U.S. Army Research Laboratory

John M. Miller
Director

FCS Technology Insertion and Transition Panel

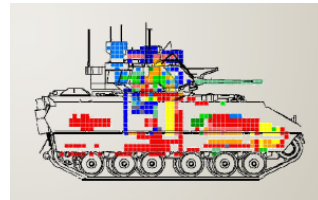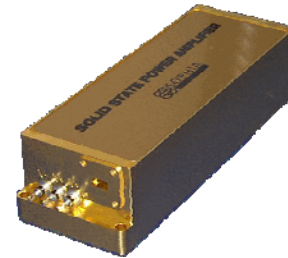**2006 Research Laboratory of the Year**

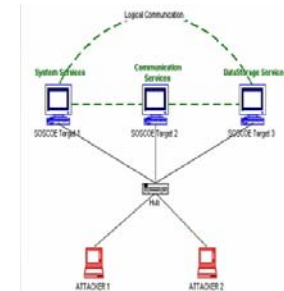# Army Research Laboratory Support to Future Combat Systems
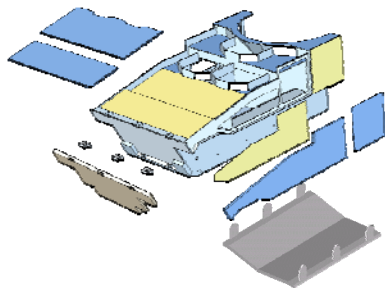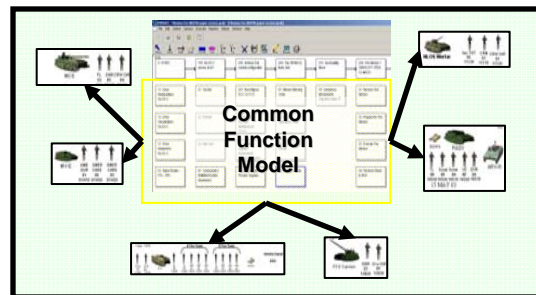
Crew Station Design

SLA Vehicle Design Support

Solid-State Power Amplifier

SOSCOE Information Warfare Analyses

Armor Technologies

Soldier Performance Prediction

Common Function Model

Tactical Wireless Network Assurance

Solid-State Power Amplifier (SSPA) for FCS SATCOM OTM (Vertex RSI system)

Purpose:

Create an SSPA "TWT replacement" for Army communications and sensor applications with:

- *Low cost, compact form factor, designed for manufacturability*
- *Increased ruggedness and power efficiency*
- *Modular architecture for rapid response to changing frequency and power requirements*

Approach:

*Coherent operation of up to eight commercial off-the-shelf (COTS) millimeter-wave integrated circuit (MMIC) amplifiers in a broadband, extremely low-loss waveguide combiner*

Payoff:

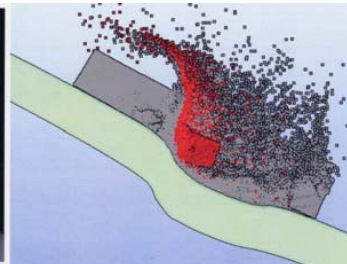- *2005 Army SBIR/STTR Phase II Quality Award*
- *Rugged, reliable Ka band power amplifier for warfighter satellite communications*
- *Selected by General Dynamics for insertion into FCS SATCOM OTM earth station (Vertex RSI system)*

Armor Technologies

FCS
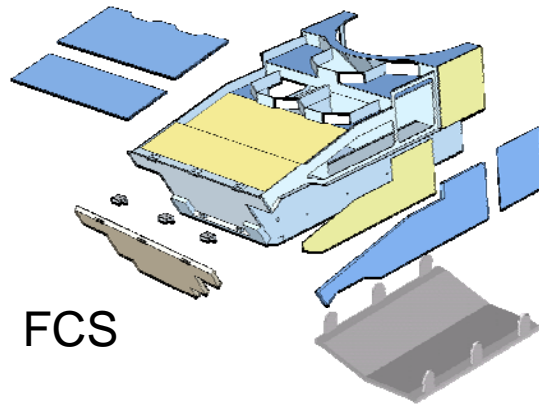
1 MeV X-Rays of Ballistic Experiments

Corresponding Numerical Simulations

Purpose:

- *In partnership with TARDEC, develop lightweight armor technologies and validate models for use by FCS to defeat Medium Caliber Automatic Cannon, Heavy Machine Gun (HMG), Artillery Fragments, IEDs, RPGs and bomblets*

- *Provide design guidance and protection strategies for mine blast protection*

Approach:

- *Couple advanced materials & lightweight structures with penetrator defeat mechanisms*

- *Validate weight and space efficient multi-functional armor technologies*

- *Develop statistically rigorous data to support models and design guidance*

Payoff:

- *Improved mobility and crew survivability for FCS vehicles at a reduced weight*

- *Transition to TARDEC for FCS and Current/Future Force tactical and logistic vehicles*

Tactical Wireless Network Assurance

Purpose:

In partnership with CERDEC, develop algorithms for wireless network protection solutions for tactical Mobile Ad-hoc Networks (MANETs)

Approach:

- *Algorithm development for detection of attacks on MANET routing involving multiple attackers*
- *Specialized clustering algorithms to create and maintain a dynamic hierarchy of intrusion detection components*
- *Analysis and assessment of intrusion detection algorithms to realistically emulate tactical MANETs*

Payoff:

- *Protect tactical MANETs from attacks*
- *Maintain Warfighter trust/confidence in battlefield information*
- *Reduce system and network vulnerabilities*
- *Enhance wireless network availability*
- *Transition through CERDEC to FCS*

Crew Station Design Needs for FCS Manned Ground Vehicles (MGV)

Sample Subject Eye-tracking Indirect Vision Driving (Pilot)

Sample Subject Eye-tracking Autonomous (Pilot)

Purpose:

In partnership with TARDEC, determine MGV crew station design and robotic interface needs

Approach:

- Quantify Soldier attention, workload, and performance through experimentation

- Optimize crew tasking through selective application of autonomous mobility technologies

- Develop embedded Soldier monitoring and evaluation capabilities in moving vehicles

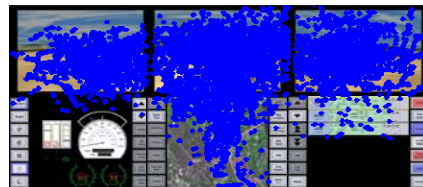- Evaluate specialized interface techniques for enhanced Soldier performance with robotic systems

Payoff:

Transitions to FCS crew station efforts:

- Indirect vision drive by wire systems designs

- Specialized operator control unit techniques

- Design guidelines for scalable robotic interfaces
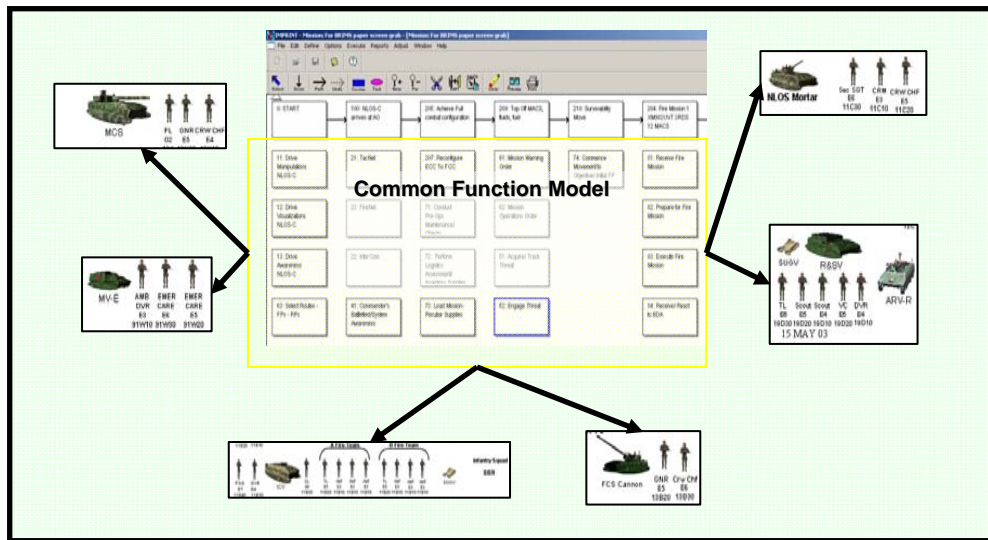
- Manual and supervisory robotic control methods

Soldier Workload and Performance Prediction

Common Function Model

MCS Crew Analysis

Commander - Driver and Gunner
Highest workload of all conditions

↓

Gunner - Driver and Commander
No shooting on the move

↓

Commander - Gunner and Driver
Best two crewmember function allocation; single vehicle commander

↓

Commander, Driver and Gunner
Two crewmembers scanning; allows hunter-killer philosophy

IMPRINT
Improved Manpower Personnel Research Integration Tool

Purpose:

Quantify impact of crew size, function allocation, and proposed technologies on Soldier mental workload and performance

Approach:

Used human performance modeling tools such as IMPRINT to identify potential high workload task combinations on a variety of FCS vehicles, e.g., Mounted Combat System (MCS), Non-Line-of-Sight Cannon (NLOS-C), and Infantry Carrier Vehicle (ICV)

Payoff:

Refinements in the FCS ORD:

- *MCS Crew changed from 2 to 3*

- *Request automated rearming of the NLOS-C*

- *"Hunter-Killer" requirements included for the MCS and ICV*

SLA Vehicle Design Support
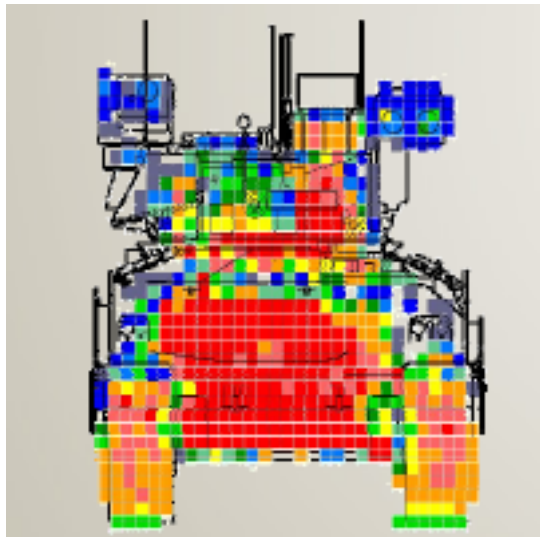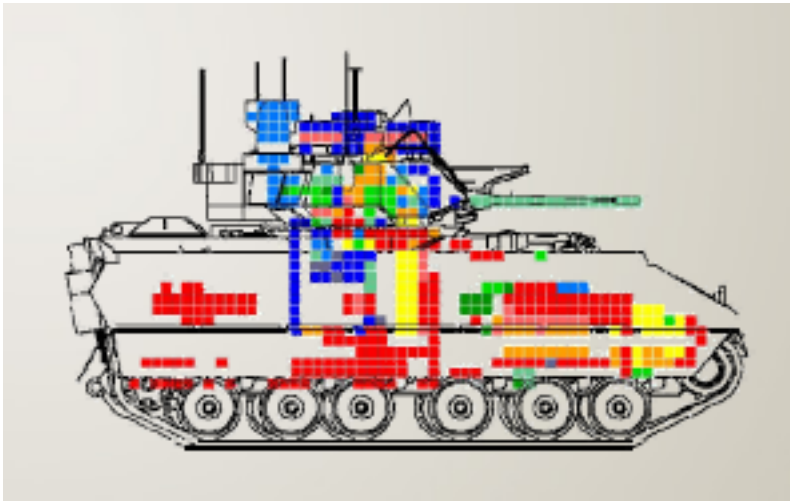
Purpose:

Collaborate with FCS platform vehicle integrators to:

- *Accomplish the Survivability Key Performance Parameters in balance with other design criteria such as weight, cost, performance, and reliability*

- *Decrease system and crew vulnerability by leveraging other proven vulnerability reduction techniques*

- *Increase crew survivability by using anti-fratricide and compartmental techniques on stowed munitions*

Approach:

Perform qualitative and quantitative analyses to identify potential vulnerabilities and recommend mitigation techniques.
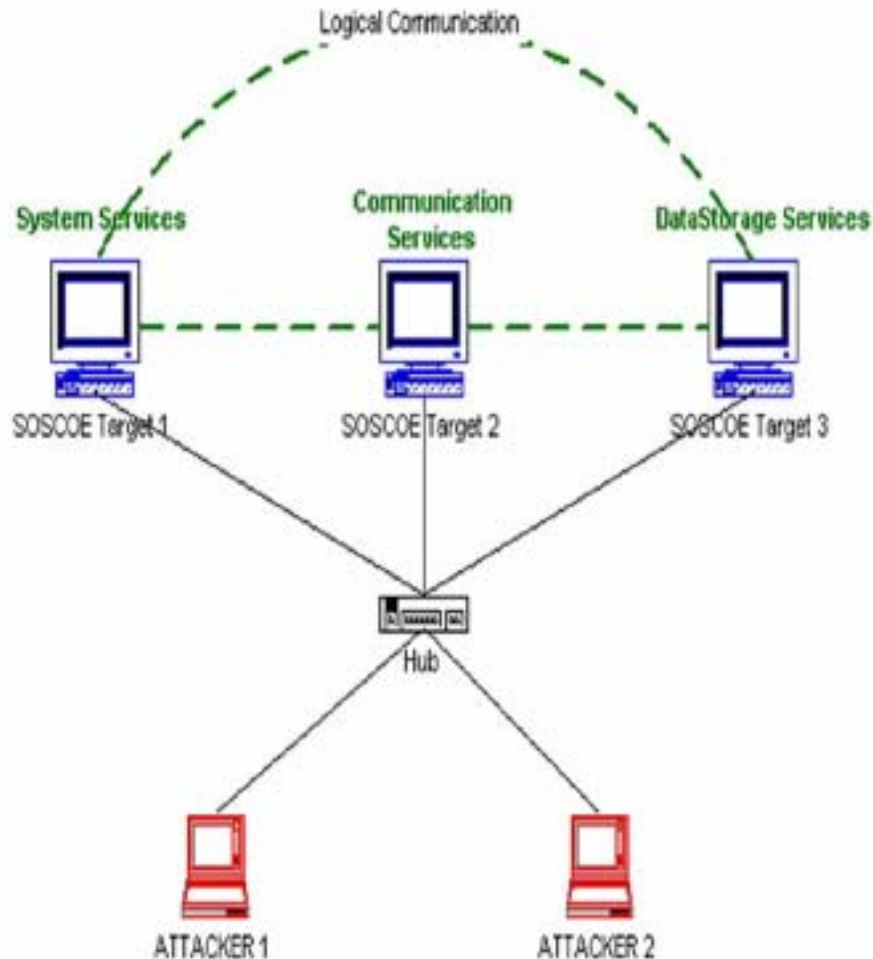
Payoff:

- *Increased platform survivability at greatly reduced cost over the development cycle of the system*

- *Transitions to FCS for Spin Out Insertions:*
  - *Advanced armors*
  - *Active protection*

System of Systems Common Operating Environment (SOSCOE) Information Warfare Analysis

Purpose:

Perform IW analyses of SOSCOE, its Intrusion Detection System and other systems.

- Determine IW vulnerabilities of SOSCOE 1.5.X
- Identify IA shortfalls
- Ensure IA measures are implemented in layers

Approach:

- Invoke IW threats against SOSCOE services and determine impact to communications between services. Use friendly (compliance) and hostile (penetration) assessment techniques
- Perform analytical study for conceptual solutions

Payoff:

- Identify IW shortcomings and mitigation techniques to enhance FCS survivability
- Provide input to FCS program for use in future SOSCOE builds, particularly 1.8.X and 2.0.X, which will be used in upcoming Spin Out activities