# Modular "Land Based Carrier" Ideas

Daniel Newport
Dr. Rob E Smith
daniel.w.newport.civ@mail.mil
robert.e.smith1699.civ@mail.mil

This briefing does not reflect the official position of TARDEC or the U.S. Army. Views expressed herein are only those of the authors.

# Modular “Land Carrier” Ideas

## Overview:

1) “The Lizard” - Modularity via detachable autonomous mission modules
2) “Mothership” - Land-based carrier concept
3) Robotic swarming to remotely assess terrain trafficability
4) Removing Constraints - Additional Ideas

# Idea 1: “The Lizard” - Modularity via detachable autonomous mission modules

# The Battleship Analog

In the not too distant past, naval battleships with 16 inch guns were the preeminent fighting force on the high seas. During World War II, it became readily apparent that the evolving aircraft carrier had greater ability to not only **see the enemy at longer distances**, but also to **engage him in decisive battle at extended ranges**; the battleship became irrelevant in the decades that followed.


This happened…

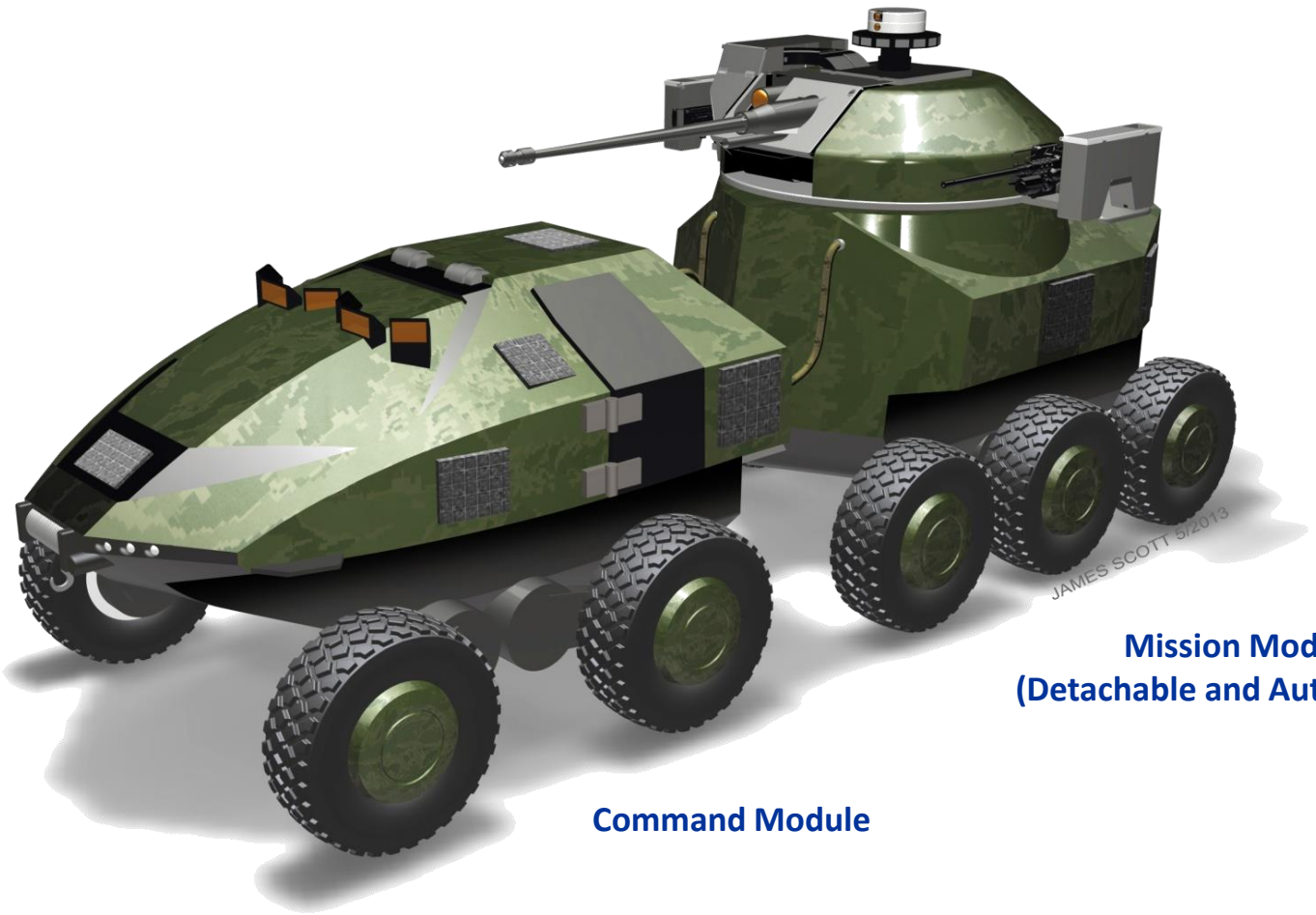

**Flying IEDs may change the nature of warfare**

Abrams Main Battle Tank

This is happening…

- Communications
- Launch & Retrieve UAS/UGV
- Provides power
- (exoskeletons, personal mobility, UAS/UGV)
- Air transportable itself
- Offensive EM/Cyber

# The “Lizard” Concept




**Mission Module**
**(Detachable and Autonomous)**

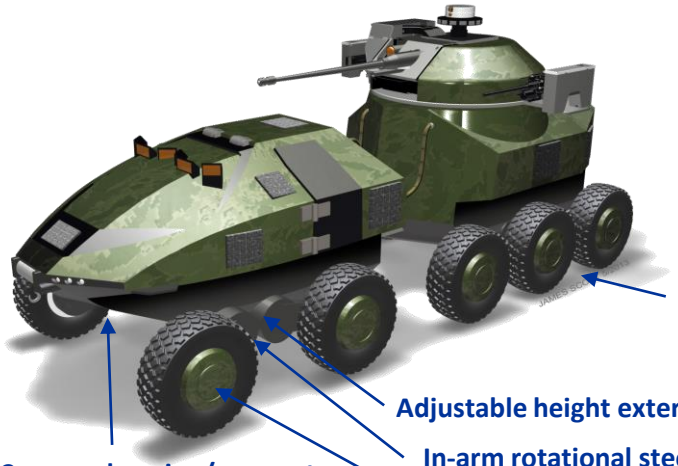
**Command Module**

# Descriptive Summary

A modular, articulated multifunctional vehicle offers potential benefits:

- Common crew/engine module/wheel motors (production, training, support)
- Enhanced mobility potential with actively controlled, powered, articulated joint
- Ability to reconfigure vehicle with multiple mission modules
- Modules can be transported independently
- Able to deploy multiple mission modules from a single command module
- Command modules could be “ganged” for self-recovery or enhanced towing capability
- Mission module can be “jettisoned” if required
- Command module provides 500kW of exportable power
- Allows seamless transition from conventional to directed energy weapons

# External Features



Remote turret/Medium caliber cannon

Dual/Rotating secondary weapons

Fully active suspension with independent load and traction control

Adjustable height external suspension

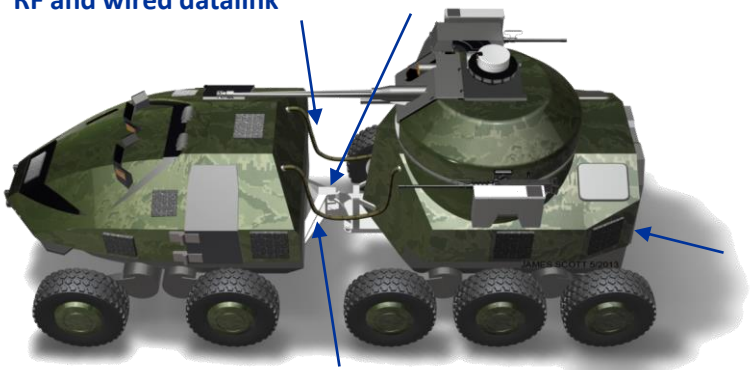
In-arm rotational steering

In-hub electric drive (all wheels)

Crew and engine/ generator located in command module

Modular, co-located target acquisition and 360° SA

Shaped underbody



RF and wired datalink

Notional articulated joint

Batteries located in mission module

Common high voltage (shielded) power connection for export power and mission module power

Rear access

# Modules

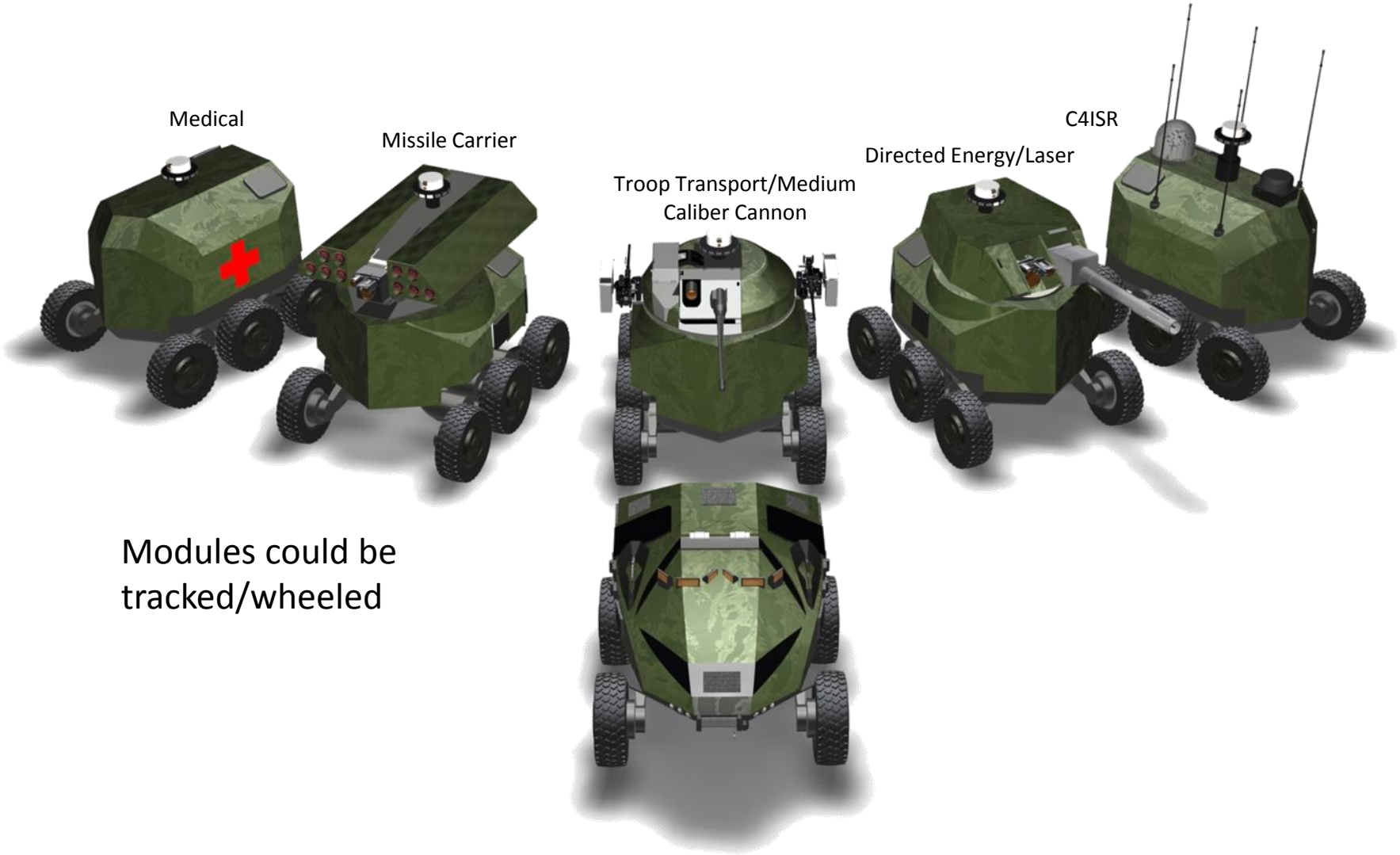
The articulated design separates the crew/engine module from the mission module. The separated mission module could operate remotely or semi-autonomously.


Detached Mission Module would have limited mobility and range under battery power


Like a Lizard's tail, the mission module can be jettisoned as a last resort for a quick escape. The weapon mission module could continue to provide covering fires when the modules separate.

# The Lizard Family

## Mission Modules




Modules could be tracked/wheeled

# Mobility DOUBLES by Simple Coupling of Vehicles

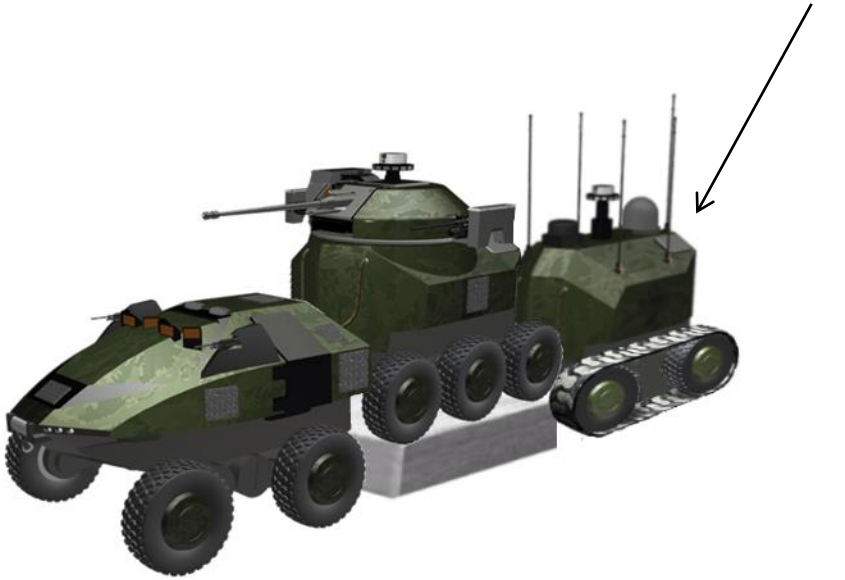
| Measured Performance Comparison* | | |
|---|---|---|
| | **Single M-113** | **Two Coupled M-113's** |
| **Step Obstacle Height** | 2 feet | 5 feet |
| **Trench Width** | 5.5 feet | 11.0 feet |
| **Water Speed** | 3.6 mph | 4.0 mph |
| **Climbing Short Slopes** | 45% | 60% |
| **Exiting Water @ Slope of** | 45% | 60% |
| **Cross Country Speed @ 6 Watts absorbed power @ 2.1 inch RMS** | 9 mph | 16 mph |

* Data and images from TARDEC testing, performed 1972.

# Lizard Excursion - Selectable Mobility

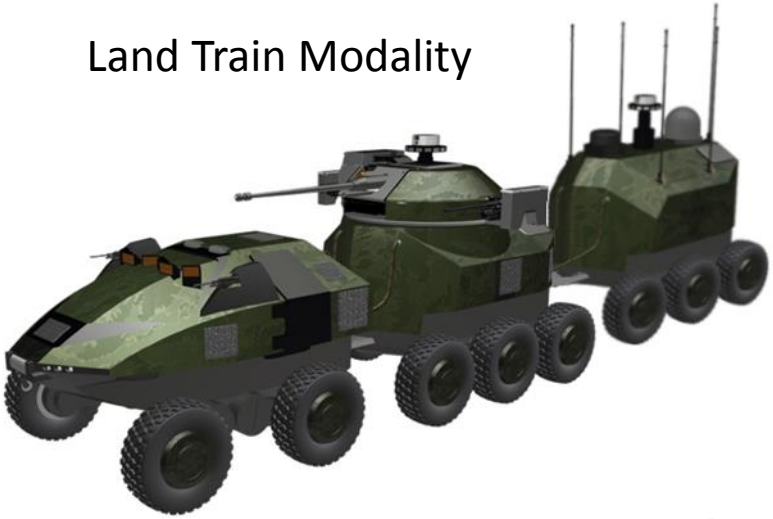
Selectable Mobility
(Tracked or Wheeled)

Add-On Mobility Trailer



# Lizard Auto-Attaching "Smart Hitch" Idea

Land Train Modality



Powered Articulation

This Module Could Detach and Help Lift Other Vehicles

Elevating Smart Hitch
(For Going Over Severe Obstacles)

Smart Hitch For Side Slope Stability

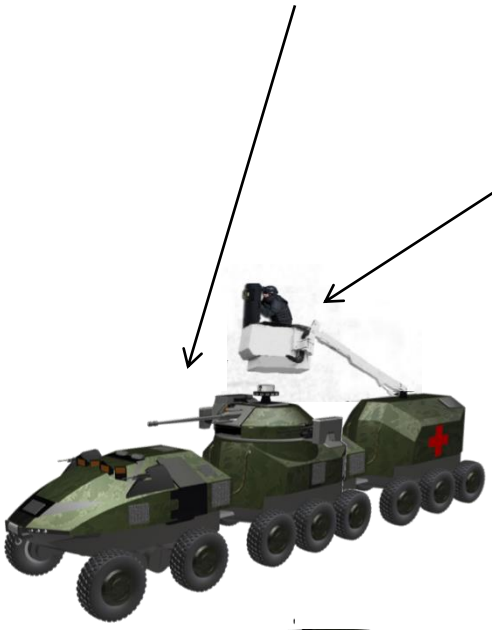
# Lizard Urban Assault

## MOUT VERTICAL ASSAULT

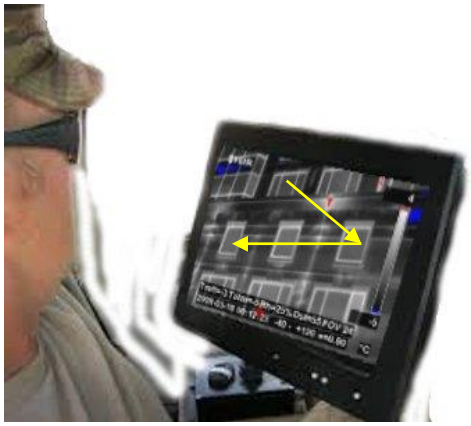
- Lethality is Not Always Weaponry it can be MANEUVER
- Provides new access to roof and other levels

High elevation angle turret

Telescoping
Boom Arm
Assault Module

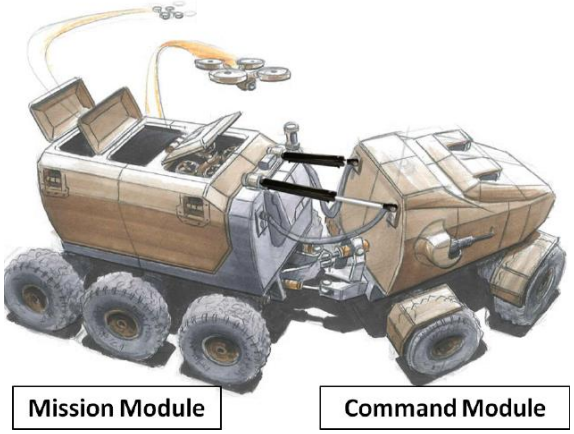


Autonomous Boom Control

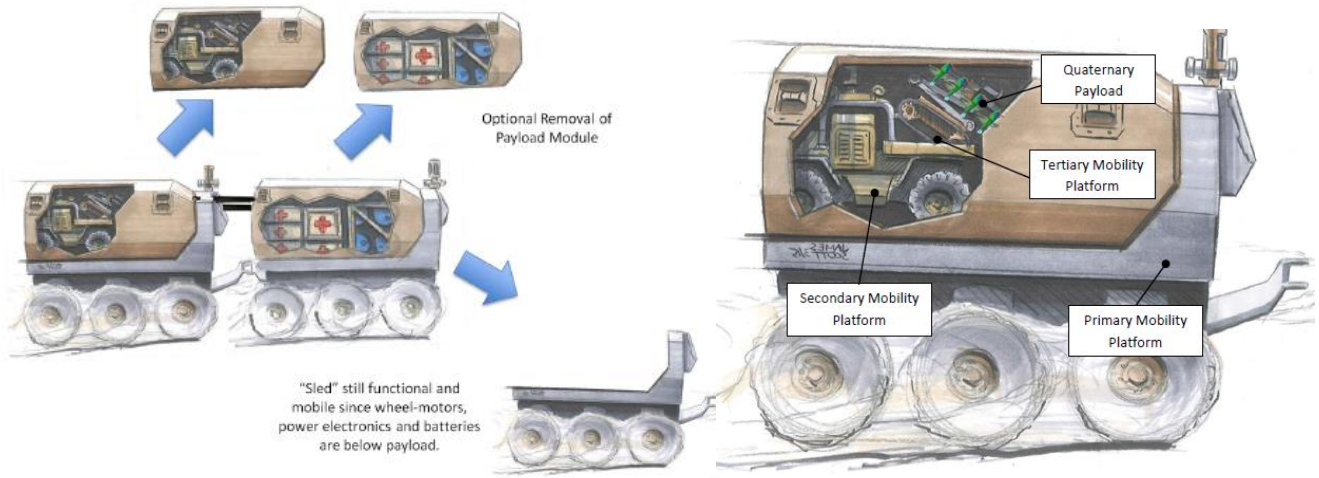


# Traditional "Swim Lanes" Become Nested

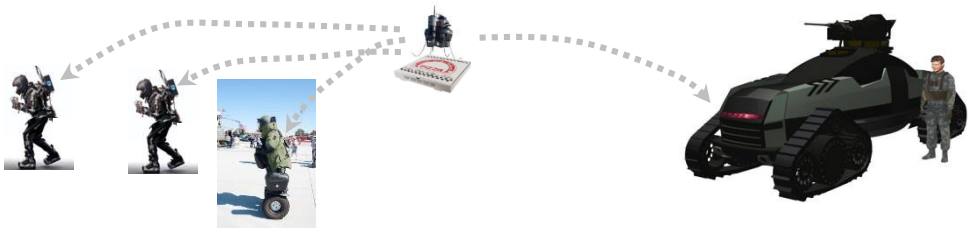
UAS Carrier/Launcher: Deployable assets instead of direct fire



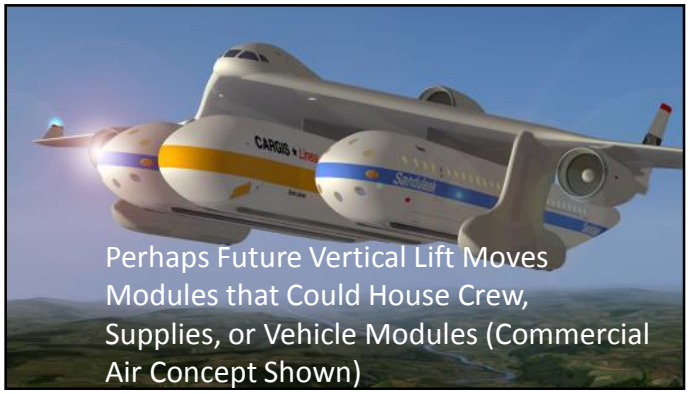

Multi-level Modularity




UAV Power/Ammo/Resupply



Exoskeletons



# Idea 2: “Mothership” - Land-based carrier concept

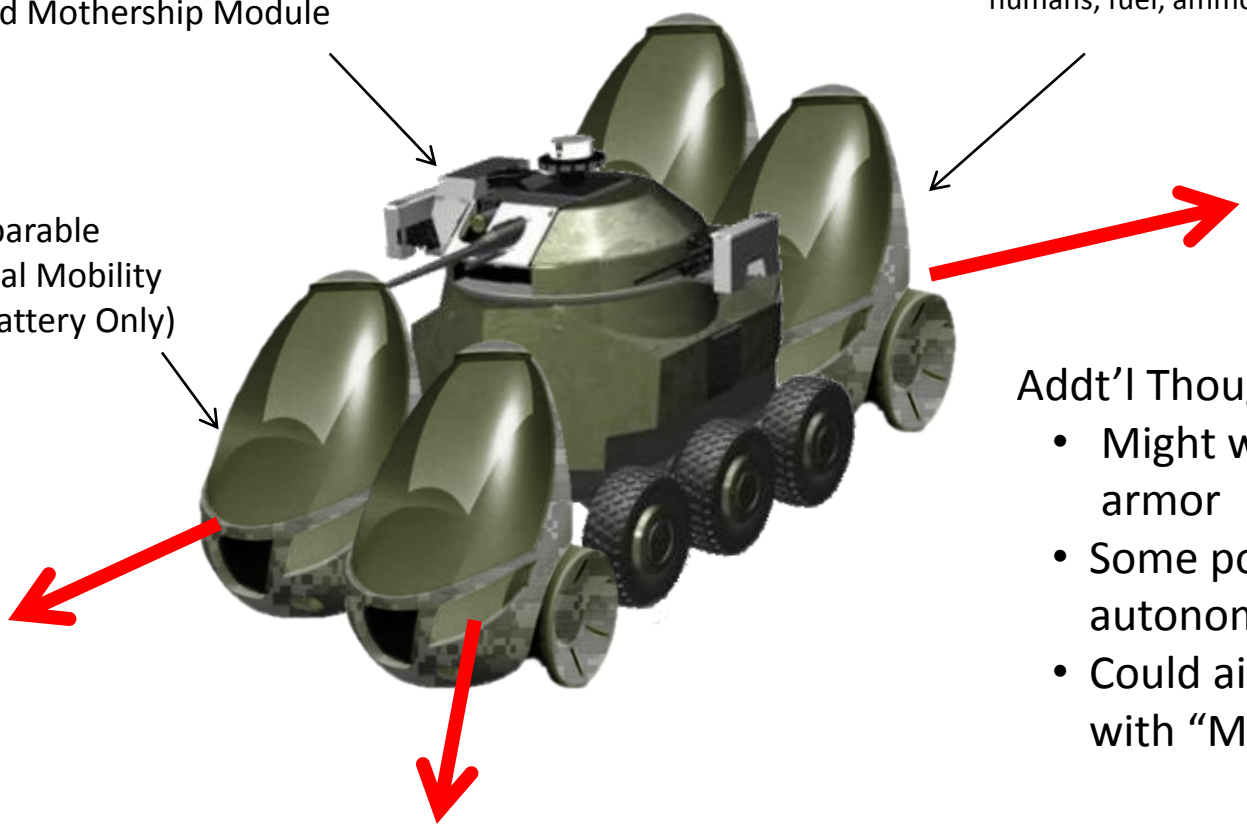
# “Mothership” Concept

Deployed UAS/ UGVs

Easter Egg Pods (Which to target? Could hold humans, fuel, ammo, rockets, empty decoy)

Powered Mothership Module

Separable Personal Mobility Pods (Battery Only)



Addt’l Thoughts:

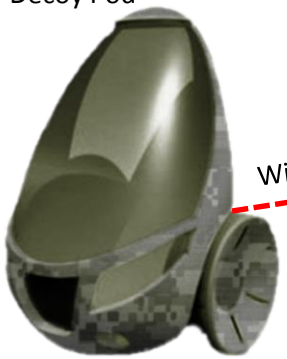
- Might want moveable or offset armor
- Some pods could be autonomous or decoys
- Could airdrop these and link up with “Mothership” later

# Mothership Concept (cont'd)

Deployed UAV (Recharges by landing on dock)

Detached Manned
Easter Egg Pod

Easter Egg Empty
Decoy Pod



Wireless Power??

Mothership Module
Provides Power/ Recharge

Exoskeleton / Dismount
Support

Deployed UGV

# Mothership Concept (cont'd)

**May be the only way to get through this type of urban traffic:**

# Mothership – Configurational Flexibility

May Need to Provide Physical Support Arms
To Control Pod Acceleration During Blast

# Another Possible Configuration (Combine w/ Lizard)

High mobility mission module (tracked)
High power/weight ratio

Easter Egg Pods

# Variation on a Theme: “Bodyguard” Concept

Dispersed Active Protection/ Threat Sensing/Anti-Personnel

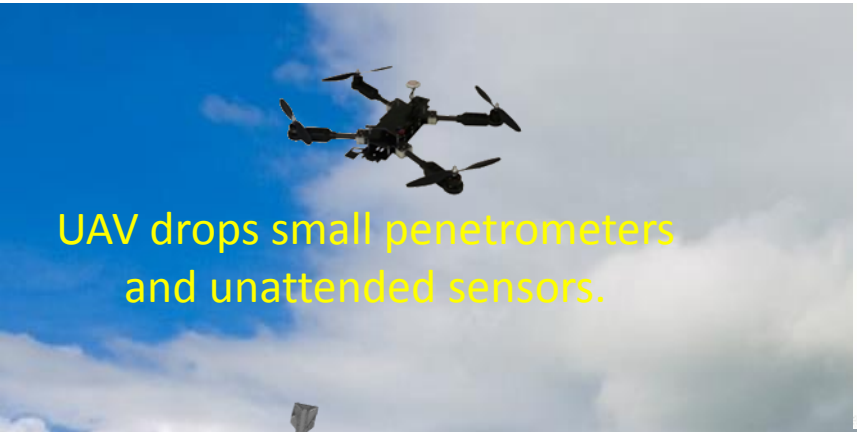
Rapidly orientable suspension geometry

- Quickly Reconfigure for low/high speed stability
- Limited crawling modality to get “unstuck” or crawl over obstacles
- Swarming behavior to counter AA/AD

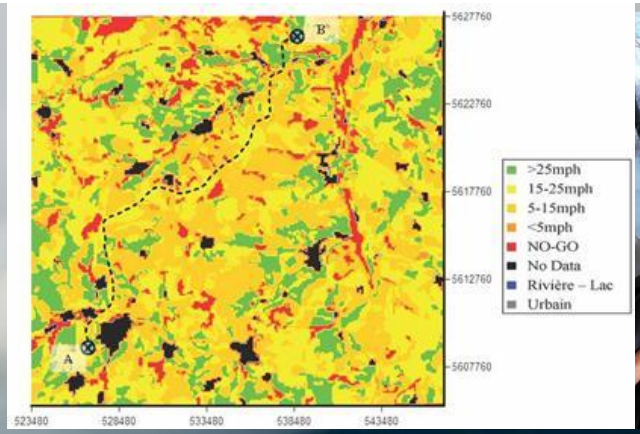
Decoy or Mine-Flail?

# Idea 3: Use of robotic swarming to remotely assess terrain trafficability

# Hypermobility Through Predictive Analytics



UAV drops small penetrometers and unattended sensors.




Build/modify map of terrain


Heads Up Driving

Hyper Mobility by Measuring/Sensing/Analyzing/Predicting

- (Almost) Never get stuck
- (Almost) Never lose control

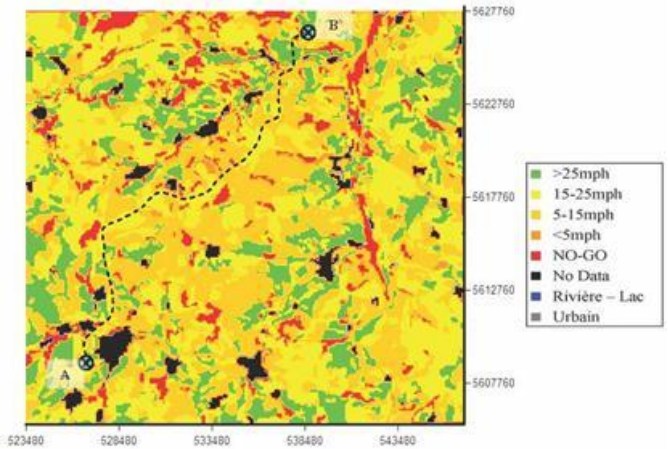
Can also measure vehicle wheel slips and feed into the network

UGV's with penetrometers

# Use UAV/ UGV Swarm to Measure Terrain

1. UGV measures soil or UAV drops penetrometers to measure

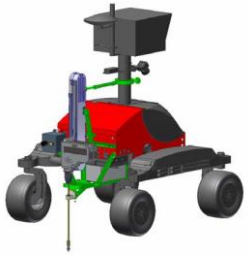
2. Use network to build up shared data

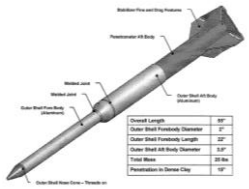



Speed and/or allowable number of vehicle passes

3. Heads-Up Driving Recommendations

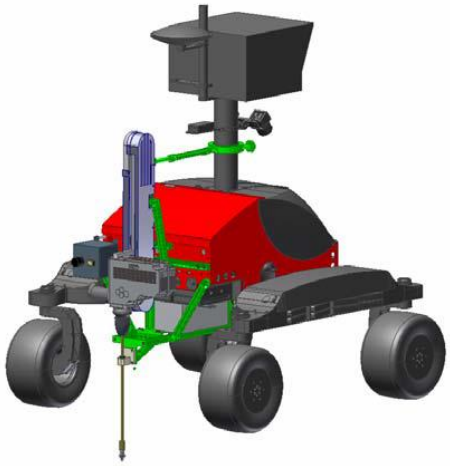

Measure Soil (More in later slides)





# Roving Penetrometers/Autonomous Mobility Scouts

Swarming Roving Penetrometers (off-road) and
Autonomous Mobility Scouts (urban)



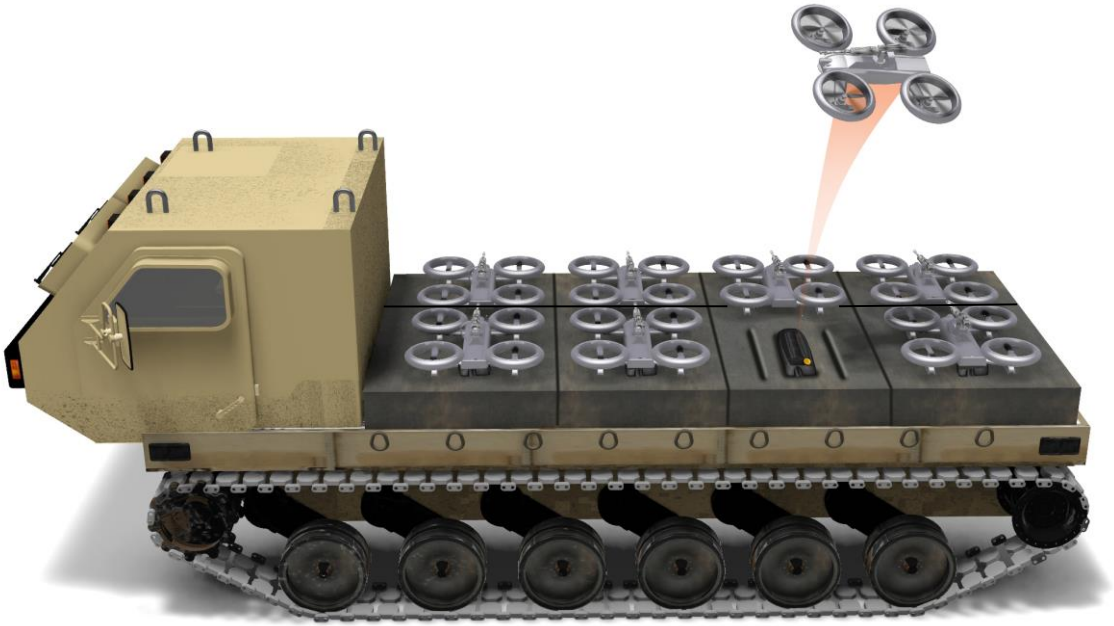
PERCUSSIVE DYNAMIC CONE PENETROMETER FOR GEOTECHNICAL SURFACE ASSESSMENT
WITH A PLANETARY ROVER.
http://www.ri.cmu.edu/publication_view.html?pub_id=6130

- Assesses, verifies and relays assured mobility corridors in urban and off-road environments.
- Fast, mobile and relatively inexpensive
- Expendable, discovery learning
- Feeds mobility data to larger manned and unmanned systems
- Mounts, charges and dismounts from “mother ship” vehicle

# 4: Removing Constraints - Additional Ideas

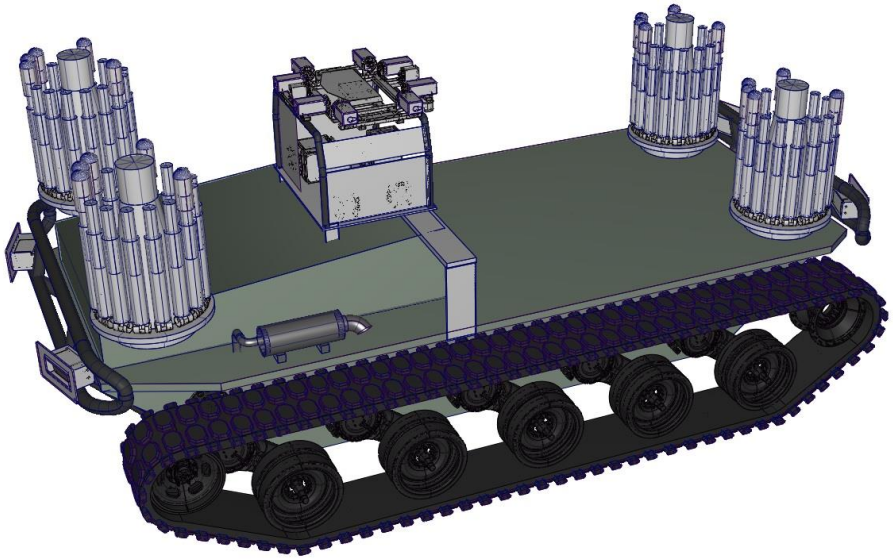
# Modular UAS Carrier/Launcher

- Drive-by-wire allows optionally manned or unmanned autonomous operation
- Rapidly reconfigure for UAS anti-armor, counter-UAS, directed energy, wireless energy sharing/distribution, C4ISR, counter C4ISR, offensive/defensive cyber…etc.
- UAS Launch and Recovery; graceful degradation “beehive mode” (e.g. vehicle stuck, under attack or disabled) allows jettison, defensive use, remote recovery or reutilization of all onboard assets
- Airborne escort with look-down defensive capability (guardian angel)
- Modular interface allows connectivity to vehicle data bus and high voltage power bus
- Rapidly swap out individual modules with two-man lift, anticipate enemy TTP response
- Mix dissimilar modules for maximized flexibility and adaptability
- Readily upgradeable as new modules are developed or become available



# Megacity Vertical Fighting Vehicle

- Oriented/optimized in the vertical plane; will rapidly identify and neutralize anti-armor and anti-personnel threats in a highly vertical megacity environment.
- Tiltable carousel launchers (4-8 per vehicle) optimized for low latency engagements in the vertical plane (armored nacelles not shown).
- Adaptive threat library rapidly identifies, targets and compiles anomalous events; adaptive, networked system is always compiling, learning and sharing information faster than enemy TTPs can evolve
- Common carousel physical interface and databus allows utilization of multiple missile types
- Unmanned operation either remotely or fully autonomously in both leading and following role
- Could also provide C-RAM capability and counter-CAS capability due to ability to load multiple missile types



# Megacity Omni-Directional Mobility

## Removing Constraints as Facilitators to Megacity Mobility

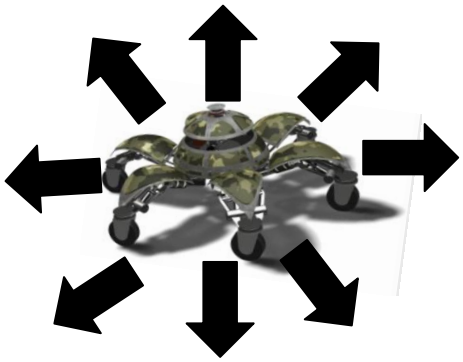
**Constraint:** Vehicles limited in mobility, especially in confined spaces; unable to maneuver laterally or in reverse with same speed or proficiency.

**Analog:** Thrust-vectoring in combat aircraft (e.g. F-22)

**Possible Solution:**

Omni-directional (in-plane isotropic) mobility allows vehicle mobility irrespective of orientation; drive backward and sideward at 100% forward speed (drive-by-wire and electric drive facilitates this, full power/full gearing).

- Decouples vehicle orientation from direction of travel.
- Could act as “virtual turret”, rotating entire vehicle irrespective of direction of travel.
- Could act as “virtual rotatable” armor resulting in armor efficiencies and preferential armor orientation relative to threat.
- In-hub electric drive and independent rotational steering allows potential independent control; could “jink” unexpectedly enhancing survivability.



# Summary

- Remove/reduce existing vehicle constraints where possible (vertical/horizontal plane, omni-directional mobility, modularity, configurational flexibility); expand the envelope in unconventional ways.
- Use multi-level modularity and rapid reconfiguration to anticipate and rapidly respond to enemy countermeasures and ensure graceful degradation.
- Multi-level modularity allows robustness and enhanced mobility through variable vehicular geometry and configurational flexibility.
- Use information (shared/networked, real-time, and predictive analytics/sensing) in lieu of energy whenever possible.
- Shared power/energy between command and mission modules; dynamic power/energy distribution and allocation at the point of need – minimizes latent/unusable energy.
- Much like an aircraft carrier, future vehicle-based power projection can and should utilize multiple modalities.