14833

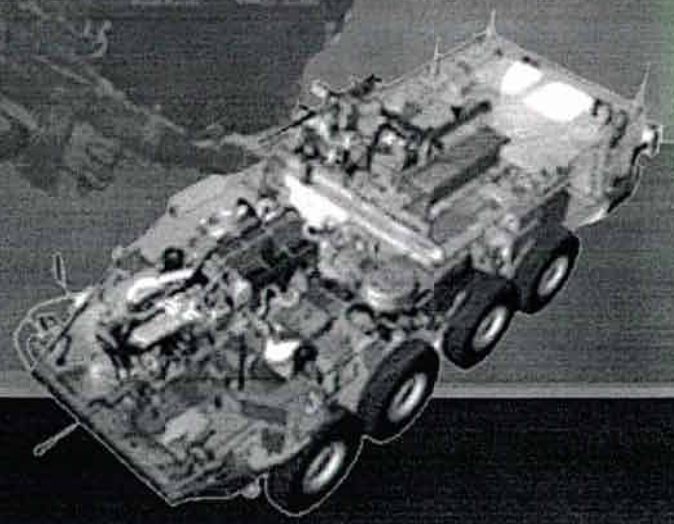
Robotic Technologies for the Future Force – The ART ATO

Jeffrey F. Jaster
ART Development Team Leader
Intelligent Systems
(586) 574-5106
jasterj@tacom.army.mil

SUPERIOR **TECHNOLOGY**

FOR A

SUPERIOR **ARMY**



TARDEC

U.S. ARMY TANK AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

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Prescribed by ANSI Std Z39-18

ARV Robotic Technologies (ART) ATO

ART Technology Surrogate

Schedule

MILESTONE (FY)	04	05	06	07	08
• Develop ARV Technology					
• Develop UGV M&S Suite					
• Analyze UGV Vulnerabilities and develop countermeasures					
• System Integration and Test					
• Conduct Warfighter Experiments and Evaluations			5		6

Purpose:

Advance the state of the art in unmanned platform technologies achieve FCS ORD capabilities of ARV systems and ARV teams.

Product:

- **Enhanced Semi-Autonomous Mobility Suite**
- **Integrated Tactical/Mission Behavior System**
- **Survivability Technology/Devices/Payload**
  - **Above products will be integrated into a surrogate ARV system demonstrators with additional Mission Modules to support User Experiments**
- **UGV Modeling and Simulation Suite**
  - **Improved models for sensors, platforms, behaviors**
  - **Models are MATREX compatible**

Payoff:

- **Reduce soldier burden/interaction**
- **Improved semi-autonomous operation in adverse weather and urban/complex terrain.**
- **Tactical behavior incorporated into semi-autonomous maneuver.**
- **Reduced vulnerability to enemy tampering.**
- **Increased soldier survivability using unmanned systems.**

FY04

FY05

RF ATD
Tech Demo FY06
Final

Continuous Technology
Spiral Integration

ART
M&S Tech
Integration

ART ATO
Warfighter
Experiment #1

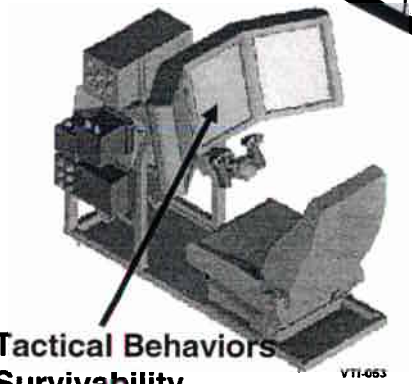
FY07

FY08

•Tactical Behaviors
•Survivability
•Perception
•Prognostic/Diagnostics

ART ATO
Warfighter
Experiment #2

Transition
PM UA



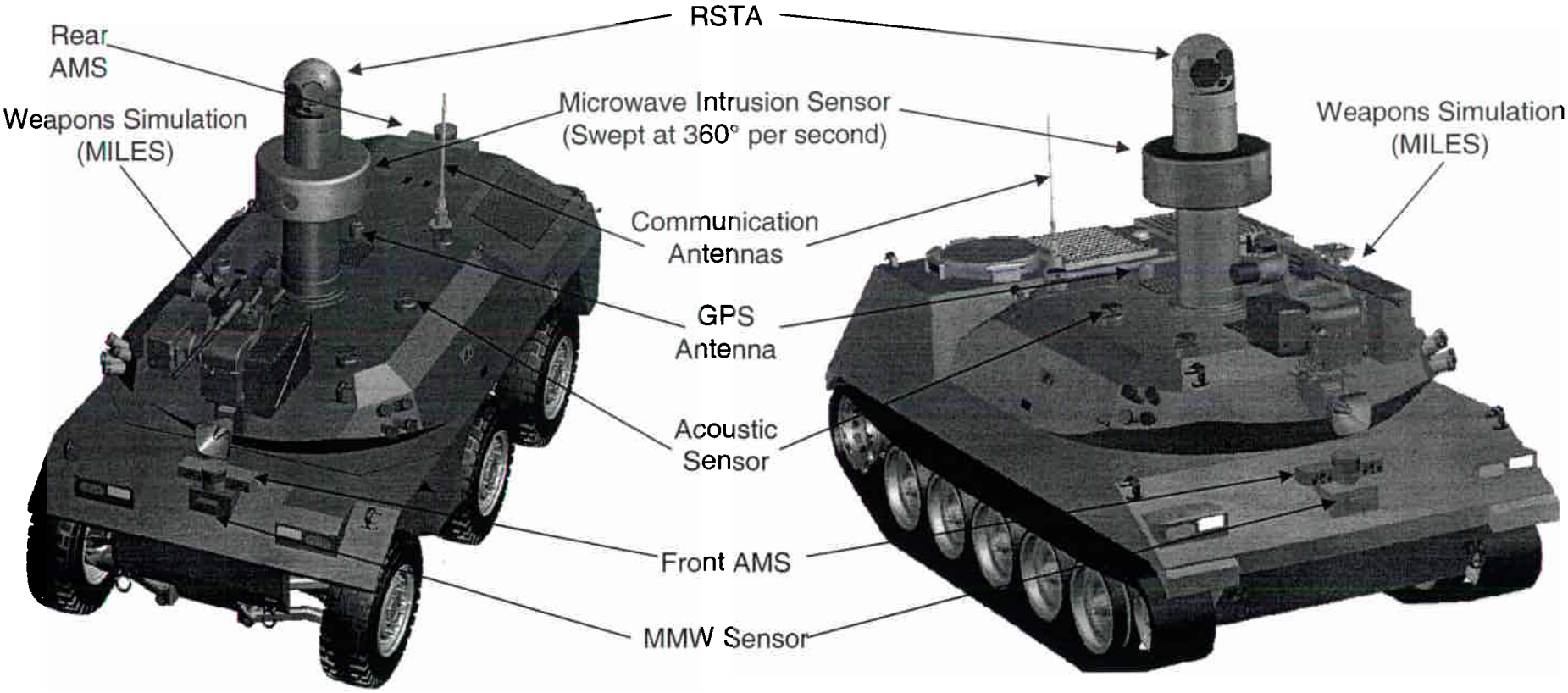
•Tactical Behaviors
•Survivability
•User TTP Development

The ART ATO is a major technology contributor to the ARV SDD Risk Reduction

ART Solution : Mechanical

Have both tracked and wheeled options to follow ARV decision

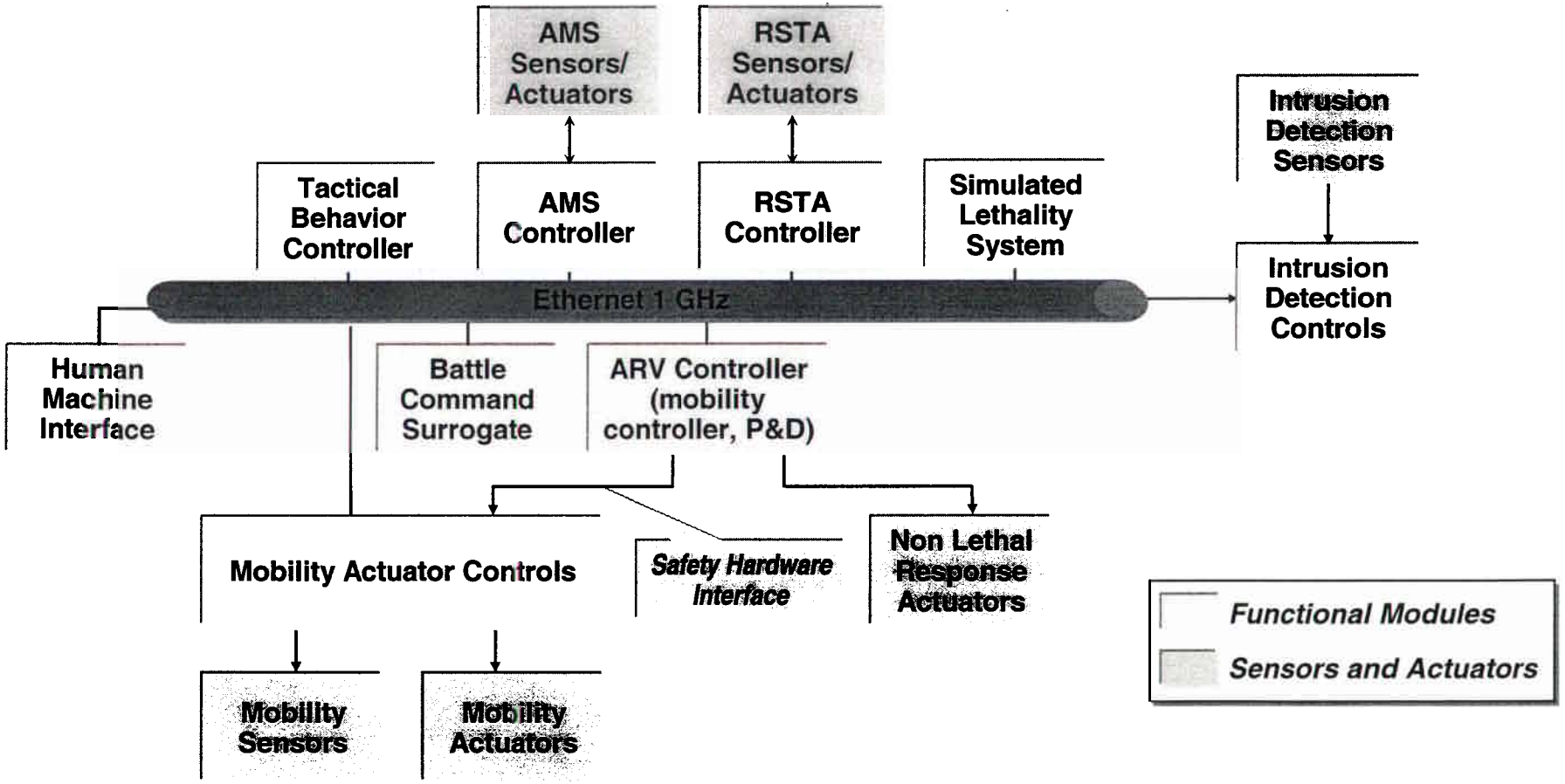
- Based off of commercial platforms (GPV 6X6, M113)



ART Solution : Vetronics

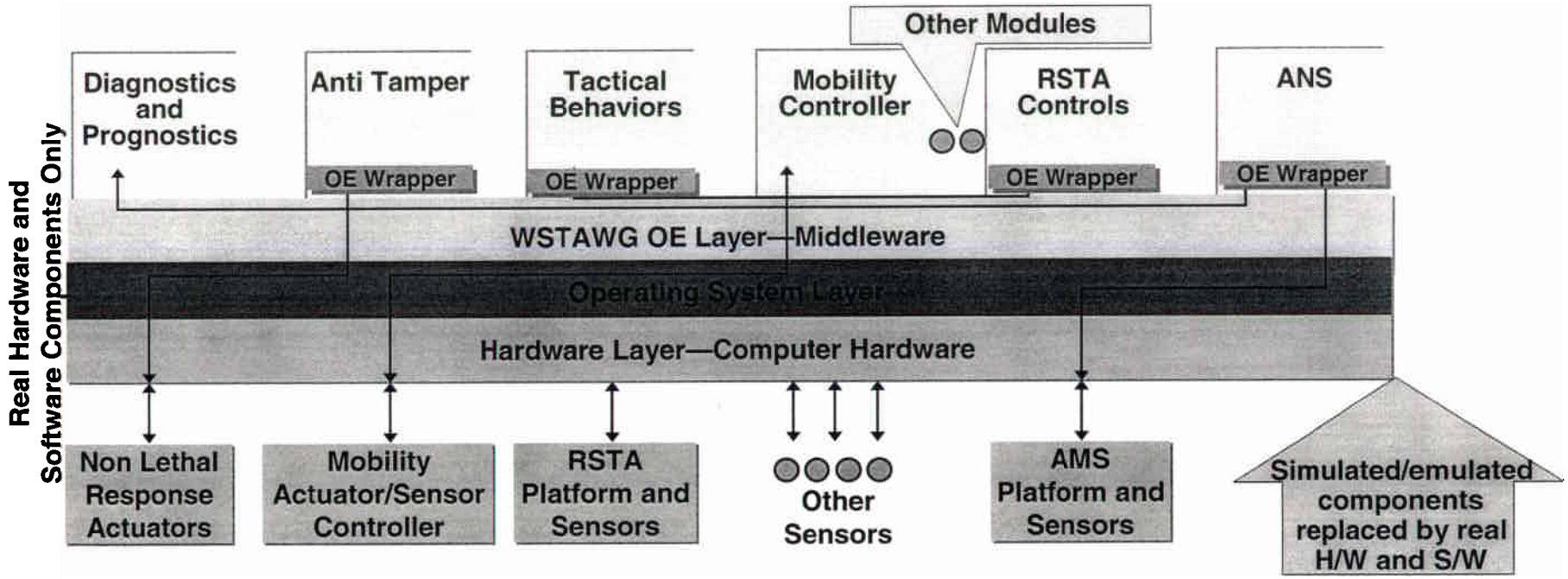
Open Vetronics architecture

- **Ethernet backbone permits addition of new components**



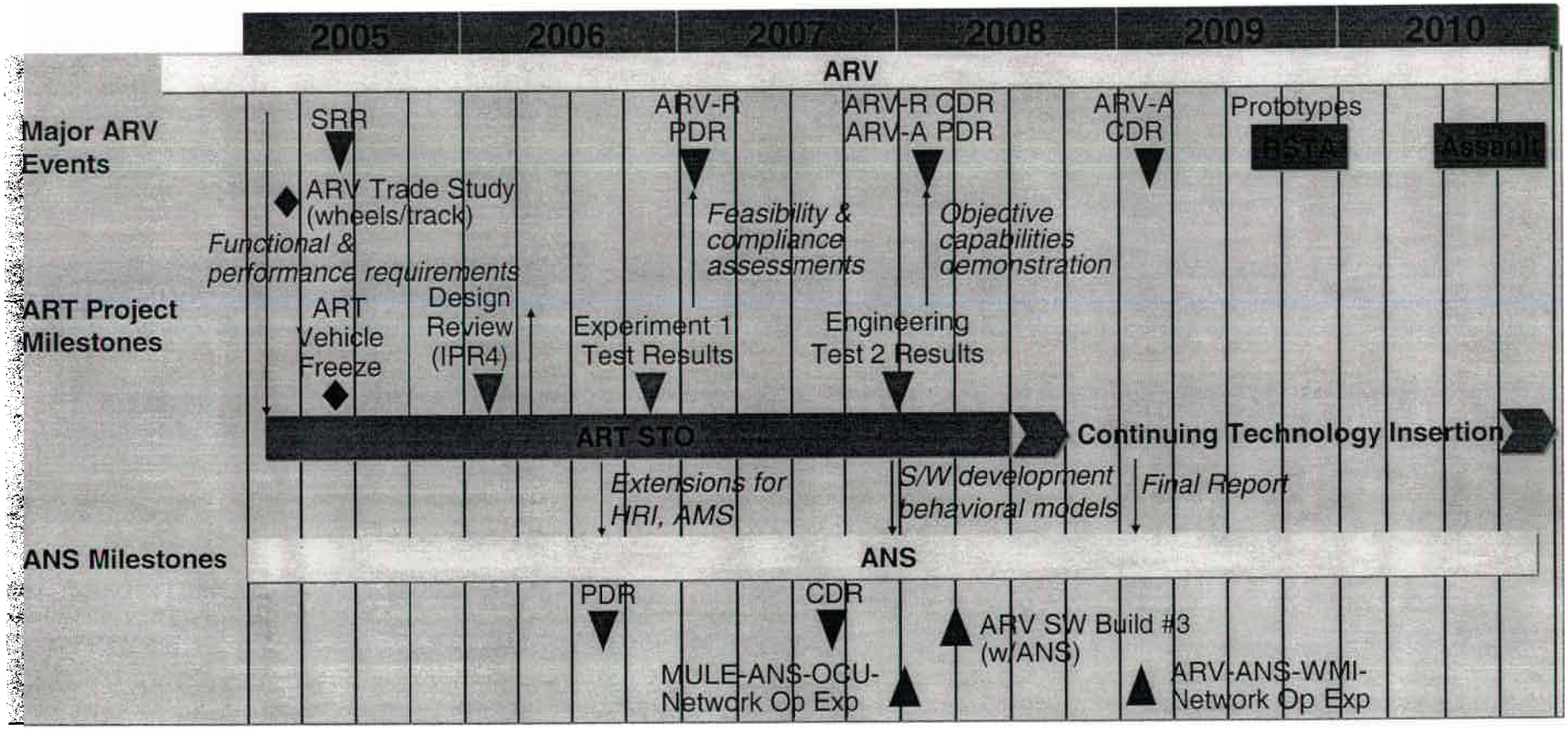
ART Solution : Software

Layered software architecture approach uses middleware to reduce integration risk



Program Plan

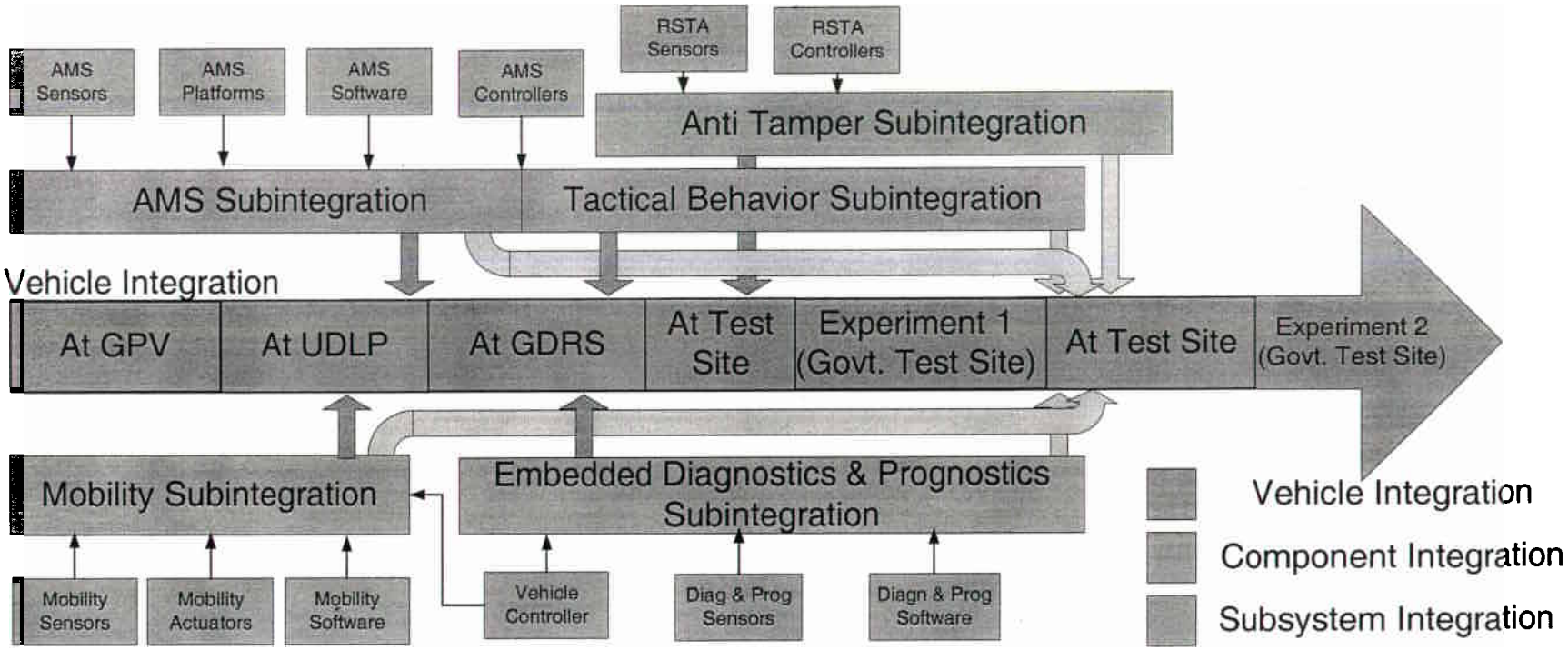
- Aligned ART experiments feed ARV and ANS



Integration Approach

Multi-site plan accommodates concurrent integration complexities

- **Time-phased integration strategy addresses availability limitations**

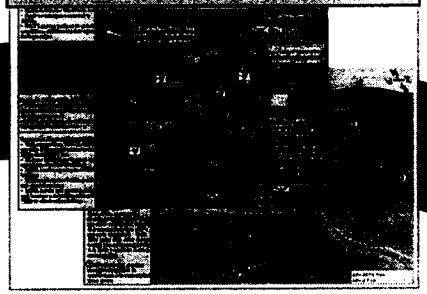


Tactical Behavior Development

UA O&O, system books, battle books, robotic TTPs, UA IPs, design reference mission, etc.

Partner with TRADOC / UAMBL to understand "how to fight"

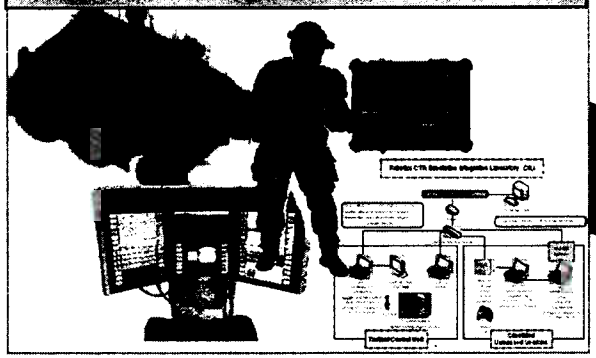
Refine FCS ARV O&O Concepts



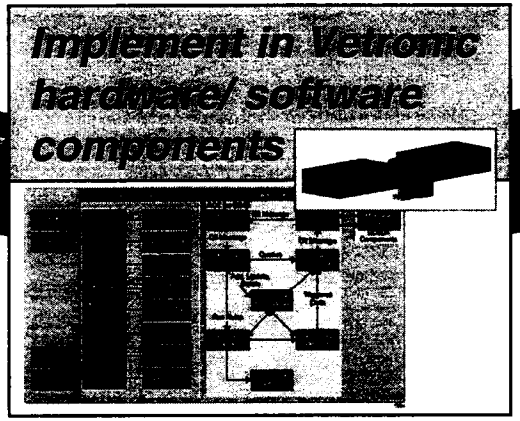
Identify and specify

Iterative Tactical Behavior Synthesis Process

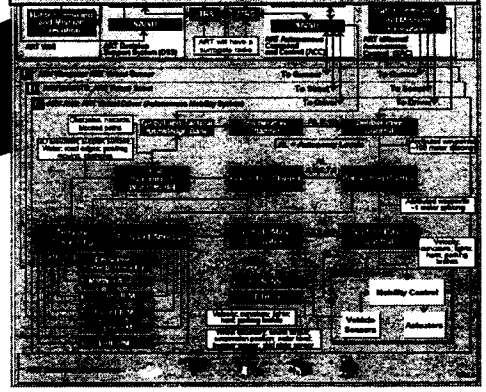
Evaluate and assess in SIL and field experiments



Implement in Vetronic hardware/ software components

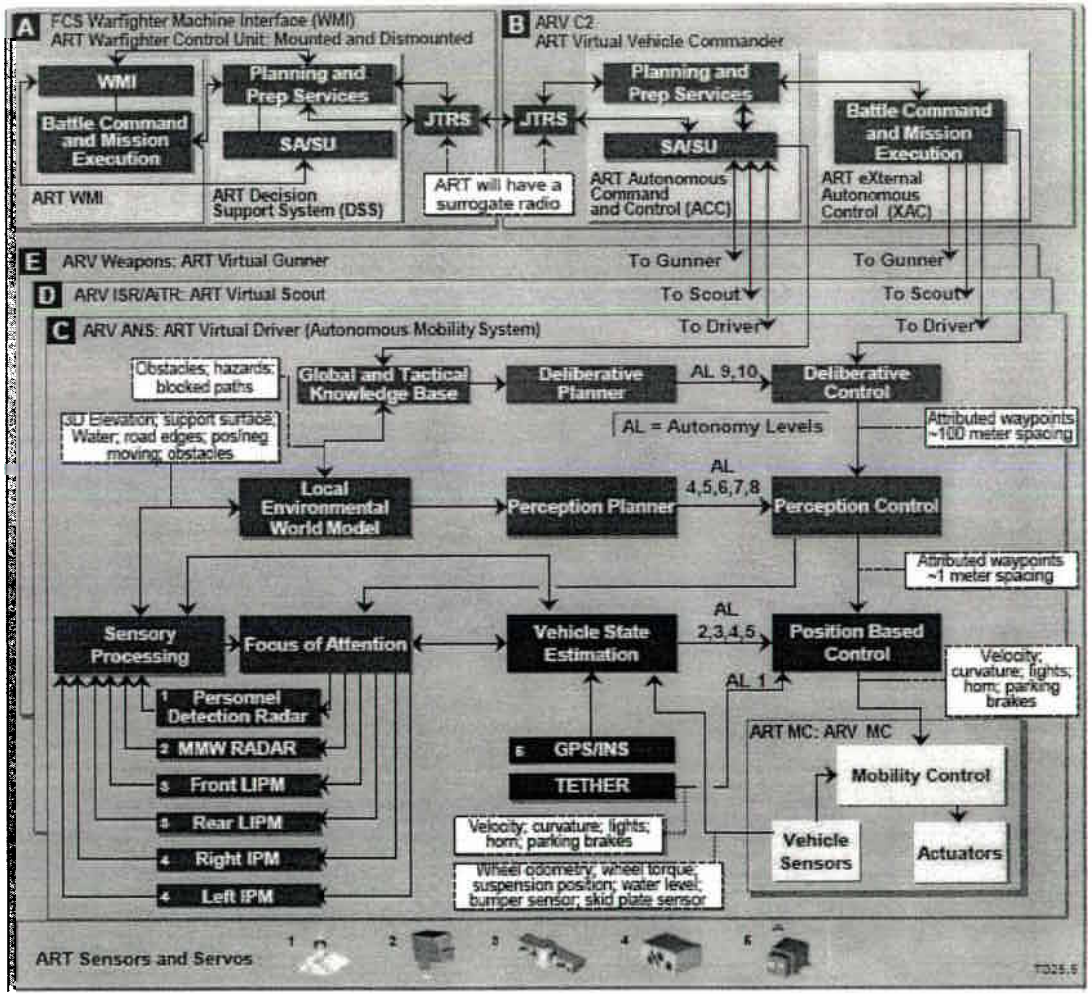


Map to intelligent control architecture



Intelligent Control Architecture

- Manages implementation of complex behaviors
- Mirrors ARV/ANS architecture
- Architecture based on 4D/RCS reference model
- JAUS-compliant
- Proven implementation: Sensor/servo to commander

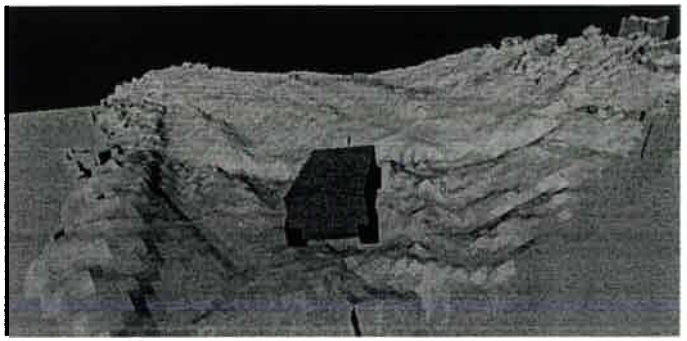


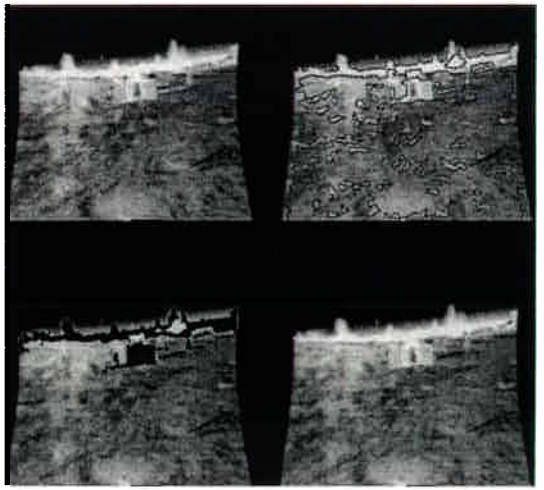
Advancing Negative Obstacle Detection

Modeling & Simulation

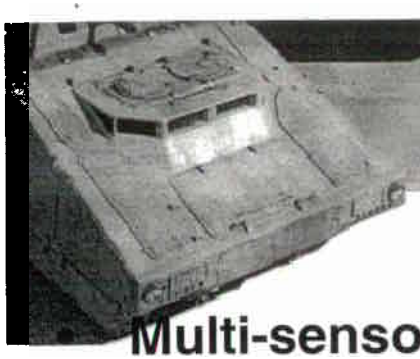
- Sensor placement
- Mobility/terrain interaction

- **High resolution sensors**
  - LADAR, Vis/NIR, LWIR
  - Pixel-level fusion
  - Advanced preprocessing
- **Accumulated world model**
  - A-priori terrain elevation
  - Temporal integration
  - Support surface tracking





Opaque Sensor Perception Advancements



Multi-sensor phenomenology

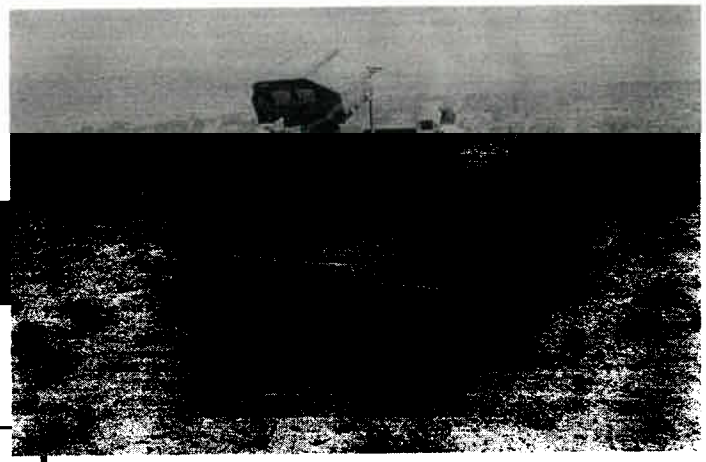
Condition	See-Through	Degraded
Dust, Smoke, Fog	MMW, LWIR (except fog)	LADAR, Vis/NIR, FPR LWIR (fog)
Moderate Vegetation	LADAR, LWIR, FPR	Vis/NIR, MMW
Heavy Vegetation	FPR	LADAR, Vis/NIR, MMW, LWIR

- **Algorithms for detection and planning**
  - Support surface determination
  - Density calculation
  - Multi-

Two-pronged approach focuses on sensor and algorithm improvements.

Perception Advancement in All Weather Conditions

- Address operations in degraded LADAR environments through multi-spectral sensors....

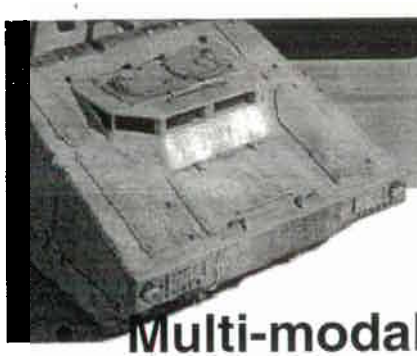


Daytime	LADAR, Vis/NIR, LWIR, MMW, FPR	--
Night / Low-Light	LADAR, LWIR, MMW, FPR	Vis/NIR
Smoke / Dust	LWIR, MMW	LADAR, Vis/NIR, FPR
Dense Fog	MMW	LADAR, Vis/NIR, LWIR, FPR
Rain / Snow	MMW	LADAR, Vis/NIR, LWIR, FPR

...and improved algorithms

- Adjustable sensor weights
- Terrain adaptive velocity
- Data registration
- Sensor fusion

Focused on graceful degradation of vehicle performance



Anti-Tamper Approach

Multi-modal detection and response for layered standoff

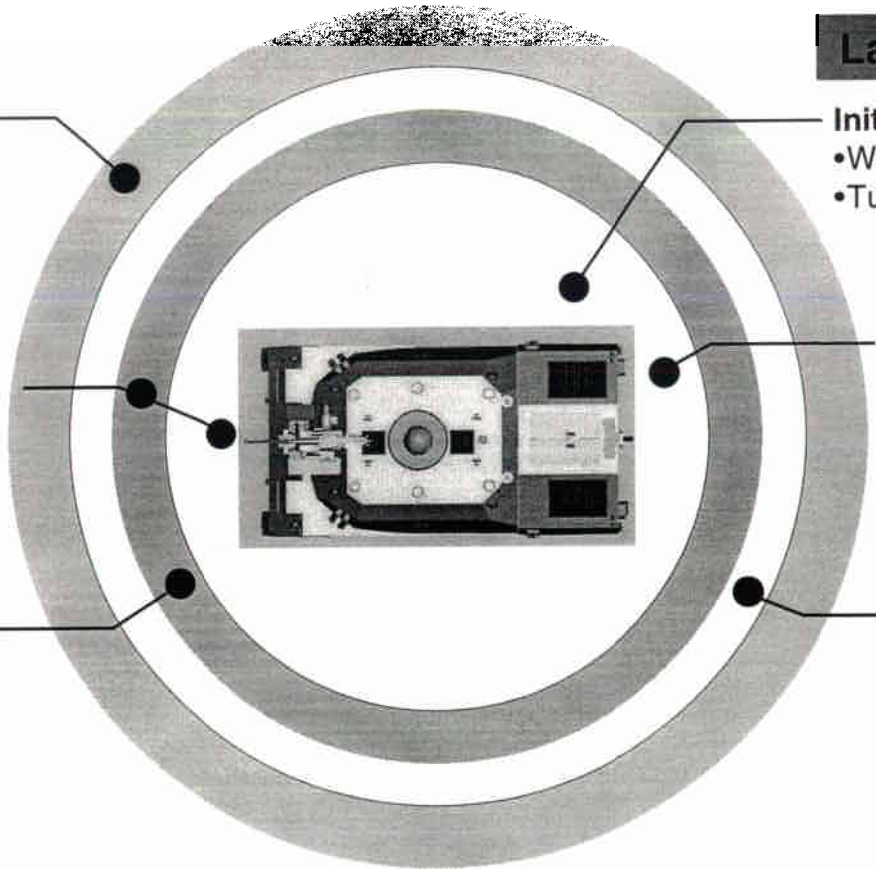
- **Integrates and augments state-of-the-art algorithms**

Layered Detection

RSTA sensors
- Impulses (direct fire) detection and localization
- Vehicular detection localization and tracking
- 360° out to ~3km

Autonomous Mobility Sensors
- LADAR 360° out to 50m
- Imaging 360° out to 100m
- Mounted/dismounted mover detection and tracking

Personnel Detection RADAR
- 360° out to 100m
- Detection and tracking



Layered Response

Initial Warnings
- Warning speaker
- Turret motion

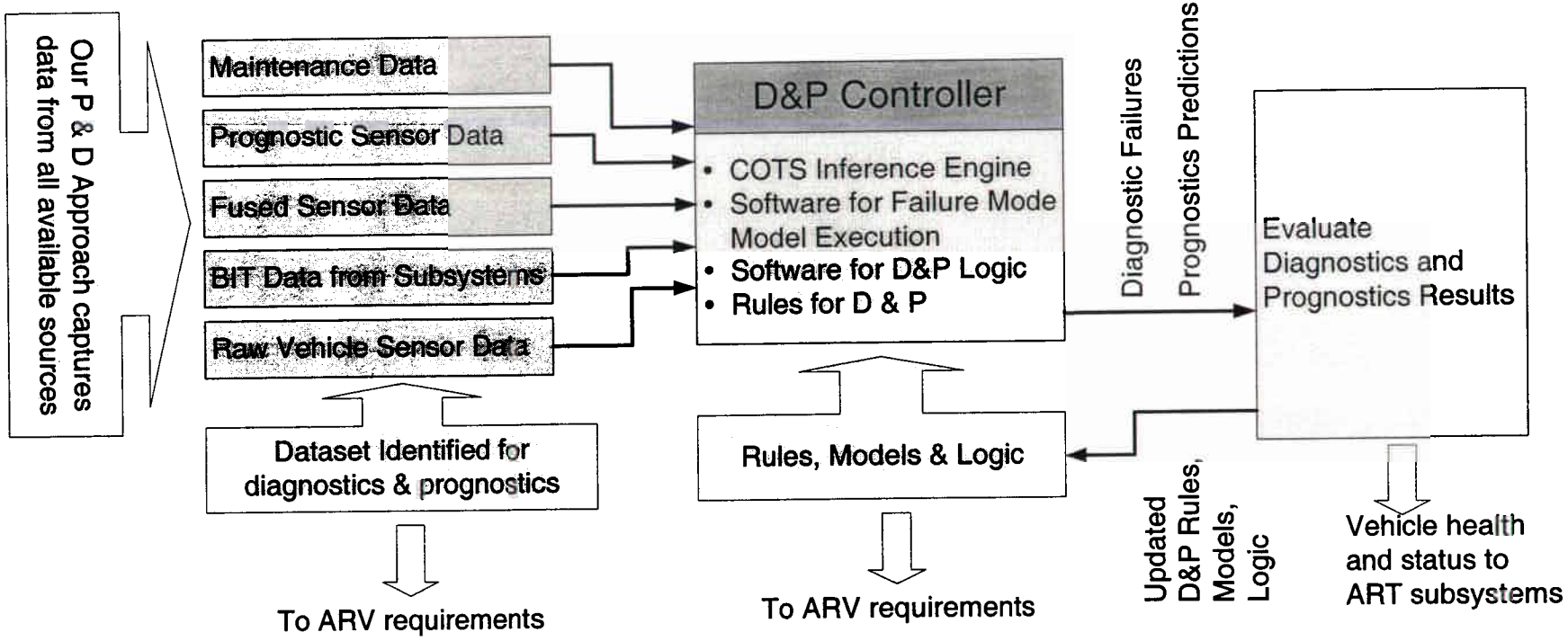
Particle Spray
- 4x90° non-turreted
- Concentrated field of 250 sting balls
- Countermeasure out to 10-15m

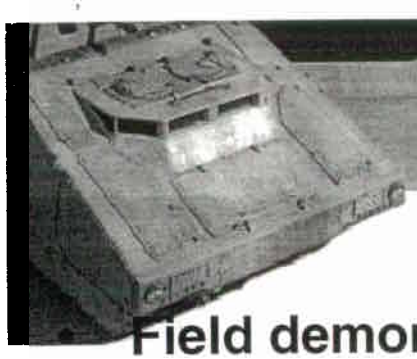
High Intensity Search Light
- Turreted 75w Xenon arc lamp with strobe
- 6m candle power
- Variable beam 2° to 40°
- Range of 1.5 miles

Prognostics and Diagnostics Architecture

Continuously update our knowledge base

- **Will take advantage of the fused sensor data on the ART platform**
- **Use a COTS based inference engine**
- **Architecture consistent with FCS ARV**





Experiment 1 Capabilities - Sept 2006

Field demonstrations utilizing ART vehicle as an ARV surrogate

– Includes both user testing (with users from UAMBL) as well as engineering tests

- **AMS**
  - Day-night operation
  - Improved negative obstacles
- **Tactical Behaviors**
  - All move modes in open terrain
  - Cooperative movement with other vehicles
  - Occupy battlefield positions in open terrain
- **Anti-tamper**
  - Detection
  - Mobility response
- **Prognostics and Diagnostics**
  - Keep vehicle safe
- **Demonstrate ART meets final mobility requirements**
- **Initial RSTA capability**
- **Interface with HRI**

Experiment 2 Capabilities - March 08

Field demonstrations utilizing ART vehicle as an ARV surrogate

– Includes both user testing (with users from UAMBL) as well as engineering tests

- **AMS**
  - All weather operation
  - Opaque sensors
- **Tactical Behaviors**
  - Tactical movement in MOUT environment
  - Cooperative engagements with vehicles and dismounts
  - Occupy MOUT positions
  - Stealthy movement
  - React to local threat
  - React to loss of mission capability
- **Anti-tamper**
  - Detection
  - Deterrence response
- **Prognostics**
  - Selected ARV use cases
- **Full RSTA functionality**
- **Simulated lethality component**

Transition, Maturation & Risk Mitigation Efforts for ARV

- **Anti-tamper Techniques**
  - Anti-tamper/ANS fusion
  - Includes 360 situational awareness
  - Includes behaviors and processes
- **Survivability Technologies**
  - UGV unique
- **Tactical behaviors/adaptive tactical reasoning**
  - System level mobility
  - Dynamic vehicle response
- **Embedded Prognostics and Diagnostics**
  - UGV unique