



# TACOM-TARDEC

## Tech Base Plan

### Supporting FCS



*Committed to Excellence*

Report Documentation Page		
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<b>Number of Pages</b> 24		



# FCS Ground Systems Technologies



**FCS**  
Combat Vehicle  
Concepts

Roger Halle  
IV.GC.1998.01

**CHPS**

Eugene Danielson  
IV.GC.1999.01

**FCS**  
Concept Studies

Paul Wilson  
III.GC.2000.03

**21<sup>st</sup>**  
**CENTURY**  
**TRUCK**

Nancee Halle  
IV.GC.2000.01

**Ground  
Propulsion  
& mobility**

Dan Herrera  
III.GC.1996.01

**Robotic  
Follower  
ATD**

Bruce Brendle  
III.GC.2000.04

**Laser  
Protection**

Doug Templeton  
IV.GC.1997.02

**FCS**  
Engine  
Technology

Charlie Raffa  
TAR-01

**FSCS**  
**ATD**

John Torvinen  
III.GC.1997.01

**BALLISTIC  
PROTECTION**

Doug Templeton  
IV.GC.2000.02

**Water  
Purification**

Bob Schalewitz  
IV.LG.2000.04

**WHLS**

John Appel  
TAR-02

**Near Term  
APS**

Charles Acir  
III.GC.2001.02

**POL  
ANALYZERS  
& SENSORS**

Steve Moyer  
IV.LG.2000.03

**CAT  
ATD**

Bruce Brendle  
III.GC.1999.02

**Full Spectrum  
AP**

Jim Soltesz  
III.GC.1999.01

**TACTICAL  
FUELS**

Luis Villahermosa  
IV.LG.2000.02

**ADVANCED  
BRIDGING**

Dural Horton  
IV.EN.2000.01

**FCS**  
**SIGNATURE  
MANAGEMENT**

Dave Thomas  
III.GC.2001.01

**OBSTACLE  
MARKING**

Andrew Culkin  
IV.EN.2000.02



# Technology Areas STOs & ATDs



## **FSCS**

III.GC.1997.01

Future Scout Cavalry System

## **SYSTEMS / CONCEPTS**

IV.GC.1998.01

Combat Vehicle Concepts & Analysis

IV.GC.2000.01

Concepts for 21st Century Truck-Based Tactical Vehicles

III.GC.2000.03

Future Combat Systems

## **SURVIVABILITY**

IV.GC.1997.02

Laser Protection for Ground Vehicle Vision Systems

III.GC.1999.01

Full Spectrum Active Protection (FSAP)

III.GC.2001.02

Survivability Technology Integration Program

IV.GC.2000.02

Ballistic Protection for FCS

III.GC.2001.01

Signature Management for FCS

## **VETRONICS**

III.GC.1999.02

Crew Integration and Automation Testbed (CAT) ATD

## **CHASSIS / STRUCTURE**

TAR-02

Warfighter / Hardware in the Loop Simulation

## **PROPULSION**

III.GC.1996.01

Ground Propulsion and Mobility

TAR-01

FCS Engine Technology

## **RUNNING GEAR**

IV.GC.1999.01

Combat Hybrid Power System (CHPS)

## **ROBOTICS**

III.GC.2000.04

Robotic Follower ATD

## **GROUND -LOGISTICS**

**SUPPORT** IV.LG.2000.02

Advanced Tactical Fuels & Lubricants

**LOGISTICS** IV.LG.2000.03

Petroleum, Oil & Lubricants (POL) Quality Analyzers & Sensors

IV.LG.2000.04

Water Purification Technology

**-ENGINEER**

IV.EN.2000.01

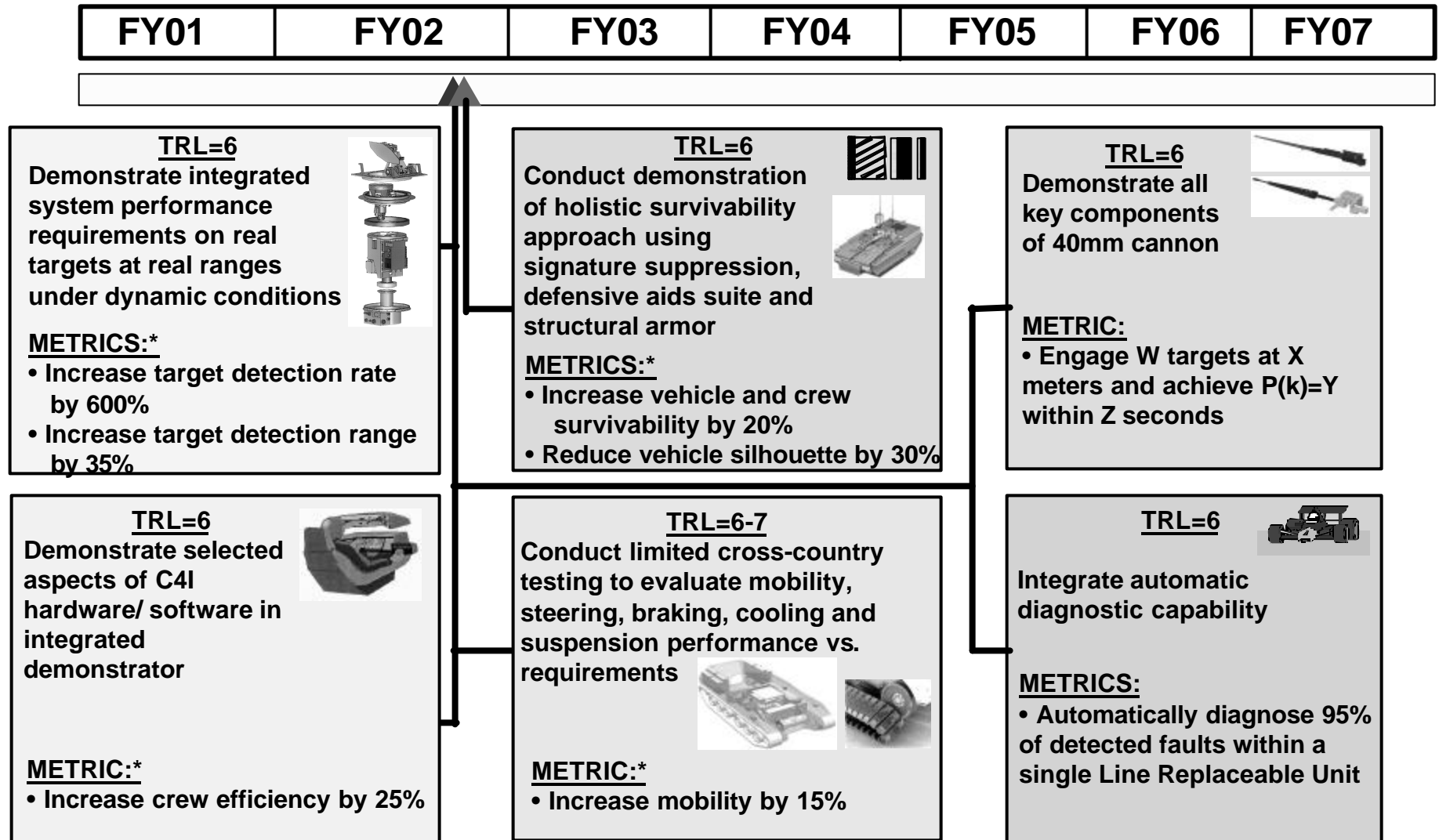
Advanced Bridging Virtual Prototyping Technology

IV.EN.2000.02

Obstacle Marking and Vehicle Guidance



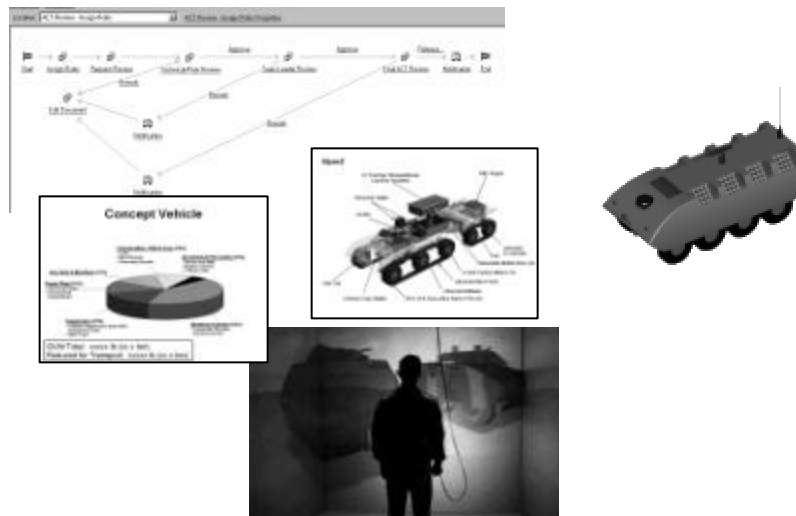
## Future Scout and Cavalry System ATD (TARDEC III.GC.1997.01)



\* Using the Bradley M3A3 as a baseline

# Program Concept Chart

## Combat Vehicle Concepts and Analysis (IV.GC.1998.01)



Open, non-proprietary concept approaches for technologies, program analysis and User requirements

### Pacing Technologies:

- Integration of advanced technologies into a C130 deployable platform meeting user requirements
- Realistic assessment of advanced concepts and technologies
- Depiction of concept functionality in a realistic, immersive environment
- Development of an advanced concepts Integrated Data Environment

### Other STO Attributes:

- Nominate as DTO: No
- Nominate as Intl Prog: Some program data covered under US/UK IEA
- Expected MNS/ORD Date: Draft FCS MNS
- Manufacturability/Producibility: Considered in concept design and IDE

Affordability Metrics: Affordability metrics from programs impact the concept design and technology selection

### Technology Protection Plan

Is it required? Yes

### Modeling and Simulation

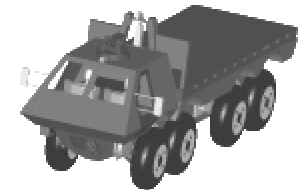
- Products, Way Ahead: CAD Concepts, Performance and Cost Analysis, Operational Effectiveness Analysis
- Interface/Integration: System Concepts/IDE
- Interface with TRAC: Coordination of CASTFOREM Analysis and thru FCS IPT process

# Program Concept Chart

## Concepts for 21st Century Truck-based Tactical Vehicles

(IV.GC.2000.01)

**Objective:** Using virtual prototyping, modeling, and simulation in an Integrated Data Environment (IDE) demonstrate the technical feasibility and operational potential of advanced commercial and military technologies with application to new and existing tactical vehicles and describe the capabilities of potential future tactical vehicles.



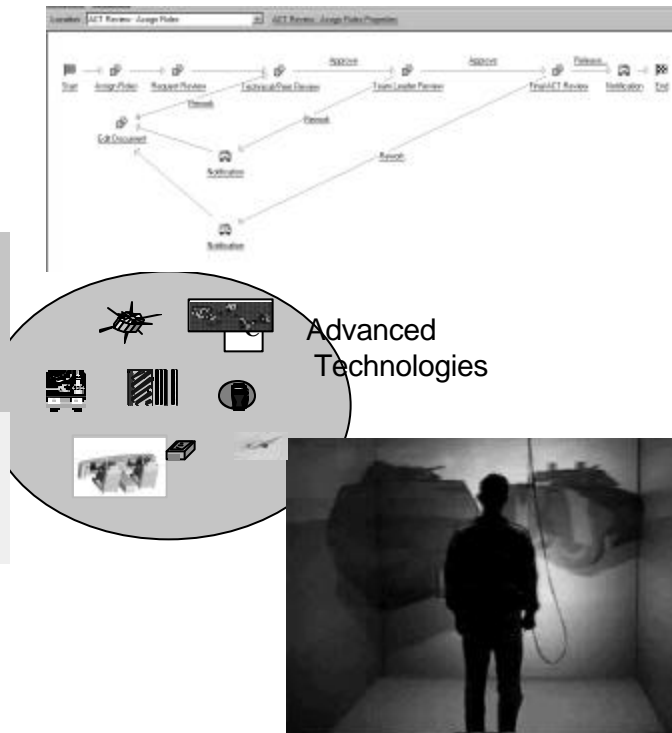
### Pacing Technologies:

Integration of advanced technologies into a vehicle platform meeting the operational and performance requirements

- Status of development of advanced technologies necessary to meet the performance goals of future logistic support platforms

Depiction of concept functionality in a realistic immersive environment

- Proliferation of tools necessary to fully implement the Integrated Data Environment



### Warfighter Payoffs:

- The Objective Force requires a major change in tactics for support of the FCS. Using the IDE, this STO will determine the effectiveness of existing tactical vehicles, upgrades or new-start vehicle programs to provide that support, assist in determining requirements and provide solutions to any shortfalls in capabilities.

**Leap ahead innovation in determining User requirements and integrating advanced technologies to revolutionize Objective Force logistic support**



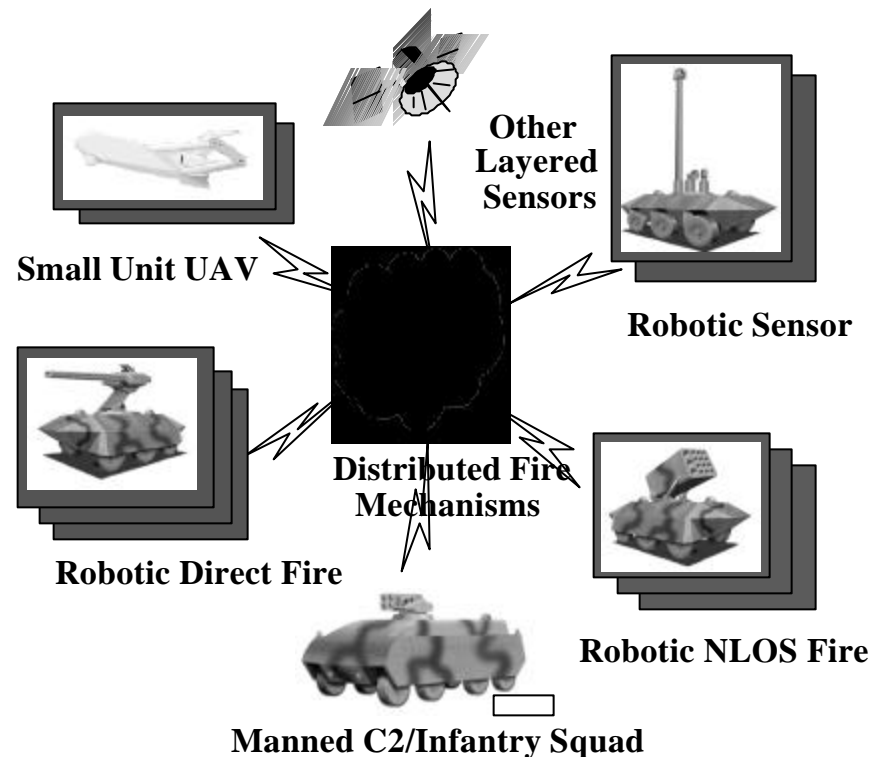
# Future Combat Systems

(III.GC.2000.03)



**Objective:** Develop and demonstrate lightweight, multi-mission capable, overwhelmingly lethal, yet strategically deployable, self-sustaining and survivable system of systems which meets the requirements of the Army for 2010 and beyond.

## The Transformation... Network Centric Distributed Force



### Pacing Technologies:

Robotics - teleoperated to autonomous

Unmanned aerial and ground vehicles

Sensors for detection, ID, targeting, Battlefield Damage Assessment

Lethality - Advanced cannon and missile systems, directed energy, non-lethals

### Warfighting Payoffs:

- Meet Army requirements for 2010 and beyond
- Strategic Deployability with C130 Assets
- Dominant Overmatch against all 21st Century Threats
- Lower sustainment cost



# Laser Protection for Ground Vehicle Vision Systems TARDEC/NSC/ARL IV.GC.1997.02

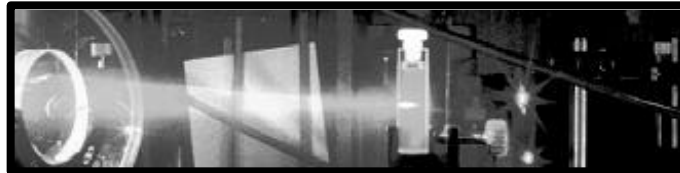
## Initiative:

Prevent Blindness to Combat Vehicle Crewmen From Laser Weapons

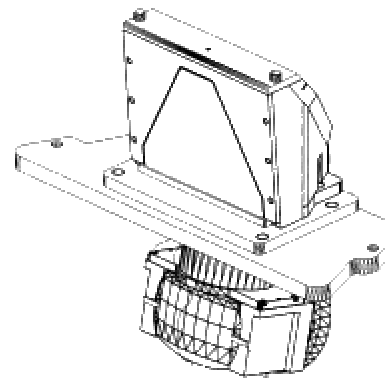
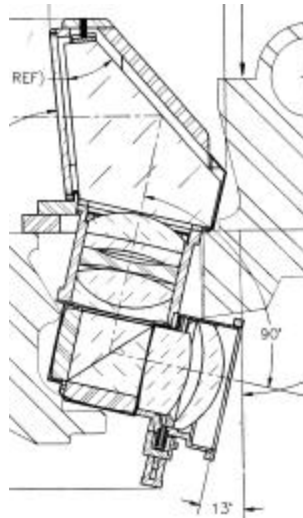
## Performance:

- ✓ Protects retina from damage for most engagement scenarios
- ✓ Significant reduction of threat effective range

Start TRL: 2



End TRL: 5



## Transition/Application:

- Application appropriate to all military day optical systems
- Further development and cost reduction is required

## Payoff:

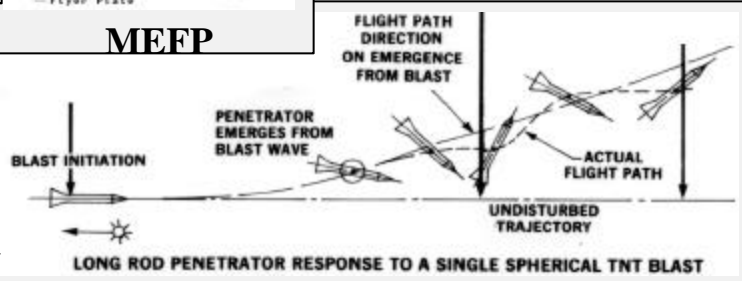
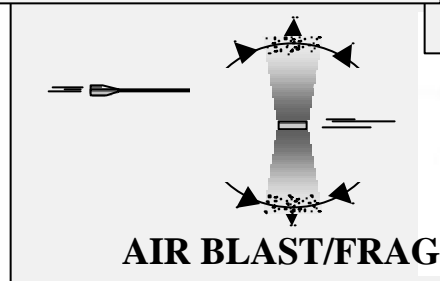
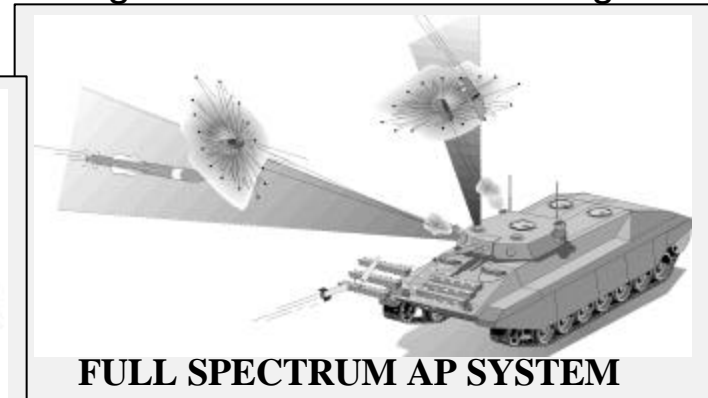
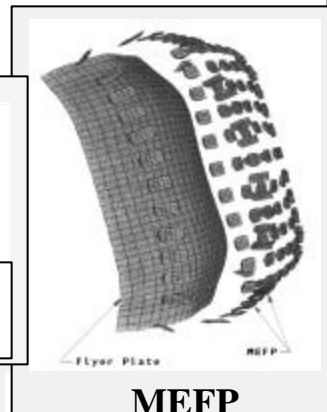
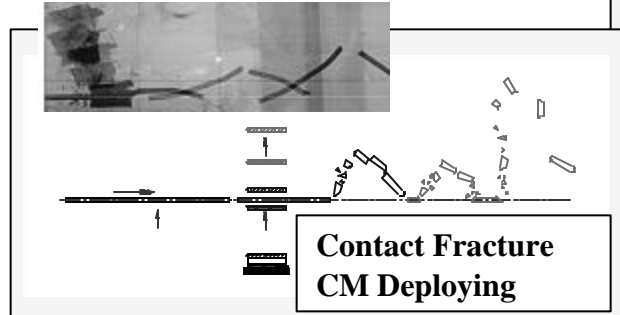
- - Survivability

# Full Spectrum Active Protection

(STO III.GC.1999.01)

## Objective:

To deliver a FSAP system design which provides hemispherical protection for light, medium and heavy ground combat vehicles against all large caliber threats including tube launched KE and HEAT



## Technologies:

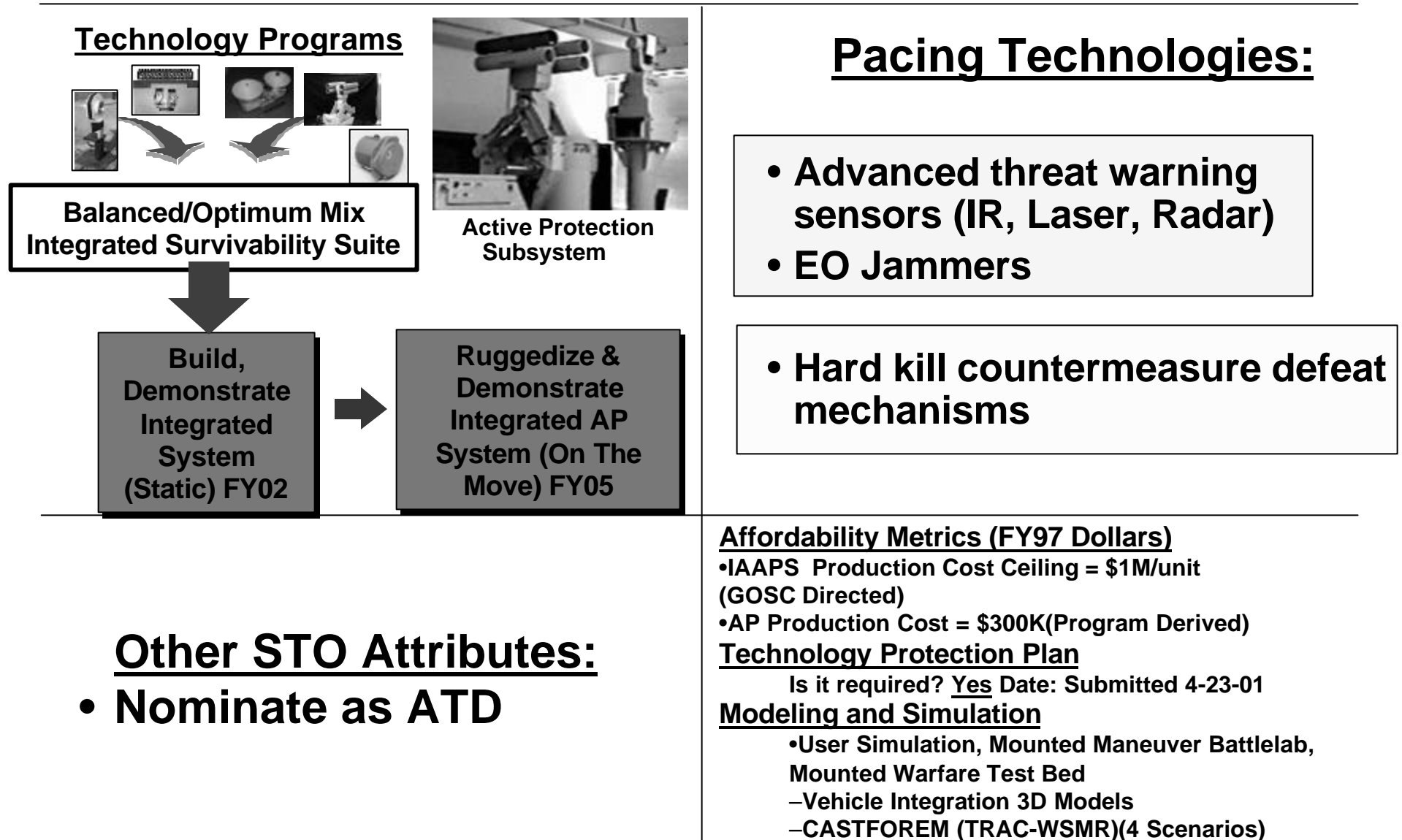
- CM's focused on combined CE & KE defeat
  - Blast/Frag
  - Contact Fracture
  - Multiple Explosively Formed Penetrators (MEFP)
- Optimal insertion through CDA

## Warfighter Payoffs:

- Minimum Wt./Deployability
- Cost Effective
- Crew Protection
- Integrable on FCS & Existing Fleet

# INTEGRATED ARMY ACTIVE PROTECTION SYSTEM ATD

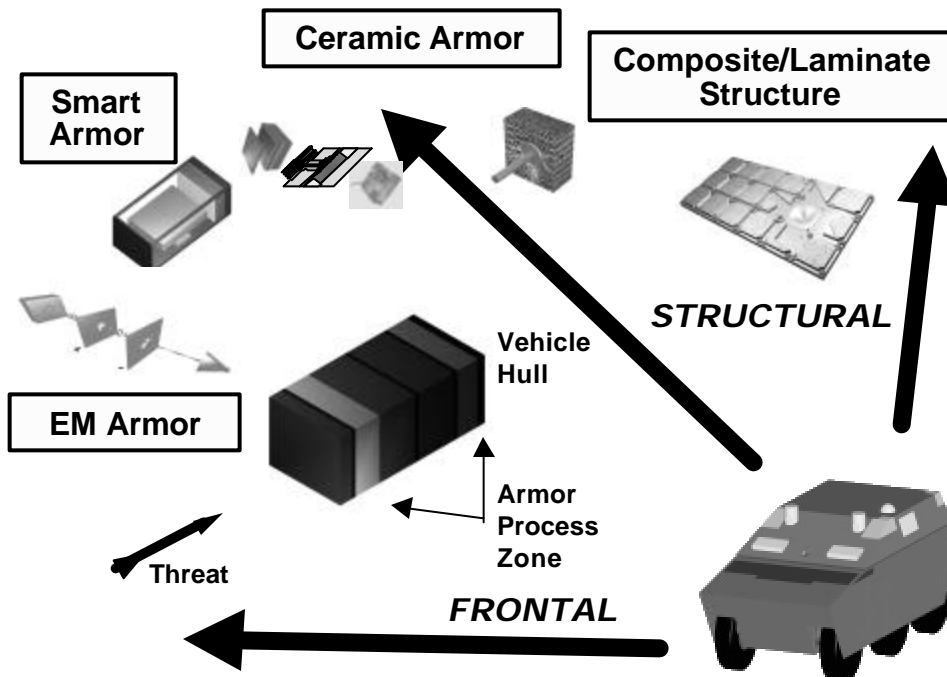
STO III.GC.2001.02





# Ballistic Protection for FCS

## (IV.GC.2000.02)



**Objective:** Protection against medium threats and residual debris in light (C-130 transportable) ground combat vehicles.

### Pacing Technologies:

- Compact embedded sensors
- Responsive, robust defeat mechanisms
- Compact Energy Storage
- Affordable ceramics

### Other STO Attributes:

- DTO: part of GV.13
- Intl Prog: no
- Expected MNS/ORD Date:
- Manufacturability/Producibility
  - Low cost ceramics

### Affordability Metrics

FCS Unit Cost (Normalized to current) - 1.0

### Technology Protection Plan

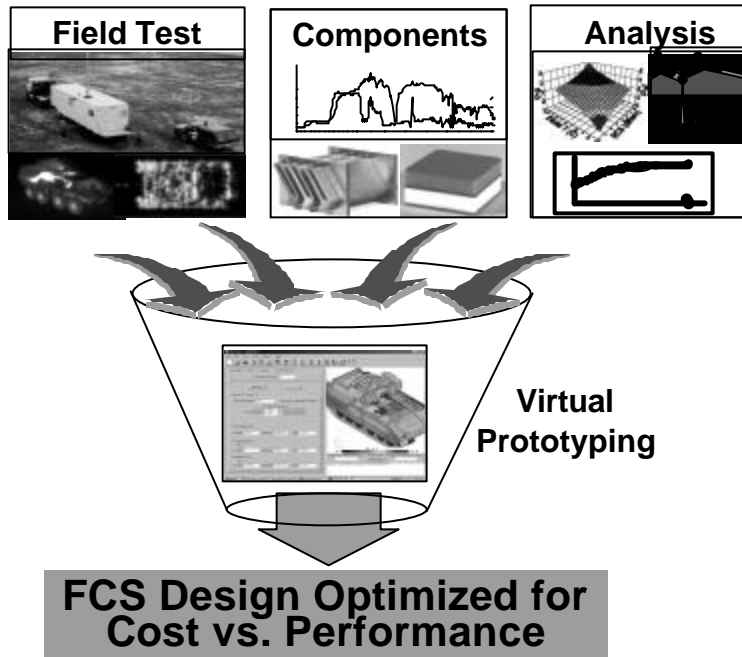
Is it required? Yes Date: in process

### Modeling and Simulation

- Improved material models for use in CTH, EPIC
- Cost vs. design models
- Avail. To PM, FCS in FY04

# Signature Management for FCS

## (III.GC.2001.01)



### Pacing Technologies:

- **Advanced materials & components**
  - Reduce cost & weight per vehicle.
  - Improve treatment durability & performance.
- **Signature modeling & characterization**
  - Predict performance of advanced treatments.
  - Trade off performance features in virtual space.
- **Vehicle optimization using virtual tools**
  - Virtual Integration of advanced treatments.
  - Determine optimal FCS configurations.

### Other STO Attributes:

- Provide virtual tools required for EMD phase.
- Utilize Tech Base & Contractor technologies.
- Expected MNS/ORD Date: FY05
- Manufacturability/Producibility of advanced materials will be developed during the STO.

### Affordability Metrics

\$200K per vehicle cost goal by end FY05

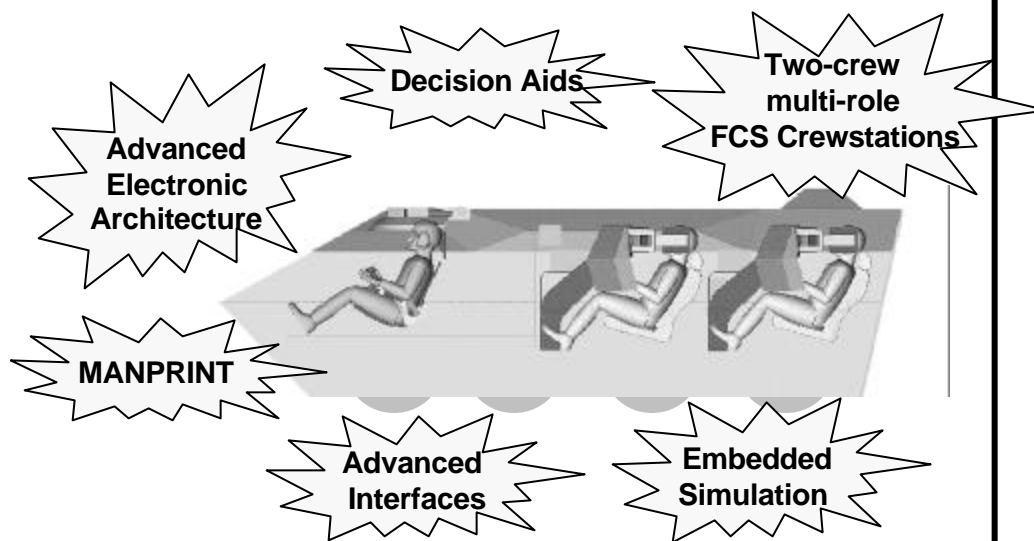
### Technology Protection Plan

Is it required? Yes Date: EMD FY06

### Modeling and Simulation

- Integrate vehicle design & signature models.
- Interface/Integration of vehicle design geometries.
- Develop force on force scenarios with TRAC.

# Crew integration and Automation Testbed (CAT) ATD (STO III.GC.1999.02 )



Concept Vehicle Shown with Onboard Safety Driver

**Demonstrate the crew interfaces, automation, and integration technologies required to operate and support Future Combat Systems**

## Pacing Technologies:

Decision Aids

Soldier-Machine  
Interface

Embedded Simulation

Electronics  
Architecture

## Warfighter Payoffs:

- *Enhanced performance, and survivability of the crew.*
- *Potential for reduced crew size (smaller, more transportable vehicles with lower logistics).*
- *Mission rehearsal capability*

## Affordability Metrics

500k Reusable SLOC Generated

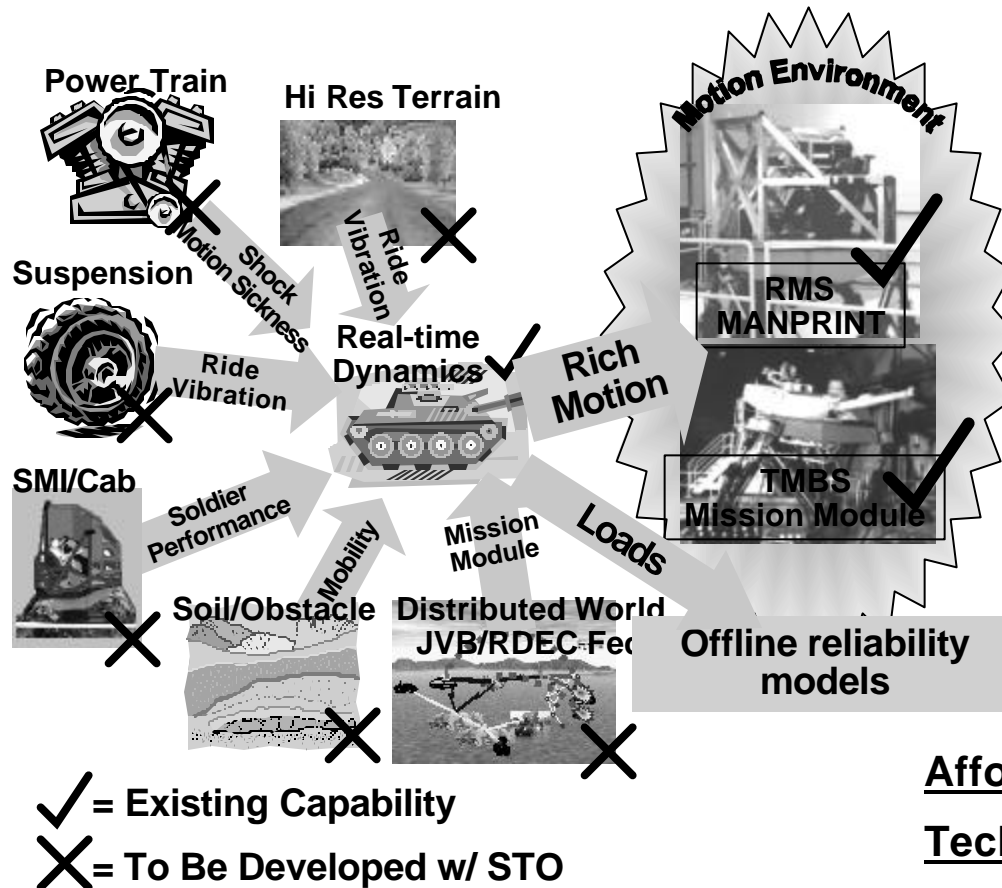
## Technology Protection Plan

Not Required.

## Modeling and Simulation

- April 2003 System Integration Laboratory
- Virtual Experiments of CAT Technologies

# Warfighter/Hardware in the Loop Simulation (WHLS) (TAR-02)



## Pacing Technologies:

Subsystem Models  
High Resolution Terrain, Soil, and Obstacle Models

FCS World Model/  
Distributed Simulation  
Crew Cab Enhancements

## Affordability Metrics

## Technology Protection Plan

Is it required? No Date: \_\_\_\_\_

## Modeling and Simulation

- STO will result in Virtual FCS platforms
- Simulation Support Plan will be developed



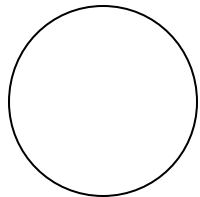
# Ground Propulsion and Mobility (III.GC.1996.01)

## Initiative:

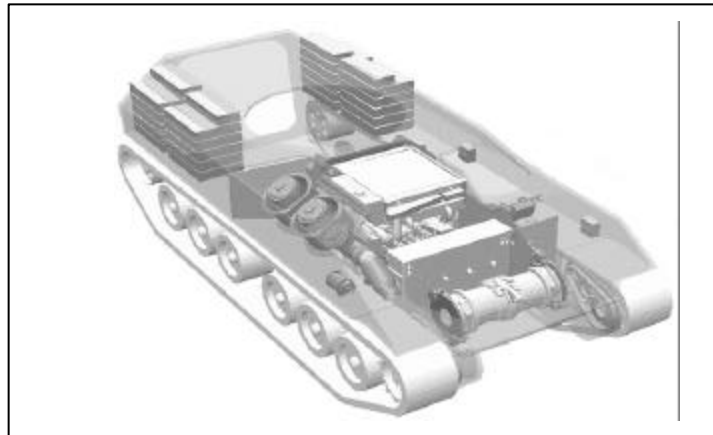
Explore and Develop Emerging Ground Vehicle Mobility Advances for future Combat and Tactile Vehicle Fleets through Cooperative Agency Electric Drive Research and High Performance Track and Suspension Technology Developments.

## Performance:

- ✓ Hybrid Electric Drive Advanced Technology Demonstrator
- ✓ Band Track
- ✓ In-Arm External Semi-Active Hydropneumatic Suspension
- ✓ Electromechanical Suspension



**Start: TRL 3**  
**End: TRL 7**



## Transition/Application:

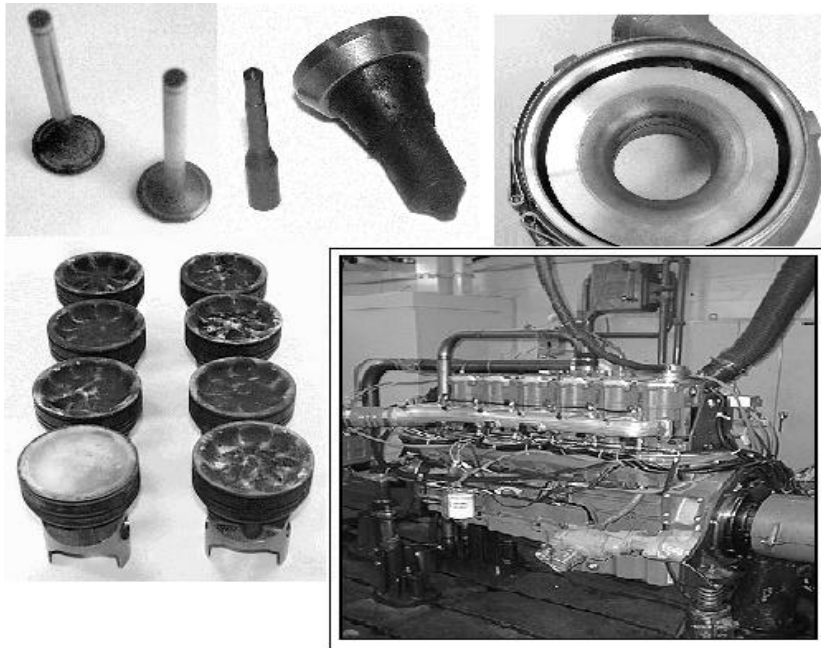
- ✓ Future Combat System
- ✓ Future Scout and Calvary System
- ✓ Crusader

## Payoff:

- Light forces more survivable and tactically mobile.
- Reduce deployed logistics footprint.



# TAR-01 FCS ENGINE TECHNOLOGY



## Pacing Technologies:

- High-pressure, common rail, flexible control fuel injection systems
- High temperature coolants and variable flow coolant pump
- Synthetic lubricants and wear coatings
- Ceramic monolithic and thermal barrier coating materials and high-temp metal alloys

## Other STO Attributes:

- DTO GV.04 Advanced Ground Vehicle Mobility Systems
- Intl. Prog - Front End is Part of US/Japan Cooperative Research Program
- Manufacturability/Producibility - To be part of new contract. Initial producibility demonstrated in cooperative effort.

Affordability Metrics - To be part of new contract. Target less than \$75/HP

Technology Protection Plan : OPSEC review procedure in place for US/Japan Cooperative Research since OCT 95.

Modeling and Simulation: FEM and Computational Fluid Dynamics Model used in conjunction with fuel injection/combustion analysis and ceramic component design. No models will be included in deliverables.

# COMBAT HYBRID POWER SYSTEMS (CHPS) (STO: IV.GC.1999.01)

While the commercial automotive sector is making significant progress in advanced mobility technologies, military mobility requirements remain unique.



Combat Hybrid Power System (CHPS)  
Notional Concept Vehicle

≠



Honda *Insight*, Hybrid-Electric



Toyota *Prius*, Hybrid-Electric

## Other STO Attributes:

- CHPS DTO is GV.16

## Pacing Technologies

- |   |
|---|
| <ul style="list-style-type: none"><li>• Pulse Forming Network (PFN)</li><li>• Li-ion Batteries</li></ul>          |
| <ul style="list-style-type: none"><li>• SiC switching devices</li><li>• Multi-GW Multi-MJ Flywheel</li></ul>      |
| <ul style="list-style-type: none"><li>• Ultra-capacitors</li><li>• Hi power density traction motor</li></ul>      |
| <ul style="list-style-type: none"><li>• Differential torque steer</li><li>• Shock tolerant wheel motors</li></ul> |

## Technology Protection Plan

CHPS is unclassified

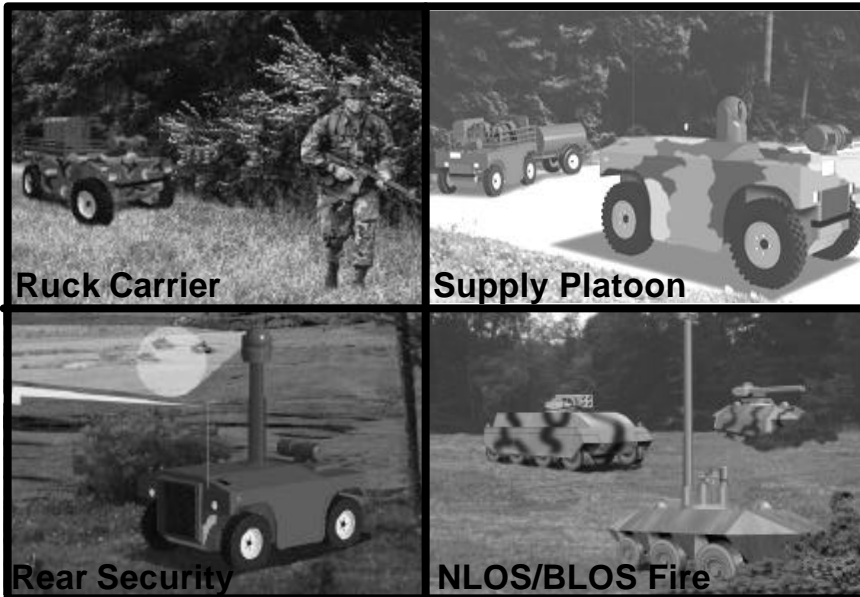
## Modeling and Simulation

Developed System Integration Model

- drive topology
- pulse loads
- power management
- fuel economy
- component life and reliability

# Robotic Follower ATD

(STO III.GC.2000.04 )



## *Demonstrate Robotics Technology Required for Early Insertion*

### Solution Approach

- *Manned leader "proofs" path to reduce perception & intelligence requirements*
- *Rapidly mature & integrate perception technology to enable higher speed & enhanced decision making capabilities*
- *Successively demonstrate maturing capability for FCS*

### Pacing Technologies:

Semiautonomous  
Perception

Soldier-Robot  
Interface

Intelligent Situational  
Behavior

Leader-Follower  
Technology

### Affordability Metrics

Total Sensor Cost <\$370k

### Technology Protection Plan

Not Required.

### Modeling and Simulation

- April 2003 M&S Demonstration of end ATD Exit Criteria
- Integrates mobility, sensor and terrain models



IV.LG.2000.02



# Advanced Tactical Fuels and

TARDEC

## Enhanced Lubricants

ADDITIVE  
ENHANCER



SYNTHETIC  
PRODUCTS



REFINERY  
PROCESS



FOR EXISTING,  
FUTURE, &  
AAN SYSTEMS

ENVIRONMENTALLY  
RESPONSIVE  
PRODUCTS

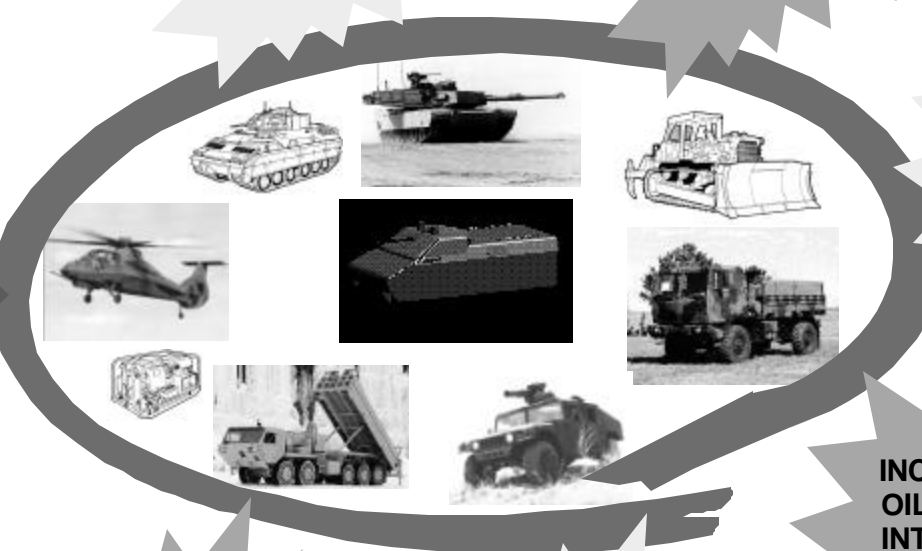
INCREASE  
FUEL  
EFFICIENCY

REDUCE  
MAINTENANCE  
COSTS

INCREASE  
OIL DRAIN  
INTERVAL

INCREASE  
OPERATIONAL  
RANGE

ENHANCE  
ENERGY  
CONTENT



MAY, 99

*Committed to Excellence*

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# POL Analyzer and Sensors

## (IV.LG.2000.03)

### ***Objective:***

- Investigate innovative applications of current and developing petroleum analysis technologies
- Leverage developmental work by DOE national labs

### **Pacing Technologies:**

- Transducers/sensors and MEMS
- Neural Network and Chemometric Software Development Tools
- Standard Diagnostic Information Architecture and Interfaces



### **Warfighter Payoffs:**

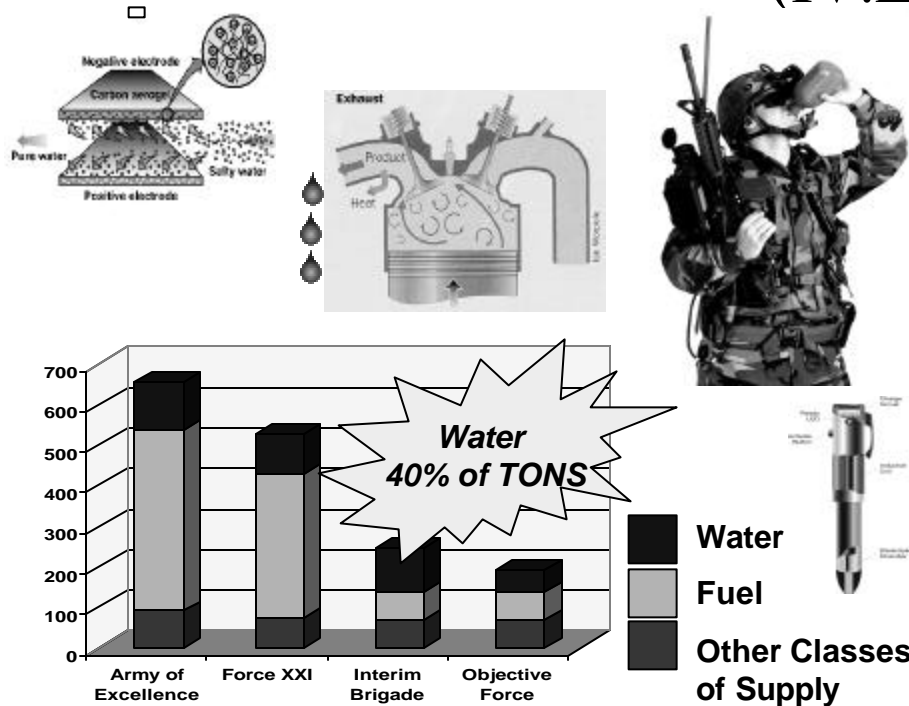
- Real Time Analysis
- Detect Impending Equipment Failures
- Unit Level Control of AOAP; Less Admin
- Reduced Logistics Footprint
- Sample Only As Needed

**Eliminate 80%or More Oil Samples**

# Program Concept Chart

## Water Purification Technology

(IV.LG.2000.04)



### Pacing Technologies

- Counter-Current Mesochannel Heat Exchanger
- Surface Modified Hydrophilic Activated Carbon
- Flow Through Capacitor
- Advanced Reverse Osmosis
- Forward Osmosis
- Electrolytic Disinfection

### Other STO Attributes:

- Nominate as DTO: Yes
- Nominate as Intl Prog: No
- Expected MNS/ORD Date:
  - Water Individual Purification System, ORD, Apr 93
  - Onboard Water Recovery Unit, MNS, Aug 91
  - Water Generation/Sustainment Component in FCS and other MNS/ORDS
- Manufacturability/Producibility: Trade-off Analysis On-going

### Affordability Metrics

Cost Versus Materials and Functions On-going Analysis

### Technology Protection Plan

Is it required? No

### Modeling and Simulation

- Computational Fluid Dynamics Modeling
- Heat Transfer/Pressure Drop Modeling
- Systems Level Modeling & Analysis

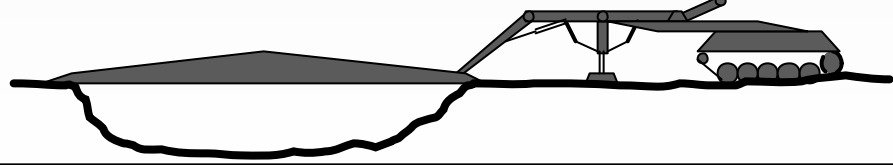
# Virtual Prototyping of Advanced Bridging Technologies

## (IV.EN.2000.01)

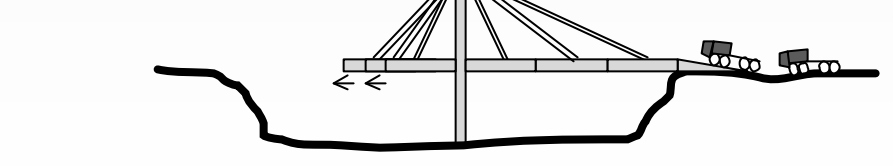
### Longer Bridges from Multiple Shorter Bridges



### Counterbalance Weight Reduction



### New Designs



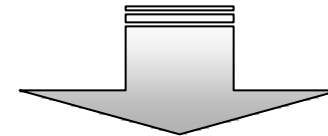
### Pacing Technologies:

Database of composite bridge performance:  
Composite Army Bridge

*Designs of effective new launching techniques*

*Designs based on new materials (composites & exotic metallics)*

*Database of effective weight reduction methodologies*



*Synthesize activities, refine for applicability to future requirements*

### Other ATD Attributes:

- Nominate as DTO: NA
- Nominate as Intl Prog: NA
- Expected MNS/ORD Date: NA
- Manufacturability/Producibility: NA

### Technology Protection Plan

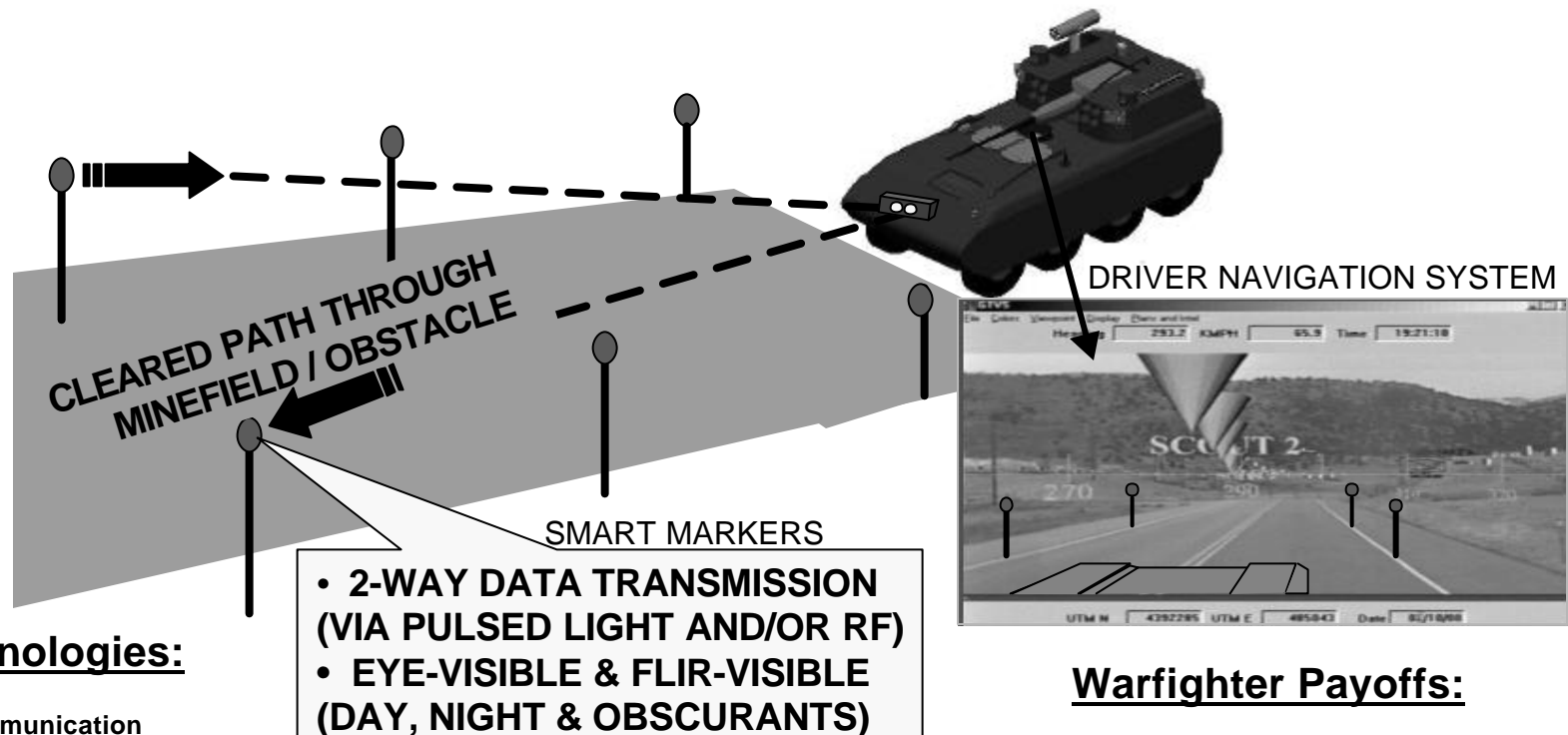
Is it required? No Date: NA

### Modeling and Simulation

- Products, Way Ahead: No new software
- Interface/Integration: None
- Interface with TRAC: [?]

# OBSTACLE MARKING AND VEHICLE GUIDANCE (STO#: IV.EN.2000.02)

**Objective:** *Provide a system composed of virtual and smart markers that communicate with a vehicle based display enabling a driver to successfully navigate through or around obstacles thus providing the maneuver support the same inherent mobility traits as the maneuver force.*



## Pacing Technologies:

### SMART MARKER:

- Optical Communication
- Obscurants/Range
- Integration with Navigation System

### NAVIGATION SYSTEM

- Augmented Reality
- Critical Navigation +/-17cm
- All Weather Operation
- Communication with Smart Markers

## Warfighter Payoffs:

- Sustain Freedom of Maneuver
- Enhanced Situational Awareness
- Rapid Collection, Processing, and Dissemination of Topographic Information
- Enhanced Battlespace Visualization



# Summary

- *The path to Army Transformation demands responsive & deployable systems*
- ***TACOM S&T Focus** is on smaller, lighter, and smarter Munitions & Vehicles*
- *We are doing things that have never been done before*

