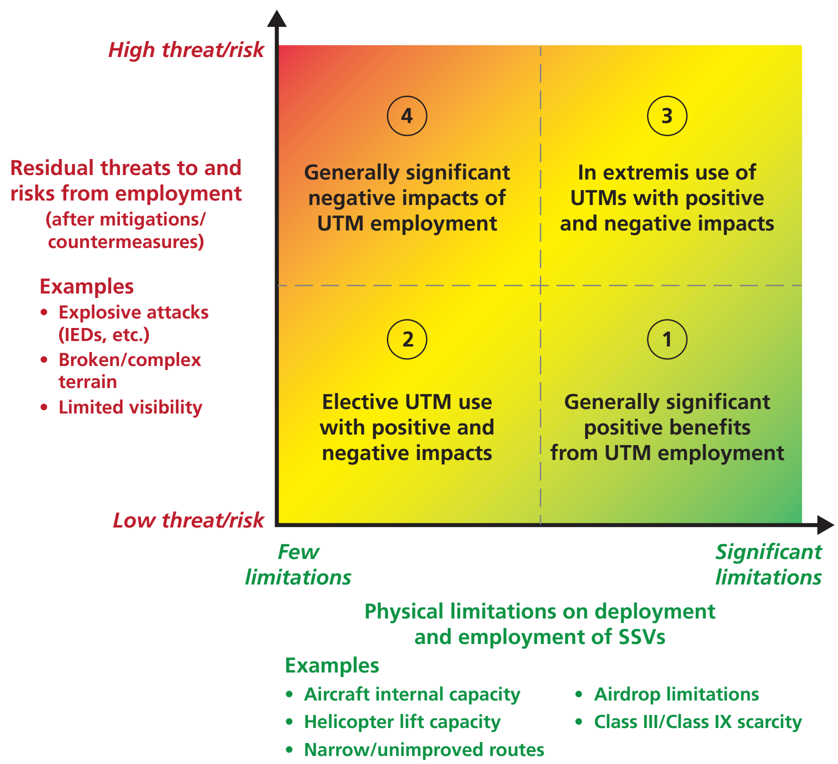
Required Capability Area	Specific Required Capabilities
Required Capability 12: The ability of Initial Entry Forces (IEF) to conduct the initial entry into an operational area	• The ability to maintain a combat vehicle and equipment complement that can be lifted or moved by existing and programmed aerial and surface assault lift assets • The ability to insert low-signature capabilities to form or support the initial entry force • The ability to land offset from enemy force concentrations and infrastructure using existing and planned assault lift assets
Required Capability 13: The ability of Reinforcing Entry Forces (REF) to quickly deploy and maneuver onto the initial assault objectives in order to provide additional firepower, protection, mobility, and required capabilities to ensure the survival of the initial entry force and the ability to achieve entry objectives necessary for mission accomplishment or transition to Follow-on Forces.	• The ability to land, via aerial and/or surface means, in a timely manner in order to support the Initial Entry Force • The ability to provide enhanced lethality and force protection during entry operations without creating a force that becomes too heavy to move rapidly or that requires reception, staging, onward movement, and integration (RSO&I) activities • The ability to tailor the REF for operations by expanding the use of small units of currently available medium and heavy forces trained to deploy rapidly on strategic lift as a REF asset and not just as a Follow-On Force • The ability to employ low-signature capabilities to insert and support the REF

Table 2.7
Key MEDCOM 2020 Scenario Operational Tasks Potentially Motivating Requirements for UTM Capabilities

Factor	Associated Operational Tasks
Constrained operating space	• Operate in densely vegetated areas around Vlore, Bulgaria to control key terrain
Constrained transport/ delivery capacity	• Conduct airborne Joint Forced Entry (JFE) operation requiring airdrop of mobility platforms using DRAS and CDS • Conduct air assault IVO Vlore, Bulgaria, requiring transport of light infantry soldiers and mobility platforms using CH-47 and UH-60 aircraft • Conduct aviation support operations requiring transport of aviation support platforms for FARP/DART missions using CH-47 and UH-60 aircraft
Insufficient road infrastructure	• Movement of airborne and air assault light forces through mountainous and remote areas near Vlore to control terrain
Extreme terrain	• Movement of airborne and air assault light forces over mountainous, rocky, and steep areas near Vlore to control key terrain
Support limitations	• Operate support area for initial entry operations with limited access to fuel and repair parts
Threat avoidance	• Utilize secondary and tertiary routes to detect and avoid deliberate asymmetric attacks (IEDs, etc.) and ambushes along primary movement routes
Operational signature	• Insert and transport long range surveillance (LRS) teams to conduct reconnaissance in advance of light infantry force maneuver
Threat vulnerability	• Avoid or survive exposure to enemy small arms, IEDs, and indirect fires
Hazard vulnerability	• Operate mobility platforms at night over unfamiliar and rugged terrain with limited rest and operational experience
Lack of interoperability	• Communicate with other maneuvering forces to transfer intelligence, coordinate maneuver, and ensure situational awareness of unit

as unusual, extraordinary responses to extraordinary circumstances, but standard and repeated responses to normal circumstances. Just as previous operations requiring UTM capabilities can be described by the mixture and relative importance of the factors listed above, commanders can anticipate future needs for UTM capabilities based on the existence and prominence of the factors discussed above. Due to the consistency of these factors over time, the Army can anticipate that future operations or particular portions of operations will encounter similar factors and a concomitant need for UTM capabilities. Figure 2.17 illustrates the characterization of general impacts on forces from UTM employment based on the two primary factors: hazard/threat to operators and availability of the SSV as an alternative. The chart prioritizes the general categories based on their overall benefit to the unit. As this chart indicates, instances where significant physical limitations on UTM employment exist and threat/hazard to occupants is low generally provide the greatest net benefits to a force from UTM employment.

Figure 2.17
Prioritized Characterization of UTM Impact on Force Based on Threats and SSV Limitations



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CHAPTER THREE

Army and Joint UTM Demand Profiles

While the Army has not invested in a coordinated effort to provide conventional units with UTM capabilities, individual Army units with specific UTM demands and some validated needs have used a range of local resources and other acquisition alternatives to develop and sustain UTM capabilities.[1] Other U.S. military services and special operations forces (SOF) have pursued similar approaches to meet often similar UTM needs. This chapter examines the mission-specific UTM demand profile associated with various types of Army unit, highlighting the UTM capabilities and associated doctrine, sustainment, training, and procurement resources that some representative units have developed to meet their demands. While these units' experiences are not generalizable to a broad cross-section of Army units, their needs are typical of units with comparable missions and demand profiles. Taken together, the UTM demand profiles of the unit types discussed in this chapter should motivate a significant Army interest in coordinated consideration of UTM capabilities.

To illustrate the various UTM demand profiles discussed, this chapter provides a detailed description of five units' recent experience with UTM: XVIII Airborne Corps Long-Range Surveillance Company (LRSC), the 101st Combat Aviation Brigade, the 86th Infantry Brigade Combat Team, the 1-6 Combined Arms Battalion, and Army Special Operations Forces (ARSOF) to include its aviation element. The chapter then describes the current Army UTM capability development and employment mechanisms and briefly touches on current combat employment of this capability.

Representative Army UTM Demand Profiles

To gain a better understanding of the specific UTM demands for various Army unit types and the potential commonality of UTM demands across them, RAND conducted field visits and interviews with a range of Army units identified as having either UTM capabilities or potential UTM needs.[2] The identified cases likely represent only a portion of UTM employment across the Army.

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1 As described in Chapter One, this report uses the term "demand" to refer to a desire for a capability to meet identified operational gaps that is not explicitly articulated in a formally validated "need" or "requirement."

2 While the research team attempted to identify and collect information from the primary and most representative conventional Army units that have some UTM capabilities, the generally ad hoc nature of current UTM capability development suggests there are potentially many other Army units with some level of UTM training, equipment, and/or sustainment not readily identifiable by the research team.

Airborne: XVIII Airborne Corps Long-Range Surveillance Company and 2 IBCT Headquarters

C Troop, 1-38 Cavalry (CAV), as XVIII Airborne Corps' LRSC, performs four primary missions: surveillance, zone and area reconnaissance, target acquisition, and target interdiction.[3] Additionally, the unit can execute route reconnaissance, emplacement and recovery of sensors, pathfinder operations, and personnel recovery (PR) and combat search and rescue (CSAR) operations.[4] To meet corps-level intelligence requirements, the LRSC's six-man teams are designed to operate 10 to 40 kilometers beyond other conventional forces and conduct tactical ground movement of up to 20 km per day. The LRSC has no organic or dedicated support capabilities and must maintain sufficient supplies to sustain operations for over three days without resupply.

Requirements and Constraints

Like other airborne units organized to support Joint Forced Entry (JFE) operations, this LRSC relies primarily on airborne delivery and rotary-wing extraction support. Consequently, LRSC teams must often deploy without SSVs, which places them in a position of either operating dismounted or availing themselves of whatever forms of mobility that readily can be delivered by airdrops or rotary-wing aircraft. The LRSC clearly benefits from UTMs, particularly for troop mobility and traveling support activities.

The LRSC's mobility requirements emphasize platforms with the following characteristics:

- efficiently air-droppable and usable immediately upon insertion
- can be rapidly inserted or extracted in combat configuration by a CH-47
- can carry sufficient supplies to operate for over three days without additional support[5]
- operates with minimal operational signature and is easily concealed to minimize the likelihood of detection
- increases the speed and staying power of otherwise dismounted formations.

Current UTM Capabilities to Address Demand Profile

As illustrated in Figure 3.1, the XVIII Airborne Corps LRSC currently maintains a UTM capability composed of ATVs and LTATVs (M-Gators) acquired primarily through informal relationships and locally available resources. The unit has also benefited from some UTM-specific operator and maintenance training, and it applies employment concepts it has developed independently and refined through training exercises.[6] Table 3.1 provides an overview of the LRSC's current UTM capabilities and associated challenges. The LRSC uses its UTM platforms primarily to accomplish these tasks:

- carry (but not mount) crew-served weapons (traveling support)
- carry soldiers and sufficient supplies, ammunition, and petroleum, oil, and lubricants (POL) to sustain independent operations for over three days (troop mobility)

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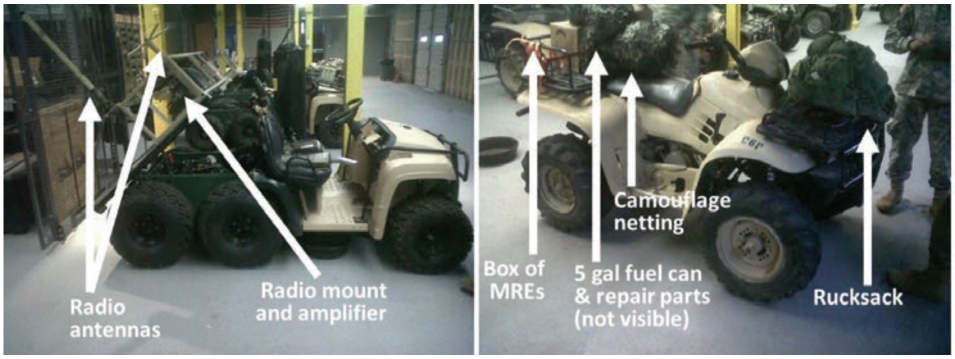
[3] Department of the Army, *Field Manual 3-55.93: Long-Range Surveillance Unit Operations*, June 23, 2009.

[4] Department of the Army, 2009.

[5] As stated in FM 3-55.93, 2009, the use of ATVs, variations of the HMMWV, and nonstandard commercial vehicles (NSCVs) can allow the LRS commander to rapidly employ teams with reduced resupply requirements while conducting operations.

[6] C Troop, 1-38 CAV, 2013. The LRSC received its current ATV platforms at no cost from 3rd Special Forces Group, also located on Fort Bragg, replacing these older ATV platforms.

Figure 3.1
XVIII Airborne Corps LRSC M-Gator and ATV Platforms



SOURCE: Photographs by authors, additional information from 1-38 CAV personnel.
RAND *RR718-3.1*

- carry radios, amplifiers, and antennas for command and control (C2) functions (traveling support).

Summary

The XVIII Airborne Corps LRSC's experience as an airborne unit and cavalry formation suggests the potential utility of rapidly deployable UTM platforms for enhancing the range, endurance, and carrying capacity of airborne or air assault forces, especially those formations that must rely primarily on mobility and stealth to avoid threats and accomplish missions. The LRSC's current UTM capability enables its LRS teams to conduct surveillance and reconnaissance missions over 72 hours and a 250-mile range without resupply.[7] These capabilities are particularly inviting for similar airborne or air assault formations that, due to delivery constraints, are left primarily to dismounted movement and operations upon insertion.

Table 3.1
Summary of XVIII Airborne Corps LRSC UTM Applications, Capabilities, and Challenges

Category	Description
Key UTM application demands	• increase speed, range, duration, and carrying capacity of otherwise-dismounted operations • rapid airdrop insertion/rotary-wing insertion and extraction • long-range ground movement for infiltration to surveillance locations • sustained operations beyond three days without external support
Key UTM capabilities	• mix of Polaris/Honda ATV and M-Gator platforms • UTM platforms formally recognized as option in Army LRS doctrine • Unit concepts of employment developed/refined in recent exercises
Supporting capabilities	• AWG-provided instruction on UTM operation and maintenance • most repair and upgrade parts purchased with unit operating funds
Key challenges and limitations	• no established procurement method for obtaining additional UTM platforms • no Army-supported UTM maintenance or sustainment program • lack of established TTPs or employment concepts

[7] Department of the Army, 2009.

Other Army Airborne Forces with Similar UTM Capabilities, Demands, and Requirements

In addition to the XVIII Airborne LRSC, the 82nd Airborne IBCTs currently maintain numerous M-Gators and UTM vehicles as part of their initial entry package (A Echelon) and reinforcing entry forces (B Echelon). Figure 3.2 provides an extract from a recent Priority Vehicle Listing (PVL) for an Airborne IBCT that identifies the UTM vehicle's priority (column A), delivery echelon (column B), and intended use (columns C and F). Like the XVIII Airborne Corps LRSC, the 82nd Airborne UTM vehicles are almost completely sustained with unit funds. Additionally, Army Forces Command (FORSCOM) has recently published a tentative plan to provide the 82nd Airborne Division a battalion-sized set of DAGOR and Polaris MRZR4 to increase the mobility of airborne IBCT forces.[8]

Air Assault/Aviation Support: 159th Combat Aviation Brigade (Air Assault)

As part of the 101st Airborne Division (Air Assault), 159th Combat Aviation Brigade (CAB) is organized to deploy worldwide within 36 hours of notification to conduct air assault and air movement operations. The brigade is composed of two assault battalions (UH-60), one medium lift battalion (CH-47), one air cavalry squadron (OH-68), one Aviation Forward Support Battalion (AFSB), and one air ambulance company (UH-60). The CAB, with its broad array of rotary-wing assets, performs a range of aviation and aviation support missions, to include air assault, air movement, FARP, and DART operations.[9, 10] The 159th CAB's mobility demands and constraints are representative of those for aviation and aviation support units,

Figure 3.2
Priority Vehicle Listing (PVL) of UTM Vehicles for a Current Airborne IBCT Forcible Entry Package

A	B	C	D	E	F
Vehicle No.	Echelon	Use	Model	Unit	Capability
8	A (Airdrop)	Nonstandard CASEVAC	Gator	BSB	Nonstandard CASEVAC
9	A (Airdrop)	Nonstandard CASEVAC	Gator	BSB	Nonstandard CASEVAC
10	A (Airdrop)	Supply movement	Gator	1-319	Supply movement
11	A (Airdrop)	Supply movement	Gator	ME IN BN	Supply movement
55	A (Airdrop)	E/1-505-supply movement	Gator	1-505	Supply movement
56	A (Airdrop)	E/1-505-supply movement	Gator	1-505	Supply movement
64	A (Airdrop)	HHC/1-404-Non. CASEVAC	Gator	1-505	Nonstandard CASEVAC
65	A (Airdrop)	HHC/1-404-Non. CASEVAC	Gator	1-505	Nonstandard CASEVAC
89	A (Airdrop)	FSC	Gator	2-505	FSC, Inf1
90	A (Airdrop)	FSC	Gator	2-505	FSC, Inf1
140	B (Airland)	Quick supply distribution asset	Gator	2-505	
141	B (Airland)	Quick supply distribution asset	Gator	2-505	

SOURCE: 3rd Infantry Brigade Combat Team (Airborne), 82nd Airborne Division, "Priority Vehicle Listing (PVL) for Forcible Entry," September 2013.

RAND *RR718-3.2*

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8 U.S. Army Forces Command, March 2014.

9 Department of the Army, *ATTP 3-18.12: Air Assault Operations*, 2011. An air assault operation is an operation in which assault forces, using the mobility of rotary-wing assets and the total integration of available firepower, maneuver under the control of a ground or air maneuver commander to engage enemy forces or to seize and hold key terrain (JP 3-18).

10 Department of the Army, *Field Manual 3-04.513: Aircraft Recovery Operations*, July 2008.

and for other unit types that depend on aviation capabilities to execute air assault operations and air movements.

Demands and Capabilities

The 159th CAB's requirements for ground mobility are many. For DART missions, for example, the CAB requires platforms that can negotiate rough or constricted terrain to access downed aircraft and carry required repair and recovery equipment. For FARP missions, CAB elements must transport the Advanced Aviation Forward Area Refueling System (AAFARS) (see Figure 3.3).[11] However, the choice of vehicles is severely limited by the CAB's reliance on helicopters, especially the CH-47. At a minimum, the CAB has to be able to lift a vehicle with a CH-47 using an external sling load. Ideally, however, many missions require transporting vehicles in combat configuration *inside* the aircraft for rapid exfiltration from the aircraft and insertion point.[12]

UTMs provide an obvious solution to many of the CAB's demands. Indeed, the 159th maintains M-Gators and has used them for the following activities (see Figure 3.4):

- movement of repair parts during aviation operations (internal ferry support)
- movement of fuel and ammo during FARP operations (internal ferry support)
- transport of repair parts and equipment for DART operations (traveling support)
- transport of DART members and individual maintenance kits (troop mobility).

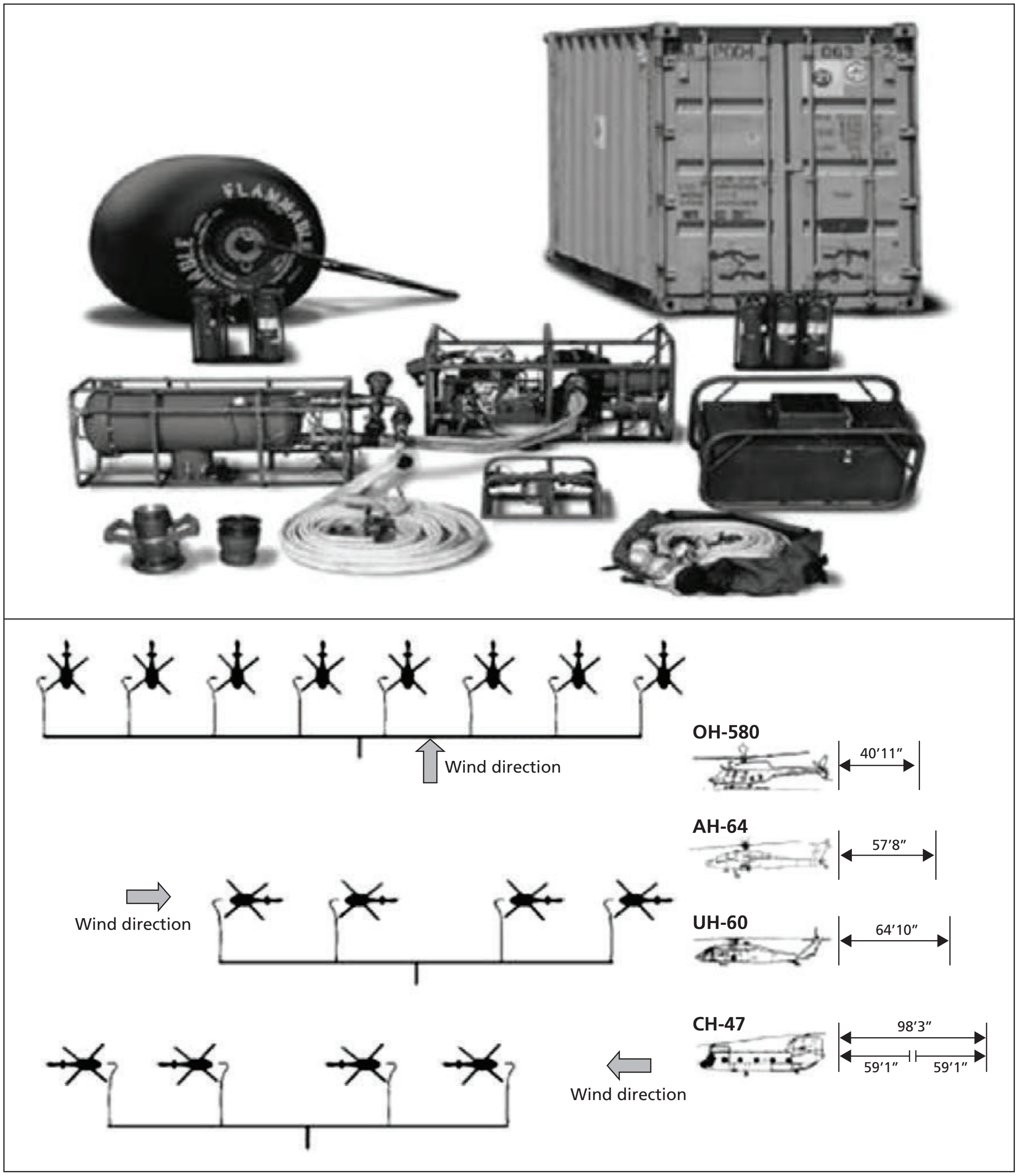
Despite the CAB's mobility demands and its use of M-Gators to meet them, the unit does not have enough to support the activities in which it engages, activities for which it cannot use SSVs because of their size and weight. Part of the problem is that although Congress initially procured M-Gators for the Army in 2000 and units have widely used the vehicle since, it is still considered a "nonstandard" piece of equipment without an authorized line-item number (LIN) or support program.[13] Although the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2000 approriated $13 million for procurement of M-Gator vehicles, this appropriation did not include a funding or requirement for the Army to establish a Program of Record or sustainment program. In the years since the initial M-Gator purchase, the Army left repair and sustainment as an informal function and sole responsibility of the units that received (or later purchased) the M-Gators.

[11] The 159th CAB and other conventional Army aviation units use the AAFARS, an operationally responsive advancement in rapid delivery of fuel to aviation units. The AAFARS is capable of deploying and initiating operations in 20 minutes or less using a four-person team. The AAFARS supports a variety of missions when the ability to supply fuel by ground transport is not possible or when the urgency of the situation requires the rapid establishment of a forward refueling capability.

[12] 159th Aviation staff, interviews with authors, April 22, 2013. When they meet ground mobility requirements, UTMs are often preferred for aviation support missions because they can be internally carried by a CH-47 and do not require the extensive preparation for external sling loading.

[13] U.S. Congress, *National Defense Authorization Act for FY 2000,* 1999. The NDAA, in response to XVIII Airborne Corps' urgent operational needs, authorized $13.0 million for purchase of the John Deere™ M–Gator as "a low cost, air-deployable, multipurpose vehicle designed for transport of logistics equipment and personnel on the battlefield and in urban terrain." This was a $12 million increase over the initial Army request. However, the NDAA appropriated no funding for sustainment or replacement of the purchased M-Gators.

Figure 3.3
Advanced Aviation Forward Area Refueling System (AAFARS) Equipment and Basic FARP Layout Dispersion



SOURCE: U.S. Army, Army Techniques Publication 3-04.94: Forward Arming and Refueling Point Operations, 2012.
RAND *RR718-3.3*

Figure 3.4
The John Deere™ M-Gator Uses by 159th Combat Aviation Brigade

Unit:	159 CAB
Model:	M-Gator A1
Manufacturer:	John Deere
Funding:	P2
Cost:	$15,000
Fuel:	Diesel/JP8
Speed:	20 mph
SUB LIN:	YF4000
NSN:	2340-01-C06-9049
Unit AUTH:	No nonstandard
Application:	DART/FARP
Airworthy:	Air assault only

SOURCE: John Deere, 2013.
RAND *RR718-3.4*

Summary

Currently, the 159th Combat Aviation Brigade (CAB) faces ground mobility challenges and demands for UTM capabilities emblematic of conventional CABs across the Army (see Table 3.2). The 159th CAB has some aging M-Gators, but not enough to meet all operational demands for them. Additionally, the lack of readily available repair parts or authorized alternatives to procure replacement platforms has decreased the number of usable platforms to support all the various CAB demands for UTM. The CAB's experiences, as a key component of air assault, air movement, and aviation support operations, also illustrate the key operational constraints and considerations that drive demands for UTM by air assault and aviation forces.

Mountain Warfare: 86th IBCT (Mountain) (National Guard)

The 86th Infantry Brigade Combat Team (IBCT) (Mountain) is a Vermont Army National Guard Light Infantry Brigade and is currently the only Army BCT with a Table of Organization and Equipment (TOE) authorization to maintain mountain warfare skills and capabilities. The 86th IBCT (MTN) both supports and uses the colocated Army Mountain Warfare School (AMWS) to develop, maintain, and export mountaineering skills.[14] The 86th IBCT (MTN) provides the Army with mountain-specific operational capabilities to execute combat operations in alpine and cold weather environments. The 86th IBCT (MTN), as a National Guard TOE unit, has Title 10–related mountain infantry missions and Title 32–related Defense Support to Civil Authorities (DSCA) missions that impose specific demands for ground mobility that current SSVs do not fully meet.[15]

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[14] Army Training and Doctrine Command (TRADOC), "History of the Army Mountain Warfare School (AMWS)," November 17, 2011.

[15] DoD Directive 3025.18, "Defense Support of Civil Authorities," defines DSCA as executed under Title 32 as support provided by National Guard forces in coordination with the governors of the affected states in response to requests for assistance from civil authorities for domestic emergencies, law enforcement support, and other domestic activities, or from

Table 3.2
Summary of 159th CAB UTM Applications, Capabilities, and Challenges

Category	Description
Key UTM application demands	• logistics support within the forward operating base • Downed Aircraft Recovery Team operations • Forward Area Refuel Point operations
Key UTM capabilities	• limited number of M-Gator platforms to meet UTM requirements • specific Army doctrine for sling load[a] and airdrop[b] of M-Gators
Supporting capabilities	• informal maintenance expertise to maintain and repair platforms • unit operating funds for maintaining and repairing M-Gators
Key challenges and limitations	• no established procurement method for additional UTM platforms • UTM platforms are not supported through the Standard Army Management Information System (STAMIS) • UTM parts availability is COTS and not ASL supported • no method for influencing design of UTM capabilities[c] • limited leadership knowledge to initiate and manage the ONS process to validate requirements[d]

[a] Department of the Army, *Field Manual 4-20.198: Multiservice Helicopter Sling Load Procedures*, 2009.

[b] Department of the Army, *Field Manual 4-20.108: Airdrop of Supplies and Equipment: Rigging Military Utility Vehicles*, 2007.

[c] 159th CAB, interviews with authors, April 22, 2013. Practitioners assess that input for UTM program design and model acceptance is determined at the Program Executive Officer (PEO) level with little or no input from personnel at the CAB level or below.

[d] 159th CAB, 2013. Unit Status Reporting (USR) and ONSs are the primary methods for identifying and validating unit equipment needs and capability requirements. While 159th CAB personnel have attempted the submission process they describe as daunting, efforts have generally failed because the initiating commands could not devote the time and consistent attention required for resolution.

Demands and Constraints

The 86th IBCT's dual responsibilities for executing state-initiated Title 32 missions and DoD-initiated Title 10 missions generate two distinct yet overlapping sets of mobility demands not adequately met by SSVs. The 86th's Title 10–related mountain warfare missions impose requirements for ground platforms that can conduct maneuver and other combat activities in the following environments:[16]

- rugged Level II and Level III terrain
- alpine regions with dense vegetation
- deep snow (at least 12–18 inches) or muddy surface conditions
- rocky or rugged terrain with few or no improved roads
- high altitudes above the limits of CASEVAC aircraft.

qualifying entities for special events. LTG William E. Ingram, Jr., *Army National Guard Strategic Imperatives Year 2011*, Washington, D.C., Army National Guard, 2011.

[16] Department of the Army, *ATTP 3-21.50: Infantry Small-Unit Mountain Operations*, 2011.

The 86th's Title 32–related missions include DSCA, Homeland Defense missions that impose requirements for ground mobility that SSVs do not fully meet.[17] The unit must be able to

- conduct C2, search and extraction, security, logistical support, and decontamination in constrained domestic emergency environments
- conduct search and extraction in rugged mountain environments.

UTM Capabilities

While the 86th IBCT developed some UTM capabilities and expertise locally, such capabilities are not Army standard and are inadequate to meet their mountain mobility requirements, especially with the removal of their few Hagglund BV-206 platforms from service.[18] While the BV-206 exceeds the size constraints for consideration as a UTM alternative, this platform's capabilities are informative because they highlight the mountain warfare limitations of SSVs that UTM is also used to address, to include mobility over deep snow and loose soil, and the need to tow dismounted skiers, as illustrated in Figure 3.5. The 86th IBCT owes its current fleet of M-Gators and Polaris Sportsman 700s (non-military model) to a specific, one-time congressional appropriation sponsored by Vermont Senator Patrick Leahy. However, this appropriation did not include key UTM support capabilities, such as trailers to transport UTM platforms or maintenance resources.

Summary

The 86th IBCT is an example of a unit with mobility demands that SSVs cannot fully meet. To sustain a viable mountain warfare capability, the 86th IBCT must train, deploy, and support small infantry units in environments with steep slopes, few roads, dense vegetation, and thick snow or mud. The M998 HMMWV can negotiate these conditions to some extent, but the unit is designed to operate in circumstances that exceed its capabilities. The BV 206, the unit's soon-to-be-defunct alternative to SSVs, demonstrates the immense value of vehicles that can disperse surface weight with tracks or skis, such as snowmobiles or tracked ATVs. Additionally, the 86th IBCT experience demonstrates the utility of UTMs to support rapid deployment to an emergency in permissive domestic disaster relief settings that are often too constrained for the SSV (see Table 3.3). Like other Army units with UTM capabilities, the 86th IBCT has developed and maintained them almost exclusively through ad hoc methods and local resources.

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[17] Homeland Response Force (HRF) Region 1 Vermont Security Element (SECEL), *SECEL Concept of Operations*. September 15, 2012. Unclassified excerpt.

[18] In 1983 the U.S. Army Tank Automotive Command (TACOM) was awarded a $24.2 million contract for the BV 206 all-terrain carriers known as the Small Unit Support Vehicle (SUSV) for fielding to units operating in extreme cold weather environments. The BV 206 consists of two tracked units linked together with a segmented steering. Because of their wide tracks, BV 206s are especially effective at mobility over think snow, mud, and sand. The BV 206 is currently in use with the 86th IBCT and Vermont Mountain Warfare School; however, discontinued from the Brigade's Modified Table of Organization and Equipment (MTOE) FY 2010. The SUSV is now a non-supported obsolete item in the Army inventory, resulting in only an ad hoc program for sustainment.

Figure 3.5
86th IBCT (MTN) Mobility Assets: SSVs, UTMs, and the BV 206 (right)

SOURCES: Vermont National Guard, 2012, and U.S. Army Public Affairs, 2011.
RAND *RR718-3.5*

Armor/Mechanized Maneuver: 1/6 Combined Arms Battalion (Mechanized)

As part of 2nd Brigade, 1st Armored Division, 1/6 Combined Arms Battalion (CAB) (mechanized) participated in Network Integrated Enterprise (NIE) to assess new capabilities and determine their potential implications for Doctrine, Organization, Training, Materiel, Leadership, Education, Personnel, and Facilities (DOTMLPF). As part of the NIE, the unit employed UTM capabilities provided by Rapid Equipping Force (REF) and supported by the Asymmetric Warfare Group (AWG) to evaluate the potential of UTM employment concepts.[19] The 1/6 CAB focused on integrating UTMs with their standard mechanized force to conduct full-spectrum operations. Outcomes of the experiments and lessons learned for 1/6 Infantry personnel supported the assessment of the feasibility and potential benefit of integrating UTM platforms with mechanized and armored forces.

Demands and Constraints

The 1/6 CAB, unlike other units interviewed for this study, did not pursue UTM capabilities to meet specific ground mobility needs not otherwise addressed by SSVs or other standard vehicles. On the contrary, 1/6 CAB was provided with UTMs to identify opportunities for and challenges to UTM employment as part of a mechanized force.

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[19] U.S. Army Training and Doctrine Command (TRADOC), "An Enduring Army Process", January 9, 2013, *NIE 14.1 Industry Day Opening Remarks*, Aberdeen Proving Grounds, MD, MG H. Greene, DASM, SoSe&I. The Network Integration Evaluation (NIE) is a series of semi-annual evaluations designed to establish a Network Baseline to rapidly shape the Army's tactical Network. Assessed are network and non-network capabilities, including Theater Provided Equipment (TPE), developing and emerging network capabilities that help determine the implications of capabilities across DOTMLPF.

Table 3.3
Summary Profile of 86th IBCT (Mountain) UTM Capabilities

Category	Description
Key UTM application demands	• mobility and support in broken, heavily vegetated, and deep-snow terrain • casualty evacuation in high-altitude, rugged, and heavily vegetated terrain • support and casualty evacuation in disaster areas (Title 32/DSCA)
Key DOTMLPF capabilities	• UTMs generally recognized as mobility options in Army mountain warfare doctrine[a] • training: no integration to prepare to fight tactically in various types of unit training or Joint exercises • facilities: obsolete equipment (SUSV) and nonstandard (ATV) cataloging of on-hand equipment do not provide installation and industrial facilities to support assigned forces or trainees
Supporting capabilities	• training is based on manufacture recommendations • ad hoc maintenance support program performed internally • baseline funding depends on state managed fiscal priorities • stable base of UTM employment and maintenance knowledge[b]
Key challenges and limitations	• no existing formal training IAW Army doctrine • Title 32 limitation in procurement and sustainability • BV 206 has been removed from unit MTOE (Obsolete)

[a] Department of the Army, ATTP 3-21.50, 2011.

[b] As a National Guard unit, 86th IBCT (MTN) personnel have significantly longer average time in their position and the BCT than comparable active-duty personnel, allowing them to more readily develop and maintain mountain skills and organizational capabilities over time. Also, the 86th benefits from the informal UTM platform operation and maintenance knowledge provided by the numerous unit personnel that privately own and operate civilian UTM-like vehicles.

UTM Capabilities

For the NIE, the AWG provided 1/6 CAB two UTM platform variants: Christini all-wheel-drive motorcycles and the Kawasaki TRX 750 side-by-side ATV, as depicted in Figure 3.6.[20] Before the unit received its UTMs, selected personnel were provided contracted training by the REF with AWG support for day and night tactical operations of the UTMs, including maintenance and repair.

While the NIE encouraged and expected commanders to develop and evaluate innovative UTM employment concepts, many of the most beneficial UTM employment concepts that they identified echoed previously demonstrated UTM platform applications. For example, during the NIE, personnel noted that UTMs offered the following capabilities:

- provided commanders with an "arms room" of multiple platform alternatives to select from and configure forces tailored to mission needs[21]
- increased elements' speed and their ability to perform reconnaissance and rapidly establish observation posts (OPs) for security and reconnaissance
- operated in urban environments that limited SSV use

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[20] These are Honda motorcycles modified by Christini Motorcycles with robust engines and an all-wheel drive system to make them better suit the specific needs of military users.

[21] Department of the Army, *Field Manual 3-21.12: The Infantry Weapons Company*, 2008. The "arms room" concept allows a sniper team to employ the sniper system that best supports the mission parameters or a battalion mortar platoon to utilize the battalion mortar squads equipped with both 120mm and 81mm mortars to operate at any one time.

Figure 3.6
Soldiers from 1/6 CAB Employ Christini Motorcycles (left) and Other UTM to Conduct Area Reconnaissance During the Army Network Integration Evaluation (NIE) 13.1 (right).

SOURCE: U.S. Army.
RAND *RR718-3.6*

- improved the speed and efficiency of marshaling and resupply during area defense or assembly area operations
- increased speed and efficiency in marshaling and guiding armored vehicles into position when preparing for both offensive and defensive operations[22]
- reduced noise and sight signatures, which increased the commander's ability to perform full spectrum operations.[23]

The experiment also identified the following significant considerations that limit UTM platforms' utility to armored and mechanized forces:[24]

- Doctrine does not exist for how to employ UTM platforms in concert with the armored and mechanized infantry forces.
- While units conducting COIN operations in Afghanistan and Iraq developed some successful TTPs for using UTM platforms, these are not necessarily applicable to more conventional maneuver operations.
- Rather than clearly adding a new capability to the unit, borrowing military manpower from other critical positions to employ UTM platforms sometimes diminished the capability of both the existing and UTM capabilities.

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[22] Maneuver Force Security/Recon: Mission tasks where UTM platforms provide supporting efforts to a main effort unit in order to enable that unit to maintain freedom of movement and maneuver. Such efforts include providing flank security, over watch, or providing reconnaissance and surveillance for a supported unit. Such missions may require UTM platforms due to their reduced physical form and operational signature (compared to current Army SSVs), or require greater speed or work capabilities than dismounted troops.

[23] Department of the Army, *Field Manual 3-0: Operations*, 2008. Full spectrum operations describe the concept to seize, retain, and exploit the initiative and achieve decisive results through combinations of four elements: offense, defense, and stability or civil support operations.

[24] 1-6 Infantry Battalion (Mechanized), interviews with authors, January 17, 2013.

- Maintaining a UTM capability requires operators and mechanics to receive formal training, probably through either a Military Occupational Specialty (MOS)- or Additional Skill Identifier (ASI)-producing school.
- Similarly, UTM operators need to keep their skills current to operate UTMs (especially motorcycles) effectively and safely in a tactical setting.
- Appropriate training, communication equipment, and leader knowledge are absolutely necessary for successful employment of the UTM platforms.
- UTM platforms capabilities require additional equipment and resources for movement on the battlefield.

Summary

The 1/6 CAB experience with UTM platforms demonstrates some potential benefits of and issues with using UTM platforms as part of a mechanized maneuver force (see Table 3.4). As expected, UTMs proved effective at operating in advance of the maneuver element, supporting urban/village operations, or establishing an OP. In these instances, the UTM capabilities extended the area of influence (AOI) of the commander in advance of and laterally to the armored formations. The speed and mobility of the UTM allowed the unit to conduct recon missions more stealthily and flexibly than its next best alternative: the 72-ton M1 Abrams tank. However, the integration of relatively small UTM platforms with heavier mechanized forces posed significant issues, including communication between UTMs and mechanized forces, transportation of UTMs around the battlefield when not in use, and dangers and threats associated with operating relatively unstable motorcycles in rough terrain and low visibility conditions.

Special Operations/Aviation Support: 160th Special Operations Aviation Regiment

While 160th Special Operations Aviation Regiment (SOAR) (Airborne) is not a conventional Army unit, its experience with UTM capabilities provides useful insights that are relevant for conventional Army units. Most important, the 160th SOAR closely resembles the 159th CAB with respect to requirements and constraints, yet because the SOAR operates within the Spe-

Table 3.4
Summary Profile of 1/6 CAB (Mechanized) UTM Capabilities

Category	Description
Key UTM application demands	• no significant UTM operational needs; some benefits identified • allowed commanders to tailor force for specific mission requirements • rapid establishment of OPs during recon operations • coordination and marshaling of assembly area and defense position occupation
Key DOTMLPF capabilities	• Christini AWD motorcycles and side-by-side ATVs • REF-contracted training for operators (through OCO funding)
Supporting capabilities	• operator training provided by certified instructors • user-level maintenance training to provide expedient repair • REF-funded repair parts program (through OCO funding)
Key challenges and limitations	• no basic doctrine or concepts for UTM platform employment with mechanized forces • limited ability to transport across battlefield with mechanized force • significant hazard associated with nighttime/NVG operations • communication and coordination with armored vehicles during maneuver very challenging

cial Operations community, it benefits from stronger institutional support for UTM use. It therefore provides a counterexample or an alternative for supporting UTM capabilities.

Requirements and Constraints

As with the CAB, the SOAR has a number of ground mobility requirements but is constrained by the airframes in its inventories, primarily MH-60s and MH-47s, special operations variants of the UH-60s and CH-47s in the CAB fleet. There is a crucial difference, however: Unlike the CAB, the SOAR benefits from strong institutional support for UTM capabilities that are particular to the Special Forces community, including established procurement processes. As a result, the SOAR not only operates UTMs more routinely than the CAB but also has been able to hone a sharper understanding of its specific UTM requirements. Specifically, beginning in 2008, the regiment developed material solutions to mitigate constraints regarding UTM use in DART/FARP operations. The SOAR wanted to increase efficiency and reduce risk during these operations by providing increased load and passenger carrying capability while increasing speed and maneuverability on site. Based on previous operations in austere environments in Iraq, Afghanistan, North Africa, and other regions, the regiment concluded that UTMs must have the following characteristics:

- at least a nine-gallon fuel tank to sustain extended operations
- bench seats with a shifter on the floor to facilitate lateral movement from one side of the aircraft to the other while in transport
- physical dimensions no greater than 153.75 inches by 62 inches by 70.6 inches including a roll cage
- the ability to transport 1,000 lb. on the rear box and at least 100 lb. on a front rack
- no less than a 9-inch ground clearance
- blackout and IR lighting, a block heater, a winch with at least a 4,000-lb. capacity, a cab heater, and cargo tie-down points on front/rear rack.

UTM Capabilities

160th SOAR obtained UTM platforms tailored to meet these specific requirements using dedicated procurement processes, and it has also benefited from specialized training primarily funded by the MFP-11.[25] The net result was a modified Ranger Crew 800 ATV (see Figure 3.7) and several subsequently developed UTM variants.

Summary

Operating with relatively well resourced operational and support, 160th SOAR has been successful in the design, validation, development, and procurement of mission-specific UTM platforms (see Table 3.5). 160th SOAR's success is attributed to the processes adopted by the United States Army Special Operations Command (USASOC) and the ability to negotiate the cycle supporting material solution integration, to include identifying, capturing, and validating salient requirements for UTM. Additionally, SOF applied industry product analysis,

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[25] Major Force Program (MFP-11) provides the U.S. Special Operations Command (USSOC) with funding authority for the development and acquisition of equipment, materials, supplies, and services peculiar to special operations. Legislation makes the military services responsible for providing standard equipment and supplies to their forces through MFP-2 funding.

Figure 3.7
160th SOAR Mission-Specific UTM Platform, RANGER CREW 800 (Modified)

Unit:	160th SOAR
Model:	RANGER 800
Manufacturer:	Polaris
Funding:	P11
Cost:	$21,000
Fuel:	Diesel/JP8
Speed:	35 mph
SUB LIN:	YF4000
NSN:	2340-01-D04-0305
Unit AUTH:	No—Nonstandard
Application:	DART/FARP
Airworthy:	Yes

SOURCE: 160th SOAR, 2012.

RAND *RR718-3.7*

operational validation, unit and user evaluation, and sustainment estimates to determine the most beneficial UTM alternatives. While the Army may not seek to invest similar resources for development of aviation-specific UTM capabilities, 160th SOAR experience determining requirements and evaluating alternatives is a good example for an Armywide UTM procurement program.

Table 3.5
Summary Profile of 160th SOAR UTM Capabilities

Category	Description
Key UTM applications	• logistics support within the forward operating base • Downed Aircraft Recovery Team operations • Forward Area Refuel Point operations
Key DOTMLPF capabilities	• mission-tailored UTM platforms • established testing and evaluation program to identify salient characteristics for UTM capability requirements • established and refined unit TTPs and SOPs for employing UTM capabilities
Supporting capabilities	• contracted supported unit-level driver and maintenance training • MFP-11 funding for platforms, repair, sustainment, and training
Key challenges and limitations	• SOF UTM procurement effective but not coordinated • no formalized program to identify evolving UTM requirements or evaluate new UTM technologies

Army Special Operations Forces

Army Special Operations Forces (ARSOF) includes various units with overlapping but distinct mission requirements that often necessitate UTM.[26] ARSOF is an Army Service Component Command that, with over 45,000 soldiers, represents a significant portion of Army capabilities and routinely serves the conventional Army as a test bed for development of emerging technologies and concepts. In keeping with this role, ARSOF's experiences with UTM development and employment are valuable resources for conventional Army consideration of UTM demands and development strategies.

In addition to SOF aviation forces' experiences with UTM discussed previously, ARSOF also includes several types of ground forces, each of which has validated UTM requirements:

- Special Force Regiment: organized, trained, and equipped to conduct special operations (SO) across the range of military operations, with an emphasis on UW capabilities
- Ranger Regiment: rapidly deployable airborne light infantry organized and trained to conduct highly complex joint DA operations with or in support of other SO units of all services
- 95th Civil Affairs Brigade: organized, trained, and equipped to provide specialized support to SOF commanders conducting Civil Military Operations (CMO)
- the 528th SB (SO)(A): provides operational logistics command and control, signal, and Role 2 medical care in support of ARSOF, as well as maintaining global situational awareness of deployed ARSOF logistics support structures.

As SOF elements, these units are required to conduct time-sensitive and dynamic operations in locations that are often remote, austere, and uncertain with limited support and sustainment from the conventional Army force structure. Due to the operational requirements, ARSOF routinely needs UTM capabilities. As a result, ARSOF has established requirements, programs, and support resources to ensure ready availability of UTM capabilities.

Due to their need to operate in austere and dynamic environments, SOF UTM requirements typically include specific SOF-peculiar modifications, such as special lighting, rollover protection, weapons mounts, radio mounts, and stowage and mounting capabilities for gear.[27] In addition, SOF UTM requirements generally include the need for high-performance vehicles that can operate at high speeds and over rough terrain (see Figure 3.8). For SOF's widely fielded Kawasaki Tyrex 750 LTATV platform, USSOCOM solicited offerings for modified commercial off-the-shelf (M-COTS) 4x4 and 6x6 vehicles with Special Operations Forces (SOF)–peculiar modifications with the following key performance parameters (KPPs):

- internally transportable by military aircraft (CV-22 and MH-47)
- payload of 1,100 lb. (4x4 variant) and 1,200 lb. (6x6 variant)
- operating range of 150 miles
- equipped with standard automotive controls to include a steering wheel

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[26] Department of the Army, *Field Manual 3-05: Army Special Operations Forces,* 2010. Army Special Operations Forces (ARSOF) includes Special Forces (SF), Rangers, special operations aviation (SOA), and Military Information Support (MIS) and Civil Affairs (CA) forces assigned to the United States Army Special Operations Command (USASOC)—all supported by the Sustainment Brigade (Special Operations) (Airborne) (SB[SO][A]).

[27] U.S. Special Operations Command, "Solicitation No. H92222-08-R-0036, Light Tactical All-Terrain Vehicle (LTATV)," May 2, 2008.

Figure 3.8
The LTATV (left) and Polaris MV700 ATV (right) as Employed by ARSOF in Afghanistan

SOURCE: U.S. Marine Corps, 2012 and Department of Defense, 2009.
RAND *RR718-3.8*

- equipped with rollover protection
- equipped with industry standard (four- or five-point) seat belts
- equipped with run-flat tires that are capable of moving the vehicle, after tire penetration, for 15 miles at 30 miles per hour.

UTM Capabilities

In addition to the LTATV, ARSOF has access to a range of UTM capabilities through the SOCOM FSOV program, to include ATVs, LTATVs, nonstandard civilian vehicles (NSCVs), and snowmobiles (MOSTs), as described by Figure 3.9. As SOF units, these forces receive equipment through both Major Force Program 2 (Conventional Forces) and MFP-11 (Special Operations Forces). Any service-common requirements are met through Army-provided MFP-2 and any SOF-peculiar requirements are met through MFP-11. Since the Army does not currently have authorized UTM platforms or supporting capabilities, ARSOF UTM capabilities are funded almost exclusively through SOCOM-administered MFP-11 funding.

Due to their established and widespread requirements for UTM capabilities, ARSOF also maintain a number of supporting capabilities, including training programs, maintenance support, and SOF-specific doctrine. For example, 10th Special Forces Group (SFG) provides a training course involving locally contracted pack animals from ranches near their base at Fort Carson, Colorado.[28] Other SFGs have pursued similar methods to coordinate UTM-specific training with MFP-11 funding. Further, ARSOF has established doctrine, *ATTP 3-18.14: Special Forces Vehicle-Mounted Operations,* specifically to guide operational employment of UTM platforms. Due to the routine employment of UTM capabilities in both combat operations and more permissive settings, ARSOF possesses an extensive base of knowledge for UTM employment when required. While conventional Army forces do not require these habitual or broadly resourced UTM-related programs, ARSOF experience and existing capabilities offer resources that conventional Army forces can readily take advantage of to develop and maintain appropriate UTM capabilities.

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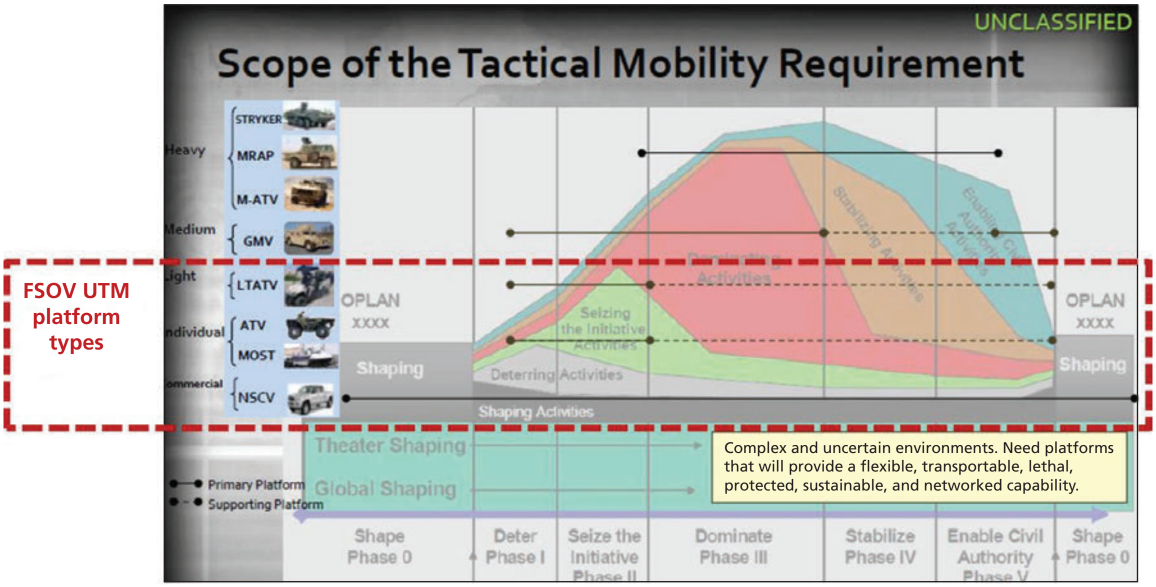
[28] 10th SFG personnel, interviews with authors, November 10, 2012.

Figure 3.9
Special Operations Vehicle Requirements, by Phase of Operations



SOURCE: Michael Ellis, "Ground Combat Systems—Mobility," *Special Operations Forces Industry Conference*, 2010.
RAND *RR718-3.9*

Summary

While ARSOF has a well-demonstrated need for and history with UTM employment, ARSOF experiences are not sufficient alone to validate conventional Army needs for UTMs. However, ARSOF's extensive experience, knowledge, and capabilities should serve as fundamental resources to inform conventional Army development and sustainment of capabilities in the numerous areas where ARSOF and wider Army needs overlap. Conversely, conventional Army development of UTM capabilities can benefit ARSOF by providing a basis of MFP-2 platforms that they can easily acquire and further adapt with MFP-11 resources to meet SOF mission requirements. Although ARSOF UTM experiences do not validate conventional Army needs, ARSOF and conventional Army UTM programs should be closely coordinated to take advantage of the significant common needs that exist.

Implications of SOF UTM Employment for Identifying Conventional Forces UTM Demands

The experience of 160th SOAR and other ARSOF with UTM illustrate some recognized SOF characteristics that have enabled the application of UTM and other technologies to meet emergent operational needs. Table 3.6 identifies these SOF characteristics and examples of these characteristics in SOF activities. These characteristics evidenced by SOF UTM employment are also applicable to some conventional Army units under certain conditions, such as small airborne force deployments and employment of Regionally Aligned Forces in austere settings. The experiences of conventional Army units employing UTM capabilities, as described above, illustrate one or more of the characteristics associated with SOF. Conversely, the demand for Army force packages with one or more of the SOF characteristics identified in Table 3.7 suggest instances where UTM employment is possibly appropriate.

Table 3.6
Summary Profile of ARSOF UTM Capabilities

Category	Description
Key UTM application needs	• tactical speed and maneuverability during special operations • mobility readily deployable by airdrop and air assault to austere and rugged locations • sustained operations with partner forces in permissive and semi-permissive environments
Key DOTMLPF capabilities	• doctrine: established Army doctrine for Special Forces employment of UTMs as part of special operations • organization: sufficient platforms and training to support unit-level UTM maneuver • training: pack animal and mechanized UTM training programs contracted with local providers • materiel: MFP-11–funded SOFM program to procure, sustain, and support development and employment of SOF-peculiar UTM capability
Supporting capabilities	• established and consistently resourced maintenance support programs • extensive base of UTM employment and maintenance knowledge from combat, contingency, and security force assistance (SFA) operations
Key challenges and limitations	• requirement to operate UTMs in semi-permissive IED environments to support local operations • some injuries and fatalities due to the demanding pace of operations and training • sustaining full range of UTM capabilities after decline of OCO funding

Overarching Conventional Army UTM Capability Trends

While SOF units like the 160th SOAR have well-established programs to develop and maintain UTM capabilities, the conventional Army units that have developed UTM capabilities have done so with internal unit resources acquired almost exclusively through temporary, informal, or ad hoc methods. In cases of unit-sourced UTM capabilities, the platforms are primarily used to improve the efficiency or effectiveness of tasks that would otherwise be conducted by individual soldiers or dismounted formations, such as airborne cavalry, mountain infantry, or aviation support operations. While recent articles have proposed UTM platforms primarily

Table 3.7
SOF Characteristics Evidenced by UTM Employment Methods

SOF Characteristics (from JP 3-05, *Special Operations*)	Examples from SOF UTM Employment
Provide tailored responses to different situations	• developed FSOV to rapidly provide a range of UTM capabilities when needed
Conduct operations in austere, harsh environments without extensive support	• employ UTM capabilities to execute and/or support operations in terrain not accessible by larger vehicles, such as mountainous and heavily vegetated terrain
Work closely with regional military and civilian authorities and populations	• employ UTM capabilities to enable effective interoperability with partner forces employing UTM or light vehicles
Deploy with a generally lower profile and less intrusive presence than CF	• employ UTM capabilities when use of larger and more conspicuous vehicles is not appropriate
Provide unconventional options for addressing ambiguous situations	• quickly develop and refine TTPs for UTM employment to conduct and support operations, such as local patrolling and engagement • readily depart from prescriptive doctrine based on mission- and context-specific concerns

for combat operations, the cases demonstrate prevalent needs for UTM capabilities to conduct support activities, such as aviation support and traveling support for dismounted formations.[29] Although these demands are not significant across all or most Army units, the demands have significant impact on the types of units discussed in this chapter. These specific unit types, taken together, represent an important component of Army capabilities and strongly suggest a compelling Army interest in coordinated development and management of UTM capabilities.

While most of the unit experiences noted support the need for UTM capabilities, some unit experiences illustrate why units may choose *not* to pursue and employ UTM capabilities. Commander's and personnel interviewed also indicated some reasons their current or previous units had decided not to employ UTMs, such as

- command directives prohibiting UTM employment
- no established program of record for UTM
- no established procurement alternative for UTM capabilities
- no established system for sustaining UTM capabilities.

While interviews repeatedly identified the reasons above for dissuading consideration and employment of UTM capabilities, this list of reasons does not represent the full range of reasons for avoiding UTM employment, the factors that influence the presence and strength of these reasons for command decisions, and the impact of such decisions on mission success (see Table 3.8). The prevalence and impact of these concerns, while not fully explored in this study, is an area that can benefit from further examination.

Current Armywide Resources for UTM Development and Employment

As demonstrated above, individual units and organizations are attempting to address the gap between the dismounted soldier and SSVs with various UTM approaches. These generally localized, tailored efforts do not constitute a coherent UTM "capability" that the Army can appropriately track, influence, and employ when needed. However, some generally uncoordinated resources do currently exist within the Army and Joint communities that the Army can draw upon to support a more coherent approach to UTM capabilities in the future.

Army Doctrine and Knowledge Resources for Tactical UTM Employment

Guidance for consideration, planning, employment, and support of UTMs in current Army doctrinal publications, as summarized in Table 3.9, is inconsistent and incomplete (detailed description of specific doctrinal excerpts are provided in Appendix C). While Army doctrine documents do not specifically address UTM concepts for executing maneuver, mobility, or support activities, some doctrinal references identify UTM platforms as potential alternatives and provide limited planning considerations for their employment. Somewhat surprisingly,

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[29] Stockwell, 2012. Stockwell argues for the tactical value of motorcycles, asserting that "by employing motorcycle formations, conventional units will be able to meet the adversary's mobility capabilities. Lacking superior mobility, the enemy will have to reevaluate how, and with what, they can initiate contact. Forcing the enemy to reorient and adjust to a constantly changing battlefield will begin to create gaps, both physically and psychologically, which can be exploited. U.S. conventional forces must incorporate sustainable light mobility that enables them to move faster and farther than the enemy." See Appendix A for further discussion of motorcycles and Stockwell's assertions.

Table 3.8
Overarching Trends from Conventional Army UTM Cases

Category	Description
Key UTM applications	• Most successful and sustained UTM applications are for internal ferry/support, traveling support, and casualty evacuation activities. • Current experimentation is evaluating utility of UTM platforms for recon/security activities.
Key DOTMLPF capabilities	• Relatively common M-Gators from congressionally mandated procurement and subsequent unit purchases • Some unit-specific COTS platforms • Specific mention of UTM platforms as mobility options in various Army manuals and technical publication • Contractor-provided training on UTM operations and basic maintenance
Supporting capabilities	• instruction on basic planning considerations in Army Mountain Warfare School • Limited evaluation and experimentation as part of the NIE
Key challenges and limitations	• No Army-wide ability to manage or support current UTM capabilities • Current repair and replacement executed primarily with rapidly declining OCO funds • No basic guidance or concepts for UTM employment • Limited consideration of hazards and threats associated with operational UTM employment

the Army has two published manuals specifically dedicated to guide the rigging of the "non-standard" M-Gator for sling load (air assault forces) and airdrop (airborne forces).[30] Currently limited safety regulatory guidance exists, though Army Regulation 385-10 directs that organizations that use COTS utility vehicles, such as M-Gators, "Mule" utility vehicles, and aircraft tugs in garrison or tactical environments, establish a basic safety program.

Army Resources for Acquisition of UTM Materiel

Existing UTM capabilities have been primarily acquired through general commercial off-the-shelf (COTS) material solutions and modified M-COTS solutions using overseas contingency operations (OCO) funds intended to replace, repair, and replenish equipment eroded through continual use in theater.[31] For example, 86th IBCT received ATVs without any military-specific modifications through congressionally mandated COTS procurement. While COTS solutions provide standard commercially available models for military use, M-COTS platforms include modifications to the basic COTS model by an original equipment manufacturer (OEM) in accordance with the tenets of Army acquisition.[32] (See Table 3.10.) For example, the Christini motorcycles purchased by Rapid Equipping Force (REF) and used by 1-6 CAB in the NIE came from the OEM with specific attributes previously unavailable on standard commercial models. For M-COTS procurements, typical vehicle performance specifications are captured in a requirements document. Any requirements not so captured are assumed to be covered by the OEM in the quality, performance, and durability of the COTS vehicle.

The M-COTS process requires identifying specific needs and key performance parameters (KPPs) and associated vehicle performance specifications. While the M-COTS process takes more time and resources than a COTS purchase, it can result in a UTM platform better

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[30] Department of the Army, FM 4-20.108, 2007, and FM 4-20.198, 2009.

[31] Department of Defense, *DoD FY 2010 Budget Request Summary Justification,* 2009.

[32] Department of the Army, "AR 70–1: Research, Development, and Acquisition, Army Acquisition Policy," July 22, 2011.

Table 3.9
Identified Discussion of UTM Capabilities in Current Army Doctrine

Army/DoD Publication		General Identification of UTM as a Platform Option	Identification of UTM Platform(s) as an Existing Unit Capability	Description of Specific UTM Capability	Specific Considerations for Tactical Employment
ATTP 3-21.50	*Infantry Small-Unit Mountain Operations*	×		×	×
ATTP 3-20.97	*Dismounted Reconnaissance Troop*	×		×	
ATTP 3-12.90	*Tactical Employment of Mortars*	×			
FM 3-55.93	*Long-Range Surveillance Unit Operations*	×			
FM 4-20.108	*Airdrop of Supplies and Equipment: Rigging Military Utility Vehicles*	×			×
FM 4-20.108	*Multiservice Helicopter Sling Load: Single-Point Sling Load Procedures*				×
ATP 4-25.13	*Casualty Evacuation*	×			
DoD Instruction 6055.04	"DoD Traffic Safety Program"	×			×

suited for specific tactical needs and conditions. However, for both COTS and M-COTS procurement, sustainment and support resources are provided only if explicitly dictated in the purchase agreement. For previous UTM acquisitions, such as the M-Gator, lack of authorized resources for repair and replacement was a significant limitation on their long-term utility. Additionally, the OCO funding that has supported most of the development, repair, and

Table 3.10
Comparing Procurement Approaches

Procurement Approach	COTS	M-COTS
Based on military requirements document	No	Yes
Performance specifications	Based on standard manufacturer specifications	Based on KPPs and other performance parameters captured in requirements documentation
Additional resources required	None	Analysis to determine KPPs and other performance parameters required
Example	86th IBCT Polaris Sportsman 700 ATVs	1-6 Infantry/AWG Christini motorcycles
Sustainment program	As negotiated in purchase agreement	

replacement of UTM capabilities declined by 24 percent from FY 2012 to FY 2013 and is expected to continue a steady decline as operations in Afghanistan wind down.[33] This will eliminate the most significant resources units have used to maintain the non-MTOE UTM capabilities, such as the M-Gator and ATVs, which they currently possess.

Nonstandard Accountability of Current UTM Platforms

To date, current unit Modified Table of Organization and Equipment (MTOE) and Table of Distribution and Allowances (TDA) property accounts do not recognize the UTM as standard equipment. While some UTM platforms such as the M-Gator already exist within the Army, these platforms are not tracked and managed as standard equipment. However, Property Book Officers (PBOs) are able to account for nonstandard equipment using the SSN-LIN Automated Management and Integrating System (SLAMIS). For example, both the M-Gator and Polaris Ranger have LINs and nonstandard national stocking numbers (NS-NSNs) in SLAMIS.[34] These nonstandard identifiers enable PBOs to use SLAMIS to account for equipment and materials down to the company level.[35] However, this system of tracking is contingent on all UTM platforms being added in SLAMIS when they are procured. With some PBOs continuing to follow existing local procedures to account for nonstandard items, the Army continues to struggle to obtain an accurate Armywide overview of specific items. This uncertainty limits accountability, fleet planning, and the provision of support requirements, such as repair parts and replacement platforms.

Sustainment Programs and Resources

The Army sustainment concept is based on an integrated process (people, systems, materiel, health services, and other support) inextricably linking sustainment to operations. While some Army units maintain UTM capabilities based on one-time local purchase, International Merchant Purchase Agreement Card (IMPAC), COTS, or M-COTS procurements, no Armywide resources or programs exist to sustain UTM capabilities, and there are few replacement parts or platforms available through the Army supply system. Current Army UTM platforms are overwhelmingly soldier-/operator-maintained, with very limited and uncoordinated resources available to develop operator- or maintainer-level maintenance skills. This almost complete lack of broader support systems has left units to maintain their capabilities with unit operating funds or, in some cases, opt not to repair UTM platforms once they break.

To address unit-specific operational demands encountered during operations in Iraq and Afghanistan, conventional Army units have primarily acquired commercial off-the-shelf (COTS) UTM vehicles as nonstandard equipment (NSE) using IMPAC or local purchase procedures.[36] This equipment is sometimes classified by Army Policy as "sustain" category NSE that is to be used only in CENTCOM and paid for with overseas contingency operations

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[33] Office of Management and Budget, "Justification for FY13 Overseas Contingency Fund Budget Request," 2012.

[34] The M-Gator A1 has a Sub-Line Item Number (LIN): Item # YF4000 and an NS-NSN: 2340-01-C06-9049; and the Polaris Ranger has a Sub-LIN:YF4000 and an NS-NSN 2340-01-D04-0305.

[35] In accordance with Army Regulation 735-5, "Policies and Procedures for Property Accountability."

[36] Army Directive 2010-07, "Non-Standard Equipment Interim Policy," 2010. This directive defines tactical nonstandard equipment as "commercially acquired or non-developmental equipment that is rapidly acquired and fielded outside of the normal Planning, Programming, Budgeting and Execution System and acquisition processes to bridge capability gaps and meet urgent Warfighter requirements."

funds.[37] However, the vast majority of the UTM vehicles purchased by Army units are not considered "sustain NSE" by Army policy and must therefore, by Army policy, "be maintained at the unit's expense or using Combatant Command resources while deployed."[38] This authorized practice of ad hoc procurement of UTM vehicles with no according formal Army training, sustainment, or force modernization dollars is the primary cause of the current confusion and dissatisfaction surrounding the Army decision not to sustain UTM as an enduring capability.

Training

Units that currently have UTM capabilities consistently identify training as a fundamental component to using them safely and successfully. However, current Army training includes very little discussion or information on planning for, employing, or sustaining UTM capabilities. Almost all of the UTM training received by the XVIII Airborne Corps LRSC, 86th IBCT, and 1/6 CAB was provided through contracted civilian instruction with varying degrees of performance criteria. Much of this UTM operator and maintenance training was provided through the contracted training programs run provided by the REF and supported by the Asymmetric Warfare Group (AWG). In general, these UTM-focused POIs typically involve vehicle familiarization, basic driver training, all-terrain safety orientation, varying levels of tactical UTM employment, and basic operator-level maintenance.

While the units with UTM capabilities have sought to sustain UTM knowledge through unit-level trainers and sustainment training, all identified maintaining operator currency as a significant concern. Some units with UTM capabilities have executed collective training, but the absence of supporting capabilities, such as trailers, significantly limits the units' ability to conduct such training. The only identified Armywide training to inform conventional Army leaders on consideration and planning for UTM employment is a single module in the Mountain Leader's Course at the Army Mountain Warfare School covering planning considerations for pack animals.

Testing, Experimentation, and Analysis

While the Army has not routinely developed UTM capabilities to meet its previous and current UTM needs, the Army has conducted a range of tests and experiments to explore innovative concepts for employing UTM-based units in the past (see Table 3.11). For example, in the 1980s, the Army's 9th Infantry Division (Motorized) tested a range of UTM alternatives as part of the High-Technology Test Bed, to include dune buggy–like Fast Attack Vehicles (FAVs) and motorcycles (see Appendix A for a discussion of FAV employment in the 9th Infantry Division [ID]). The 9th ID concept sought to develop a rapidly deployable and highly mobile infantry division. However, the 9th ID motorized capabilities were retired and never demonstrated in an operational setting. Recently, the Army has considered concepts for integration of UTM capabilities, including evaluation of UTM platforms as part of the Networked Evaluation Experiment (NIE). While some recent testing and experimentation has included UTM platforms as part of wider concepts, the general lack of significant, progressive, and coordinated UTM experimentation has limited the Army's ability to develop, assess, and refine

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[37] Government Accountability Office, "Improved Cost Analysis and Better Oversight Needed over Army Nonstandard Equipment," 11-766, 2010.

[38] Army Directive 2010-07, 2010.

Table 3.11
Selected UTM-Pertinent Evaluations, Analyses, and Studies

Evaluation, Study, or Analysis	Year
Commodity Service Test Procedure Motorcycles and Scooters (U.S. Army Test and Evaluation Command)	1968
Test of Military Motorcycles (Armor and Engineer Board)	1979
An Assessment of United States Army High Technology Test Bed (Defense Science Board)	1983
9th Infantry Division High-Technology Test Bed	1985
Applying the National Training Center Experience (RAND)	1987
JANUS Modeling of Motorcycles in the Battalion Scout Platoon	1988
Maneuver Battalion Scout Platoon Concept Evaluation (U.S. Army Armor School)	1990
Battalion Reconnaissance Operations at the National Training Center (RAND)	1996
Sixty Years of Reorganizing for Combat: A Historical Trend Analysis (Combat Studies Institute)	1999
Increasing the Mobility of Dismounted Marines, Small Unit Mobility Enhancement Technologies: Unmanned Ground Vehicles Market Survey (SPAWAR)	2009
Network Integration Evaluation (NIE) exercise 13.1. (U.S. Army Capabilities Integration Center)	2012
Assessing the Impact of Autonomous Robotic Systems on Army Force Structure (RAND)	2013

UTM concepts of employment to meet existing needs and explore the impact of emerging technologies, such as remotely operated vehicles, on maneuver.

Emerging Technologies

Actual and perceived threat vulnerability, hazard vulnerability, and lack of interoperability have generally discouraged Army development and employment of UTM capabilities in the past. However, emerging technologies pursued by the Army, DoD, and industry are offering promising alternatives to reduce the limiting factors associated with some UTM applications. Specifically, the potential for optionally and autonomously controlled vehicles limits the exposure of soldiers to hazards associated with UTM operation. For example, Figure 3.10 shows some of the prototype platforms designed for autonomous and optionally manned control, as well as legged locomotion, to execute the squad supply mission in the future. As illustrated by Figure 3.11 from the recent RAND study, an automated squad supply carrier requires medium task complexity but could have widespread influence on Army forces.

Beyond just autonomous control, a number of emerging technologies could help address and reduce the factors that currently dissuade UTM use, as summarized in Figure 3.12. However, the most promising developments are for UTM execution of Tactical Activities that do not explicitly require humans to occupy the vehicle during operation, such as internal ferry support and CASEVAC, rather than the activities that are inherently tied to soldier presence on the platform.

Figure 3.10
Unmanned UTM Prototypes: Lockheed Martin Robotic Mule (left), and DARPA Legged Squad Support System (LS3) (right)

SOURCES: U.S. Army, 2013, and DARPA, 2012.
RAND *RR718-3.10*

Contemporary Combat Employment of UTM Capabilities

While the Army has not managed the coordinated development of UTM capabilities, recent combat operations have motivated individual units to acquire UTM capabilities to meet operational needs. These applications have included traveling support, internal ferry/support, coordinated maneuver, and other Tactical Activities to resupply hilltop outposts, maintain isolated

Figure 3.11
Likely Complexity and Impact of Ground Robotics Developments for Army Forces

		Risk factor (threats/hazards)		
		Low	Medium	High
Likely impact	Widespread	Patrol sensor platform, EOF air, IED preliminary interrogation	Squad supplies carrier, perching comms relay	Patrol recon/ scout
	Moderate	RON site security, CQB room recon	CASEVAC, less-than-lethal platform	Patrol weapons platform, patrol obstacle breacher
	Niche	CQB door breacher, PSYOP platform	CQB security	IED interrogating and neutralizing

UTM applications

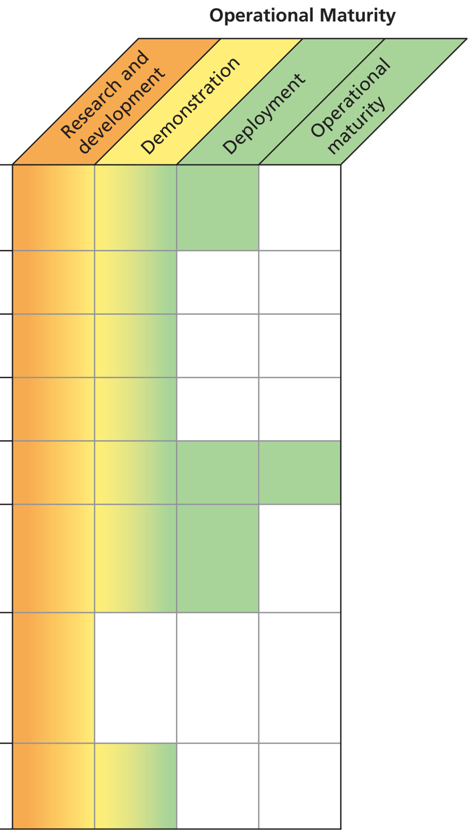
Army Robotics Roadmap: "C-IED is dominant mission set"

SOURCE: Matsumura et al., 2013.

RAND *RR718-3.11*

Figure 3.12
Emerging Technologies to Mitigate Dissuading Factors for UTM Employment

Dissuading Factor	Emerging Technology	UTM Implication
Threat vulnerability	Optionally manned vehicle operation	• Allow remote control of UTM platform to remove soldier from platform in threat situations[a]
	Autonomous vehicle operation	• Allow UTM platform to follow and support dismounted forces[b]
	Motorcycle electric drivetrain propulsion	• Minimal audible and heat signature for UTM platform[c]
	Spall liners	• Lightweight, flexible armor for interior of UTM platforms[d]
Risk vulnerability	ATV track systems	• Increased stability on ice, snow, and uneven surfaces
	Panoramic night vision goggles	• Improved depth perception and peripheral vision for vehicle operation in low-visibility conditions
Lack of interoperability	Augmented reality operator's helmet	• Built-in navigation system and voice-controlled interface for hands-free communication, navigation, and situational awareness
	Legged robots	• Operate over narrow and uneven terrain with dismounted soldiers (like pack animals)



[a] John Matsumura, Randall Steeb, Matthew W. Lewis, Kathryn Connor, Timothy Vail, Matthew E. Boyer, Steve DiAntonio, Jan Osburg, Kristy Gonzalez Morganti, James McGee, Paul S. Steinberg, *Assessing the Impact of Autonomous Robotic Systems on the Army's Force Structure*, Santa Monica, Calif.: RAND Corporation, 2014. Not available to the general public..
[b] Matsumura et al., 2014.
[c] Steven Hoarn, "Zero Unveils MMX Military Motorcycle: It's Electric," Defense Media Network, June 14, 2013.
[d] DuPont, *Kevlar Technology for Advanced Vehicle Armoring*, 2013.

RAND *RR718-3.12*

FOBs, sustain extended dismounted patrols, and support partner force UTM-based forces. An operator referring to his experiences applying UTM platforms in Afghanistan provides one of the most detailed descriptions of UTM use (Tactical Activity identification added):

> We used M-Gators as supply carriers and 60mm mortar carriers for a long-range movement we conducted of a total of eighteen miles from our FOB up into a remote valley and back [Traveling Support]. The roads and bridges would not support M-ATVs and the mission did not justify rotary-wing support. While this likely violated the CENTCOM policy of un-armored vehicles on any road, the Gator was the only way we could travel up into the area with enough water and mortar ammo to support us in case of enemy contact. We also used Gators in support of an operation we conducted in Barge Matal Nuristan. We flew in two Gators into Barge Matal, and then used them as machine gun platforms and ammo/supply carriers with M240 machine guns on tripods to move down a river valley to secure an objective approximately 6 kilometers away [Coordinated Maneuver]. After securing the

> objective, we were forced to remain in Barge Matal for approximately 60 days to secure it, so we flew in an additional three Gators and used them for local patrolling and to move supplies off the drop zone and back to our positions [Local Patrolling].[39]

Additionally, Army units have employed locally available pack animals on numerous occasions to conduct Traveling Support activities in locations where other UTM platforms were not available or were too large to operate on narrow foot paths. Most notably, Army units have used local donkeys to haul heavy supplies when establishing and resupplying remote observation posts (OPs) in Afghanistan.

One element that the known examples of contemporary Army UTM use have in common is that none of the UTM operators reported receiving any previous training or employment guidance. Unit discretion guided UTM use in the absence of relevant doctrinal guidance. Additionally, the diversity of the UTM variants used in Afghanistan, each with different capabilities, also made it difficult to develop specific employment guidance. It makes sense that the reported uses of UTMs varied widely, as did the contexts and associated hazards.

Other Service or Joint UTM Employment Programs and Resources

Although current Army programs and resources to develop and support UTM capabilities are quite limited and generally ad hoc, other services and SOF have developed more deliberate UTM programs. Through coordination and formal agreements, these USMC and SOF programs are resources that the Army can potentially draw from and support to meet common UTM demands and validated requirements.

U.S. Marine Corps

To meet similar mission profiles and tactical demands as Army units, the USMC has pursued programs to develop UTM knowledge and capabilities, such as pack animal instruction at the Marine Mountain Warfare Training Center (MWTC).[40] With a permanent stable of pack animals, trained "muleskinners," and multiple programs of instruction on pack animal employment, the MWTC training offers the most comprehensive and established pack animal training available in the U.S. military.

Similar to Army experiences with UTM platforms, the Marines have developed and then done away with mechanical UTM platform capabilities over time due to changing operational expectations and command consideration of UTM viability. For example, in the past decade the Marines developed a program to procure and maintain motorcycles. Based on its experience maintaining and not employing the motorcycle capability, Marine leadership recently canceled the program and removed all military motorcycles from their inventory. The USMC also maintains the ITV—in effect a modern variant of the classic Jeep—for use by reconnaissance units and artillery battalions as a primary mover for the EFSS 120-mm rifled mortar, as pictured in Figure 3.13. Other Marine UTM capabilities consist of a broad mix of COTS and M-COTS platforms, to include M-Gators and Polaris RZRs that are used for a variety of

[39] Personal communication from LTC Douglas G. Vicent, January 4, 2013.

[40] Mockenhaupt, 2009. The Marine Corps has taught a pack-animal course at the MWTC since the early 1980s, when the CIA sent the mujahedeen thousands of mules to ferry supplies through the mountains from Pakistan into Afghanistan.

Figure 3.13
USMC Internally Transportable Vehicle (ITV) Delivered by CH-53 (left) to Carry and Support 120-mm Mortars (right)

SOURCE: United States Marine Corps, 2012, and Marine Corps Times, 2009.
RAND *RR718-3.13*

single-mission purposes. M-Gators have also been used by Marine Wing Support Squadrons (MWSSs) to establish FARPs. As illustrated in Figure 3.14, the Marine Chemical Biological Incident Response Force currently uses the M-Gator for Internal Ferry/Support activities based on its suitability for rapid loading and unloading from rotary-wing aircraft.

Since 2007, SOCOM has used the Family of Special Operations Vehicles Program to ensure coordinated identification of UTM requirements, efficient acquisition of UTM capabilities, and coordinated sustainment of on-hand UTM capabilities. As discussed above, the FSOV program's platforms and processes can provide a useful guide to inform conventional Army development and sustainment of more limited UTM capabilities. SOCOM's strategy has been to use this program to procure a COTS material solution that can be modified to meet SOF requirements. Within the UTM realm, the FSOV mission is focused on the devel-

Figure 3.14
Marine Chemical Biological Incident Response Force (CBIRF) Use of the M-Gator for Rapid Deployment in CH-47 and Ch-53 Helicopters

SOURCE: United States Marine Corps, 2007.
RAND *RR718-3.14*

opment, procurement, and sustainment of wheeled mobility capabilities, in particular ATV and LTATV variants.

FSOV UTM platform specifications, as detailed in salient requirements, are given in terms of a desired "objective" (O) and a minimal or "threshold" (T) requirement. The platform specifications also include intended use profiles. For example the platform specifications for one ATV alternative included a statement describing the intended use profile:

> [T]he operational spectrum of the UTM shall utilize profiles inclusive of vehicle loaded with the rated payload and serviced with standard products to meet specified performance requirements and be demonstrated on surfaces that it is expected to be used: less than 10% on primary roads, 20% on secondary roads, 65% cross country and trails, <5% in an urban rubble environment.

Figure 3.15 shows some of the performance parameters identified through FSOV testing and evaluation for the SOF Light Tactical All-Terrain Vehicle (LTATV).

Due to their sustained emphasis on UTM use, SOF units have also invested resources to develop and capture basic UTM employment knowledge and concepts in doctrine. Naval Special Warfare and Army Special Operations have both developed doctrine for UTM employment that provide useful resources for conventional Army development of foundational UTM planning, employment, and sustainment concepts. Current SOF doctrinal references on UTM include

- Army Field Manual 3-05.213, *Special Forces Use of Pack Animals*
- Navy Tactics, Techniques, and Procedures (TTP) 3-05.9, *Naval Special Warfare Tactical Ground Mobility*
- Army TTP 3-18.14, *Special Forces Tactical Ground Mobility*.

Summary

Conventional Army units consistently have mobility demands and validated requirements that are best met or perhaps can only be met by UTM vehicles. Due to the persistence of these demands, localized UTM capabilities have emerged across the Army even without full authorization or support. However, because of a lack of institutional support for developing, acquiring, and sustaining UTMs, as well as for providing training and doctrinal guidance, units are more or less on their own to manage and sustain the capabilities they have developed. At the same time, there are Army units with similar demands for UTM capabilities that do not have resources to meet them.

In contrast, Marines and Special Operations Forces have greater institutional support for UTM capabilities. This support has translated into better access to platforms that are better tailored to meet specific requirements, as well as more robust training and sustainment resources. While conventional Army units may not need SOF's platform diversity or robust UTM program, the Army can likely draw from SOF and Marine Corps overlapping requirements and existing programs to develop appropriate UTM capabilities. Meanwhile, emerging technologies, especially autonomous robotic control, are offering the opportunity to limit the operational threats and hazards traditionally associated with operational UTM employment.

Figure 3.15
SOF LTATV Performance Parameters Summary Sheet

Specification	Spec Ref	Threshold	Objective
Materials	3.0	Per specification	—
Environments	3.1.1	Per Specification	—
Temperature	3.1.2	(-25) to 120 degrees F without special kit	—
Environmental Conditions	3.1.3	300 feet below sea level to 13,000 feet about sea level	—
Air Drop	3.2.1	Capable	Certified
Engine	3.3.1	Gasoline	Diesel and JP8
Payload 4x4 (KPP)	**3.3.2**	**1,100 lbs**	**1,400 lbs**
Payload 6x6 (KPP)	**3.3.3**	**1,200 lbs**	**1,500 lbs**
Curb Weight 4x4	3.3.4	1,600 lbs	1,200 lbs
Curb Weight 6x6	3.3.5	2,000 lbs	1,600 lbs
Speed at VCW	3.3.6.1	45 mph	60 mph
Speed at GVW	3.3.6.2	40 mph	45 mph
Longitudinal Slopes	3.3.7.1	45% slope	60% slope
Side Slopes	3.3.7.2	40% slope	45% slope
Range (KPP)	**3.3.8**	**150 miles on organic tank of fuel**	**200 miles on organic tank of fuel**
Blackout Lighting	3.3.10	Capability	—
Ignition Switch	3.3.11	Keyless ignition	—
Transmission	3.3.12	Automatic with high, low, and reverse gears	—
Power Requirements	3.3.13.1	12V system	24V system
Master Disconnect	3.3.13.2	Equipped	—
Alternative Starting	3.3.13.3	With use of 12V automotive jumper cables	With NATO Slave system for 24V
Power Outlets	3.3.13.4	Two 12V power outlets (cigarette)	Three 12V power outlets (cigarette)
Turning (static)	3.3.14	20 ft	10 ft
Seating	3.3.17	Two fully combat-equipped soldiers	Three fully combat-equipped soldiers
Vehicle Controls (KPP)	**3.3.19**	**Standard automotive vehicle controls**	**—**
Roll Over Protection (KPP)	**3.3.20.1**	**SAE J1924 (ROPS)**	**SAE J1924 (ROPS)**
Seatbelts (KPP)	**3.3.20.2**	**Four individual points releasable by a single mechanism/lever for all occupants**	**—**
Weapons Mounts	3.3.21	Two locking articulating weapons mounts	—
Altitude	3.3.22	300 feet below sea level to 13,000 feet without manual adjustments	—
Suspension	3.3.23	Accommodate varying payloads. If manual adjust, 15 minutes or less	If manual adjust, 5 minutes or less
Litter	3.3.24	One standard military litter	Two standard military litters
Underbody	3.3.25	Robust skid plate	—
Anti-Theft	3.3.26	Securable vehicle	—
Service Brakes	3.3.27	ANSI/ITSDF B56.8-2006	—
Emergency Brakes	3.3.28	ANSI/ITSDF B56.8-2006	—
Vertical Step	3.3.29	10 inches	18 inches
Break-Over Angle	3.3.30	18.5 degrees	—
Water Fording	3.3.31	20 inches	30 inches
Ground Clearance	3.3.32	8 inches	12 inches
Towing	3.3.33	Like vehicle towing and have two inch receiver hitch with a receiver mount pintle hook and a two inch ball combination	The vehicle will have a tow bar that can be used to be towed by a like vehicle and/or HMMWV
Operational Reliability	3.4.1	3.7 engine operating hours and 32 miles at least 95%. Mean time between failures of not more than one per 1,000 miles.	Mean time between failures of not more than one per 2,000 miles.
Maintenance	3.4.2	OEM maintenance manuals	—
Part and Service	3.4.3	Manufacturer or dealer network nationally	Manufacturer or dealer network worldwide
Maintenance Reliability	3.4.6	Pre-operation check and weekly PMCS at operator level (-10)	—
Vision Devices	3.5.4	Ability to operate with night vision and/or thermal imaging devices	—
Run Flat Capability (KPP)	**3.5.5**	**15 miles at 30 mph**	**—**
Stowage for SOF Equipment	3.5.7	Built in provisions for securing cargo	—
Acoustic Noise	3.5.8.1	Industry standards	Not be heard by the human ear at 50 meters
Thermal Signature	3.5.8.2	NONE	Insulation and/or a heat shield to reduce thermal signature (IR signature)
Winch Kit	3.5.10	Front winch for self recovery at GVW	—

SOURCE: 160th Special Operations Aviation Regiment (SOAR). "LTATV Performance Matrix," submitted to inform USSOCOM development of a Request for Proposals (RFP) for the LTATV, submitted September 1, 2010.

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CHAPTER FOUR

A Tailored Process for Assessing UTM Alternatives to Meet Unit Operational Requirements

Introduction

The generally ad hoc development and use of UTM capabilities by conventional Army forces, as discussed in Chapter Three, suggests that current methods for considering UTM demands are rarely systematic, explicit, or complete. As a result, conventional Army units' previous attempts to develop and sustain UTM capabilities without explicit Army guidance, support, or resources have generally shared the following traits:

- Leaders with previous experience with or affinity for UTM capabilities initiate UTM development efforts.
- Little systematic mission or platform analysis is completed to compare mobility alternatives and identify comparative benefits and concerns for UTM use.
- The resources that are immediately available and familiar primarily dictate the platforms selected for use.
- UTM demands are generally addressed through stopgap, temporary measures outside the Joint Capabilities Integration Development System (JCIDS) process.
- Little consideration is given to long-term sustainment of the UTM capabilities developed, such as new sustainment training, repair, and interoperability.
- UTM capabilities are employed and assessed in training exercises without full consideration of their appropriateness and permissibility in likely combat environments.
- UTM demands identified by Army units are often not translated to a validated requirement through a formal process such as the JCIDS due to limited knowledge of JCIDS and the time for pursuing the complex and extended process.

As these trends indicate, the lack of Army attention to and support for coordinated consideration of UTM demands has resulted in inconsistent results with varying levels of sustainability, safety, and operational appropriateness. The JCIDS cycle has historically fielded responses to validated needs in 13 to 26 months after validation, well beyond a unit's deployment period.[1, 2] Unit interviews and AAR comments indicate that this daunting timeline moti-

1 Department of Defense Science Board, *Report of the Defense Science Board Task Force on the Fulfillment of Urgent Operational Needs*, July 2009. This report acknowledges and describes the numerous challenges DoD has faced in providing timely and appropriate solutions to operational needs.

2 Government Accountability Office, *Opportunities Exist to Expedite Development and Fielding of Joint Capabilities*, 2012. This report describes the extensive time required for validated needs to receive a fielded capability indicating that a number of urgent need solutions have been fielded in a year or less, and most initiatives (26 of 30 audited) required up to two years

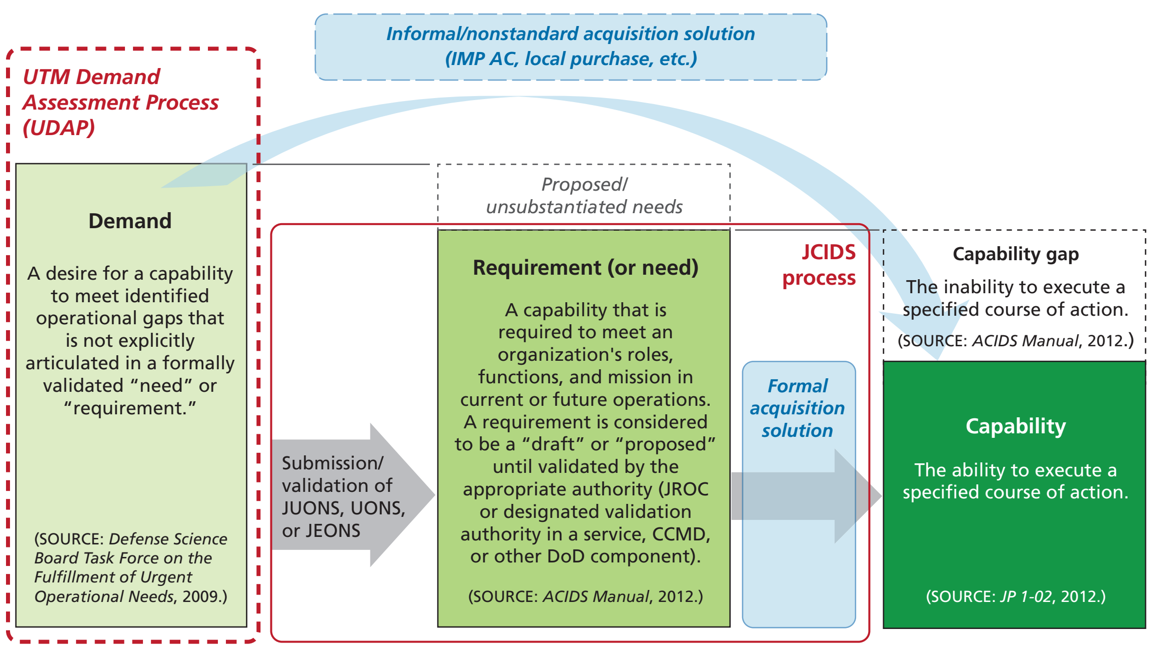
vates many units to opt out of the formal acquisition process and pursue ad hoc approaches to UTM development described in Chapter Three. The UTM Demand Assessment Process (UDAP) described in this chapter provides a systematic methodology for assessing UTM demands and comparing UTM capabilities with other available alternatives.

Purpose and Applicability of the UDAP

The UDAP is designed to guide Army organizations' assessment of specific mobility demands that UTM platform options can address as part of an immediate analysis of alternatives. The UDAP guides consideration of immediately available alternatives, while the JCIDS process is the appropriate method for formal and long-term assessing, validating, and prioritizing Joint military capability requirements.[3] As Figure 4.1 illustrates, the current JCIDS process defines the requirement validation and formal acquisition of military capabilities. However, no resources exist to guide the numerous units that develop UTM capabilities outside the formal JCIDS process to meet their (undocumented) demands for UTM capabilities. The UDAP provides a systematic process for these units to:

- fully assess their demand for UTM
- make informed decisions about informal acquisitions
- articulate their proposed "requirement" prior to initiating the JCIDS process.

Figure 4.1
Role of the UTM Demand Assessment Process (UDAP) and Relationship with the JCIDS Process



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for fielding, with a median time to initial fielding of a capability being 13 months for fielded initiatives and an estimated 19 months for initiatives not yet fielded.

[3] Chairman of the Joint Chiefs of Staff, CJCS Instruction 3170.01G, *Joint Capabilities Integration and Development System (JCIDS)*, March 1, 2009.

Furthermore, UDAP results can form the basis for crafting an appropriate operational needs statement through the JCIDS by helping the intending user to assess and articulate the specific mission requirements and corresponding capability gaps. The UDAP is designed to support the user's eventual pursuit of JCIDS, REF, or other appropriate process if compelling capability demands are identified. With this in mind, the UDAP is designed for Army leaders and staffs with the following characteristics:

- have a demonstrated or likely demand for UTM vehicles and associated capabilities
- have the ability to procure (or influence the procurement of) these platforms
- consider commercial off-the-shelf or modified options that are readily available for procurement and that can be used for military applications with minimum modifications.

To illustrate application of the UDAP, this chapter builds onto the UNIFIED QUEST 2012 MEDCOM operational scenario discussed in Chapter Two and summarized in Table 4.1. It applies the UDAP to an IBCT with some exposure to UTM capabilities to inform evaluation of potential mobility alternatives, to include SSVs and UTMs, to meet operational requirements associated with securing lodgement areas with the potential follow-on expeditionary operations. This scenario is specifically selected as one that presents clear demands and opportunities to employ UTM platforms. For brevity, this report features a single scenario used because of its illustrative quality. Analysis of this single scenario demonstrates the potential value of additional comparative analysis of mobility alternatives across a range of scenarios to provide the Army with useful insights on the broad utility of UTM vehicles as compared to other mounted and dismounted modes of mobility.

Table 4.1
Overview of MEDCOM Scenario

Scenario Aspect	Description (from 2012 UNIFIED QUEST)
Terrain	• steep and rocky mountain areas of northern Greece • objectives like airfields with numerous dispersed facilities to secure (fuel storage, hangars, etc.)
Threat	Improved and proliferated weapons and other technologies capable of denying access to and freedom of action within an operational area, to include • attacks on ground convoys • booby traps • ambushes • chemical attack • dispersed enemy and sabotage around airfield objectives
Mission	• execute airborne and air-assault Joint Forcible Entry Operations (JFEO) at offset insertion locations to secure lodgement areas for follow-on forces consistent with the *Joint Concept for Entry Operations*[a] • conduct follow-on expeditionary operations
Key characteristics	• includes execution of multiple "offset" entry operations (10–30 km from insertion to objective) • includes seizure of dispersed

SOURCE: U.S. Chief of Staff, "UNIFIED QUEST 2012: MEDCOM Adjudication," June 8, 2012.

[a] Joint Chiefs of Staff, the *Joint Concept for Entry Operations* (JCEO), 2014.

The UTM Demand Selection Process (UDAP)

The UDAP involves five sequential steps to assess UTM capability demands (Figure 4.2).

Before presenting the UDAP in detail, it is important to review the two basic approaches to UTM requirements that this report describes in Chapter One. Specifically, Army units generally possess one of two (or both) perspectives on UTM capability demands:

- a top-down perspective that considers UTM platforms as a potential alternative to SSVs (as would be the case for mechanized units)
- a bottom-up perspective that considers UTM as a means to augment otherwise dismounted elements (as would be the case for light infantry units).

The differing approaches to UTM consideration are important because they involve different basic assumptions for assessing the appropriateness of specific UTM platforms, as listed in Table 4.2. Consequently, these differing approaches can lead to different priorities in each step of UDAP. One example is in *Coordinated Maneuver* activities. A dismounted unit might value the increased firepower and endurance provided by a UTM platform compared to only dismounted soldiers. Speed is not a priority factor for the dismounted unit, because almost any UTM would enable it to go faster than without one. The dismounted unit is not comparing UTMs with SSVs but rather is comparing UTMs to operating without any mechanized assistance. In contrast, a mechanized unit may seek to operate as it would with SSVs, but with ones that have better access to rough or constricted terrain. While the mechanized unit will value the UTMs' relative superiority over SSVs in mobility, it will likely want a UTM platform that is as interoperable with SSVs as possible.

MEDCOM Scenario Application

To illustrate the pertinence of the UDAP, we apply the UDAP in the MEDCOM scenario discussed in Chapter Two. Specifically, this discussion describes the likely considerations of an airborne or air assault IBCT unit executing the Joint Forced Entry (JFE) mission as described in the scenario. In the illustrative case that follows, the IBCT commander applying the five-step UDAP is clearly taking a bottom-up approach to improve the capabilities of his dismounted infantry and will likely seek increased speed and carrying capacity with UTM platforms.

UDAP Step One: Identify Key Tactical Activities (TAs) for Mission

The first step of the UDAP is to identify the specific mobility capability gap that exists with regard to a mission or set of missions. In particular, the user must explicitly identify the specific relevant Tactical Activities (TAs) defined in Chapter Two (e.g., Coordinated Maneuver, Immediate Pursuit, etc.) where the gap exists. Note that this step is purposefully agnostic with regard

Figure 4.2
UTM Demand Assessment (UDAP)

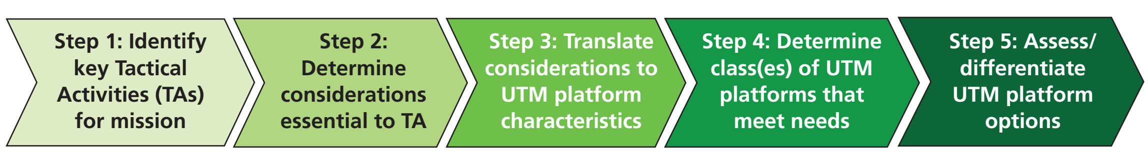

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Table 4.2
Top-Down and Bottom-Up Approaches to UTM Consideration

Assessment Paradigm	Top-Down Approach to UTM Consideration	Bottom-Up Approach to UTM Consideration
Description	• considers UTM as an alternative to SSVs	considers UTM as a means to augment dismounted elements
Example applications	• consideration of UTM to augment vehicle-centric formations (motorized, mechanized, or armored forces) or enable maneuver when constraints preclude SSVs	extension of a dismounted patrol's range and fire power by carrying extra supplies and crew-served weapons
Key assumptions	• fundamental constraints preclude the use of SSVs (delivery, terrain, etc.)	SSVs, even if they can be used, are not always useful for dismounted operations

to specific platforms, tasks, missions, and planning processes included. This step focuses on the mission: Which activity does the mission entail that will require some type of mobility? This step does not focus on specific mobility platforms but is intended to enable consideration of the range of potential mobility options and to enable identification of the most broadly applicable solutions that can meet multiple operational needs. Based on specific mission characteristics, this step could identify non-UTM alternatives that can sufficiently execute the TAs included.

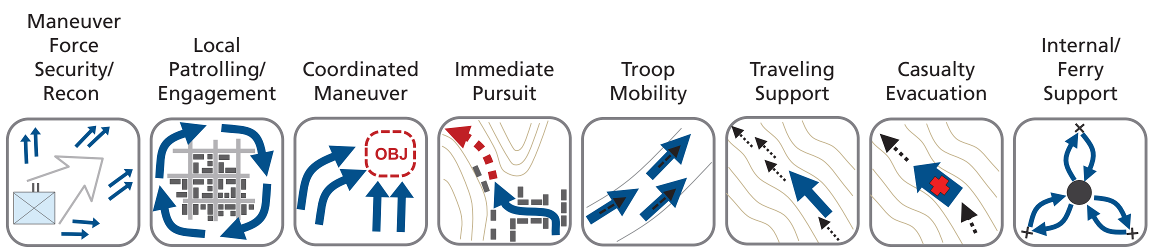
MEDCOM Scenario Application

Our hypothetical IBCT unit preparing for the MEDCOM scenario would identify the following TAs as relevant to the mission of establishing an aerial point of debarkation/sea point of debarkation (APOD/SPOD): Maneuver Force Security/Recon and Coordinated Maneuver (Figure 4.3). Delving deeper, the unit would recognize the need to prepare other possible requirements that might entail other TAs. For example, the unit would likely want to prepare for a potential follow-on humanitarian assistance/disaster relief (HA/DR) mission that would include local patrolling/engagement TAs as well. Finally, the unit would end up with a list of TAs likely requiring mobility capabilities. This list forms the basis of UDAP Step Two.

UDAP Step Two: Determine Mission Considerations Essential to TA Execution

Keeping the previously identified TAs in mind, the second step of the UDAP prioritizes the most important considerations for mission accomplishment and should directly affect the selection of mobility options. As illustrated in Figure 4.4, the various considerations—including operational constraints—that govern platform suitability fit into

Figure 4.3
Tactical Activities



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five basic aspects of platform employment: planning, delivery, employment, recovery, and sustainment. Note again that this step of the UDAP is purposefully agnostic to specific mobility platforms to identify the best-suited platform across the range of identified activities. More detailed discussion of these aspects of operation and their assessment within the UDAP is provided in Appendix D.

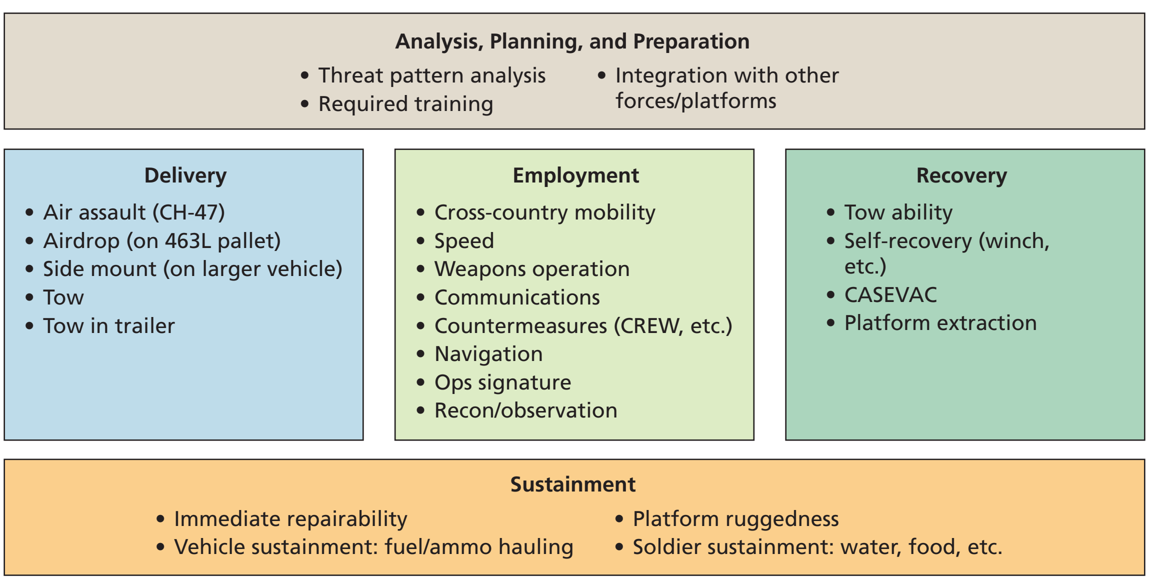
Differing Tactical Activities, unit task organizations, and operational environments will likely place differing priorities on the five aspects of UTM employment. For instance, a Maneuver Force Security/Recon mission will likely prioritize communications and cross-country mobility over weapons employment. Similarly, Traveling Support will likely prioritize load divisibility and cargo capacity over weapons employment and operational signature. The need to rely on CH-47s or operate in an environment with few or no improved roads would place clear constraints on platform choices that should be captured during this assessment. Ultimately, each combination of mission profile, required Tactical Activities, and operational environment can result in a unique "bundle" of considerations and priorities across the five aspects of mobility employment for determining the most appropriate UTM or non-UTM mobility option.

MEDCOM Scenario Application

As illustrated in Figure 4.4, the IBCT would identify considerations for UTM employment associated with each employment aspect (delivery, employment, etc.). Based on the operational characteristics of the MEDCOM scenario, the IBCT would likely prioritize the following UTM employment considerations:

- suitability for transport in a range of potential delivery platforms (especially if it is not clear how the Joint force will deliver and subsequently move the IBCT)

Figure 4.4
UTM Employment Considerations Within the Five General Aspects of UTM Employment



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- ability to support employment of light infantry battalion weapons (e.g., M240 machine gun, Mk-17 grenade launcher, 81mm mortar system, and Long Range Advance Scout Surveillance System (LRAS3)
- ability to traverse diverse terrain
- limited operational signature (e.g., audible range, thermal signature, and observability).

Given potential delivery method constraints and the terrain associated with the MEDCOM scenario, the operational benefit of UTM capabilities is fairly clear. The IBCT, having worked through the first two steps of the UDAP, can benefit from being better able to articulate a request for UTM capabilities. While this stage of the UDAP does not focus on a specific platform, at this stage the unit now has a better sense of how to prioritize particular characteristics and capabilities of mobility options. For example, the unit might place less relative value on considerations of speed, range, self-recovery, and sustainment if the BCT is tasked to operate in a relatively small area and permissive lodgement as opposed to more contested areas beyond an establish beachhead or airhead.

Assessments in the UDAP should include explicit identification and assessment of potential risks from UTM employment based on the specific operation and operational environment (see Table 4.3). Risk considerations should include assessment of the dissuading factors for UTM use (as defined in Table 2.5) and their potential impact on commander determinations to employ or not employ UTM capabilities. Due to the operational specificity of motivating and dissuading factors for UTM employment and lack of definitive analysis of UTM employment, final determination of whether and how to employ UTM capabilities relies on a qualitative determination by commanders. The potential peril of these decisions is increased by the lack of broad experience or analysis to inform commanders' weighing of the benefits and risks associated with UTM employment in each respective operational setting.

UDAP Step Three: Translate UTM Employment Considerations into UTM Platform Characteristics

The third step of the UDAP focuses on identification of desired platform characteristics based on the identified considerations from UDAP Step Two. Selection of an appropriate UTM platform requires the UDAP user to translate the considerations identified in UDAP Step Two into desired UTM performance characteristics. Unlike the more general and qualitative con-

Table 4.3
Key Risk Factors and Example Operational Considerations to Inform UDAP

Factor	Example Operational Risk Considerations to Inform UDAP
Threat vulnerability	• The probability of potential attacks of UTM (or alternative) options • The impact of attacks on UTM (or alternative) options given UTM protection and method of employment, and likely threat capabilities and employment
Hazard vulnerability	• Potential types of calamities based on terrain, method of employment, and other environmental factors • Impact of calamities on vehicle occupants and overall force should they occur
Lack of interoperability	• Potential negative consequences from differences in size and situational awareness between different force elements, such as isolation of individual elements and fratricide
Sensory capacity demands	• Potential degradation of ability to collect sensory inputs and operate sensory systems in combination with vehicle operation

siderations of the earlier steps, these characteristics are measurable attributes to enable a more rigorous assessment of mobility alternatives. To determine these performance characteristics, the UDAP user must identify which platform characteristics are most important to meet the identified needs. These characteristics should closely resemble and ultimately inform the key performance parameters (KPPs) identified during the JCIDS process.[4] Figure 4.5 provides an example list of platform characteristics. Based on the specific operational demands of the user, other characteristics might be more appropriate to facilitate a useful comparison of alternatives. Appendix D provides additional detail on identifying platform characteristics for assessment.

Each characteristic in Figure 4.5 should have definitions that can be objectively observed or measured. For example, weapons employment implies that the UTMs must not only be capable of accommodating weapons mounts (and provide a stable firing platform), but also cargo weight and volume must be taken into account to accommodate associated demands, such as crew-served weapons ammunition. This is clearly a characteristic that the evaluator can classify as "pass" or "fail" for each potential UTM alternative. In the illustrated scenario, NVG operation may also constitute a key characteristic if infrared illuminators and laser sights will be used. Finally, situational awareness factors, such as whether the UTM platform can accommodate power-amped radios, should be considered. At the completion of this UDAP step, the user should have a list of priority platform characteristics that can be observed, measured, and compared in UDAP Step Five. Careful identification and definition of characteristics in this step allow for more accurate evaluation and differentiation in UDAP Step Five.

MEDCOM Scenario Application

After the BCT has assessed and prioritized the mission considerations for the MEDCOM scenario in UDAP Step Two, these considerations must be expressed in terms of UTM platform characteristics to evaluate options and select a platform. The unit can capture this analysis process with a chart listing all characteristics for assessment of UTM platform alternatives. Figure 4.5 provides a notional example of such an analysis to identify the most important characteristics for the MEDCOM scenario. If the IBCT unit in this example considers a follow-on local patrolling/engagement mission as a possibility, partner capabilities could influence prioritized performance characteristics to support interoperability and information operations purposes.

UDAP Step Four: Determine Best UTM or Other Vehicle That Could Best Meet Needs

Once the unit has identified priority UTM platform characteristics, it can determine the optimal class or classes of UTM. Rather than attempting to classify each of the various UTM platforms potentially available, the user can apply a set of basic UTM categories based on the fundamental and relatively permanent distinguishing characteristics. The research team identified these fundamental differentiating characteristics as described below based on input from Army and Marine Corps UTM practitioners, subject-matter experts on mobility platforms,

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[4] Chairman of the Joint Chiefs of Staff, 2009. This DoD guidance for executing the JCIDS process defines KPPs as

> those attributes or characteristics of a system that are considered critical or essential to the development of an effective military capability and those attributes that make a significant contribution to the characteristics of the future joint force as defined in the Capstone Concept for Joint Operations. KPPs must be testable to enable feedback from test and evaluation efforts to the requirements process.

Figure 4.5
Example Platform Characteristics to Assess UTM Alternatives

UTM Employment Aspect	Consideration	Characteristic	Type of Metric
Analysis, planning, and preparation	Initial operator training required	Number of hours of training required for operator to achieve designated level of proficiency	Numeric value
	Sustainment operator training required	Number of hours of training required per quarter for operator to maintain designated level of proficiency	Numeric value
Delivery	Lifting and tie-down	Meets lifting and tie-down provision requirements per MIL-STD-209 and MIL-STD-1366	Y/N
	Mission-ready time (after disembarkation)	Shall be capable of debarkation from C-130 aircraft or CH-47 (internal) and combat operation in 5 minutes by two (2) persons	Y/N
	Transport platform suitability	Two platforms can be internally carried simultaneously (in combat configuration) in a CH-47, CH-53, or CV-22	Y/N
Employment	Trafficability	The ability of the vehicle to traverse specified terrain (on-road and off-road)	Numeric value (VCI/RCI)
	Remote operation	Platform can be alternately controlled through remote control from at least 100 meters	Y/N
	Constrained-space operations	Exterior width (function of land-use assessment in trafficability analysis)	Y/N
	Partner capabilities	Like or similar to partner primary operating platform	Y/N
	Audible operational signature	Range of audible detection under operating conditions	Numeric value
	Slope performance	Max lateral slope traverse performance	Numeric value
	Carrying capacity	Max cargo volume	Numeric value
	Operational range	Max cruising range at gross vehicle weight (GVW)	Numeric value
	Fording depth	Maximum water fording level (without fording kit)	Numeric value
	Visual operational signature	Range of observation of vehicle in representative operational terrain	Numeric value
	Level of protection	Base level of platform protection	Armor category
	Additional protection	B-kit add-on armor capable	Y/N
	Weapon mount integration	Weapons mount permit weapons employment while traversing 180 degrees	Y/N
	Restraint system	Prevent the operator from being ejected during off-road operations	Y/N
Recovery	CASEVAC-capable	Equipped or can be configured to move casualties by DoD standard	Y/N
	Towing	Maximum tow load on fixed gradient	Numeric value
	Self-recovery	Ability to mechanically self-recover	Y/N
	Like vehicle towing	Ability to tow like vehicle over gradient and distance	Y/N
Sustainment	Fuel commonality	Ability to operate on primary unit fuel (i.e., JP 8)	Y/N
	Maintenance training required	Percentage of Maintenance Tasks Level-10, -20, -30	Numeric value
	Range before refuel	Cruising range plus additional carried fuel	Numeric value
	Storage capacity	Total volume of equipment stowage	Numeric value

NOTES: Trafficability is a standard metric that allows formal comparison of mobility alternatives with an analytically supported numerical value. NATO terrain analysis demonstrates trafficability analysis including variables such as terrain, land-use, and vegetation among others (Jonathan Stewart et al., *Terrain Analysis Support: Mobility Modeling for Peace-keeping Operations*, U.N. Cartographic Section, 2009 ESRI International User Conference Presentation).

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and analysis of previous UTM employment.[5] As illustrated in Table 4.4, the three primary characteristics that most clearly dictate UTM suitability are the following:

- **Track width:** This differentiating characteristic of a UTM alternative dictates how many platforms can fit in various delivery modes, such as in a CH-47, or an airdrop pallet, and determine how easily they can move over terrain constricted by vegetation or human development.
- **Maximum carrying capacity:** This total weight-bearing "envelope" of a UTM chassis determines the total weight of all hardware, personnel, and equipment that the UTM can carry. This capacity dictates the cumulative weight of riders, cargo, protective armor, or vehicle hardware the chassis can carry. These values generally correspond to vehicle size and construction but are likely to increase as ultra-light materiel and vehicle design technologies evolve, improving vehicle carrying capacities.
- **Physiological stress:** This characteristic corresponds to the UTM platform's effect on the human operator or, in the case of quadruped, the operator and animal. For example, operation of a motorcycle, with its requirement for constant stabilization, would entail more physiological stress than operating a four-seat full-duty UTM with a padded seat and power steering, under most conditions.

Generally, larger classes of UTM platforms are preferable over smaller classes when they meet the basic mission needs because they can carry additional hardware, cargo, or personnel as dynamic missions might require. Based on analysis of UTM usage preferences and patterns, we identified the following general conditions for preferring each class of UTM platform:

- **Full-duty platform:** Army units will likely choose a full-duty platform when the unit values speed, endurance, range, cargo capacity, situational awareness, and force protection more than the ability to traverse the most difficult terrain and delivery (as defined). Overall, the full-duty platform offers the highest relative performance across the full array of characteristics.
- **Midsize platform:** Army units will likely choose a midsize platform over a full-duty platform when the unit values the ability to traverse marginally more difficult terrain and expanded delivery options at the expense of speed, endurance, range, cargo capacity, weapons employment and force protection.
- **Compact platform:** Army units will likely choose a compact platform over a midsize platform when the unit values the ability to traverse marginally more difficult terrain, ease of procurement, and larger cargo capacity at the expense of speed, fuel consumption, range, and situational awareness.
- **Subcompact platform:** Army units will likely prefer a subcompact platform over larger platforms when the unit values the ability to traverse difficult terrain, a reduced operational signature, and delivery at the expense of speed, range, cargo capacity, force protection, individual protection, crew sustainment, and situational awareness.

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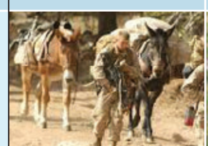
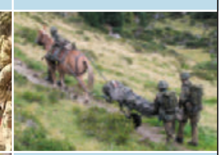
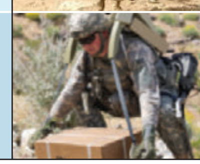
5 While track width and physiological limitations are factors that will likely not change significantly in the future, developments in materials technology and load carriage systems could enable the maximum carrying capacity of UTM of a given track width to increase over time. The values listed in Table 4.4 are based on current industry figures and would need to be reassessed regularly to provide accurate guidance for UTM selection.

Table 4.4
Classes of UTM Platforms with Differentiating Characteristics

UTM Platform Class	Track Width	Max Carrying Capacity (soldier equivalents)	Physiological Limitations	Examples
Full-duty	Dual (+) (70")	3,000 lbs (12>)	Low	
Midsize	Dual (60")	1,600 lbs (6.5>)	Moderate	 
Compact	Dual (-) (48")	750 lbs (2.5>)	Moderate	 
Subcompact	Single (+) (36")	375 lbs (1.5>)	High	
Quadruped	Single (+) (36")	375 lbs (1.5>)	High	 
Human-enabled	Single (30")	375 lbs (1.5>)	High	

- **Quadruped:** Army units will likely choose a quadruped when the unit values the most reduced operational signature, the ability to traverse the most difficult terrain, procurement, and the smallest fuel and parts consumption. However, a quadruped lacks speed and endurance, and demands very specific operator training and feed with limited aerial delivery options.
- **Human-enabled:** Army unit will likely choose a human-enabled platform when delivery is of the utmost importance. In choosing this platform, the unit sacrifices speed, cargo capacity, maintenance, and ease of procurement.

Using the UTM platform class illustrated above, the operational unit can more easily consider the key characteristics that differentiate potential UTM options and then consider platform options with the appropriate class or classes that are most readily configured to optimally meet the range of intended applications. For example, some platforms allow multiple configurations, such as a cargo bed or additional seating, to meet mission-specific needs. This concept of flexible configurations of a common platform is a consistent feature of existing tactical wheeled vehicle programs, such as the HMMWV family of vehicles and the planned fielding of the JLTV with a base utility platform that will exist in a variety of configurations, through the installation of kits and mission essential equipment required to perform their primary operational role, to include general purpose, support, and close combat weapons platforms.[6] For cost and resource efficiency, a UTM platform from the preferred UTM class that can be readily reconfigured to execute multiple Tactical Activities would likely be preferable for conventional Army units that must prepare for a range of potential operations. Figure 4.6 illustrates how some units have configured UTM platforms to specifically serve as lightweight strike vehicles to execute Maneuver Force Security/Recon and Coordinated Maneuver activities.

This approach should yield a set of UTM categories that, based on their differentiating characteristics, minimally meet the operational needs. While multiple categories might meet the immediate operational need identified, one would likely pick the largest category of suitable UTM based on the increased carrying capacity and the corresponding potential to add functionality such as protective armor, additional riders, or additional cargo, in response to changes in the mission or environment.

MEDCOM Scenario Application

For this scenario, the IBCT would likely prefer a platform from the full-duty class of UTMs, since it can be delivered by a CH- and DRAS airdrop platform and will provide a larger total cargo capacity to carry cargo or attachments, such as weapons, armor, ammunition, or additional soldiers, compared with other UTM options.. However, if the unit anticipates the need to execute operations with numerous dispersed dismounted units, the unit might prefer mid-size or compact class UTM platforms, since a single CH-47 or DRAS platform can potentially accommodate multiple smaller UTM platforms, as opposed to only one full-size UTM platform. Lastly, the IBCT could encounter conditions in mountainous areas where dismounted forces must operate on narrow footpaths to secure key terrain. In this case, some knowledge and experience with employing locally available pack animals by dismounted forces could prove beneficial for conducting Traveling Support activities.

UDAP Step Five: Assess/Differentiate Platform Alternatives

The final UDAP step focuses on assessing all the different alternatives identified in UDAP step 4 based on the key performance characteristics identified in UDAP step 3. The UDAP process should consider both options within the workable UTM platform class or classes and other existing or potential non-UTM options. For the unit to assess a UTM alternative as the best option, the UTM alternative must either fill an articulated gap in capabilities or better serve a mission requirement than current alternatives. Additionally, the selected UTM option must provide marked advantages while still being within overall hazard and safety tolerances. Because the differentiation and final selection of alternative depend significantly on mission-

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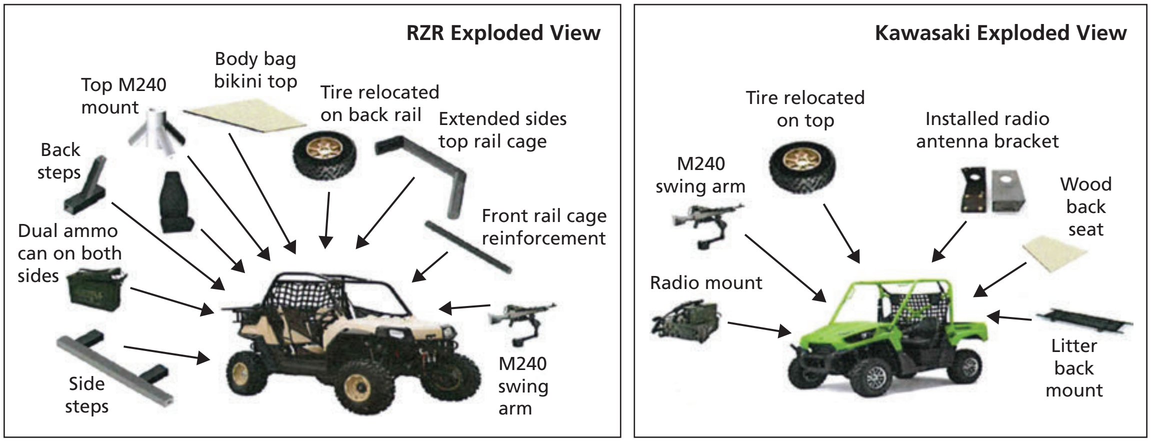
[6] Department of the Army, "Joint Light Tactical Vehicle Concept of Operations Version 3.6," January 6, 2012. The JLTV as currently conceived will comprise two variants, a two-seat and a four-seat variant, and a companion trailer (JLTV-T). The two-seat variant (Combat Support Vehicle [CSV]) is intended to have one base vehicle platform, the Utility (JLTV-UTL). The four-seat variant (Combat Tactical Vehicle [CTV]) is intended to have two base vehicle platforms, the General Purpose (JLTV-GP) and the Close Combat Weapons Carrier (JLTV-CCWC). The base vehicle platforms will exist in a variety of configurations through the installation of kits and mission-essential equipment required to perform their primary operational role.

Figure 4.6
SOF Modifications to Configure the Polaris RZR and Kawasaki Tyrex Platforms for Use as Lightweight Strike Vehicles



SOURCE: Department of Defense, 2013.
RAND *RR718-4.6*

specific operational and environmental characteristics, a sound assessment process requires significant unit consideration and adaptation. In general, the unit must execute the following assessments:

- identify COTS and M-COTS platform alternatives that currently exist or are available within the suitable UTM platform classes: This can include reviewing manufacturer data and identifying platforms already in use by other forces for other functions.
- determine functional metrics for evaluation of the key characteristics: The unit must determine metrics based on its operational needs for each characteristic. These metrics should enable the unit to measure and evaluate each potential alternative's ability to meet each priority characteristic.
- measure/estimate performance characteristics of identified alternatives: Use available resources to collect measurements for identified metrics associated with platform characteristics. If measurement is not possible, the unit should consider available information to enable estimation of the performance characteristics for each identified alternative, such as manufacturer information and previous evaluations.

MEDCOM Scenario Application

IBCT execution of this UDAP step could include detailed measurement of each alternative or general assessments based on available information, depending on the time and resources available. Due to the limited preparation time associated with most contingency operations, the IBCT in this scenario would likely need to conduct a brief qualitative assessment of potential UTM alternatives based on readily available information, such as manufacturer data or previous analysis. Figure 4.7 shows a notional example of an output from the UDAP process to briefly communicate the overall suitability of identified alternatives.

At the completion of this step, the unit should have an evaluation of identified UTM platform alternatives based on each platform's measured or estimated performance in the key characteristics identified in UDAP Step Three. The unit then picks the platform with the highest relative performance in the characteristics deemed most important. In this case, the IBCT unit leader and his or her staff would likely seek an LTATV platform because the assessment indicates that this platform has the best composite performance for the key characteristics identified at the left side of Figure 4.6.

Unit-Specific UTM Demand Profiles and Validated Requirements

While the specific UTM selection depends significantly on the existence of specific expected operational conditions and unit demands, "bundles" of common UTM need factors are significant for certain unit types based on the operations they are anticipated to conduct and the inherent constraints associated with their primary missions. For example, airborne infantry forces depend almost completely on airdrop for initial delivery of key equipment, to include supplies and mobility platforms. In consideration of UTM options for an airborne unit, the constraints imposed by aircraft and airdrop method performance would be key considerations for translation into performance characteristics and assessment of alternatives. These unique bundles of considerations are discussed below for some force types that have demonstrated need for and employment of UTM capabilities. Conversely, absence of the clear motivating factors discussed next suggests that UTM vehicles would likely not meet a compelling need for that unit type.

Likely UTM Considerations for Airborne Forces

Airdrop and delivery capacity of aircraft and airdrop pallets fundamentally dictate airborne units' tactical mobility need.[7] As a result, delivery options, cruising range, ease of maintenance, and capability of extended sustainment in austere environments are likely all key considerations.[8] As Figure 4.8 illustrates, Army airborne forces currently have some experience in and guidance for airdrop of UTM platforms.

Currently, the XVIII Airborne Corps and 82nd Airborne Division are primarily focusing on a top-down UTM approach (miniaturizing vehicle to meet constraints), seeking a combat vehicle with many of the SSV's characteristics that fits within delivery constraints. The specific UTM requirements are identified and explained in 82nd Airborne Division (2014), submitted in March 2014.[9] In response, FORSCOM has initiated a program to provide UTM capabilities to airborne IBCTs. This ONS states that the 82nd Airborne Division requires mobility options that are internally transportable in a CH-47. The UTM options will not replace the SSV as the primary ground mobility platform for airborne force but will exist as a battalion-sized set of vehicles that could be provided as additional equipment when needed for the Global Response Force (GRF) forcible entry operations. When considering related air-load planning for a basic GRF force package, the unit will tailor the force structure based

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7 Department of the Army, *FM 90-26: Airborne Forces,* 1990. Airborne forces execute parachute assaults to destroy the enemy and to seize and hold important objectives until linkup is accomplished. The parachute assault enhances the basic infantry combat mission: to close with the enemy by fire and maneuver, to destroy or capture him, and to repel his assaults by fire, close combat, and counterattack.

8 Infantry Warfighter Forum staff, interviews with authors, January 25, 2013.

9 U.S. Army Forces Command, March 2014.

Figure 4.7
Notional Assessment of UTM Alternative for Operational Needs

NOTIONAL

Characteristic	Polaris 700	"Big-Dog" Robotic Vehicle	LTATV	M-Gator
Audible operational signature	1	4	2	3
Cargo volume	4	2	3	1
Cargo weight	4	1	2	3
Cruising speed	2	3	1	4
Delivery	2	4	3	1
Partner capabilities	1	4	3	2
Range before refuel	1	4	2	3
Situational awareness	4	1	3	2
Visual operational signature	1	4	3	2
Weapons employment	3	4	1	2

NOTIONAL

Suitability
Exceeds requirements
Meets requirements
Does not meet requirements

Ordinal ranking of alternatives
1, 2, 3, 4

RAND *RR718-4.7*

on the number of aircraft (usually C-17s) allocated. A key factor affecting UTM use (transport volume is often a bigger constraint than total weight), appropriateness of a UTM is often determined by the total space available and is based on available cargo area and mix of forces. Figure 4.8 shows a UTM platform that the 82nd Airborne currently has ready for immediate deployment and airdrop to support GRF operations.[10]

Likely UTM Considerations for Air Assault/Air Mobile Forces

Since air assault and air mobile forces move primarily by rotary-wing aircraft, aerial delivery is a key constraint for platforms to meet ground mobility requirements for this unit type.[11] Once the platforms are delivered, units most often use the mobility platforms to carry weapons or cargo in support of dismounted troops.

Air assault forces, while traveling inside the rotary-wing aircraft, use sling-load operations for rapid movement of heavy, outsized cargo. While the M-Gator was not specifically designed for air assault operations and is internally transportable in a CH-47, Army doctrine provides guidance for sling loading the M-Gator by CH-47 aircraft. However, internal transport of the M-Gator and other UTM platforms is often preferred during rotary-wing insertion because the platform can be driven off the aircraft in combat configuration and immediately ready to operate. Figure 4.9 shows the internal and external loading of UTMs for air assault forces.

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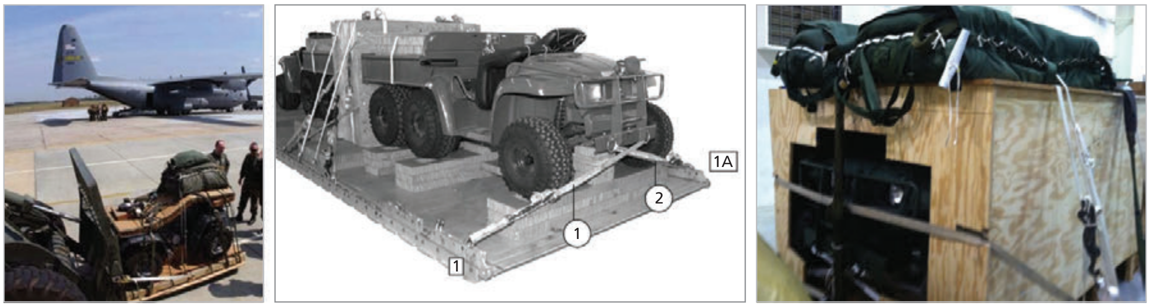
10 Based on research team observation of XVIII Airborne Corps GRF equipment.

11 Department of the Army, *ATTP 3-18.12,* 2011. Doctrine defines an air assault operation as "an operation in which assault forces, using the mobility of rotary-wing assets and the total integration of available firepower, maneuver under the control of a ground or air maneuver commander to engage enemy forces or to seize and hold key terrain."

Figure 4.8
UTM Platforms Rigged for Airdrop with Airborne Forces Deployment



SOURCES: 160th SOAR, 2012; FM 4-20.108, 2001; and research team; 2013.
RAND *RR718-4.8*

Likely UTM Considerations for Mountain Warfare Forces

Units that conduct mountain warfare apply infantry small-unit tactics almost exclusively in Level II and Level III terrain, demanding vehicles that can support dispersed dismounted infantry operations in steep and constricted terrain, dense vegetation, and across deep snow, ice, and mud.[12] Furthermore, the degraded mobility and increased movement times associated with mountain warfare often demand unique sustainment solutions. For mountain infantry, cross-country mobility and the ability to operate at high altitudes are likely more important considerations than high-end speed or ability to mount and operate crew serve weapons.

Likely UTM Considerations for National Guard Forces Title 32 Operations

While National Guard units have primary Title 10 missions like their active duty and reserve counterparts, they also have Title 32 Defense Support to Civil Authorities (DSCA)[13] duties in addition to their TOE-designated missions. Title 32 operations are conducted in generally permissive domestic environments and require employment of "critical dual-use equipment," formally identified as having both operational and DSCA applications, such as HMMWVs, utility helicopters, and medical treatment capabilities.[14] However, these DSCA missions often occur in disaster or emergency settings, such as hurricane or wildfire response.[15] Platforms that are readily deployable and enable efficient execution in nonhostile environments receive particular emphasis. While these units would probably not prioritize force protection, reduced operational signature, or weapons employment in DSCA operations, they would likely need to traverse diverse terrain including urban obstacles, carry cargo, and perform CASEVAC.

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12 Department of the Army, *ATTP 3-21.50*, 2011.

13 Department of the Army, *Army Doctrine Publication (ADP) 3-28: Defense Support to Civil Authorities*, July 2012. Defense Support of Civil Authorities is defined as support in response to requests for assistance from civil authorities for domestic emergencies, law enforcement support, and other domestic activities, or from qualifying entities for special events.

14 Department of the Army, *AR 220-1: Army Unit Status Reporting and Force Registration—Consolidated Policies*, April 15, 2010. Critical dual-use (CDU) equipment items are those that support the operational requirements of Army units and are necessary to enable Army units and personnel to assist civil authorities in responses to natural disasters, acts of terrorism, and other human-caused disasters as identified in national planning scenarios (that is, facilitate DSCA).

15 Based on discussion of recent, assigned, and likely DSCA disaster response activities with commanders and staff from the Vermont and California National Guard units.

Figure 4.9
Internal and External Transport of UTM Platforms by Rotary-Wing and VTOL Aircraft

SOURCE: FM 4-20.198, 2009, 160th SOAR, 2012; and USMC, 2011.
RAND *RR718-4.9*

Likely UTM Considerations for Aviation Support Forces

Aviation support operations, such as Forward Arming and Refueling Point (FARP) operations and Downed Aircraft Recovery Teams (DART), are often limited to delivery by the rotary-wing aircraft they support. Especially for DART elements, the ability to depart aircraft quickly is important, emphasizing the ability to fit inside a CH-47 in combat configuration rather than requiring time-consuming sling load procedures for external carry. Required tasks on the ground include moving heavy loads and soldiers over rough terrain. For FARP operations, a platform's ability to carry bulky and heavy fueling equipment is a primary consideration.

Likely UTM Considerations for Stryker and Mechanized Forces

While Stryker and Armor BCT needs for UTM platforms are not high, due to the capabilities of their primary platforms,[16] UTM platforms have demonstrated benefits for rapidly accessing steep or constricted terrain otherwise unreachable by larger maneuver platforms. The UTMs also allow for efficient execution of marshaling, support, and coordination tasks.[17] However, the limited ability of UTM platforms to sustain long-distance movement requires them to be transportable when not immediately needed. Due to these considerations, motorized and mechanized forces would likely value compact platform size. Additionally, the need to coordinate movement of UTM-based forces with maneuver forces would emphasize command, control, communications, and situational awareness as key considerations for UTM platforms. These units would likely emphasize a platform with speed, the ability to traverse diverse terrain, and fuel and parts that are common with other vehicles in the BCT.

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[16] Department of the Army, *FM 3-90.6 14: The Brigade Combat Team*, 2010. Doctrine describes Armor BCTs as "balanced combined arms units that execute operations with shock and speed with their main battle tanks, self-propelled artillery, and fighting vehicle-mounted Infantry that provide tremendous striking power but require significant strategic airlift and sealift to deploy and sustain." And Stryker BCTs "balance combined arms capabilities with significant strategic and intra-theater mobility and operational reach with the Stryker wheeled armor combat system, making it more deployable than the HBCT and having greater tactical mobility, protection, and firepower than the IBCT."

[17] U.S. Army 1-6 Combined Arms Battalion, interviews with authors, January 17, 2013. C Company, 1-6 CAB found UTM platforms beneficial for establishing assembly areas and coordinating area defense placement. C Company also identified reconnaissance, observation, and identifying sectors of fire as tasks that a Bradley would generally perform, but that could be done by UTM as an economy of force and way to reduce operational energy.

Specific Army Special Operations Forces Needs

While Army SOF have mission-specific performance requirements that are not all common in conventional force UTM demands and are often met by MFP-11 funding, ARSOF would benefit from a service-provided UTM platform with robust construction, ability to traverse rugged terrain, and simplicity of sustainment and repair that can be readily tailored to meet various SOF-specific mission requirements.[18] In addition to this flexibility, operational signature, procurement, and crew sustainment would likely be significant considerations for MFP-2 service-provided platforms for SOF-peculiar refinement.

Determining UTM Capability Levels Required by Army Units

While the unit types discussed previously and others have demonstrated broad and legitimate demands and validated requirements for UTM capabilities to execute their primary and assigned missions under certain situations, they may not necessarily require UTM capabilities for all operations and environments they could encounter. Based on the Army's previous experiences evaluating UTM-pure experimental units and likely future operational requirements, UTM-specific units are probably not required nor an efficient use of scarce resources.[19] Like the current FORSCOM effort to provide airborne forces with a battalion-sized set of UTM capabilities, Army provision of UTM capabilities to units through a Modified Table of Organization and Equipment (MTOE)[20] or Basis of Issue Plan (BOIP)[21] would enable a resource-conscious strategy for augmentation of unit mobility capabilities on an as-needed basis to respond to mission-specific UTM needs as they occur. To foster effective planning and management of unit-level UTM capability development, the Army should assess the level of UTM capabilities appropriate for a given unit based on the unit-specific factors most likely to dictate need for UTM capabilities, as described in Table 4.5.

Consideration and analysis of these factors for the specific unit should inform determination of the level of UTM capability demanded by each unit, to include knowledge, training, and equipment that the unit should develop and sustain to meet mobility requirements. For example, the Army could identify an appropriate capability level from a range of delineated

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[18] For Army SOF, service-common materiel is provided by the Army through MFP-2 resources, while SOF-peculiar adaptations to the MFP-2 materiel are executed with MFP-11 resources.

[19] Larry Parsons, "Air Support of the High Technology Light Division in a Contingency Area," *U.S. Army War College Project Studies*, 1982. For example, the Army found that the 9th Infantry Division units equipped only with UTM platforms were useful for executing certain specific missions but were not sufficient to effectively conduct full-spectrum operations. As this analysis describes, "the HTLD represents a significant departure from existing forces . . . One of the HTIB charters is to take full advantage of high technology to make the HTLD competitive against heavier units . . . The idea is to place very lethal weapons in a very mobile force so it can destroy a variety of enemy units."

[20] Department of the Army, Army Regulation 71-32, *Force Development and Documentation—Consolidated Policies,* 1997. An MTOE is an authorization document that prescribes the modifications to a basic TOE that are necessary to adapt its mission, capabilities, organization, personnel, and equipment to meet the needs of a specific unit or group of units. A Department of the Army (DA)-published MTOE is the official authorization document for the TOE units and is the authority for organization property on hand in the organization.

[21] Department of the Army, 1997. A planning document that lists 100 percent wartime requirements for augmentation to mobilization TOE (when directed by HQDA), in which a new or improved item will be required; the number of items to be included in each organization element; and other requirements and personnel changes needed to operate, maintain, and transport the item.

UTM capability levels for each assessed unit. Figure 4.10 provides an example concept of potential UTM capability levels for Army units potentially requiring UTM capabilities based on the level of knowledge, training, and equipment required given the factors discussed above. However, there are many units in the Army that face few or none of the factors described in Table 4.5 or that possess an alternative capability that meets unit needs as good, better, and/or safer than a UTM alternative. For the significant portion of Army units for which these UTM demand factors do not exist, UTM capabilities are not required or appropriate unless unit factors change due to changes in mission or the associated tactical environment. However, for the units where the UTM demand factors are present and significant, absence of this capability constitutes a considerable limitation on the units' ability to execute assigned or likely missions.

Conclusions

Due to the relative affordability of UTM platforms and complexity of the JCIDS process, tactical Army units consistently demonstrate a willingness to pursue informal or field expedient acquisition, sustainment, and employment of UTMs. The relative inexpensiveness of UTM platforms has allowed units more ad hoc acquisition opportunities, namely with IMPAC and local purchases.[22] However, these acquisition decisions are often made without full consideration of the actual range of unit needs and the mobility alternatives that are best suited to meet them. The UDAP described in this chapter provides a readily applicable methodology for assessing unit demand for UTM and other mobility alternatives in advance of a formal JCIDS process that generally requires 13 to 26 months to successfully respond to a need (if validated).[23] In addition to addressing immediate unit consideration of mobility options, the UDAP is also a scalable framework that, with appropriate scaling, can form the conceptual basis for consideration of Army-wide strategies for developing UTM capabilities.

[22] For example, a brigade commander in the 82nd Airborne Division can currently make an individual purchase of less than $50,000 with no further review required by the Division Commander.

[23] Government Accountability Office, 2012. While the JCIDS process generally requires 13 to 26 months to field a response to a validated need, the USP is designed so that an operational planner can complete the process within a couple of hours and in concert with staff analysis and planning processes.

Table 4.5
Factors Influencing the Level of UTM Capability Required by Army Units

Factor	Description	Implications for UTM Employment
Assigned mission(s)	An operational activity that a unit is formally assigned to plan for, prepare for, or to execute as reported by the Army Unit Status Reporting (USR).[a] This factor addresses a unit's enduring need for UTM to execute core unit activities.	Constitutes enduring requirements for UTM capabilities that are essential to unit operations across assigned and potential missions, such as FARP execution by aviation support units.
Contingency mission	A mission requiring a unit to task-organize for rapid deployment in order to meet operational plans and contingency requirements. For example, deployment as part of the Global Response Force (GRF).	Constitutes temporary UTM requirements associated with a specific assigned mission for a specific period. For example, vehicle airdrop requirements for GRF-assigned airborne units.
Geographic focus area	A unit requirement to develop capabilities for conducting operations in a specific region and/or provide support to a specific Geographic Combatant Command (GCC). For example, geographic focus areas defined for Regionally Aligned Forces (RAF).	Implies existence of UTM requirements to operate in a specific environment and/or with specific limitations based on the geographic location, such as sustainment limitations or partner force capabilities.
Expected opportunity for premission training and preparation	The anticipated time and resources that the unit will have for developing required capabilities prior to initiation of operations, to include materiel fielding, individual training, and collective training.	Dictates the available time to field UTM platforms and conduct required individual and collective training prior to operational employment.

[a] Department of the Army, AR 220-1, 2010.

Figure 4.10
Unit UTM Capability Levels Based on Knowledge, Training, and Equipment

	Capability Level 1	Capability Level 2	Capability Level 3	Capability Level 4
Level of UTM knowledge/experience	Basic conceptual understanding of UTM concepts	Limited understanding of UTM concepts	Limited execution of UTM concepts	Routine execution of UTM concepts
Level of training	No specialized training	Few trained personnel (master drivers)	Some trained units (recon platoon, etc.)	All units trained
Level of equipping	No on-hand UTM equipment	No on-hand UTM equipment	Some on-hand UTM equipment	All required equipment on hand

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CHAPTER FIVE

Strategies for Developing and Sustaining Army UTM Capabilities

As this study demonstrates, UTM capabilities remain appropriate, demanded, and required to meet some of the mobility needs that the U.S. Army, like other militaries and other services, continues to face for missions in demanding physical and threat environments. This reality is most clearly demonstrated by the wide range of Army units that have invested and are currently investing their own resources to develop and sustain the UTM capabilities their respective missions demand. The Army can likely meet the current and expected future UTM requirements through thoughtful investment in UTM capabilities and, just as important, their long-term sustainment. This chapter summarizes the key observations from this study, and Army strategies for assessing UTM demand, managing UTM acquisition and development, and addressing UTM requirements. This chapter concludes with a set of DOTMLPF recommendations to execute the most appropriate UTM development and sustainment strategy identified.

Observations

This study identified a number of trends that have heavily influenced Army UTM needs and capabilities and that the Army must consider when determining a long-term UTM strategy. These observations are not specifically issues that the Army must address, but rather are realities the Army must acknowledge and understand to develop a practical and sustainable approach to UTM capabilities.

Contemporary operations and operating environments present "bundles" of factors that can favor or discourage UTM employment. As discussed in Chapter One, a relatively small set of factors are consistently cited in historical and contemporary experience for decisions to employ or not employ UTM platforms. While factors such as delivery capacity and constrained maneuver spaces can preclude SSVs for mounted mobility and leave dismounted mobility as the only alternative, they are often offset by the dissuading factors, especially operational threats.

The *tactical* threat is the most difficult factor to offset, and it has routinely outweighed the potential benefits of UTM in the judgment of operational commanders. While current Army and DoD leadership identify the IEDs and similar tactical threats as a persistent operational reality in the future, this threat will likely not be evenly distributed across operations or environments, leaving situations where UTM platforms are effective and beneficial options for executing certain Tactical Activities. Recent reporting indicates that commander hesitation to employ UTM platforms does not necessarily rest on tactical factors alone, such as probability and impact of losses, but also on the public relations perils associated with public perceptions of requiring soldiers to operate on vehicles with little or no protection in threatening environments. Consequently, UTM use to execute Tactical Activities that do not entail close and sustained combat with the enemy, such as Troop Mobility, Internal Ferry Support, and Traveling Support, are likely more feasible in the near term than use of UTMs to execute Tactical Activities with a likelihood of direct combat engagement like Maneuver Force Security/Recon or Coordinated Maneuver.

UTM capabilities provide a validated alternative to reduce *operational* risks and increase operational flexibility through reduction of requirements for delivering an "operationally significant force." The recently published Joint Concept for Entry Operations (JCEO) identifies "The ability to land offset from enemy force concentrations and infrastructure using existing and planned assault lift assets" as a required capability for initial entry operations. The 82nd Airborne's according Operational Needs Statement (ONS) for "enhanced tactical mobility" with UTM capabilities identifies the value of UTM for reducing the identified risk and the immediate requirements for an initial entry force. The current lack of comparative analysis and modeling precludes the Army from fully understanding the overall impacts of UTM vehicles that might increase tactical risk to individuals while decreasing operational risk to the force.

Despite the current threat environment that has generally precluded formal Army consideration of UTM capability development, other militaries, services, and individual Army units have found appropriate and tactically beneficial methods for employing UTM capabilities. While the IED threat is persistent and pervasive for some environments and operations, the U.S. Army will likely be required to conduct a range of operations in diverse environments where UTM platforms are more mobile, sustainable, and otherwise appropriate than SSVs, such as the M-ATV or forthcoming JLTV. As this report and the associated case studies (Appendix A) demonstrate, other comparable militaries and services have found that UTM platforms are required to meet a range of operational needs and enable readily tailorable mobility options.

While UTM requirements do exist for conventional Army units, apparent reluctance of tactical units to participate in the formal requirements validation process has left legitimate demands for UTM capabilities undervalidated, underrepresented, and not fully understood. Because the timeline of formal methods to address an Army unit's UTM demands often extends well beyond the unit's tactical planning or force generation horizon (such as a deployment cycle), units demanding UTM capabilities often do not consider submitting an ONS to validate UTM requirements through the JCIDS process an effective method to meet their immediate UTM demands. Tactical units needing UTM capabilities have often decided and are currently deciding not to pursue the formal requirements and acquisition processes because they perceive the process as incapable of meeting their immediate operational needs. Recent DoD analysis that found that "'rapid' acquisition is countercultural and will be under supported in most traditional organizations" supports the validity of these perceptions.[1] While some rapid fielding initiatives have been completed in a year or less, most initiatives occur within two years.[2] The tactical immediacy of UTM demands, an unwieldy requirements

1 Defense Science Board, 2009..

2 Government Accountability Office, 2012.

validation process, and the relative ease and affordability of acquiring UTM platforms has led numerous Army units to believe that ad hoc and informal methods are the best alternatives to meet their pressing tactical mobility demands.

Existing information does not provide sufficient information to assess the impact on conducted operations from not having UTM capabilities. While previous and current UTM platform employment demonstrates an implicit requirement for UTM capabilities, available information is not sufficient to fully assess the "regret," or adverse impact on executed missions, from not having UTM capabilities. Existing information clearly indicates few instances of mission failure due to lack of UTM capabilities. However, available information does strongly suggest that leaders and units plan their operations to best utilize the capabilities they have access to, as directed by the military Decision Making Process (MDMP) during mission analysis.[3] This means that in most cases, units without UTM capabilities will likely not attempt activities for which their existing mobility platforms are likely inadequate. Rather than precipitating mission failure, lack of UTM capabilities more often curtail how units plan and conduct operations.

The growth in size and weight of the Army's standard service vehicle (SSV) has resulted in more unmet tactical mobility requirements for operations in constrained trafficability environments. The Army's SSV for light tactical mobility has consistently grown in size and weight over time to enable more protection and armament. The improved mobility of UTM vehicles over SSVs or other armored platforms cannot outweigh the value of protection in settings where the threat is significant and larger vehicles are available and able to operate. While the SSV's growth has resulted in improved survivability of occupants and lethality, it has reduced Army ability to support dismounted or delivery-constrained forces that must face operational trafficability conditions, such as rough terrain and dense urban development, precluding or significantly limiting use of SSVs. Some Army units, such as airborne and air assault forces, face current and continuing constraints that make delivery of the current SSVs for potential employment infeasible and leave no formally available options for mounted mobility.

Coordinated Army UTM capabilities are generally nonexistent. While some Army units have developed and employed UTM capabilities to address tactical mobility needs unmet by the SSV,[4] these capabilities are almost completely built on unit-specific resources that are not available to all Army units with similar ground mobility needs. Army UTM platforms that are available to some units, such as the M-Gator, do not have sufficient resources to enable effective sustainment and employment. Due to this lack of coherent UTM capabilities or supporting resources, the Army as a whole does not possess a legitimate UTM capability that can supplement, but not replace, current organizational capabilities. However, FORSCOM efforts initiated since this analysis propose development of a battalion-sized UTM capability for airborne infantry forces that will, if executed, constitute the initial component of an increasingly coordinated Army UTM capability.

The Army can develop the basic UTM capability needed with some limited foundational investments. While UTM capabilities require limited resources to develop and sustain, effective and safe UTM employment requires core knowledge and skill that are hard to generate quickly when the operational need arises. Developing the core UTM knowledge and

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[3] U.S. Army, ATTP 5-0.1, *Commander and Staff Officer Guide*, 2011. The MDMP's "Mission Analysis" includes "review of available assets."

[4] U.S. Army Forces Command, 2013. This ONS identifies and explicitly describes one set of needs for UTM.

experience needed requires some limited but coordinated investment in foundational UTM resources, especially doctrine, training, experimentation, and support programs that do not currently exist. Development of these basic resources and the limited materiel investment they entail can enable the Army to expand and/or tailor UTM capabilities to meet specific operational needs as they occur.

The Army Cost of Not Having Coordinated UTM Capabilities

While individual Army units have realized immediate benefits from ad hoc development of UTM capabilities, there are long-term costs to the Army from not pursuing a coordinated UTM capability development program. These costs include

- **Loss of tactical flexibility.** Without vehicles smaller than the SSV, the Army does not have the vehicular flexibility to use alternate routes in many operational environments beyond dismounted movement and its associated limitations. Movement along routes that cannot sustain the heavier SSV is not an option (other than by foot), denying the Army the flexibility to use less improved routes and/or to avoid channelizing terrain when METT-TC conditions warrant. While not all situations or routes are appropriate for UTM employment, absence of options currently constrains employment beyond METT-TC conditions and command judgment.
- **Increased operational risk to initial entry forces.** As explicitly documented in the Joint Concept for Entry Operations and the 82nd Airborne's ONS for UTM, the absence of UTM capabilities for tactical mobility of initial entry forces increases the operational risk to the Joint force by increasing the delivery requirements to deploy a mobile IBCT and further exposing the Joint force to rapidly improving antiaccess threats.
- **Diminished opportunity to reduce the burden on dismounted soldiers through offloading to immediately accessible platforms.** Without UTM, the only other options are the rucksack or SSVs when terrain and operational constraints permit. For the steep or restricted terrain, the rucksack is the only option. For units facing constrained delivery requirements, little or no SSV support is feasible, leaving primarily dismounted soldiers to execute Tactical Activities.
- **Ceding the opportunity for improved fire and maneuver for ground forces in some circumstances.** If weapons are UTM-mounted, arguably faster maneuver could be achieved over difficult terrain and better supported by fire. UTM platforms provide the dismounted formations the ability to carry or maneuver with mounted or portaged heavy weapons (mortars, machine guns, recoilless rifle, etc.) with dismounted elements and in spaces too constrained for SSVs. Currently, accurate analysis and modeling exist to quantify this potential impact.
- **Loss of the chance to subject the UTM alternatives currently acquired locally by Army units to the Army's rigorous development process**, to include development of broader operational concepts and capabilities. While there are challenges and inefficiencies associated with current development and acquisition processes, they entail rigorous needs validation and performance assessment that are valuable so the Army can understand and address long-term UTM requirements. Given the history of ad hoc UTM capability development by Army units, they would probably continue to pursue these

efforts in the absence of coordinated Army guidance or support. These individualized acquisition and support efforts would leave Army units subject to whatever the marketplace provides, rather than acquiring something that more precisely meets their needs. Additionally, long-term development and refinement of emerging technologies to improve UTM capabilities, such as autonomous control, would be left undone or disjointed from Army tactical needs.

Four UTM Strategies for Going Forward

As this report demonstrates, conventional Army units have a recurring but not necessarily continuous demand for UTM capabilities. This demand is driven primarily by three trends that are unlikely to change in the near future:

- consistent growth in the size and weight of the SSV
- increasing loads carried by dismounted soldiers
- increasing antiaccess/area denial (A2AD) threats to the Joint force required for delivery of initial entry forces.

Currently, some Army units are pursuing ad hoc UTM programs based almost exclusively on locally available resources. The convergence of these factors strongly suggests the Army should consider a set of potential strategies for developing a resource-conscious, coordinated program to develop and sustain a core set of UTM capabilities, to include doctrine, training, and sustainment resources, which conventional forces can rapidly expand to meet likely operational demands associated with appropriate Tactical Activities such as Troop Mobility, Traveling Support, and Internal Ferry Support.

To guide Army consideration on potential UTM strategies, we identified four general options for addressing the persistent but inconsistent need for UTM capabilities by conventional Army. The analysis identified these four strategies as UTM-specific analogs to strategies that the U.S. Army, Special Operations Forces, other services, and other forces have pursued to develop and maintain UTM capabilities or other systems, such as mountain warfare capabilities, with similar demand characteristics (e.g., narrowly defined demands based on specific and often nonpersistent mission and environmental characteristics).

1. **Status quo: unit-specific UTM capabilities:** This approach requires little resource commitments for the Army and relies on units employing informally available resources to meet UTM needs. This approach assumes that units with legitimate UTM capability needs can and will find locally available resources and methods to meet their needs. This is the approach that the Army is, by default, currently pursuing.
2. **Minimal investment in foundational UTM capabilities for selected units:** This approach generally entails limited and carefully considered investments in platforms, training, doctrine, and support programs. The objective of this approach is to develop a better, broader Army appreciation for potential benefits and considerations of employing UTM platforms. It ensures presence of foundational UTM capabilities while remaining

flexible as the operational demands change. This strategy should explicitly leverage current and future ARSOF UTM development and employment programs.

3. **Procure an optimal UTM platform or mix of platforms for all Army needs:** This approach requires the Army to identify a common UTM capability and outfit major formations, such as battalions or brigades, with it, to include materiel, training, doctrine, and support. However, this is not consistent with how UTM platforms have been most successfully used historically and currently, because no one UTM system meets all requirements for all mission or environments for all units. This approach requires potentially significant resources and may not meet all key UTM requirements; therefore, we do not recommend it.
4. **Procure a UTM capability for each potential need:** Based on potential future environments and capabilities, the Army might determine that a much more UTM-centric force is appropriate and thus try to deduce configurations for all plausible missions and environments. This approach would likely entail a considerable investment of time and money to develop, test, field, train, and support a wide range of UTM capabilities. This approach would necessitate a shift in the Army's perceived importance of UTM versus all other mobility platforms. However, there is no evidence that this is a reasonably efficient approach or even possible given the variety of ways UTM platforms have been used.

Strategy 1 requires no further action or resources from the Army but also ensures that many of the mobility needs not addressed by the growing SSV fleet will continue to go unmet, at least by formal Army programs and capabilities. As illustrated in this report, this approach has resulted in some challenges for a range of Army units, especially those that rely heavily on dismounted formations to execute their primary missions and those with inherent limitations on mobility platform size, such as airborne, air assault, and aviation units. Continuation of this strategy continues the pattern of locally developed capabilities that are not well supported by sustainment, training, or doctrine resources.

Strategy 3 requires the Army to invest significant resources to develop and sustain a broad program to identify, field, and support one or more UTM platforms. This option would likely resemble USSOCOM's current FSOV program. Based on recent operational trends, SOF needs for UTM platforms appear much more consistent and require more specifically tailored platforms to execute mission-specific functions. However, this research did not identify any clearly identified and generalizable requirements for UTM that are likely needed to warrant the significant investment of resources this strategy would entail. Additionally, the range of previous and current UTM applications identified makes the probability of anticipating and meeting all UTM needs low. While the Army needs the ability to develop and employ UTM capabilities when needed, identified needs documentation and other information do not provide a convincing case that the Army requires or would necessarily benefit from this strategy entailing a well-resourced and broadly applied UTM materiel program.

Strategy 4 will require the Army to identify every potential UTM need and develop a tailored UTM platform solution to address each need. As this report demonstrates, UTM capabilities have often been employed in ways that, although fundamental to mission success, were often not anticipated. A significant benefit of basic UTM capabilities is the flexibility with which soldiers and units can apply them to a range of activities. In addition to being resource intensive, this strategy would likely not address all the specific UTM needs that future operations would present.

Of the four general strategies the Army can follow, Strategy 2 offers the best opportunity to develop a resource-conscious approach to UTM capabilities that focuses on basic resources and capabilities for flexible application to meet most UTM needs as they arise. Additionally, this strategy ensures sufficient basic UTM resources exist to scale up UTM capabilities rapidly if a significant increase in demand occurs. The appropriateness of this strategy is further reinforced by FORSCOM's recently initiated effort to develop a battalion-sized set of UTM vehicles for employment by airborne infantry during forcible entry operations.

This strategy includes developing the fundamental UTM doctrine, training, experimentation, and support capabilities through limited investments and coordination with other services and SOF to identify and exploit economies of scale from common UTM capability requirements. Due to the past and current breadth of UTM testing, evaluations, and investments by SOF, the Army should consider USASOC as a fundamental partner and resource that can provide the wider Army the opportunity to validate or refine existing SOF capabilities for conventional Army use. This strategy is also consistent with historical and foreign experience maintaining foundational UTM capabilities with limited resources. Table 5.1 provides a summary of what a "basic" Army UTM capability could consist of.

Recommendations for Developing Appropriate UTM Capabilities

Given the Army chooses Strategy 2 and the recommended prioritization of UTM program investments discussed above, there are activities that appropriate Army commands should engage in to further develop and capture UTM capabilities for the future.

Table 5.1
Suggested Composition of a "Basic" Army UTM Capability

Capability Area	Description
Doctrine	• Army Tactics, Techniques, and Procedures (ATTP) publication to identify key concepts and considerations for tactical UTM employment to execute each of the Tactical Activities identified in this report
Materiel (vehicles)	• A small number of battalion-sized UTM vehicle sets for employment by units with validated requirements • A set of vehicles for sustained familiarization and training separate from the battalion-sized employment sets • A list of suitable UTM vehicles for employment identified by Tactical Activity
Training	• Establish proponent to develop and maintain UTM employment and sustainment expertise • Mobile Training Teams (MTTs) to provide master driver and maintenance to units with immediate and likely demands for UTM capabilities • Coordinated unit training with UTM sets for units with immediate and likely requirements to employ UTM
Sustainment	• Coordinated program to identify and provide appropriate parts repair, upgrade, and replacement by vehicle set managers and units with validated needs
Analysis, testing, and evaluation	• Sustained programs to identify appropriate UTM options and improvements required • Modeling and assessment of tactical/operational risks associated with employment of UTM versus other mobility alternatives

Doctrine

Refine Army doctrine to provide sufficient concepts and technical information for effective and safe UTM employment. While some current Army doctrine publications briefly mention UTM capabilities as an option, the doctrinal discussion of UTM capabilities, limitations, and considerations is inconsistent and insufficient for appropriate leader- and operator-level consideration of UTM capabilities for executing tactical tasks. As discussed in Chapter Three, a number of doctrinal documents provide limited discussion of UTM platforms as a potential option. However, these documents do not necessarily align with the most prevalent applications of UTM abilities demonstrated by historical and recent operations. The *Army Doctrine 2015* structure provides a suite of publication types to support discussion of appropriate UTM capabilities for potential tasks and operating environments. The Army should refine existing doctrine to discuss UTM platforms as potential mobility options, planning considerations for UTM use, and guidance for operational employment of UTM capabilities at appropriate levels of Army doctrine. Table 5.2 lists the suggested integration of UTM discussion at each level of Army doctrine.

Develop an Army Techniques Publication or comparable resource that specifically addresses training, planning, employment, and support considerations associated with UTM employment. Information collected and analyzed for this report suggests that UTM capabilities can be and are being applied to a wider range of activities and unit types than previously considered. Further, user experiences and emerging technologies suggest significant differences between UTM capabilities and LTV platforms. Therefore a dedicated ATP is likely required to capture the unique knowledge and skills required for safe and effective tactical employment of UTM platforms.

Table 5.2
Example Type and Location of UTM Discussion by Army Doctrine Category

Army Doctrine Category	Publication Intent[a]	Suggested UTM Discussion
Army Doctrine Publication (ADP)	An Army publication containing fundamental principles by which the military forces or elements thereof guide their actions	No discussion of UTM appropriate for ADP-level publications
Army Doctrine Reference Publication (ADRP)	Detailed explanation of all doctrinal principles included in corresponding ADP	Brief identification of UTM capabilities among other potential platform options
Field Manual (FM)	Lays out tactics and procedures explaining how the Army executes operations described in ADP	Identification of UTM platforms as demonstrated and potential options for executing key functional missions. Identify UTM platforms that are available and used by specific unit types that are authorized to maintain or have access to them.
Army Techniques Publications (ATP)	Contains techniques—"Non-prescriptive ways or methods used to perform missions, functions, or tasks"	Discussion of concepts and procedures for employing UTM capabilities to execute specific tactical tasks. Technical guidelines for delivery, employment, and maintenance of UTM platforms.
Applications	Interactive media, podcasts, mobile apps	Training media on UTM operations fundamentals (safety, maintenance, etc.)

[a]U.S. Army Combined Arms Center, "Doctrine 2015 Information Briefing," May 2, 2012.

Organization

Develop planning conferences and workshops with other services and SOF to determine common UTM needs and take advantage of economies of scale for resource-conscious sustainment of UTM capabilities. As discussed in this report, the USMC and SOF have UTM needs that are similar to conventional Army UTM needs. Additionally, USMC and SOF maintain UTM materiel, training, experimentation, and support capabilities that, through appropriate coordination and mutual support, the Army can leverage to develop and sustain required UTM capabilities. The Army should use memoranda of agreement (MOAs) and regular conferences with the USMC and SOF to coordinate UTM capability development and sustainment efforts. The Maneuver Center of Excellence (MCOE) is likely the most appropriate Army organization to accommodate these conferences.

Use specialized National Guard units to maintain low-density UTM competencies and experience. Currently, the Army uses the 86th IBCT (MTN) and associated Army Mountain Warfare School (AMWS) to lead Army development, sustainment, and promulgation of mountain warfare competencies. National Guard soldiers often remain in a given unit much longer than their conventional Army counterparts, giving them the ability to develop and refine the low-density skills required to conduct technical mountain warfare operations.[5] These soldiers provide the Army with a valuable method to export mountain warfare expertise to other Army units through resident courses at AMWS and Mobile Training Teams (MTTs). Other areas of the Army have adopted similar practices of identifying and resourcing units to maintain capabilities and expertise for specific mobility applications. For example, ARSOF assigned certain Special Forces Groups to developing and maintaining mobility expertise and capabilities consistent with their regional focus.[6]

The Army should consider identifying an appropriate National Guard unit to lead long-term development and refinement of UTM-related expertise. Additionally, use of a National Guard unit in this capacity would also leverage the extensive utility of UTM capabilities to support Title 32 Defense Support to Civil Authorities operations conducted routinely by National Guard personnel.

Training

Develop training resources to establish and maintain basic UTM knowledge that units can apply flexibly to develop and employ UTM capabilities effectively. Safe and effective UTM employment requires specific knowledge and skills that do not readily exist for most Army units that do demand or could require UTM capabilities. While UTM knowledge and skills are specific, they are sufficiently transferable that required expertise could likely be developed primarily through unit-level training supported by MTTs, limited resident course instruction, and field exercises. The training should address four aspects of UTM employment listed in Table 5.3. Based on recent experience, the initial training required for basic operation and maneuver with various UTM platforms is relatively small, as described in Table 5.4.

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5 86th IBCT (MTN) and AMWS personnel, interviews with authors, November 5, 2012.

6 For example 3rd Special Forces Group (SFG) and 5th SFG are assigned the responsibility of and are resourced for maintaining desert mobility capabilities and expertise, while 10th SFG has a commensurate role in maintaining capabilities and expertise for cold weather mobility and use of quadrupeds.

Table 5.3
Types of Training Required for Successful UTM Employment

Training Type	Description	Example Delivery Options
Operator training	• Development of knowledge and skills for safe and effective preparation and tactical operation of UTM platform(s)	• Mobile training teams • Master-driver training • Simulation-based training • Multimedia doctrine products (apps, podcasts, etc.)
Maintenance/ sustainment training	• Development of knowledge and skills to conduct basic preventative maintenance, repairs, and improvements to UTM platform(s)	• Mobile training teams • Master-mechanic training • Multimedia doctrine products (apps, podcasts, etc.)
Leader planning and familiarization	• Knowledge to guide effective integration of UTM capabilities with other organizational capabilities to execute appropriate unit missions	• Resident courses • Application-based training resources • Training scenarios • Multimedia doctrine products (apps, podcasts, etc.)
Collective training	• Exercises to develop operator and leader training unit ability to tactically employ multiple UTM platforms and other organizational capabilities	• Mobile training teams • Simulation-based training • Field exercises

Coordinate training programs and resources with the USMC and SOF to develop coordinated UTM training strategies to meet common UTM expertise requirements. For example, the MWTC offers programs of instruction (POIs) on employment of pack animals that can, with proper coordination and resources, accommodate Army needs for training on pack animal employment. Through coordination with the USMC and SOF, the Army can provide or gain access to training programs and resources.

Materiel

Formally recognize the requirement for the Army to maintain some coordinated UTM capabilities and define the Ultra-Light Tactical Vehicles (ULTV) as a distinct type of equipment in Army materiel strategy documents, such as the *Army Tactical Wheeled Vehicle Modernization Plan*. While this report demonstrates that UTM is both required and informally exists within the Army, current Army materiel strategy documents do not identify it as a specific need for development and procurement. Discussion of the existence of UTM

Table 5.4
Estimated Training Time Required for Basic UTM Operation, Maintenance, and Tactical Employment, in Days

UTM	Basic Operation	Tactical Employment	Maintenance	Total
Pack animal	4	4	2	10
Motorcycle	5	3	2	10
LTATV	1	2	3	5
M-Gator	1	1	1	3

NOTE: Based on assessment of Asymmetric Warfare Group (AWG) personnel familiar with REF-provided UTM training and interviews with MWTC personnel.

needs in key materiel strategy documents will support consideration of the continuing need for UTM development, evaluation, and acquisition.

Test and evaluate potential UTM platform options to identify materiel alternatives that can be tailored to meet salient requirements across a range of mission profiles for conventional Army units. Technological improvement of civilian recreational vehicles has increased the potential options to meet Army UTM platform needs. However, thorough testing and evaluation are required to determine the most likely UTM applications and the performance characteristics required for each. Due to the potential for UTM employment to increase effectiveness of Army units (especially dismounted activities) significantly, the Army should focus resources on developing and evaluating concepts through experimentation for the most effective employment of UTM platforms in accordance with operationally realistic use profiles.

Identify one UTM vehicle type or a small set of types that meet most Army-wide needs for further development and validation of UTM concepts of employment. Based on the significant commonality of UTM need characteristics across conventional Army units, one or a few UTM platforms can likely provide a solution that, in various configurations, can optimally meet most Army UTM needs. With information from testing and evaluation, the Army can more effectively identify a common platform or small set of platforms that units can readily adapt to meet most priority UTM requirements across missions. Initially, these platforms should likely be UTM models that are already authorized for testing and evaluation, such as the DAGOR, M-Gator, and LTATV (Polaris RZR) that Army and SOF commands already possess or are pursuing.

Develop a UTM support program that enables authorized units to satisfy sustainment requirements, especially repair materials and replacement parts. Based on the analysis conducted for this report, the lack of coordinated sustainment resources is the most significant challenge for conventional Army units that currently possess UTM capabilities, requiring them to acquire parts through informal means and reducing the usability of existing UTM platforms. Previous attempts to develop UTM capabilities have procured platforms without considering long-term sustainment or replacement. The Army needs a coordinated method to ensure sustainment of both current and future UTM materiel capabilities.

Leadership

Provide training and doctrinal resources to enable leader consideration of UTM capabilities as an option and to enable planning for UTM capability employment. Through training and doctrine resources, provide basic guidance for leader planning for and employment of UTM capabilities. One potentially significant limitation for UTM employment is lack of leader knowledge of UTM capabilities or concepts for employing them in coordination with other capabilities. Presenting UTM capabilities as a beneficial option requires leaders to have basic knowledge of UTM benefits and limitations, as well as that key planning considerations should precede UTM platform use.

Facilities

Provide guidance for leader identification of terrain features and training areas required to enable home station or deployed training on key UTM training requirements. As described by current practitioners and subject-matter experts, operationally realistic UTM training requires training operators on a broad range of potential terrain and conditions they may encounter in operations. Leaders and practitioners require some basic guidance to identify key training requirements and coordinate for appropriate training areas to meet UTM-specific needs.

Prioritizing Army UTM Investments

While this report demonstrates that the Army has a requirement for UTM capabilities in general, the various potential UTM capabilities and applications do not provide equal opportunities to realistically improve Army operations based on unit needs and the technology currently available. The significant threats and hazards associated with some UTM applications make their execution in combat operations less likely and harder to justify investment in. Therefore, the Army should consider the following when prioritizing possible UTM program investments:

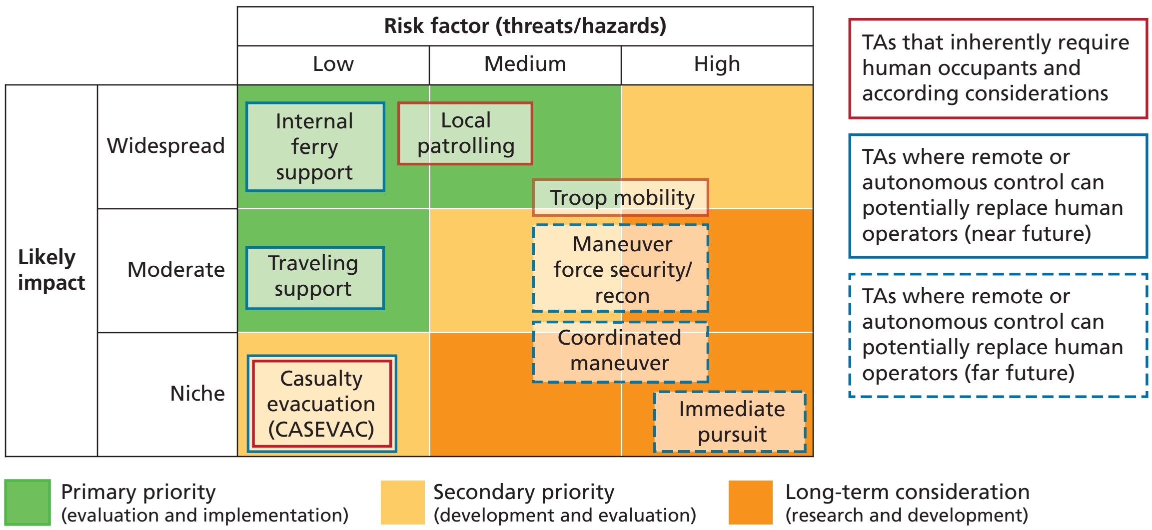
- **likely impact:** the total number and importance of units that can potentially benefit from UTM development for a Tactical Activity
- **associated hazards and threats:** each of the Tactical Activities includes implicit realities about the hazards and threats their execution will likely face. These associated hazards and threats influence the appropriateness and justifiability of executing these Tactical Activities with UTM platforms in actual combat environments.
- **impact of emerging technologies:** Capabilities such as optionally manned control, remote operation, autonomous control, and legged robotic platforms offer the potential to drastically improve UTM performance and reduce the need for human operators on the vehicle and their attendant vulnerability issues. Tactical Activities, such as Traveling Support, that do not specifically require human occupants can decrease threat concerns by operating without them.

Figure 5.1 provides a framework for integrating these three considerations to prioritize Tactical Activities for UTM investments. The placement of Tactical Activities in this illustration is based on qualitative information collected and analyzed in this study. However, Army application of this framework should include prioritization of investments based on detailed quantitative and qualitative analysis of impact, threat/hazard, and technology implications.

Final Thoughts

As this report demonstrates, the Army has consistently encountered ground mobility requirements that the SSV fleet did not and does not fully address. Army units have dealt with this situation by pursuing a range of formal and more often informal efforts to develop and employ required UTM capabilities. Previously, these UTM capabilities consisted primarily of pack animals and motorcycles, but emergence of new commercial technologies for a dramatically expanded civilian recreational ATV industry has drastically increased the Army's potential alternatives for meeting the current demands and requirements for smaller and lighter mobility alternatives by conventional Army units. Improved protection and counterthreat capabilities offer important materiel opportunities for the Army to drastically reduce the hazards and threats previously associated with UTM employment. Emerging technologies such as remote and semi-autonomous control capabilities also offer the potential to remove the human opera-

Figure 5.1
Recommended Priority of UTM Program Investments Based on Impact and Hazards Associated with Tactical Activities



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tor from the vehicle and significantly reduce or even avoid many of the hazards that have dissuaded Army commanders from pursuing and employing UTM vehicles. These innovations can potentially reshape the paradigm for executing Tactical Activities where the occupant is not an inherent part, such as support-related activities. The creative employment of current UTM capabilities informally developed by individual units and the emergence of new technologies demonstrate the potential of UTM vehicles, if appropriately applied, to help meet conventional Army units' well-demonstrated and continuing need to address the mobility limitations of SSVs.

APPENDIX A

The Historical and Contemporary Use of All-Terrain Vehicles, Bicycles, Motorcycles, and Quadrupeds

It is a central finding of this study that UTMs—though they appear to be only of occasional value and thus generally are dealt with in an ad hoc fashion—respond to perennial tactical mobility requirements. Neither the requirements nor the types of solutions adopted to meet them are new.

The case studies presented below are intended to provide historical context and specific examples for the observations and analysis in this document, based on past and present UTM usage across a range of conflicts, environments, and militaries. One is our basic description of UTMs as meeting ground mobility requirements that are not met by standard service vehicles (SSVs) or larger platforms. This gap can be viewed either from the "top-down perspective," meaning one seeks to replace an SSV with something smaller and lighter, or from the "bottom-up perspective," meaning one seeks to enable foot soldiers to carry more and move farther, faster. Either way, UTMs have proved valuable to the soldiers who have had access to them but not always in the envisioned application. It is rarely possible to argue that they were "mission critical" in the cases identified, given that it is nearly impossible to prove a counterfactual argument regarding what might have happened if units had had more or less access to them.

Based on the case study analysis in this appendix, we find the following insights:

- All-terrain vehicles (ATVs) stand out as the single most useful UTM platform because of their flexibility and adaptability. They are simply able to meet a wider range of mobility requirements than other platforms; they meet them as well as or better than other UTM platforms.
- While motorcycles do present some comparative benefits over other UTMs for narrowly defined tactical applications, military motorcycles have a problematic history demonstrating that they are often a poor choice relative to other current UTM options.
- The continuing limitations of UTMs and other mobility platforms to access and traverse all the terrain negotiated by dismounted soldiers have dictated the enduring utility of quadrupeds—in particular pack animals—and suggest continued investment in retaining and disseminating institutional knowledge regarding their use.
- Bicycles have repeatedly proven their military value and should be taken more seriously as an option for enhancing the mobility of light infantry with low cost and the minimal training required for their safe operation.

We also find that the primary barriers to effective UTM employment include cultural resistance and lack of appropriate understanding of UTM capabilities and limitations. Sometimes commanders do not understand how to use UTM or appreciate their potential value.

Sometimes leaders are dismissive of UTM capabilities for any number of reasons. This generally dismissive attitude toward UTMs is illustrated by the classic example of pack animals, which the Army tried to remove from service long before the requirement for them diminished, apparently because of a belief in mechanization and machines' ability to meet all tactical mobility requirements. This pattern is demonstrated by the Army's experiences with other platforms as well, such as the M274 Mule that was phased out with the fielding of the HMMWV. While the Army has consistently dismissed the need for UTM capabilities as a whole, motorcycles have appeared, been divested, and reappeared due to a general overemphasis on platform performance and underacknowledgement of their considerable hazards and limitations in tactical environments by advocates. The motorcycle, given the physiological stress of tactical operation, exposure to threats, and limited carrying capacity, has rarely been the best available option and has seen little employment in actual combat operations. These cases demonstrated a cyclical fascination with potential employment of UTMs in direct combat roles and consistent disregard of their well-demonstrated value for less dynamic support applications.

The historical and contemporary examples selected for the case studies are not intended to be comprehensive. Rather, they are intended as representative examples of the different applications of the four most prevalent UTM types and the value these UTM capabilities have brought to the military elements that have employed them.

All-Terrain Vehicles and Lightweight Tactical All-Terrain Vehicles

ATVs and LTATVs recently have been widely embraced throughout the U.S. military and beyond for a variety of tactical mobility purposes (a general description of ATV and LTATV platforms is provided in Figure A.1). Indeed, one of the surprises of our study has been the relative ubiquity of ATVs and LTATVs, primarily due to their broad utility, relatively low cost, and minimal training requirements. They can be and have been employed to execute a broad variety of the types of Tactical Activities identified in this analysis and illustrated in Figure A.2.[1] Additionally, they respond to the needs to both substitute smaller, lighter vehicles when constraints preclude SSV use and to enhance the capabilities of otherwise vehicle-less dismounted formations. Moreover, these UTM options have relatively small training and sustainment costs. Contemporary operators are enthusiastic about these platforms—often describing their contribution as "mission critical" and noting how they are often finding new uses for them, although they point to significant concerns primarily relating to maintenance and training requirements.[2] In effect, what they observe is that it does not take much to sustain and train for ATVs and LTATVs, but it often takes more than what is generally provided.

Historical Usage

ATVs and LTATVs trace their history to the Second World War, when mechanized armies developed vehicles to meet tactical mobility requirements that the cars and trucks available at the time could not. The United States developed the quarter-ton truck (the Jeep). As illustrated

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1 A detailed description of these activities is provided in Table 2.1 in Chapter Two.

2 Based on review and analysis of AARs from combat employment of ATVs and LTATVs in Iraq, Afghanistan, and elsewhere.

Figure A.1
Case Study Description and Examples of ATV and LTATV Platforms

Vehicle Type	Description (for Case Studies)	Example Platforms
All-terrain vehicles	Multi-track UTM platforms that require the operator to straddle the vehicle	
Light tactical all-terrain vehicle (LTATV)	Multi-track UTM platforms that require the operator to sit in a traditional upright driver's position	

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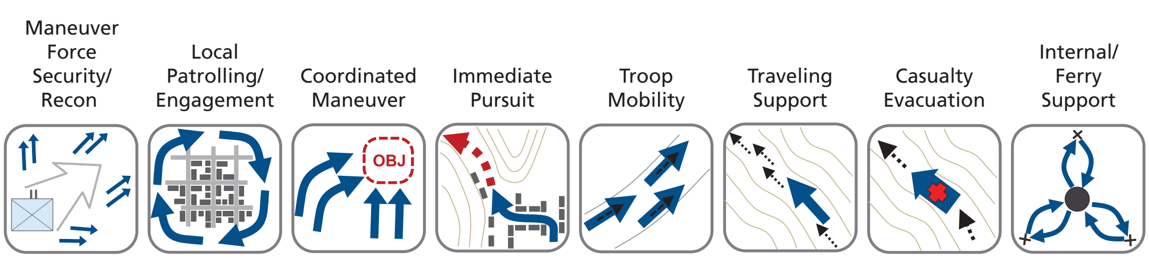
in Figure A.3, the Germans developed motorcycles and sidecars to fill the niche before progressively replacing them with the VW jeep (the Kübelwagen) and the Kettenkrad—a half-tracked motorcycle—as they became available (see the motorcycle case study for a discussion of the Germans' use of motorcycles). The Kettenkrad can be thought of as the true ancestor of the modern ATV, and it bears a remarkable resemblance to the newest member of the ATV family, the Special Mission Terrain Vehicle (SMTV). The Kettenkrad transported people and functioned as a light tractor capable of pulling trailers and light artillery. It was air-transportable, being designed to fit inside the hold of a Ju-52 aircraft—a common medium transport plane at that time. The Kettenkrad was in fact Germany's only gun tractor that could be transported in that manner. Finally, the Kettenkrad worked where other motorized transport could not, on steep inclines and in deep mud, sand, and snow.

In the meantime, the United States—which had ample supplies of Jeeps and used motorcycles only for limited applications—made do with the Jeep until 1948, when the U.S. Army experimented with the "Jungle Burden Carrier," which suggests that the Army did not regard the Jeep as meeting all of its tactical mobility requirements. The Carrier evolved into the M-274 "Mechanical Mule," which the Army introduced in 1956, about the same time that it was phasing out real mules.[3] As pictured in Figure A.4, the M-274 was designed for the purpose of accompanying infantry and assisting it through a range of functions. Although we

Figure A.2
Demonstrated Tactical Activities Executed with UTM Platforms



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3 "U.S. Military M274 Truck, Platform, Utility 1/2 Ton, 4X4," *Wikipedia, the Free Encyclopedia*, December 14, 2012.

Figure A.3
The German Kettenkrad (left and center) and the Prototype Special Mission Terrain Vehicle (right)

SOURCES: German Army Archives, 2012, and 10th Special Forces Group, 2013.
RAND *RR718-A.3*

could find few specific examples of M-274 use, it is evident that soldiers and marines put it to wide use in Vietnam. It was phased out only with the introduction of the HMMWV in the 1980s,[4] which was supposed to obviate the need for it.

Dune Buggies and the Toyota War

As the HMMWVs were being brought into service in 1980, the Army also began to use the 9th ID as the Army's High-Technology Test Bed (HTTB) to experiment with a new force structure that was intended to be as deployable as light infantry yet pack the firepower of a heavy division. The 9th ID force structure was constrained by a requirement that it would be transportable by 100 C-141 aircraft for rapid deployment, ruling out heavy mechanized vehicles.[5] The planners experimented with mounting relatively large weapons on light vehicles in the hope that mobility and lethality could make up for the lack of protection.

Given that the 9th ID in some ways resembled the German Panzergrenadier division (see the motorcycle study), it seems fitting that the vehicle that has come to symbolize the whole experiment is a descendant of the Kübelwagen, the Fast Attack Vehicle (FAV), which

Figure A.4
Demonstrated Applications of the M-274 Mule

SOURCE: U.S. Army Transportation Museum.
RAND *RR718-A.4*

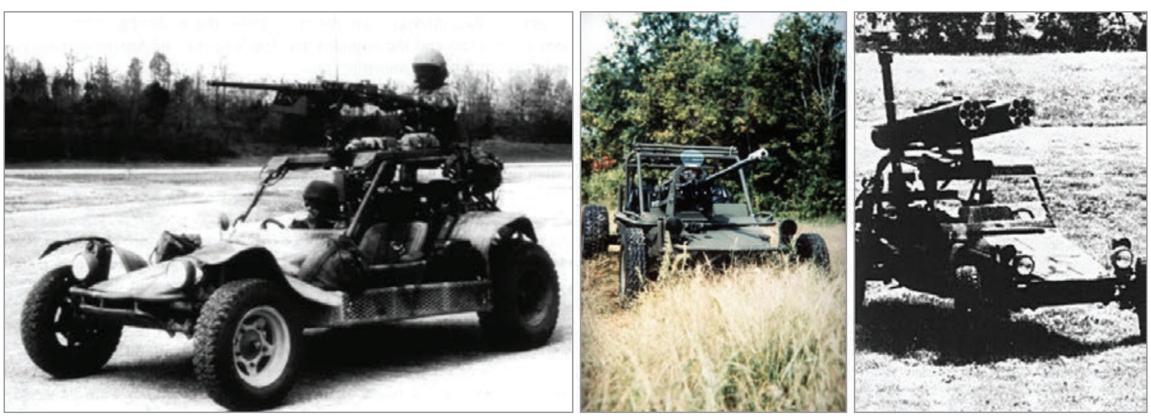
4 U.S. Army Transportation Museum, "Mechanical Mule," August 7, 2012.

5 Parsons, 1982.

is a militarized two-wheel-drive dune buggy powered by a Volkswagen Beetle engine that shared the Beetle's basic layout.[6] The 9th ID experimented with mounting a wide variety of weapons on the FAV, including the .50-caliber machine gun, the Mk19 grenade launcher, 25-mm Bushmaster, and TOW missiles as illustrated in Figure A.5. However, field tests demonstrated the ability of recoil from large weapons to destabilize and flip the light FAV platform. What did reportedly work better than expected was the FAV-mounted TOW missile launchers that TRADOC opposed because the two-man FAV crew was inconsistent with doctrine that required a crew of three on TOW-equipped platforms.

One of the intriguing aspects of the 9th ID's vision was the intention of fielding FAVs to execute conventional military missions, such as movement to contact and deliberate defense. The results of the field exercises demonstrated the value of these highly mobile and lightly protected platforms for dynamic offense operations but also indicated their inability to conduct deliberate defense or other deliberate missions emphasizing protection. Mobility, it turns out, could make up for a lack of protection in some missions, so long as the forces could stay on the move, evade the enemy, and avoid decisive engagements or requirements to hold a defensive line.[7] Notwithstanding the potential for UTM employment demonstrated by the 9th ID, the experiment came to an early conclusion before the end of the decade, largely because of bureaucratic resistance and the cancellation of the Armored Gun System (AGS) program that was central to the 9th ID's intended force structure. The Army replaced the FAV with the HMMWV in conventional forces, though the FAV, renamed the Desert Patrol Vehicle and later the Light Strike Vehicle, was employed by SOF in Operation DESERT STORM and after. However, SOF reportedly found dune buggies too deficient in cargo carrying capacity,

Figure A.5
Configurations of the Fast Attack Vehicle Employed by 9th ID with a .50-Caliber Machine Gun (left), 30-mm Gun (center), and 2.75-mm Rocket Launcher (right) Weapons Systems



SOURCE: U.S. Army.
RAND *RR718-A.5*

6 The Germans—and modern dune buggy users—found that two-wheel drive was sufficient given the light loading on the front wheels and a flat floor pan that made it possible for Kübelwagens to slide over sand and snow. VW developed a four-wheel-drive variant but found that the additional capability was minimal and did not compensate for the added weight and complexity.

7 Bowman, Kendall, and Saunders, 1989.

too low to provide good visibility, and too long in the wheelbase—giving them a propensity to "bottom out" or "high center" in undulating terrain.

At the same time that the 9th ID was experimenting with light mobility, a war between Chad and Libya was putting the same ideas to the test. As pictured in Figure A.6, Chad fielded a highly mobile force based on Toyota 4x4 pickup trucks—many armed with French-supplied MILAN antitank guided missiles (ATGM) and U.S.-supplied Redeye man-portable air defense missiles (MANPADs)—against Libyan forces with a relatively heavy force consisting of Soviet-made heavy and medium armor. According to Kenneth Pollack, the United States offered the Chadians heavier vehicles and weapons, but the Chadians turned down the offer in favor of the pickups, ATGMs, and MANPADs.[8] The Chadian leader reportedly assessed that the heavier weapons would be more of a hindrance than help, while the trucks would enable his forces to rely on maneuver and traditional desert warfare tactics. Indeed, the Chadians successfully exploited their greater mobility to destroy the Libyan forces. Of course, the Chadians had other advantages to support their nimble desert forces: French airpower, French and U.S. intelligence support, and high motivation. The Libyans, moreover, were limited by lack of sustainment for Soviet equipment and little effective training to execute their Soviet-based doctrine. With some supporting capabilities such as close air support (CAS) and targeting intelligence, the highly mobile Chadian force, with limited protection and advanced weapons systems, successfully engaged Libyan armor forces in a conventional confrontation.

Contemporary ATV and LTATV Usage

To return to the U.S. military, the introduction of the HMMWV in the 1980s did not obviate the need for the M274 Mechanical Mules as expected. On the contrary, the transition away from the venerable Jeep toward the larger and heavier HMMWV increased the capability gap between conventional transport and the tactical mobility requirements of infantry and SOF. The gap grew rapidly after 2001 with the up-armoring of the HMMWV and eventual replacement with the MRAP due to the pervasive threat of IEDs against lightly armored vehicles in Iraq and Afghanistan. The FAV might have filled some of this gap but, with similar dimen-

Figure A.6
"Technical" Trucks Like Those Employed by Chadian Forces as Troop Mobility and Coordinated Maneuver Platforms

SOURCES: U.S. Marine Corps, 2002, Creative Commons, 1986, and U.S. Government, 1994.
RAND *RR718-A.6*

[8] Kenneth Pollock, *Arabs at War,* undated, p. 387.

sions and less carrying capacity than the HMMWV, proved a dead end. Instead, the U.S. military and others in the 1990s began to meet the unaddressed tactical mobility requirements through limited introduction of the ATV/LTATV—which can be thought of as combining the strengths of the Mechanical Mule with some of those of the FAV—and the embrace of the Mercedes Benz Geländewagen (often referred to as the G-Wagen) family.

In the late 1990s, the U.S. Army adopted the John Deere M-Gator, the first of a class of vehicles that became known as LTATVs. This led to the introduction of militarized variants of the Kawasaki Mule and the Polaris Ranger, and pure ATVs like the Polaris Sportsman. Marines and Navy SEALs have also embraced ATVs and LTATVs, as have most NATO forces and others. As we shall see, ATVs and LTATVs generally have the same applications, capabilities, and weaknesses, although the side-by-side LTATVs seem to offer distinct advantages with respect to carrying capacity, passenger capacity, and the ability to have someone free to watch and fire a weapon—in other words, ride shotgun.

Examples of how U.S. and other forces use ATVs and LTATVs are numerous. The following sample is far from exhaustive but generally representative:

- Marines in Afghanistan use LTATVs such as Kawasaki Mules and Polaris Rangers for Traveling Support for patrols or Internal/Ferry Support for going back and forth from landing zones and remote posts in areas where HMMWVs cannot operate either because of the terrain or because base conditions are too austere to support extensive HMMWV use.
- Dismounted Army patrols in Afghanistan patrolling several kilometers away from outposts have found it useful to use ATVs to carry extra ammunition and mortar rounds because that "allowed the dismounted patrol to move a greater distance with less fatigue and additional ammunition and supplies." Army soldiers also fabricated a field-expedient mount for putting Mk-19s on the back of ATVs, racks for carrying mortar and Mk-19 rounds, and a platform for medical evacuations.[9]
- Navy SEALs in Afghanistan in 2008 transitioned from HMMWV-derived Ground Maneuver Vehicles (GMVs) to LTATVs because the enemy was using off-road ratlines and because of the IED threat on roads.
- The 1-38 Cavalry Long Range Surveillance Troop has used ATVs and LTATVs for Traveling Support, including moving crew-served weapons from place to place to conduct fire support, and using them as a command and control platform by placing heavy radio equipment on them. They have used them in an Internal Ferry capacity behind lines to resupply elements, and for Coordinated Maneuver when moving to cordon/blocking locations in difficult terrain. They found ATVs and LTATVs are also good for bypassing likely threats on routes such as IEDs.
- Marines found that ATVs and LTATVs were useful for flanking patrols to detect command initiation wires, ambushes, and remote control improvised explosive devices (RCIEDs).[10]
- A Combined Joint Special Operations Task Force–Afghanistan (CJSOTF-A) memo dated March 15, 2009 noted ATVs and LTATVs are used in conjunction with MRAPs

[9] Ed Peskie, Justin Schwengler, and David Fivecoat, "Tactical Adjustments for Afghanistan: TF 3-187's Experience in Paktika, Ghazni Provinces, 2010–2011," *Infantry*, August 2011, p. 29.

[10] AAR.

for scouting safe routes and noting danger areas such as soft shoulders, illustrating execution of the Maneuver Force Security/Recon activity with UTMs. Operators have used them to do route reconnaissance and clear choke points or take high ground that might be used by enemy RCIED trigger men. They use them for "squirter control" (blocking the enemy from slipping out of cordon and search operations), quickly positioning snipers, liaison with indigenous forces (courier), and CASEVAC.

- The French Army relies on ATVs for operations in Guyana, where dense forests preclude the use of larger vehicles; the Finnish Army has a similar requirement for operations in dense forests with few roads and thus uses ATVs extensively, according to the Finnish defense attaché in Washington, D.C.[11]

ATVs and LTATVs thus not only extended the range and maneuverability of dismounted patrols in areas where SSVs cannot go but also increased their firepower, with weapons systems enabling them to engage the enemy at greater distances, thanks in particular to the Mk-19 and mortars.[12] They can transport personnel and supplies, perform CASEVAC, and work with larger vehicles to scout and provide security on the flanks. They are fast enough for setting blocking positions near objective for "squirter control" or even to enable Rangers to seize airstrips, and sufficiently maneuverable for urban operations, according to a Joint Operational Requirements Document (JORD). The JORD says that LTATVs give Rangers the ability to move fast to do airfield seizures and Direct Action in non-permissive urban operations. LTATVs, moreover, can keep GMVs out of trouble by doing flank security. The same document goes so far as to recommend LTATVs' use in lieu of motorcycles. But this is not all: A general theme in the reports related to ATVs and LTATVs has been their flexibility; once units have them, they find ways to use them.

As these examples illustrate, the fundamental justification for ATVs and LTATVs is that forces, especially infantry and SOF, sometimes operate in places where they cannot take HMMWVs and MRAPs because they are precluded by terrain, austerity, or portability, and when troops need to go faster and/or carry greater loads than they could on foot. Indeed, according to the XVIII Airborne Corps LRSC, ATVs and LTATVs are "mission critical" when, in the words of the CJSOTF-A memo, "there is no alternative other than dismounted operations, when operating on narrow trails or steep terrain, and when the total weight of equipment exceeds 100 pounds per man." The memo adds that

- ATVs and LTATVs alone are internally transportable by helicopters
- ATVs and LTATVs allow fully equipped combat soldiers to move rapidly around the battlefield on terrain unsuitable for conventional vehicles
- ATV/LTATV use will only grow as MRAPs and other armored vehicles get bigger.

ATV and LTATV users, despite their enthusiasm for the platform, have noted a number of considerations and potential issues that need addressing. Perhaps the most common one mentioned is the difficulty of maintaining the machines in the field, which is primarily due to a lack of expertise, a lack of appropriate tools, and a lack of access to spare parts. Some models have emerged as particularly prone to failure, most notably the XA, the filters and fuel injec-

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[11] Interview with Lt. Col. Markku Viitasaari, May 28, 2013.

[12] Peskie, Schwengler, and Fivecoat, 2011, p. 29.

tion system of which have been found to be insufficiently robust and requiring constant disassembly for cleaning and replacement. Some operators have had to leverage personal connections to commercial ATV/LTATV dealers to have parts shipped to them by mail. According to some reports, the mechanical problems are also related to insufficient training: Operators who are improperly trained in the use of ATVs/LTATVs in harsh terrain are prone to do things with their machines that make them break down quickly.

Training, in fact, is often mentioned in reports as insufficient, as many ask for greater predeployment training, in particular the opportunity to learn proper techniques on real machines in environments similar to those encountered in the field. These reports do not link the training to safety—in contrast to motorcycles—but instead argue that they would be able to do more with the machines if given the opportunity to experiment with them, as well as learn to use them without breaking them as often.

Snowmobiles

Special mention must be made of snowmobiles, which can be thought of as a subset of ATVs and direct descendants of the Kettenkrad. Snowmobiles have the distinction of having unique mobility capabilities in certain conditions relative to other motorized vehicles. Other wheeled UTM platforms cannot do what snowmobiles can do, meaning it seems reasonable that missions including transit over snow and ice must have some snowmobile capability. The snowmobile's capability to operate over snow, ice, and saturated earth is primarily a product of the platform's ability to distribute its weight over a much greater area than wheeled vehicles. Recent, new UTM prototypes like the Special Mission Terrain Vehicle (SMTV) shown in Figure A.3 have applied this approach to develop new options for mobility over loose, sandy, and muddy surfaces.

The snowmobile in the form familiar to us today dates back to the 1950s and has been widely adopted by many militaries. Probably all modern militaries that operate in snowy conditions have some snowmobile capabilities. Snowmobiles have a variety of uses and can be applied to all Tactical Activities identified in this analysis because of their towing capability. For example, according to the Finnish defense attaché at the Finnish Embassy in Washington, D.C., Finnish infantry squads each have one snowmobile during the winter.[13] The snowmobile can tow ten soldiers on skis or casualty sleds to execute CASEVAC.

The Canadians rely on snowmobiles, which they refer to as Light Over Snow Vehicles (LOSV), to provide mobility along with ATVs for their new Arctic Response Company Groups (ARCGs). These units have a wide range of missions, including "Sovereignty Patrols," "full spectrum operations including combat, stability, and Assistance to Law Enforcement Agencies," disaster relief, patrolling and surveillance, and community outreach, that are executed in mountain and arctic environments.[14] In contrast to the Finns, who issue only one snowmobile to each squad, the ARCG members are all issued a snowmobile each. Interestingly, the Canadian military has found that traditional Inuit cargo sleds work very well when towed by snowmobiles and have them as part of their standard equipment (see Figure A.7).[15]

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[13] Viitasaari, 2013.

[14] Canadian Forces, "Initial Operating Capability: Arctic Response Company Groups, Master Implementation Plan," February 20, 2010, p. 7.

[15] CBC News, "Canadians Turn to Native Dog Sleds for Arctic Sovereignty Patrols," December 1, 2011.

Figure A.7
Canadian Arctic Response Company Group Training (left) and Recovery (right) of LOSVs

SOURCE: Canadian Army Land Force Western Area, 2012.
RAND *RR718-A.7*

Trends in ATV/LTATV Usage

Our survey of historical and contemporary ATV and LTATV use indicates that there is likely to be a persistent demand for ATVs/LTATVs for the foreseeable future, primarily because of the broad range of applications to which they can be put and the relatively low threshold required for proficient use in terms of training and expertise. ATVs and LTATVs are also particularly useful because they respond to both sets of requirements that together constitute the UTM niche, allowing them to readily

- substitute for SSVs when various constraints preclude SSV use, primarily because of their size
- enhance infantry capabilities by enabling them to go further, faster, and for longer durations with greater firepower than they could otherwise carry.

As for countermobility threats or other threats, ATVs and LTATVs are inherently light platforms that trade protection for mobility, which sometimes translates into the ability to use both roads and smaller trails to avoid threats concentrated on defending and denying use of primary routes. Even with the increased mobility, the almost complete absence of protection has generally limited routine and responsible ATV and LTATV employment to relatively permissive environments.

The primary constraints on effective ATV and LTATV use to meet the persistent requirements described previously have generally been

- expertise (operating ATVs/LTATVs, maintaining the vehicles)
- institutional support (can the Army provide the ATVs/LTATVs sought by units?)
- support (can operators acquire they parts they need?).

As we shall see in our discussion of motorcycles, the training and support required for operating ATVs and LTATVs is not trivial, but the training requirement in particular is significantly smaller than that associated with motorcycles.

Bicycles

Bicycles have a long record of military use and have proven to be more useful than one might expect. As we shall see, bicycles generally have been employed for mobility and Traveling Support, but examples can be found of their application for all eight of the Tactical Activities identified by this analysis, including coordinated maneuver and immediate pursuit. Moreover, in most cases they have exemplified the bottom-up approach to the tactical mobility gap: They have been used to enhance dismounted infantry who otherwise would have no vehicles at their disposal, not even quadrupeds. Indeed, the basic argument for bicycles today is what it was in the 1880s, when European militaries began experimenting with them: Giving foot soldiers bicycles enables them to go faster and farther, all while carrying heavy loads. The bicycle, as demonstrated over time, provides significant tactical utility relative to the resources required to develop and support this UTM capability (e.g., initial purchase cost, maintenance, parts, training).

Historical Usage

According to the most comprehensive study of military bicycles, Major Stephen T. Tate's thesis, "Human Powered Vehicles in Support of Light Infantry Operations," European armies first began integrating bicycles into their forces in the 1880s soon after the introduction of the first useful bicycle design, the Rover Safety Bicycle, which uses the now familiar format of a diamond shaped frame and a chain drive. The first American military experiment with the bicycle began in 1896, and it is revealing for two reasons: First, the results were surprisingly positive. Second, the Army lost interest nonetheless, which, in light of the Army's extensive use of bicycles in World War I, may have been the result of institutional cultural resistance rather than an objective assessment. This general cultural aversion would prove a persistent barrier to greater bicycle use by the Army throughout the century.

The experiment was conducted by an all-black infantry unit—the 25th Infantry Bicycle Corps, based in Missoula, Mont.—which developed its own best practices and bicycle modifications while conducting a number of long-distance trips (including a ride to St. Louis, Missouri) using the bicycles over open country and poor-quality dirt roads. Though plagued by mechanical problems, above all flat tires, the Buffalo Soldiers demonstrated the simple advantage given to them by the machines, which was that they enabled them to move long distances with heavy loads far more quickly than they could have on foot.[16] During the 25th's trip to St. Louis, for example, even on their shortest advance they managed 37.7 miles, and Tate calculated that they achieved greater than a 4-km-per-hour speed advantage over a modern light infantry unit on foot. This was true even though the 25th had to make frequent stops to repair tires. The same unit also demonstrated the bicycles' utility when sent to Havana soon after the end of the Spanish-American War, when it was tasked with putting down riots. They improvised swarming techniques whereby they used the bicycles to reach trouble spots

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[16] Tate, 1989.

quickly and mass by coming from multiple directions, and they used the bicycle frames to form barricades.[17]

According to Tate, the Army abandoned bicycles when the unit returned from Cuba. Meanwhile, the Europeans continued to experiment with them, and the British deployed thousands during the Boer War, primarily to make up for shortages of horses.[18] There, many soldiers benefited from bicycles that could be folded up and carried when the terrain was too rough to ride but unfolded and mounted as soon as the terrain permitted. These were also useful for pursuit operations, when soldiers needed to move fast. [19]

The American, Belgian, British, French, German, and no doubt other militaries used hundreds of thousands of bicycles during WWI for a variety of purposes. According to Tate, during the initial phase of the war when long troop movement was common, bicycle-mounted troops operated as cavalry and filled other roles that required rapid movement.[20] Bicycle-mounted troops sometimes clashed, and both the Belgians and the Germans had notable successes using bicycles for deep penetration work behind enemy lines. In the Belgian case, they operated on bicycle for extended periods of time in German-occupied Belgium, where they cut communication lines and railroads.[21] In the German case, Tate cites examples of their use of bicycles to move quickly and quietly at night to seize bridges in advance of infantry offensives.[22] On the Western Front, after the fighting ground down to trench warfare, the various armies used bicycles to move infantry reinforcements quickly to wherever they were needed.[23] Elsewhere, different armies—above all the Germans—integrated bicycle troops into their maneuver units, much as motorcycles would later be in the Second World War.[24] The Finns apparently adopted the German use of bicycles to enhance the capabilities of light infantry and put its bicycle- (and ski)-equipped light infantry to good use in the Winter War against the Soviet Union (see Figure A.8). According to the Finnish defense attaché in the Finnish Embassy in Washington, D.C., Finland's need to move through dense forests is one reason for the Finns' embrace of the bicycle.[25] Another, he said, is the unavailability of motorized alternatives. The Finns used bicycles because it was the best alternative to walking that they had access to.

In World War II, despite the wide use of motorcycles and the introduction of Jeeps and Kübelwagens, bicycles continued to play important roles. The German Army in particular continued to use bicycles in maneuver units, supplying them not to mechanized infantry (see the discussion of Panzergrenadier divisions in the section on motorcycles, below) but to light infantry who otherwise would be on foot. One hope was that they would be able to keep up with mechanized units. In Poland, the speed of the advancing armor was too great; the cyclists could not

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17 Tate, 1989.

18 Tate, 1989.

19 Tate, 1989.

20 Tate, 1989.

21 Tate, 1989.

22 Tate, 1989.

23 Tate, 1989.

24 Tate, 1989.

25 Viitasaari, 2013.

Figure A.8
Finnish Winter War–Era Soldiers with Bicycles, and Recent Finnish Bicycle Training

SOURCES: Finland Army Archives, 2012.
RAND *RR718-A.8*

keep up with the Panzers.[26] However, during the Norway campaign, the Germans used bicycle troops in tandem with tanks to pursue Norwegian defenders in mountain passes and narrow valleys, where trucks were too cumbersome and the rate of advance was not as great as in Poland. The armored vehicles provided fire support to the cyclists, who could either follow the tanks closely or advance ahead of them—mounted or dismounted—as the situation dictated. The bicycles helped the German infantry move quickly, which kept the Norwegian defenders from being able to execute orderly retreat and prepare defenses.[27] The Germans relied on bicycles in particular with the Volks Grenadier divisions, raised during the resource-poor later stages of the war. According to Tate, one of the Volks Grenadier divisions was able to maul the American 106th Division badly in the Ardennes in December 1944, in part because of the flexibility that the bicycle-mounted troops gave German commanders: The bicycles enabled light infantry to move and redeploy much more quickly than they would have been able to otherwise.

Arguably the most striking use of bicycles was by Japanese forces in the assault on Singapore. British defenders reckoned that the roads and trails approaching Singapore on the Malay Peninsula were not conducive to large motorized operations, and a dismounted attack would move sufficiently slowly for the British to be able to form proper defensive lines, destroy bridges, etc., buying time for reinforcements. The Japanese, however, foiled the British plans by providing the invading force with thousands of bicycles, enabling the Japanese infantry to keep up with tanks, and enabling the entire Japanese force to advance much faster than the British anticipated. Whenever the British destroyed a bridge, for example, the Japanese simply hoisted their bicycles on poles and carried them across rivers and streams. When they could not use the roads, they pushed the bicycles through the jungle.[28] As was the case in Norway, the quick-moving bicycle-equipped attackers were able to prevent the defenders from organizing better defenses.

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[26] Tate, 1989.

[27] Tate, 1989.

[28] Tate, 1989.

For their part, the British had success using bicycles for airborne troops. The most notable example Tate cites is the use of bicycles by British commandos who raided a German radar installation on the French coast in 1942. British planners realized that the site was too well defended from the sea to deploy troops by boat; nor could they parachute soldiers close to the site without being detected. Their solution was to drop at night commandos equipped with folding bicycles eight miles from the installation and have them bicycle silently to it, where they successfully preserved the element of surprise. After they completed their mission, they were picked up by the Royal Navy.[29]

The American Army during World War II used large numbers of bicycles, but only in what might be described as "administrative roles" such as couriers, although Tate notes that GIs prized captured German bicycles, and the 84th Infantry Division formed an ad hoc bicycle unit using captured equipment. It never went further, however, and Tate speculates that the resistance was cultural. For example, he notes that roughly a year before Pearl Harbor, the Chief of the Infantry asked the Infantry Board at Fort Benning to review the use of bicycles in light of the Germans' success with them in Norway. According to Tate, the Infantry Board's letter in response to the query offered a number of reasons for not using bicycles but closed with what he regards as the real reason: The letter said that the commander of the unit designated for testing bicycles, the 4th Infantry Division, simply did not want to test bicycles and was more interested in testing the new Jeep.

Following the Second World War, the most notable use of bicycles by a military at war was by the Vietminh and later the Viet Cong for carrying supplies, particularly along the so-called Ho Chi Minh trail. The Vietnamese used modified bicycles as hand carts, pushing them along rather than riding them, with as much as 500 pounds of cargo on each bicycle. Although to a large degree the lack of motorized alternatives dictated the Vietnamese use of bicycles, according to Tate, the Vietnamese appreciated the fact that bicycles on roads, with a much smaller signature than a vehicle, were difficult to detect by reconnaissance aircraft; the bicycle porters, because they made little noise, could also hear planes coming in time to seek cover. They could also opt to travel at night or simply abandon roads for footpaths with the bicycles. Basically, there was nothing either the French or later the Americans could do to interdict the traffic. The bicycle porters' resistance to interdiction might have been a reason for North Vietnamese commander General Vo Nguyen Giap's defense of bicycle porters at a time when he was under pressure to adapt more conventional military methods.

On the American side, American forces supplied local defense forces with bicycles to enhance their ability to patrol as well as to enable them to rush a reaction force to a location when required. Bicycles enabled fewer defenders to cover more ground, which may have been the lesson the Finns learned in their conflict with the numerically superior Soviet Army.

Contemporary Usage

Few modern militaries use bicycles for anything more than on-base transportation or occasional Special Forces applications. Two recent exceptions are the Swiss, who abandoned their bicycle units in 2008 as part of general budget cuts, and the Finns, who still train with their bicycles and keep them on their Tables of Organization and Equipment but do not operate them.

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[29] Most source information on this page comes from Tate, 1989.

According to the Finnish defense attaché, the Finnish Army historically has valued bicycles because of the country's remote areas, where forests are dense and roads large enough to support trucks and armored vehicles are few.[30] Bicycles enabled light infantry to move about relatively quickly; they would take trucks as far as they could but then dismount with their bicycles and ride on from there. They switched to skis when there was too much snow on the ground for bicycles. The attaché said that the Army insists on training all soldiers in bicycle usage (how to load the bicycle, how to "crash stop"), but it has relegated the bicycles to a backup role, largely because the current Finnish Concept of Operations places little emphasis on operating in the remote areas where they would be of particular value. To some extent, the attaché noted, the Finns' insistence on keeping the bicycle capacity has to do with tradition, given the iconic place of the bicycle in Finnish military history, specifically with respect to the Winter War against the Soviet Union.

The Swiss appear to have used bicycles in the same way. That is, they issued them to light infantry to enhance their mobility as they moved through forests and mountains. (Tate notes that Swiss bicycle companies were also issued ATVs "similar to the old U.S. M274 motorized mule" to carry reserve ammunition and night sights.[31]) Swiss bicycle troops were also expected to carry their own sustenance and heavier loads compared to American infantry: 110 lbs compared to 72 lbs, and, as Tate notes, they expended much less energy doing so. Otherwise, according to Tate, the Swiss used the bicycle regiments precisely as they did normal infantry, only with an enhanced ability to deploy and move from place to place (see Figure A.9). They bridged the gap between light and motorized infantry units. This made them particularly useful for certain kinds of engagements when the extra mobility would be a significant asset, such as performing a "hasty defense," meaning scrambling to secure a critical piece of terrain such as a pass to block an enemy advance. Also, the Swiss thought bicycle troops were particularly useful as a reserve—just as they were used in WWI—because of their ability to rush relatively quickly to reinforce a position.

Analysis

The military use of bicycles over time demonstrates the dual nature of the niche filled by UTM: They replace SSVs when constraints preclude their use, while also enhancing the capabilities of light infantry. Whether or not they still have use today is debatable, although arguably the extremely low cost of purchasing, maintaining, and operating bicycles lowers the threshold for their consideration and adoption by modern militaries for some uses. Despite their clear performance limitations versus other comparable UTM platform options such as the motorcycle, the bicycle has some comparative advantages that still make it a viable option in some specific instances:

- compactness: bicycles require relatively little space to transport or store
- portability: bicycles are easily carried and portaged across impassible areas
- sustainment: bicycles do not require external energy (fuel, feed, etc.)
- maintenance: bicycles are relatively easily and quickly repaired
- economy: bicycles are much less expensive than motorized platforms

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[30] Viitasaari, 2013.

[31] The source of most information on this page is Tate, 1989.

Figure A.9
WWII Swiss Army Bicycle with Antitank Weapon (left) and Recent Swiss Army Bicycle Training (right)

SOURCES: Creative Commons, 2013, and Swiss Armed Forces, 1989.
RAND *RR718-A.9*

- safety: speed limitations of bicycles diminish the potential for and impact of operator injuries
- operational signature: bikes do not have the significant noise signature associated with motorized platforms.

The Finnish and Swiss use of bicycles—which follows the German lead—suggests that wooded environments, mountains, and urban areas with particularly narrow trails and passages are particularly apt. Airborne troops could also benefit, just as British raiders did in World War II in their assault on a German radar installation.

Motorcycles

Motorcycles have been a part of military inventories since before the First World War. They can be and have been used for every Tactical Activity identified in this analysis and Figure A.2, particularly when mated with a sidecar. However, as illustrated in Figure A.10, the single-track motorcycle when mated with the sidecar becomes essentially a dual-track UTM with characteristics and application much closer to the current LTATVs discussed previously than the narrow and nimble image associated with military motorcycles. Applying the UTM platform classes presented in Chapter Four, a motorcycle would be considered a subcompact UTM, while the motorcycle and sidecar together would be considered a compact UTM platform. For these reasons, the motorcycle with the sidecar should be viewed as demonstration of the motorcycle platform writ large.

Given the distinction between traditional motorcycles and their sidecar variations, the analyzed case studies strongly suggest that in most cases alternative forms of tactical mobility, when available, do the job sufficiently well but without the significant challenges and hazards associated with traditional motorcycle employment. To be more precise, a well-documented body of experience exists indicating that military motorcycle employment is significantly more dangerous than SSVs and even other UTM platforms, such as the motorcycle and sidecar combination. A primary cause of this elevated hazard is the physical rigor and constant attention required to safely and effectively operate a motorcycle in a tactical environment. Operators

Figure A.10
The German Motorcycle Single-Track UTM (left) and More Prevalent German Motorcycle-with-Sidecar Dual-Track UTM

SOURCE: German Army Archives, 2012.
RAND *RR718-A.10*

have few available faculties to do other tactical tasks, such as observe, communicate, or shoot, while they are busy operating the motorcycle safely. While the addition of a sidecar to the motorcycle addresses many of the hazards associated with operation, it fundamentally changes the nature of the vehicle by doubling its width and its superior ability to navigate narrow trails.

Interest in military motorcycles returns often when a new advance in motorcycle technology offers the promise of improving their capabilities or reducing their liabilities. However, these innovations do not change the fact that motorcycles have two wheels and a relatively high center of gravity and require near constant balancing and adjustment for safe operation. To be fair, there remain some things that motorcycles do best or that only motorcycles can do, meaning that motorcycles probably will continue to have *some* place in military inventories. But that place will and should likely remain a narrow niche.

Historical Usage

The military use of motorcycles began on the eve of the First World War, and motorcycles saw extensive use in all or most of the armies that fought in that conflict. Although motorcycles were used mostly for courier duty, many armies experimented with motorcycles for a variety of offensive purposes, including troop mobility and reconnaissance and as mobile machine gun platforms. In at least one documented instance, the British Army found the motorcycle-mounted machine guns useful for providing fire support in different places as needed. The United States similarly deployed motorcycles and has as many as 10,000 in its inventory; however, there is no evidence that the Americans ever put their Harley-Davidson and Indian motorcycles to use for anything other than courier work or administrative tasks. The U.S. military appears not to have embraced the machines as tactical capabilities prior to World War II, with some limited exceptions when the Marines used motorcycles during its various small wars of the 1920s.[32] The Army in 1939 decided to phase motorcycles out of its inventory, largely

[32] Jerry R. Fry, "Use and Testing of the Motorcycle by the US Army, April 1917 to February 1977," Fort Leavenworth: U.S. Army Command and Staff College, 1977.

because of the mechanical problems associated with the Harley-Davidsons and Indians, and concentrate on developing the Jeep.[33] It went to war with a relatively small stock of remaining 1930s bikes.[34] According to one source, the Army used only 5,000 motorcycles in World War II, as compared to more than 600,000 Jeeps.[35]

The Wehrmacht and the Motorcycle

The lack of interest on the part of the U.S. military differed sharply with enthusiasm for motorcycles demonstrated by the German Wehrmacht, which introduced tens of thousands of bikes—many with powered sidecars—into its conventional forces as motorcycle infantry (Kradschützen), making them organic to Panzer (armored) and Panzergrenadier (mechanized infantry) divisions, in which motorcycles function as a stand-alone Kradschützen battalion or as part of armored reconnaissance units. The Germans used these units to execute a broad variety of the cavalry-like Tactical Activities identified in Figure A.11, including Coordinated Maneuver, Maneuver Force/Security Recon and Troop Mobility, as well as Traveling Support and probably Casualty Evacuation. The Kradschützen usually fought dismounted from their motorcycles, but they sometimes fought from their bikes, often using machine guns mounted on the sidecars (see Figure A.12).

The contrast between the Germans' and the Americans' use of motorcycles has led some to argue that the U.S. military's lack of interest in motorcycles has its roots in the poor quality of the early Harley-Davidsons and Indians for tactical use, particularly when compared

Figure A.11
German Kradschützen Employing Motorcycles with Sidecars for Coordinated Maneuver (left) and Troop Mobility (right) Tactical Activities

SOURCE: German Army Archives, 2012.
NOTE: German military motorcycles were designed to carry three soldiers using a sidecar and a rear seat.
RAND *RR718-A.11*

33 Fry, 1977.

34 Fry, 1977.

35 Michael Green, *Military Motorcycles*, 1997.

to the Germans' superb BMWs.[36] Motorcycle proponents argue that if the United States had developed motorcycles that sufficiently met military requirements as the Germans did, the U.S. military would have used them more and might still be more positive about their use.[37] This assessment of early Army experiences with motorcycles has led subsequent motorcycle proponents periodically to advocate for U.S. military motorcycle concepts and capabilities patterned after the successful use of motorcycles by the Kradschützen.[38] However, further analysis indicates that the resource-limited Germans did not use the motorcycles extensively because they were the *best* alternative, but because they were often the *only* alternative for many units. The problem with this argument is that it overlooks the context in which the Germans used motorcycles as well as the results of the Germans' experience with them. More to the point, the German experience demonstrates a consistent theme in UTM platform use: The value of a particular UTM platform derives less from its superior capabilities than from the inability of available conventional alternatives to meet tactical needs.

What shaped the Wehrmacht's requirement for motorcycles were doctrine and the lack of more conventional alternatives. The German military placed a premium on maneuver and speed—which inspired the formation of its Panzer and Panzergrenadier units—and thus it had a large need for tactical mobility. The Germans wanted their armor to move fast, and

Figure A.12
Wehrmacht Motorcyclists, Dismounted for Combat

SOURCE: German Army Archives, 2012.
RAND *RR718-A.12*

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36 See, for example, Fry, 1977.

37 Both Jerry Fry, author of the 1977 thesis on the U.S. Army's use of motorcycles, and Captain Kyle Stockwell, today's leading motorcycle proponent, have made this argument. They point to the Germans' superior technology as the reason for their embrace of the motorcycle and argue that the U.S. Army's lack of interest resulted from its failure through the 1960s to develop motorcycles good enough to meet military requirements.

38 See, for example, Stockwell, 2012.

their infantry to keep up. However, in the 1930s, when the Wehrmacht took shape, the Germans had none of the armored tactical mobility platforms called for by doctrine and little in the way of tactical mobility of any sort that could keep up with tanks off road. They did have motorcycles, so motorcycles were used instead.[39] The vast majority of motorcycles employed by the German Army were employed with a sidecar to carry additional personnel, cargo, and weapons, making them more closely resemble the current LTATV in use and capability than the two-wheeled all-terrain bike that many motorcycle advocates support.

As the war progressed, two things happened that recent Army motorcycle proponents fail to note in their arguments regarding the Germans' embrace of motorcycles. First, although the Kradschützen performed well in the opening offensives of the war, when speed mattered a great deal and the opposition was generally in disarray, they faltered in Russia in 1941 with the onset of rains that turned roads to mud and, of course, the ice and snow of the Russian winter. Moreover, motorcycle infantry proved to be exceptionally vulnerable on open terrain when facing an enemy capable of concentrating firepower. The motorcyclists were decimated. Second, German industry began to provide the Wehrmacht with ever more capable vehicles, some armored. These included trucks, the VW Jeep known as the Kübelwagen, armored personnel carriers, some of which were half-tracked, and the half-tracked motorcycle/tractor called the Kettenkrad. Beginning in 1942, the Wehrmacht began to shed motorcycle formations and switch Kradschützen and other motorcyclists to other vehicles, especially the Kübelwagen, the Kettenkrad, and armored personnel carriers, when available. In 1943, the remaining motorcycle units were integrated into the armored reconnaissance formations.[40] For these formations, the vehicles of choice were almost always armored and had at least four wheels.

The U.S. Army did at one point during World War II ask Harley-Davidson and Indian to reverse engineer the Wehrmacht's BMW R71 motorcycle and produce a machine that featured some of the German machine's advantages, including the use of a drive shaft instead of a chain, a boxer engine, which was less likely to overheat, and foot shifters. The resulting Harley-Davidson XA and Indian Model 841 failed to impress the Army enough to change its view of motorcycles as having an extremely narrow role.[41] The XA, even if it measured up to the BMW R71, most likely did not constitute a compelling argument for using a motorcycle rather than more conventional alternatives except for the courier role or traffic police, tasks for which the standard Harley-Davidsons already were more than suitable. After the war, the U.S. Army phased out its motorcycles, eliminating them altogether in 1957.[42] The postwar German Army, it should be noted, saw things similarly and relegated motorcycles to courier and traffic police duties, at least as far as general-purpose forces were concerned. By the early 1970s, Bundeswehr use of motorcycles was limited to worst-case scenarios in which all other means of communication or transportation are inoperable. Noting the demotion of motorcycles, a *Der Spiegel* magazine article from 1971 on the subject grimly inquired what kind of news there would be to convey if the situation had gotten that bad.[43]

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[39] Scheibert Horst, *Panzer-Grenadier Motorcycle and Panzer Reconnaissance Units: A History of the German Motorized Units, 1935–1945,* 1991.

[40] Horst, 1991.

[41] Green, 1997.

[42] Fry, 1977.

[43] "Hei, Wie Das Hallt," *Der Spiegel,* January 3, 1971.

Postwar Use of Motorcycles

Motorcycles continued to be used by modern, mechanized armies after the Second World War primarily for courier and military police work but also for reconnaissance and deep penetration operations, generally by Special Forces. One example of motorcycle use by general forces is that of the 3rd Battalion, 22nd Infantry, in Vietnam. According to a news report, the battalion commander decided to equip his reconnaissance unit with four motorcycles to quickly scout narrow marsh and jungle trails in conjunction with jeeps mounted with M60 machine guns. "This mobile unit can cover a great deal of territory in a very short time," the report quotes the commander, "which enables us to gain information on the whereabouts of the enemy." According to the battalion executive officer, "Recon has provided us with valuable information which normally we would not have."[44]

By the early 1970s, the U.S. Army, perhaps because of units like that described above, was aware that a new generation of mostly Japanese motorcycles constituted a vast improvement over the performance of 1940s-era machines and offered many potential advantages. The emergence of civilian motorcycles with greater off-road capability, more power, and less weight began another round of testing with a particular interest in the suitability of motorcycles for recon scout activities. The tests were conducted in 1972 and involved fielding a scout section equipped with Suzukis as part of larger exercises.[45] According to the Interim Report, the unit performed eight different tactical missions, including tank killer and rear area security. They also tested the portability of fully loaded bikes using a variety of internal and external techniques with UH-1H and CH-47 helicopters (two can be loaded inside the UH-1H and two on external ramps, while 11 can fit inside a CH-47), and the helicopter-borne motorcyclists performed tactical missions such as forward observer, antiaircraft (Redeye), and pathfinder.[46] All in all, the Interim Report found that the motorcycles performed well and offered significant potential. A memo from U.S. Army Combat Developments Command from the same period also noted that the Jeep did not provide "complete cross-country mobility" and air-mobile and light infantry had "no ground transportation."[47] Motorcycles would improve the range of reconnaissance and scout units, who would perform "more economically with motorcycles than with present vehicular equipment." The memo recommended further evaluation.

The Department of the Army and other units involved in testing motorcycles disagreed with the positive conclusions of the 1972 trials. According to Fry, the Department thought motorcycles had too many limitations. Moreover, in 1974, the 101st Airborne conducted its own tests and concluded that motorcycles were a poor option because the rider has to concentrate too much on selecting a path to serve as an observer, was too deafened by vehicle noise and the muffling effect of his helmet to detect enemy activity, and was unable to defend himself at close range when mounted.[48] Notwithstanding the 101st's negativity, a number of units—including the 101st—asked for a few motorcycles to be added to their TOEs or called for further testing, largely because most agreed that motorcycles could play a limited but valuable role. As Fry notes, however, the Army never got fully behind motorcycles largely because

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44 Kirk Ramsey, "25th Infantry Division in Vietnam," Tropic Lightning News, undated.

45 U.S. Army, *Motorbike Evaluation Interim Report MASSTER Test No. 1034*, 1972.

46 U.S. Army, 1972.

47 Ben S. Malcom, "Memorandum for: CO USACDCINA; Subject Use of Motorcycles in the Army," July 18, 1972.

48 Fry, 1977.

it could never define a clear requirement for them. Motorcycles persisted in the Army through the 1990s here and there, but only in small numbers and in limited roles.[49] In 1990 the Army conducted a concept evaluation of potential scout platoon configurations that included two ten-vehicle configurations incorporating the military motorcycle (MILMO).[50] Through evaluation of exercises at the National Training Center (NTC), this evaluation observed that the MILMO was able to gain access deep into the enemy's rear, and the MILMO suffered lower loss rates than the M3 CFV or HMMWVs evaluated. While these noncombat demonstrations suggested potential benefits of MILMO for Army recon activities, they were not subsequently added to the conventional Army force structure.

The U.S. Marine Corps had similar experiences with attempts to employ the motorcycle. For example, the Marines, who had abandoned motorcycles after World War II, began to reevaluate them in 1977 and eventually placed an order for a few hundred Bombardiers in 1982.[51] In the 1990s, they replaced the Bombardiers with about 260 Kawasakis.[52] According to the *Marine Corps Gazette*, the Kawasakis were intended for courier, route reconnaissance, and convoy escort duties.[53]

During this time, motorcycles continued to find a home with SOF, whose requirements such as speed and portability align more closely with motorcycles. Perhaps the best known example of motorcycle operations is the efforts by various special forces including the British SAS to hunt for SCUD launchers in western Iraq during the Gulf War. There the concept was for helicopter-delivered motorcycle patrols to cover large swaths of the desert quickly without being detected.

Contemporary Usage

Unsurprisingly, SOF and even conventional forces found increased interest in and demand for motorcycles after September 11, 2001, and the invasions of Afghanistan and Iraq. Marines used motorcycles for rapid airfield surveys, while SEALs in Afghanistan reported that at times motorcycles alone enabled them to reach enemy positions.[54] SOF operators in Afghanistan also preferred to employ motorcycles that sounded like the motorcycles commonly used by the Afghan population, allowing them to minimize their operational signature. SOF after action reports (AARs) also noted that the motorcycles made it easier to infiltrate villages as well as interact with locals. Motorcycles are also useful because Afghan security forces use them.[55]

Although the motorcycle has proven its usefulness in Afghanistan and Iraq, the available reporting suggests that ATVs and LTATVs have done the same jobs in these operations at least

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49 For example, Department of the Army, Field Manual 7-72, *The Light Infantry Battalion* (1989) lists 15 military motorcycles (MILMO) as part of the Headquarters Company's authorized equipment. However, no information exists to indicate the authorized motorcycles were ever fielded or used as part of the light infantry battalion.

50 U.S. Army Directorate of Combat Developments, 1990. This report evaluates the operational effectiveness of two variations of the maneuver battalion scout platoon configured with ten vehicles and four surrogate military motorcycles (MILMO) and compares them with the then-current scout platoon with six M3 Cavalry Fighting Vehicles.

51 Jack Sands, "The Motorcycle Marines," *Leatherneck*, November 1982, p. 69.

52 "Cycles in Combat," *Marine Corps Gazette*, March 1982; "New Motorcycle Buy Underway," *Marine Corps Gazette*, January 1992.

53 *Marine Corps Gazette*, 1992, p. 6.

54 U.S. Department of the Navy, TTP 3-05.9, *Naval Special Warfare Tactical Ground Mobility,* 2003.

55 Joint Lessons Learned System-SOF (JLLS-SOF), 2013.

as well and have additional benefits. Perhaps the most damning statement comes in a Joint Operational Requirement Document for LTATVs dated 2004:

> Motorcycles being used by SOF have significant operational shortcomings. These shortcomings are the result of the continuous challenges associated with operator motorcycle training, serious injuries that result from training mishaps, and inadequate horsepower to operate over varying types of terrain. The amount of time required to conduct initial operator training and maintain motorcycle proficiency is extensive and detracts from training other core tasks. Additionally, motorcycle operations under [night vision goggles] have resulted in numerous serious injuries to the vehicle operator. Motorcycles also currently lack auxiliary power hookups to allow off-the-vehicle use of communication, medical, or other military equipment. Motorcycles also require the operator to concentrate on the balance of the vehicle to keep it upright; the LTATV would free him of this task and allow him to perform other physical and cognitive functions (i.e., observe, communicate, or shoot) with greater efficiency. In addition, the use of motorcycles severely limits the amount of payload an operator can transport. The LTATV will accommodate larger payloads.

As for the Marines, the Marine Corps Systems Command personnel indicate that the Marines have not used motorcycles in combat in recent years and this year decided to remove them from their inventories.[56] Command personnel indicated that training is an issue, and few have requested having motorcycles. Finally, the diesel motorcycle that the Marines developed has a proprietary engine for which it is difficult to get repair parts. Due to the often ad hoc and informal nature of UTM employment, some unauthorized and otherwise undocumented use of locally purchased nonstandard motorcycles by Marines is possible. However, this research did not identify any accounts or data to indicate such employment.

Recent conventional Army and Marine experience does not mean that motorcycles are without utility, only that the range of missions that they can do that other UTMs cannot or that justify the costs involved in using motorcycles are relatively few. The Finnish Army, for example, has found that in the dense forests in which some of their units operate where ATVs are too wide, only motorcycles offer the mobility and the speed required for courier and reconnaissance work.[57] While recent experience does not indicate that motorcycles are no longer useful, it does suggest that the potential combat activities and environments where a motorcycle is both preferable to other UTM platforms and an acceptable alternative for tactical commanders are narrowly defined.

Analysis

The motorcycle's role as a military UTM option has largely been supplanted by an array of alternatives starting with the Jeep and Kübelwagen and most recently ATVs and LTATVs that can provide most of the same UTM capabilities with less hazard and more versatility. As with the German Wehrmacht, motorcycles are most often used to meet tactical mobility requirements in the complete absence of suitable alternatives. With the ever-increasing civilian technology to improve ATVs and LTATVs, the set of requirements still not met by vehicles other than motorcycles are continuing to steadily decrease. Moreover, motorcycle operations carry a

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[56] Email communication, March 5, 2013.

[57] Viitasaari, 2013.

cost in terms of the relatively higher investment in training required to operate the machines safely compared to dual-track UTM options.

Quadrupeds

One of the surprises of this study has been the persistence of the requirements for using quadrupeds in spite of mechanization and institutional efforts on the part of the U.S. Army and other forces to transition away from them. Within this analysis, quadrupeds refer to the broad class of quadruped mammals that can either be ridden or used to carry or pull loads, primarily horses, mules, and donkeys. But the universe of potential quadruped UTM options can also include llamas, reindeer, elephants, dogs, and others. The focus of this section is on examining precisely how quadrupeds contribute to Army capabilities, in which specific contexts they are valuable, and problems or other issues with quadruped use that should be taken into consideration by Army planners.

Historical Usage: World War II to 2001

That modern soldiers turn to animals to fill a variety of transportation requirements is all the more striking given the enthusiasm for and sometimes clear institutional bias in favor of machines, many of which were specifically introduced with the expectation that they would replace animals. Yet from the Second World War to the present—in certain circumstances—U.S. soldiers and marines and their counterparts in comparable mechanized forces have found it preferable or simply necessary to resort to quadrupeds.

Pack and Riding Animals

What is notable about U.S. Army use of pack and riding animals in the Second World War is that while the Army still maintained quadruped capabilities, it appears to have been intent on moving away from animals apace with mechanization. The Army was not prepared adequately to meet their requirements, so the Army improvised, using locally available animals and equipment and forming provisional quadruped units. The available evidence indicates that U.S. military units would have used animals even more extensively if they had possessed more resources. Clearly, they accomplished missions without the animals, which makes it all the more difficult and important to determine how valuable they really were.

At the outbreak of the war, the U.S. Army and presumably the Marine Corps retained a significant mule capability. The Army maintained a wide range of pack-animal capabilities, including

- the Army Mule Corps based at Ft. Carson, Colorado
- a mule operations school, also at Ft. Carson
- mule-related equipment in unit Tables of Organization and Equipment (TOEs)
- an established infrastructure to purchase American-bred mules and transport them to the point of operational need.

Nonetheless, the Army's requirement for mules during the war was greater than anticipated. For example, the Army made no plans to include mules in the North African theater, although Army units in Tunisia found mules to be essential. Mountainous terrain was one problem. Another was that rains made roads impassable to motor transport. Also, mines sometimes forced troops to bypass roads in favor of narrow trails on which trucks and jeeps could not be used. Because they brought no mule capabilities with them and could not expect any to be sent, commanders in Tunisia patched together their own mule capabilities using locally bought animals and equipment, and they put mules to work carrying supplies and casualties, transporting mortars, and packing disassembled howitzers.

In Sicily and subsequently in Italy, the Army found that the steep and mountainous terrain made mules ever more useful. In Italy in particular, trucks often could not get close to the front, so lengthy mule trains were required to bridge the gap between the trucks and the troops fighting in the mountains. Mules provided critical supplies, evacuated casualties, and brought badly needed heavy weapons systems to mountain positions in the forms of mortars and howitzers.

Besides lacking mules and equipment, the Army in North Africa and Italy was short trained personnel and had to rely on volunteers with personal knowledge of mules, as well as local contractors. The Army also lacked veterinarians. Absent expertise and veterinarians, the Army treated its mules badly, causing a considerable portion of Army mules to be incapable of carrying loads. The Army dealt with this by treating the mules as expendable. It preferred to replace infirm mules with new ones rather than treat them. The Army also found that standard-issue harnesses—when available—did not work on locally purchased mules because of their different shapes and sizes, so they ended up buying harnesses along with the animals from local breeders.

U.S. and British forces also made considerable use of mules in the Pacific, especially in the "China-Burma-India" theater, where the animals enabled them to conduct deep penetrations far beyond their ability to supply fuel for motor vehicles, although they also used mules for more typical roles such as hauling supplies and howitzers. This was also the case elsewhere in the Pacific. At Guadalcanal, for example, a battalion that landed during later stages of the campaign and had to operate relatively far away from supply depots brought 1,000 mules, with many if not all assigned to the role of supplying artillery. A firing battery consisted of 117 mules, which was enough to pack four 75mm howitzers and 200 rounds of ammunition. More mules were needed to move ammunition forward; still more were required to transport forage for the other mules.[58]

In contrast to Europe, U.S. forces in the Pacific found local animals ill-suited to the tasks at hand and relied instead on animals imported from the United States and Australia. One thing they had in common with troops in Europe was the absence of adequate veterinarian services, which was a particular problem in the Pacific because the imported mules were vulnerable to various diseases and other physical ailments associated with the climate and unfamiliar environment.

Interestingly, during the Italian campaign, U.S. Army units had a requirement for horses in a classical cavalry role, owing primarily to terrain but, in some cases, also to the fast pace of the German Army's withdrawal at various points. According to a 1991 study by Lieutenant Colonel Onoszko, the 3rd Infantry Division in Sicily in July 1943 stood up a provisional horse-mounted reconnaissance squadron using captured German horses and equipment. The squadron conducted "reconnaissance to the flanks and to the rear of enemy positions," "recon-

[58] Emmett M. Essin, *Shavetails and Bell Sharps: The History of the U.S. Army Mule,* Lincoln: University of Nebraska Press, 1997.

naissance and counter-reconnaissance screen," and "flank contact with neighboring units in the mountains." The Army disbanded the squadron in December 1943, however, because it lacked the ability to replace either the horses or the necessary equipment.

The Army's decision to disband the cavalry squadron arguably was premature, given what it would encounter in Italy. There, both the mountainous terrain and, in some phases of the campaign, the speed of the German withdrawal combined to create a requirement for horse-mounted cavalry. According to Onoszko, two major generals interviewed at the end of the war said that they thought horse-mounted cavalry would have been more useful than mechanized cavalry in Italy in many respects. "In the ten months campaigning north of Rome," one major general stated, there was never "a time when I would not have welcomed some good horse cavalry" for the purpose of pursuing and cutting off withdrawing German elements.[59] They envisioned using horse cavalry in traditional roles such as reconnaissance, harassment of enemy lines, raids, and covering infantry moving on foot. In Italy's mountains, horses offered a degree of speed and mobility that neither motorized transportation nor foot soldiers offered. The need for speed was felt more strongly when German lines broke, and German forces scrambled back to form new lines.

Perhaps because of further mechanization as well as the introduction of helicopters, the U.S. military made no provision for bringing mules to Korea. Nonetheless, as was the case in Tunisia, U.S. commanders in the field found that the terrain called for mules, and Army and Marine units eagerly snapped up captured North Korean and Chinese mules and Mongolian ponies and put them to use. Four years after the Korean conflict, the U.S. Army disbanded its Mule Corps and appears to have dissolved its pack animal infrastructure and schools, although the Marines may have retained them longer. The Army relegated the use of pack and harness animals largely to Special Forces and irregular warfare, specifically insurgency and counter-insurgency (COIN) operations. Thus, the U.S. military in the late 1950s judged that pack and harness animals would have little place among general purpose forces in a conventional conflict—notwithstanding its experience in the Second World War and Korea.

It should be noted that at about the same time, the French Army made extensive use of mules in Indochina and Algeria, but not in the basic logistical and mountain artillery roles for which the French Army, like the U.S. Army, had used animals in the Second World War and earlier.[60] Instead, France used mules to provision remote outposts and assist with deep penetrations.[61] The French assessed, however, that the end of their colonial wars meant the end of that particular requirement, encouraging them to limit their use of mules to the minimum required to maintain some institutional knowledge. That came to an end in 1975, when France finally got rid of its last mules. [62] Interestingly, the French Army nonetheless continues to think it worthwhile to preserve the institutional knowledge regarding using camels for logistical purposes, and it teaches camel operations at the desert warfare school operated by the French Army in Djibouti (details follow). Many other modern militaries also maintained

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59 Peter W. J. Onoszko, *Horse-Mounted Troops in Low Intensity Conflict: An Argument for the Development of a Horse-Mounted Capability Within the United States Special Operations Forces*, individual study project, Carlisle, Pa.: U.S. Army War College, 1991, p. 11.

60 Claude Milhaud and Jean-Louis Coll, "Utilisation du mulet dans l'armée Française," *Bulletin De La Société Française d'Histoire De La Médecine Et Des Sciences Vétérinaires*, 2004.

61 Milhaud and Coll, 2004.

62 Milhaud and Coll, 2004.

riding and pack animals through the Cold War, mostly because of mountainous conditions. These include the Argentinian, Austrian, German, and Swiss militaries (discussion follows).

Although the U.S. Army largely abandoned pack and harness animal use by conventional forces in conventional conflict, a 1965 Army study of pack animal requirements makes clear that the Army still understood that animals as well as other UTM could play a useful role in irregular warfare, particularly guerrilla war, insurgencies, and counterinsurgencies. Basically, the Army's stance at the time was that commanders could augment their Table of Organization and Equipment (TOE) with UTM, including animals, as needed, depending on local circumstances. Thus, Army Regulation 700-22 indicated that "within the Department of the Army animals will be used when the task cannot be accomplished effectively and economically by other available means."[63] FM 31-22, the then-current COIN manual, argued that whatever could not be carried and is essential must be "transported by other modes of transportation, such as bicycles, indigenous porters, pack animals, and rafts and sampans." The key, the Field Manual continued, was flexibility so that commanders could select the right mode of transportation.[64]

Thus U.S. Army Special Forces in Vietnam at various times used several kinds of quadrupeds as UTM, including local ponies and, most sensationally, elephants: Special Forces operating in a particular area of the Cambodian border in the early 1960s used from four to ten elephants on patrols. These could carry 2,000 pounds of equipment each, and sometimes they placed command centers atop elephants, which offered a high platform for mounting radio aerials.[65]

Dogsleds

A number of militaries used dogsleds in both World Wars in arctic or alpine conditions for packing supplies and evacuating casualties, including France, Germany, and Italy. The U.S. Army operated roughly 50 dogsled teams during World War II, primarily in the Arctic (from Alaska to Greenland) to search for downed aircraft and recover what they could.[66] As for a combat support role, only the U.S. 10th Mountain Division, which was created for the purpose of invading Norway, included a dogsled unit for packing supplies and evacuating casualties. The 10th Mountain was never deployed for that purpose, however.[67] The same source reports that the Army intended to deploy dogsled units to help out in the Battle of the Bulge, but bureaucratic bungling prevented the units from deploying before the snows melted.[68] The plan included airdropping the teams by parachute.[69]

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63 U.S. Army, United States Army Combat Developments Command, *U.S. Army Requirement for Pack Animals*, 1965. Special Warfare Agency, June 1965.

64 U.S. Army, 1965.

65 U.S. Army, 1965.

66 Robert A. Kollar, "Review of Dean, Charles L., Soldiers and Sled Dogs: A History of Military Dog Mushing," H-War, H-Review, August 2005.

67 Kollar, 2005.

68 "It's Raining Cats and Sled Dogs!" *Great Northern Adventure Blog*, undated.

69 "It's Raining Cats and Sled Dogs!" undated.

Today it appears that only Denmark maintains dogsled capabilities. The Danish Army uses the sleds for long-range patrols in Greenland.[70] Theirs is a noncombat mission. Indeed, according to the Finnish defense attaché, dogsleds are unsuitable for combat operations because of the noise, which travels far in cold temperatures.[71]

Contemporary Usage

The first contemporary use of quadrupeds by modern mechanized armies in recent years was probably the famous use of horses by CIA paramilitaries in the early stages of the Afghanistan war. The incident does not appear to have been repeated, however. In contrast, U.S. and other militaries' interest in pack animal capabilities has grown considerably along with the realization that they remain valuable so long as armies continue to operate in mountainous, austere environments. Conventional Army forces in Afghanistan have reported both procurement of local donkeys and, more commonly, payment of services from local donkey handlers. Interviewees indicated that lack of experience and appropriate support facilities were key challenges for maintaining pack animals.[72] Interviewees indicated temporary contract of local pack animals with handlers for the duration of specific missions was much more common and was much simpler to support.[73]

Foreign Militaries

The most extensive user of mules and horses for mountain operations today is probably Argentina, which has several mountain brigades designed to operate in the Andes, each equipped with riding and pack animals. The Argentinians still operate OTO Melara Mod-56 105-mm mountain howitzers, which can be pulled or packed (disassembled) by mules as pictured in Figure A.13.

The Austrian Army similarly maintains horses and donkeys for its alpine troops and operates a pack animal school. Austrian doctrine calls for using animals for local patrolling and crowd control as well as Troop Mobility, Traveling Support, and Internal Ferry/Support Tactical Activities.[74] According to a 2005 article on the Austrian Army website, pack animals are essential for mountain operations, at least in winter, particularly for patrolling and for maintaining remote posts wherever helicopter access is inconsistent or impossible.[75]

Brazil roughly a decade ago began replacing its horses and mules with African water buffalo for operations in the Amazon, where the buffalo apparently are more resistant to jungle diseases. According to a Brazilian officer quoted in a news article, the buffalo can carry their weight in cargo (1,100 lbs) and can forage for food, whereas mules had to have food provided for them. The officer said that the animals help them cover larger distances in their patrols.[76]

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70 Michael Finkel, "The Cold Patrol: Two Young Danes Find Out If They're Tough Enough for the World's Only Military Dogsled Team," *National Geographic*, 2012.

71 Viitasaari, 2013.

72 86th Infantry Brigade Combat Team (Mountain), 2012.

73 Roberts, 2012. For example, Army units have temporarily or permanently procured pack animals to enable resupply of remote outposts in Afghanistan.

74 Volmar Ertl, "Tragtiere Im Einsatz," *Österreichs Bundesheer*, May 2005.

75 Ertl, 2005.

76 Terry Wade, "Brazil's Army Drafts Water Buffalo for Amazon Role," Red Orbit, April 29, 2006.

Figure A.13
Argentinian Army Mule Packing a Howitzer Barrel (left) for the OTO Melara Mod-56 105-mm Mountain Howitzer (right)

SOURCE: Ejército Argentine, 2009.
RAND *RR718-A.13*

The British Army has apparently used mules here and there, including in Kosovo in the 1990s, until finally disbanding its last mule-equipped unit in the mid-1990s.[77] That unit served in Hong Kong and used mules to supply hard-to-reach posts along the Chinese border.[78] British units do, however, currently rotate through the USMC mule packing school in California.

France no longer uses quadrupeds; however, the French military teaches camel operations at France's desert warfare school in Djibouti. According to the current battalion chief in charge of the school, the French military—which maintained camel-mounted cavalry for colonial operations up until the end of the Algerian war—considers it worthwhile to retain the institutional knowledge for using camels as pack animals. The French consider their camel course a valuable venue for familiarizing troops with desert operations as well as a vitally important aspect of life for desert populations in Djibouti and elsewhere. Assessments provided by French training staff suggest that the French consider expertise in camel operations to be useful for security assistance programs. The desert school's French faculty manages the camel course, but the school hires local camel tenders and rents the animals locally to avoid the significantly greater costs associated with owning them. The course familiarizes soldiers with camels and teaches them how to pack loads and how to organize and run a caravan. The course incudes a training exercise in which the students use camels to bring supplies to a remote position and provide Traveling Support for a patrol. As illustrated in Figure A.14. the French Army has provided opportunities for participation in camel training by U.S. military personnel.

In addition to the French, other countries still maintain some camel capabilities to perform Tactical Activities. As depicted in Figure A.14, United Nations soldiers, United Nations Mission in Ethiopia and Eritrea (UNMEE), rode camels to monitor the Eritrea-Ethiopia boundary.[79] Moreover, Chad, Niger, India, Morocco, and Jordan all retain camel-mounted

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77 Army Rumour Service (ARRSE), "Do the British Army Still Use Mules as Transport?" online discussion, started February 16, 2009.

78 "British Army Replaces Mules with Helicopters," *Anchorage Daily News,* January 6, 1976.

79 Mike Markowitz, "Camels at War," Defense Media Network, March 1, 2013.

forces for tactical functions, while a number of other countries maintain camels for ceremonial purposes based on historical lineage.[80]

The German Army retains a mountain unit that operates and teaches the use of mules and Haflingers—a breed of mountain horse that can be ridden and used as pack animals (see Figure A.15). During the Cold War, the mountain troops used the mules and Haflingers for a variety of duties, including packing mountain howitzers. Currently, the focus is on Traveling Support (including CASEVAC), Troop Mobility, and Internal Ferry/Support. The Bundeswehr began using mules in Kosovo in 2002 for the purpose of patrolling and supplying observation posts during the winter months, when helicopter access is often limited. The Germans reportedly found that without the mules they would not have been able to operate many of the posts. They found that the animals could handle snow up to a meter in depth, and also that buying animals locally was preferable to bringing them in from elsewhere because of the local animals' natural acclimation to the environment.[81]

Another modern army that has used pack animals recently is the Israel Defense Forces (IDF), which in about 2004 reportedly acquired llamas for Special Forces to execute Traveling Support activities for dismounted patrols. The available reporting indicates that the Israelis value the animals for, among other things, their silence. It is not clear if the Israelis still use the animals: One report says that the animals performed poorly in the 2006 Lebanon war, and a 2011 newspaper report suggested that the IDF was thinking about ending its experiment with the llamas and other animals (it was using antelope, among other things, to clear grass along fencing on the highly monitored border with Lebanon) to save on veterinary costs.[82]

Figure A.14
U.S. Soldier Participating in French Desert Training with Camels (left) and United Nations Soldiers on Camelback Monitoring the Eritrea-Ethiopia Border (Right)

SOURCES: DoD Public Affairs, 2012, and United Nations, 2013.
RAND *RR718-A.14*

[80] Markowitz, 2013.

[81] Marcel Muth, "Zusammen Schaffen Wir Das," *Y: Das Magazin Der Bundeswehr*, February 2011; "Tradition Und Monderne," *Heer*, March 13, 2007; "Gebirgstragtiere," Panzerbaer, website, undated; Andreas Groth, "Tiere bei der Bundeswehr Das Muli ist der beste Kamerad," *Frankfurter Allgemeine Zeitung*, October 9, 2012.

[82] Amir Rapaport, "The Logistic Failures Will Not Be Repeated," *IsraelDefense*, May 10, 2012; Gil Ronen, "IDF Mulls Releasing Oryxes, Llamas and Barbary Sheep," *Israel National News*, June 23, 2011.

Figure A.15
Bundeswehr Haflingers

SOURCE: Germany Bundeswehr, 2011.
RAND *RR718-A.15*

Quadrupeds in Operation Enduring Freedom

Returning to the United States military, Operation Enduring Freedom revived U.S. interest in pack animals, leading to the publication in 2004 of a new Field Manual on pack animal use (FM 3-05.213), the revival of the pack animal course at the John F. Kennedy Special Warfare School, and the establishment in 2008 of a mule packing course at the Marine Corps Mountain Warfare Training Center (MWTC). Although data regarding pack animal use in Afghanistan are incomplete due to the almost total absence of official reporting of pack animal use, it appears that animals have been and are being used in ways comparable to French usage in Indochina and Algeria, i.e., facilitating patrols in remote areas and provisioning remote outposts in difficult terrain.

U.S. soldiers and Marines have been using donkeys in Afghanistan after finding that mules are culturally unacceptable there because of taboos regarding breeding different species together. Using skills and knowledge acquired at the MWTC as well as training programs conducted by Special Forces in Colorado and Montana, and relying on local donkey handlers, U.S. forces have been able to acquire animals, load them with supplies including water, machine guns, Mk-19s, and machine gun and Mk-19 tripods, and use them on patrols in areas in which there are no roads beyond goat trails, according to a Marine captain who participated in these patrols. He observed that using donkeys to carry gear "was the most efficient way to cover the distances required to complete the mission timelines." Another Marine report indicated that at altitudes of 8,000 feet and above in Afghanistan, the only way to get supplies from "the valley floor" to the mountain tops other than airdrops was to rent Toyota Hilux pickup trucks to carry supplies to a certain point and then switch over to animals for the rest of the journey.[83]

The captain pointed to a number of limitations that needed to be factored into pack animal operations. First, the animals required protection—the longer the train, the more protection was required. This meant that soldiers and marines had to be assigned to protect the animals rather than perform other duties. Moreover, although forage was easy to find on loca-

[83] Marine Mountain Warfare Training Center staff, 2013.

tion, water was an issue. The animals had to pack enough water for their use and stop for regular water breaks. The water limited the amount of other items the donkeys could carry. Finally, carrying heavy items required careful loading and careful use of the animals. According to the captain, on one patrol the donkey carrying an Mk-19 died of exhaustion. This forced the patrol to redistribute items and obliged individual Marines to carry greater weights. One thing that helped them, according to the captain, was that the local Provincial Reconstruction Team kept careful track of livestock prices and therefore could inform officers tasked with buying animals regarding what constituted a good price.

Analysis

The preceding examples demonstrate the use of quadrupeds in a variety of UTM applications. It seems that modern armies almost certainly will find it necessary or simply desirable to fall back on animals. If we refer back to our concepts, we find that animals' primary role has been Traveling Support. Primarily horse-mounted Coordinated Maneuver, Maneuver Force Security/Recon, and Immediate Pursuit also are possibilities, although modern examples are rare, at least if we limit our regard to mechanized forces that possess motorized alternatives. The use of quadrupeds for Local Patrolling/Engagement also takes place, although it appears to be more relevant for civilian policing or the unusual requirements of the "Sovereignty Patrols" conducted in the Arctic by the Canadian and Danish militaries. Even in the Canadian case, dog use appears to be rare, as for most purposes Canada's Arctic forces rely on ATVs and snowmobiles.[84]

Using animals primarily in a Traveling Support role enables foot soldiers to carry more equipment and supplies, operate in areas far from conventional resupply, and, in effect, go farther faster. The animals' ability to convey heavier weapons and their ammunition—from machine guns, MK-19s, and mortars to howitzers—also enables infantry to wield greater firepower than would otherwise be possible.

The obvious question to ask, though, is why would a modern Army unit avail itself of animals in a UTM function as opposed to obvious conventional, mechanized alternatives? In the case of quadrupeds, the primary operational constraint that dictates their selection is terrain. Specifically, quadrupeds still maintain one key advantage over currently available mechanized UTM options—they can navigate almost any terrain humans can traverse on foot. However, prototype systems like DARPA's Legged Squad Support System (LS3) are developing technology enabling four-legged robots to move and navigate terrain like quadrupeds.[85] Logistical considerations, particularly the ability of animals to forage, and signature may also be factors. The biggest constraint on animal use is not the availability of animals—which should be acquired locally in any case, obviating the need to maintain large numbers at home—but in the knowledge required to use them, which in the case of the U.S. and foreign Western militaries is maintained through specialized schools and training courses. Extensive training is not necessary, but it is no longer the case—as it was back in the 1940s—that soldiers bring with them from their private lives familiarity with harness, pack, or riding animals.

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84 Canadian Forces, 2010, p. 5.

85 Alex Knapp, "DARPA Robot Trudges over the Tough Terrain Where Soldiers Tread," *Forbes Magazine,* December 12, 2012.

Key Observations from Analysis of UTM Employment

As the examples presented in this appendix illustrate, the fundamental justification for ATVs and LTATVs is that forces, especially infantry and SOF, sometimes operate in places where they cannot take HMMWVs and MRAPs because they are precluded by terrain, austerity, or portability, and when troops need to go faster and/or carry greater loads than they could on foot. Indeed, according to XVIII Airborne Corps Long-Range Surveillance Company (LRSC) leaders interviewed during this study, ATVs and LTATVs are "mission critical" because the next best option is "Joe-power," or the use of individual soldiers (referred to commonly as "Joes"), to carry loads including supplies, weapons systems, and the soldiers themselves. A CJSOTF-A memo describing the need for UTMs captures the consistent theme, stating "there is no alternative other than dismounted operations, when operating on narrow trails or steep terrain, and when the total weight of equipment exceeds 100 pounds per man." The memo adds that

- UTMs alone are internally transportable by helicopters
- UTM allows fully equipped combat soldiers to move rapidly around the battlefield on terrain unsuitable for conventional vehicles
- UTM use will only grow as MRAPs and other armored vehicles get bigger.

The cases discussed in this appendix suggest a number of trends that have influenced and will likely continue to influence development and employment of UTM capabilities.

- Militaries have consistently encountered operations or aspects of operations where their SSVs were unavailable or inappropriate due to limited transport capacity, constrained operating space, lack of sustainment, or other factors.
- Dismounted forces facing these factors have selected UTM platforms not necessarily because they are the *best* mobility alternative, but because they are the *best available* alternative to dismounted soldier movement and load carriage.
- UTM platforms have consistently been used to execute a broader range of Tactical Activities than originally intended because of their flexibility and ease of use.
- Even in the era of IED prominence, other services and foreign militaries have continued to find situations where UTM employment was required or preferable to SSV employment.
- While Tactical Activities involving close combat have been repeatedly developed and demonstrated through experiments and evaluations, the reality of combat operations has often dissuaded significant consideration of UTM use for these activities by operational commanders.
- Support-related Tactical Activities exist for a wide range of unit types and are not as exposed to IEDs and other threats as the close combat–related Tactical Activities, such as Maneuver Force Security/Recon, Coordinated Maneuver, and Immediate Pursuit.

While UTM-related technologies, such as autonomous robotic control, are promising to drastically improve the potential of mechanized UTMs, the limited but persistent need for quadrupeds has continued because of their ability to go almost everywhere dismounted soldiers go.

APPENDIX B

Detailed Platform Transportability Analysis

Table B.1 assesses the ability of common delivery methods for Army forces to carry a range of current Army ground vehicles and representative UTM vehicles. As the table indicates, many up-armored Army platforms that are currently used for mobility and maneuver cannot be delivered with common methods and procedures (red cells) or require significant alteration (yellow cells). The table also identifies how many of each ground vehicle each delivery method can carry. These assessments are based on analysis of delivery method capacity and the key characteristics of each ground vehicle, to include dimensions and weight.

Table B.1
Detailed Platform Transportability Analysis

Delivery Platform/Method	Carrying Limitations: Weight (lbs)	Area (sq. ft.)	Height (in)	Width (in)	Length (in)	Transportability at Combat Weight (with estimated number of vehicles): Maxx Pro Dash	M-ATV	JLTV-A	M1151 UAH	M998 HMMWV	Toyota Hilux 4 x 4	LTATV	M-Gator A1	Polaris ATV	Christini Motor-cycle	Pack Animal (mule)
C-130J	42,000	312	102	96	468		1[a]	2	2	2	2	4	4	10	20	h
Advanced Low Velocity Airdrop System (ALVADS)	42,000	320	118	120	384		1[d]	1[d]	1[d]	1[d]	1[d]	1[d]	1[d]	n/a	n/a	h
PLS Pallet	33,000	160	n/a	96	240			1	1	1	1	4	2	4	12	h
CH-47 Sling load	26,000	n/a	n/a	n/a	n/a			1[b]	2	2	1[e]	2[f]	2[f]	4[g]	12[g]	n/a
CH-47 Internal	16,000	225	78	90	360				1[c]	1[c]	1	3	3	4	12	h
Dual-Row Airdrop System (DRAS)	14,500	132	118	88	216				1	1	1	1	2	4	8	n/a
UH-60 Sling load	9,000	n/a	n/a	n/a	n/a					1	1[e]	2[f]	2[f]	4[g]	12[g]	n/a
20 ft Shipping Container	8,000	160	102	96	240					1	1	2	2	4	12	h
463L Pallet	7,500	66	96	108	88								1	2	4	n/a
UH-60 Internal	2,640	20	68	54	90									1	2	n/a
Container Delivery System (CDS) A-22 Container	2,200	32	83	48	96									1	2	n/a

Vehicle Characteristics		Maxx Pro Dash	M-ATV	JLTV-A	M1151 UAH	M998 HMMWV	Toyota Hilux 4 x 4	LTATV	M-Gator A1	Polaris ATV	Christini Motor-cycle	Pack Animal (mule)
	Height (transport) (in)	109	105	93	76	60	73	76	49	48	44	96
	Width (in)	102	98	96	87	86	69	59	60	48	32	42
	Length (in)	246	247	219	194	180	202	117	108	83	73	108
	Transport Weight (lbs)	47,750	31,000	18,000	12,000	6,400	5,130	1,900	3,000	1,050	325	850

[a] Only with waiver.
[b] This is the objective criterion for current prototypes, indicating transport is possible only without supplemental armor and combat load, with a significant assessed risk that the final model will not make this threshold (Government Accounting Office, 2012).
[c] Cannot be carried in combat configuration.
[d] Vehicles dropped individually.
[e] Standard Toyota Hilux does not have sufficient hardware for standard rigging and would require nonstandard rigging techniques.
[f] Based on standard sling load procedures (Army Field Manual 4-20.199, *Multi-Service Sling Load Procedures*).
[g] Transported in a 20-foot shipping container.
[h] Not authorized, but possible through nonstandard loading methods and adaptation of the transport platform.

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APPENDIX C

Detailed Summary of Army Doctrinal Discussion of UTM Capabilities

Table C.1 provides a detailed description of the identified excerpts from current Army doctrine that specifically discuss or allude to employment or support of UTM platforms such as ATVs and M-Gators as part of conventional Army operations.[1]

[1] Army Special Forces has doctrinal publications specifically dedicated to the use of mechanized UTMs and quadrupeds, respectively. However, these references are not included here, since they do not pertain to conventional Army forces.

Table C.1
Summary of Army Doctrinal Discussion of UTM Capabilities

Army Doctrinal Publication		General Identification of UTM as a Platform Option	Identification of UTM Platform(s) as an Existing Unit Capability	Description of Specific UTM Capability	Specific Considerations for Tactical Employment	UTM-Related Excerpts
ATTP 3-21.50	*Infantry Small-Unit Mountain Operations*	×		×	×	6-106: Use of motorcycles, ATVs, NSTVs, and other motorized means for ground transportation in mountains 6-115/-116: Description of pack animal capability 6-117/-118: Planning considerations for pack animals 6-119: Use of ATVs/Gators for sustainment
ATTP 3-20.97	*Dismounted Reconnaissance Troop*	×		×		5-92: Discussion of benefits of using ATVs, variations of the HMMWV, and NSTVs to rapidly employ teams and reduce sustainment requirements 5-93: General duration and range of ATV-based LRS missions 5-95: Benefits of the NSTV in areas that limit use of standard military vehicles 5-149: Use of ATV team in lieu of dismount team to recon larger sites 7-36: Use of NSTV for concealment in urban environment to help LRS team to blend in
ATTP 3-12.90	*Tactical Employment of Mortars*	×				6-104: Discusses potential use of mounted off-road movement, but does not mention UTM as a primary capability for this movement
FM 3-55.93	*Long-Range Surveillance Unit Operations*	×				5-92. LRSUs use a variety of vehicles to support themselves when conducting operations. The use of all-terrain vehicles (ATV), variations of the HMMWV, and nonstandard tactical vehicles (NSTVs) allows the commander to rapidly employ teams with reduced resupply requirements while conducting operations. 5-93: The ATV's primary mission is short-range mounted reconnaissance. The ATV provides the capability to conduct surveillance and reconnaissance missions over a 48-hour or 250-mile range (carrying extra fuel) without resupply in austere environments over difficult terrain.
FM 4-20.108	*Airdrop of Supplies and Equipment: Rigging Military Utility Vehicles*	×			×	This manual shows and tells how to prepare and rig the following configurations of the Military Utility Vehicles (M-Gator), one 80-cubic-centimeter minibike, one or two 250- to 300-cubic-centimeter motorcycles, one 350-cubic-centimeter Yamaha four-wheeled quad-runner on a combat expendable platform, and one 500-cubic-centimeter Polaris four-wheeled quad-runner on a combat expendable platform.
FM 4-20.108	*Multiservice Helicopter Sling Load: Single-Point Sling Load Procedures*				×	2-42. Procedures for rigging *one* John Deere M-Gator, Model #VGM6X01001, side by side (shotgun method) for single-point sling load 2-43. Procedures for rigging *two* John Deere M-Gators, Model #VGM6X01001, side by side (shotgun method) for single-point sling load
ATP 4-25.13	*Casualty Evacuation*	×				**All-Terrain Utility Vehicles** 3-10. The family of small all-terrain vehicles such as the John Deere M-Gator may fill the gap created with the phasing out of the 1/4-ton truck M-151 (Jeep) and M-274 mechanical mule that the HMMWV is too large to fill. These vehicles provide a wide range of functionality and are used for a variety of utility work and the transportation of supplies and equipment. With minimal modification they can easily carry casualties and litters.
DoD Instruction 6055.04	"DoD Traffic Safety Program"	×			×	4.f.(2). Tactical Motorcycle and ATV Training. Provide operators of Government-owned tactical motorcycles with initial training for motorcycles as required in paragraph 4.f.(2) of this enclosure and with training tailored to satisfy specific mission objectives. Government-owned ATV operators shall complete the Specialty Vehicle Institute of America-based course and training tailored to satisfy specific mission objectives. 6.(e). Motorcycle and ATV Operations. Tactical Motorcycle and ATV Operations. Develop and approve safety requirements for tactical motorcycles and ATVs integrating operational risk management into tactics, techniques, and procedures training.

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APPENDIX D

Supporting Information for Execution of the UTM Selection Process (UDAP)

UDAP as General Guide for UTM Consideration

Although the mission considerations (Figure 4.4 in Chapter Four) and platform characteristics (Figure 4.5 in Chapter Four) were developed based on review of doctrine, historical UTM use, and interviews with current UTM users, these do not represent exhaustive lists. The considerations and characteristics that drive UTM selection are mission specific and environment specific, requiring the practitioner applying the UDAP to complete these steps based on the expected mission(s) and conditions. This appendix provides additional information for application of the UDAP to unit-specific needs.

Notes for Step One: Determine Which Tactical Activities Apply

For this step the UDAP user must identify which Tactical Activities (from Figure 4.3 in Chapter Four) he or she will need to execute as a part of considered operations. To do this, the UDAP user should identify the Army Unified Tasks to be executed. This information will often come from explicit tasks identified in the unit or higher command orders. The UDAP user must identify which Tactical Activities are required to execute the assigned tasks. A brief example of this "crosswalk" between explicit Army Unified Tasks and the Tactical Activities is illustrated in Figure 2.1 in Chapter Two. While the eight Tactical Activities identified describe all historical and current UTM applications, it is possible that the user could identify additional unique Tactical Activities in this step. With the primary Tactical Activities identified, the user can then proceed to UDAP Step Two.

Notes for UDAP Step Two: Determine Mission Considerations Essential to Tactical Activity Execution

When executing UDAP Step Two the user should go through the planned operation systematically to identify every point where execution of the operation will require specific mobility platform considerations. As the UDAP user goes through the conceived operation and identifies key UTM considerations, the user should add the consideration to the most appropriate of the five aspects of employment identified in Figure 4.4 in Chapter Four. If conducting UTM selection in concurrence with the Military Decision Making Process, the user can identify UTM operations as a specific category and the detailed employment considerations in the synch matrix see Figure D.1).

Notes for UDAP Step Three: Translate UTM Employment Considerations into UTM Vehicle (or Other Mobility Platform) Characteristics

For this UDAP step, the user should identify measurable characteristics that enable evaluation of UTM and other mobility options to determine how well they meet the considerations identified in UDAP Step Two. Specifically, the user should be able to evaluate each of the characteristics with the information that is available or can be readily compiled. While the user could have the time and resources to do testing and evaluation in some instances, some time- and resource-constrained decisions could require using proxy values or readily available information, such as manufacturer data. Below are some examples of potential characteristics and evaluation metrics to evaluate ability of UTM options to address operational considerations.

Capacity Characteristics

- **Cargo Volume (ft^3):** Maximum cargo volume of the platform in normal operation, measured in cubic feet. This measure may include cargo stored in stowage spaces, externally strapped, etc.
- **Cargo Weight (lbs):** Cargo-carrying weight limit for the platform, measured in pounds. This measure may include cargo stored in stowage spaces, externally strapped, etc.
- **Load Divisibility (rating 1–10):** Subjective rating of how the cargo volume and weight of a platform is divided out among the different stowage spaces, racks, and mounting points (if applicable). A rating of 1 indicates the most consolidated divisibility; 10 indicates the least consolidated. Load divisibility rated by the UDAP manager.

Functionality Characteristics

- **Audible Operational Signature (db):** Measurement of noise generated by the platform during normal operation, measured in decibels.
- **Autonomous Operation (yes=1, no=0):** Is the platform capable of any level of autonomous operation?
- **CASEVAC (number of litters):** How many litters is the platform capable of stably transporting?
- **Crew Sustainment (1–10):** Subjective rating of how capable the platform is at providing life support functions for the occupants, such as air conditioning, heating, and CBRN protection. A rating of 1 indicates no crew sustainment capabilities (e.g., a motorcycle); 10 indicates the most sustainment capabilities (e.g., a full-duty pickup truck with heating, air conditioning, and CBRN protection). Crew sustainment is rated by the UDAP manager.
- **Delivery (number of options):** The number of options available to deliver the platform directly into a tactical environment (roll-on/roll-off, sling-loaded, trailer, etc.).
- **Fuel Commonality (1–10):** Subjective rating of ease of acquiring fuel. The rating captures availability of fuel type (e.g., motor gasoline, DF-1, DF-M, DF-2) as well as any ability for the platform to accept multiple fuels. A rating of 1 indicates little commonality (e.g., a platform that uses a single niche fuel); a rating of 10 indicates the highest level of commonality (e.g. a platform that uses diesel as a primary fuel but has multi-fuel capability). Fuel commonality is rated by the UDAP manager.

Figure D.1
Example of UTM Employment Planning Synchronization Matrix Used in the MDMP Process

Time/Event		H – 24 hours	H-hour	H + 24
Enemy or adversary actions		Monitors movements	Defends from security zone	Commits reserve
Population		Orderly evacuation from area continues		
Decision points		Conduct aviation attack of OBJ Irene		
Control measures				
Movement and maneuver	1st BCT	Move on Route Irish	Cross LD	Seize on OBJ Irene
	2nd BCT	Move on Route Longstreet	Cross LD	Seize on OBJ Rose
	3rd BCT			FPOL with 1st BCT
	Avn Bde	Attack enemy reserve on OBJ Irene		
	R&S			
Reserve				
Intelligence				
Fires		Prep fires initiated at H-5		
Protection	Engineer			
	PMO			
	AMD			
	CBRN			
Sustainment				
Mission command			Main CP with 1st BCT	
Close air support				
UTM Employment		**Rotary-wing insertion**		**Airdrop resupply**
Nonlethal		Surrender broadcasts and leaflets		
Host nation				
Interagency				
NGOs			Begins refugee relief	

AMD	Air and missile defense
Avn Bde	Aviation brigade
BCT	Brigade combat team
CBRN	Chemical, biological, radiological, and nuclear
CP	Command post
FPOL	Forward passage of lines
LD	Line of departure
NGO	Nongovernmental organization
OBJ	Objective
PMO	Provost marshal office
R&S	Reconnaissance and surveillance

SOURCE: U.S. Army 5-0, 2012.
NOTE: The first column is representative only and can be modified to fit formation needs.
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- **Individual Protection (1–10):** Subjective rating of the safety features of the platform (e.g., seat restraints, roll bars). A rating of 1 indicates no protection organic to the platform (e.g., a motorcycle); 10 indicates the most protection (e.g., a full-duty pickup truck with roll cage, crumple zones, and airbags). Individual protection is rated by the UDAP manager.
- **Partner Capabilities (1–10):** Subjective rating of the compatibility of a platform with a partner security force (e.g., ease of use, equipment mounting, electrical output). A rating of 1 indicates limited partner capability (e.g., a specialized quad that is best suited for use with NATO countries only); 10 indicates the most partner capability (e.g., a mule or light pickup truck).
- **Situational Awareness (1–10):** Subjective rating of the ability for the platform's crew to navigate, use C4ISR gear, and the platform's ability to amplify transmissions or otherwise interact with C4ISR gear. A rating of 1 indicates minimal situational awareness (e.g., a motorcycle with a single rider who cannot use navigation tools or C4ISR gear while riding without endangering himself); a rating of 10 indicates the greatest situational awareness capability (e.g., a full-duty pickup truck with power-amplified radios and Blue Force Tracking). Situational awareness is rated by the UDAP manager.
- **Self-Recovery (yes = 1, no = 0):** Ability of the platform to be recovered by another like platform (e.g., an ATV pulling another ATV out of a ditch).
- **Traverse Diverse Terrain (Go = 2, Slow-Go = 1, No-Go = 0):** Ability of the platform to traverse terrain types. Although detailed terrain analysis can be conducted (such as the TTPs in FM 5-33 Terrain Analysis), the multiple measures that formal terrain analysis results in may not be appropriate for the level of detail required for the UDAP. Therefore, the more general designations of go, slow-go, and no-go are used. Go indicates that the platform can traverse the widest range of terrain. Slow-go indicates that the platform has some capability to traverse uneven terrain. No-go indicates that the platform cannot be used off unimproved roads.
- **Threat Force Protection (0–5):** Ability of the platform to protect occupants from enemy direct and indirect fire (to include IEDs) from all aspects during normal operation. Levels are derived from NATO STANAG 4569 Protection Levels for Occupants of Logistic and Light Armored Vehicles, where 1 indicates protection from rifle fire, and 5 indicates protection from automatic cannons. For platforms that have no protection, 0 is added.
- **Visual Operational Signature (ft2):** Measured by one long-axis and one short-axis profile, in square feet.
- **Weapons Employment (None = 0, Unsupported = 1, Mounted = 2):** The ability of the occupants of the vehicle to employ weapons while the vehicle is in operation, ranging from none (e.g., a motorcycle rider who must stop and stabilize himself before employing a rifle), to unsupported (e.g., the passenger of a compact ATV employing a rifle from his seat), to mounted (e.g., a pintle mount for crew-served weapons in the bed of a full-duty pickup truck).

Infrastructure Characteristics

- **Ease of Procurement (days):** Estimate of the time from decision to delivery of the first platform.

- **Ease of Repair (1–10):** Subjective rating of how difficult it is to repair a vehicle, incorporating characteristics such as how easily parts are obtained, any need for specialized tools, ability to conduct maintenance in the field, and ease of access to components. Greatest difficulty of repair is indicated by 1; 10 indicates the easiest to repair. Ease of repair is rated by the UDAP manager.
- **Individual Maintenance Training (hours):** Hours of instruction required for initial training that enables a maintainer to conduct an intermediate level of maintenance on the platform.
- **Individual Operator Training (hours):** Hours of instruction required for initial training that allows an operator to achieve proficiency in operating the vehicle under normal (relative to the platform) operating conditions.
- **Sustainment Operator Training (days):** A measure of the perishability of the initial operator training, measured from the time the operator last used the platform to the time by which he will need to receive formal sustainment training.
- **Sustainment Maintenance Training (days):** A measure of the perishability of the initial maintenance training, measured from the time the operator last maintained the platform to the time by which he will need to receive formal sustainment training.

Performance Characteristics

- **Acceleration (0–60 mph):** Time it takes the platform to reach 60 mph from a standing start on an improved road surface.
- **Cruising Speed (mph):** Maximum safe speed that the platform can achieve for six hours of operation on normal (relative to the vehicle) terrain.
- **Range (km):** Distance that a platform can travel on a single tank of fuel, not including any fuel carried as cargo.
- **Fuel Consumption (mpg):** Fuel efficiency of the platform, measured in miles per gallon of fuel.

Trafficability Characteristics (from Standard AMSAA Definitions)

- Roads:
  - *Primary Roads:* Two or more lanes, all-weather, maintained, hard surface roads with good driving visibility used for heavy and high-density traffic. These roads have lanes with a minimum width of 2.7 m (9 ft.) and the legal maximum GVW/gross combined weight for the country or state is assured for all bridges. Surface roughness values range from 0.1 inch Root Mean Square (RMS) to 0.3 inch RMS.
  - *Secondary Roads:* Two lane, all-weather, occasionally maintained, hard or loose surface (paved, crushed rock, gravel) roads intended for medium-weight, low-density traffic. These roads have lanes with a minimum width of 2.4 m (8 ft.) and no guarantee that the legal maximum GVW/gross combined weight for the country or state is assured for all bridges. Surface roughness values range from 0.1 inch RMS to 0.6 inch RMS.
  - *Trails:* One-lane, dry-weather, unimproved loose-surface roads intended for low-density traffic. Trails have a minimum lane width of 2.4 m (8 ft.), no large obstacles

(boulders, stumps, logs . . .) and no bridging. Surface roughness values range from 0.1 inch RMS to 2.8 inch RMS.
– *Cross-Country:* Virgin terrain which has no previous traffic (off-road), and combat and pioneer trails.

- **Average Speed, V-(XX):** Represents the average speed over the (XX) percent most navigable or vehicle-friendly terrain in a given region. (Example: V-80 is the average speed of the vehicle over 80 percent of the most navigable terrain being considered.) The percentage of navigable terrain may be considerably less for cross-country conditions; thus, the percentage shown for those terrains is commonly less than those for on-road conditions (i.e., reported V-50 cross-country speed versus V-100 on-road speed).
- **Trafficability:** The percentage of terrain (typically cross-country) that can be traversed by a platform is expressed as %Go. (Similarly, that which cannot be traversed by a platform is expressed as %NoGo.) NoGo is defined as the percentage of the terrain where the vehicle is immobilized due to various factors (e.g., soil resistance exceeds vehicle power, insufficient traction, vegetation, obstacles, steep slope).
- **Soft Soil Mobility:** The minimum soil strength required in order for the platform to make a single pass in fine-grained soils (not sand) without becoming immobilized. This soil strength is known as the single-pass vehicle cone index (VCI-1). The lower the VCI-1, the softer the soil can be and still be traversed by the vehicle.

Soil Moisture Seasonal Conditions:
– **Dry:** The dry condition describes the lowest soil moisture and associated soil strength found during the driest consecutive 30-day period of an average rainfall year.
– **Wet:** The wet condition describes soil moisture and associated soil strength found during the wettest consecutive 30-day period for an average rainfall year.
– **Snow:** The snow condition assumes that the cross-country terrain and trails are frozen and uniformly covered by 10 in. of dry snow.
– **Sand:** Predictions are made for a condition in which the actual terrain is converted to an all-sand terrain to represent sand dunes. This is accomplished by converting all actual soils to dry desert sand with appropriately reduced strengths and doubling all slopes to maximum of 60 percent. Although predictions for this seasonal terrain condition are synthetic, the changes are considered reasonable for an exploration of vehicle performance in general.

Notes for UDAP Step Four: Determine Class of UTM Vehicle (or Other Mobility Platform) That Best Meets Characteristics

Rather than trying to evaluate every potential UTM option, the UDAP user will often need to conduct an initial sorting of options based on a few salient characteristics. As illustrated in Table 4.4 in Chapter Four, the UDAP user can sort the potential alternative by selecting the class of UTM platforms that meet operational needs. These classes should be based on the most salient performance aspects. Based on analysis of current and historical UTM employment, this study identified the three platform characteristics that most clearly differentiate appropriate alternatives: track width, platform carry capacity, and physiological stress imposed by UTM operation. Generally, the user will select the largest suitable class of UTM platforms because it will provide the largest potential for inclusion of mission-specific equipment, additional hardware, or additional riders. If operational needs warrant, the UDAP user can identify sorting classes based on more salient performance characteristics.

Notes for UDAP Step Five: Select Appropriate Mobility Platform

In this UDAP step, the user will compile and synthesize information collected during the previous UDAP steps to identify the most suitable or desirable mobility alternative, which may not necessarily be a UTM vehicle. A few example methods for compiling and comparing vehicle information are provided below. As with the other UDAP steps, the user can refine these methods or develop alternate methods if they are more appropriate to the operational needs.

There are several ways to determine platform class based on the platform characteristics identified in Step Three. Here are some examples:

1. A *weighted* process that adds numerical weights to characteristics depending on how important they are to the user. Table D.1 gives an example of a notional weighted score for a compact UTM platform. The platform with the highest score would be the most preferable in this case.
2. A *ranked* process in which the platform type that is the superior in the most measures wins. Table D.2 gives an example of a notional ranked score for a compact and full-duty platform.

Table D.1
Example Weighted Score Method

Characteristic	Unit Measure	Compact Initial Score	Weight	Final Score
Cargo volume	Cubic feet	10	200	2,000
Cargo weight	Pounds	700	1	700
Load divisibility	Subjective (1–10)	3	10	30
CASEVAC	Litters	1	100	100
Traverse diverse terrain	2, 1, or 0	2	100	200
Range	Kilometers	250	1	250
Total score				3,280

Table D.2
Example Ranked Score

Characteristic	Unit Measure	Compact Score	Full-Duty Score	Result
Cargo volume	cubic feet	10	55	Full-duty
Cargo weight	pounds	700	1,500	Full-duty
Load divisibility	subjective (1–10)	3	2	Compact
CASEVAC	litters	1	2	Full-duty
Traverse diverse terrain	2, 1, or 0	2	1	Compact
Range	kilometers	250	700	Full-duty
		Best Alternative		**Full-duty**

Note that the scale direction of some characteristics (e.g., acceleration) is different from most others. That is, where higher scores would generally be considered better for most categories, there are some scales where a smaller number is better. These scores can be weighted negatively if using a weighted process. No conversion is needed for a ranked process—only the order needs to be reversed. When evaluating UTM platform types, it is important to note that the decision should be made only on the platform characteristics that were identified in Step Three.

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The Army owns and operates a large fleet of wheeled combat and support vehicles, divided into three categories: heavy, medium, and light tactical vehicles. It also often uses ground mobility capabilities that are not formally identified in any of the categories, such as all-terrain vehicles and motorcycles, as well as some continuing use of pack animals. These vehicles are informally classified as ultra-light tactical mobility (UTM).

Most recently, forces in Afghanistan have used several types of UTM, to include ATVs and pack animals. In April 2014 Army Forces Command (FORSCOM) initiated a plan to develop established sets of UTM vehicles for airborne forces. Given the persistent use of UTM currently and throughout the Army's history, a more detailed examination is warranted to determine whether the Army should formally acquire and equip units with such vehicles. This report assesses the unvalidated needs (demands), validated needs (requirements), current ad hoc capabilities, and key considerations for developing and sustaining formal Army UTM fleets.

The various potential UTM investments and applications do not provide equal opportunity to improve current and future Army operations. Furthermore, the threats and risks associated with some UTM applications make their use in combat less likely and investments in them harder to justify. This report identifies and assesses various potential methods for Army development of UTM capabilities. The Army should consider likely impact, risks and threats, and emerging technologies when prioritizing the employment methods, or Tactical Activities, described in this report to address with UTM program investments.

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