Challenges of Developing Unmanned Systems To Operate in a NetCentric Environment

Director
Technology Integration
Assessment and Futures

COL Cindy Bedell

Discussion Points

- Congressional Guidance
- Industrial and Military Standards
- The Challenge of Communications
- Mapping the Technology to Warfigher Needs
- Current Research Efforts

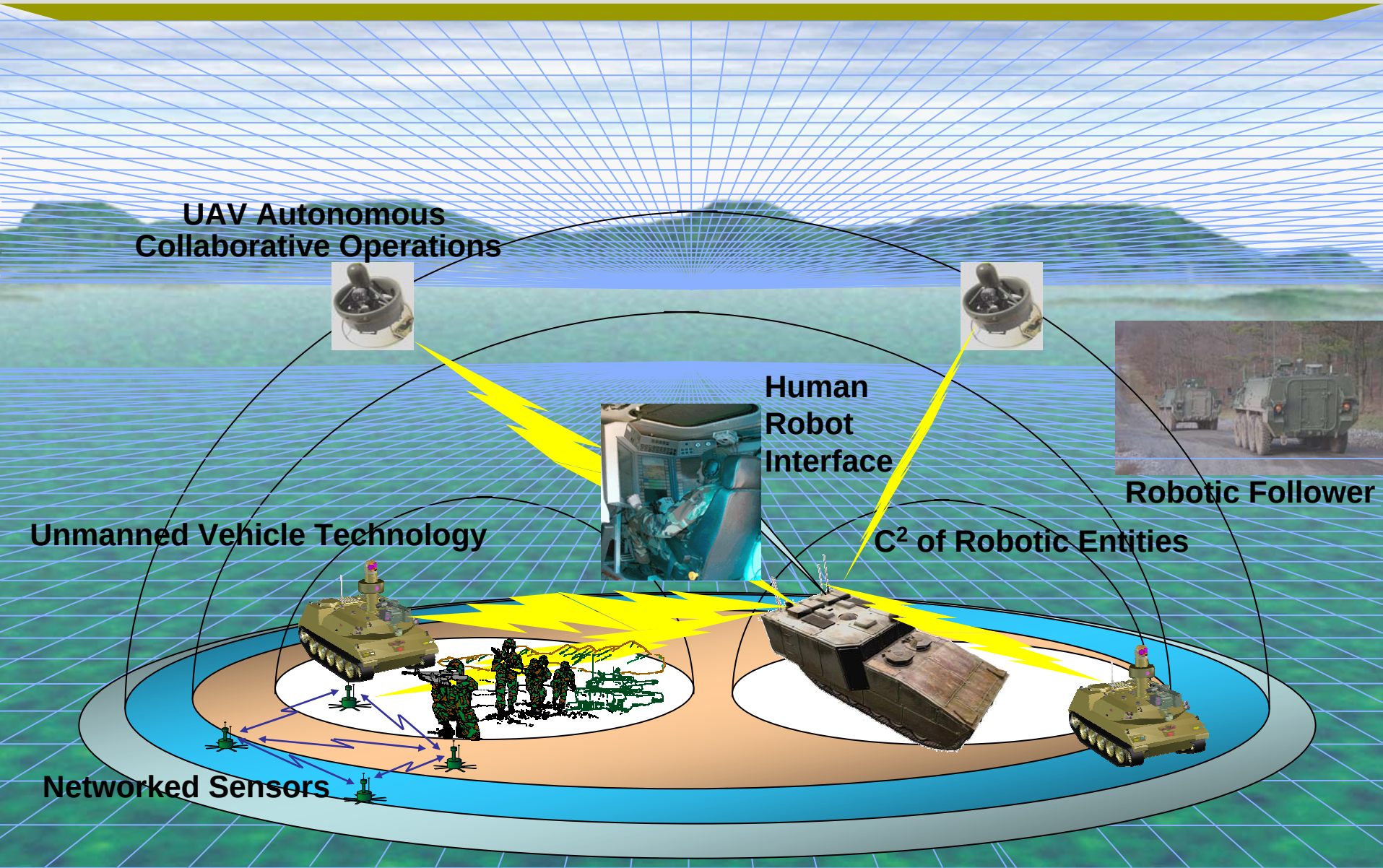
Call for Transformation with Robotics

It shall be a goal of the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that—by 2010, one-third of the operational deep strike aircraft of the Armed Forces are unmanned; and by 2015, one-third of the operational ground combat vehicles of the Armed Forces are unmanned.

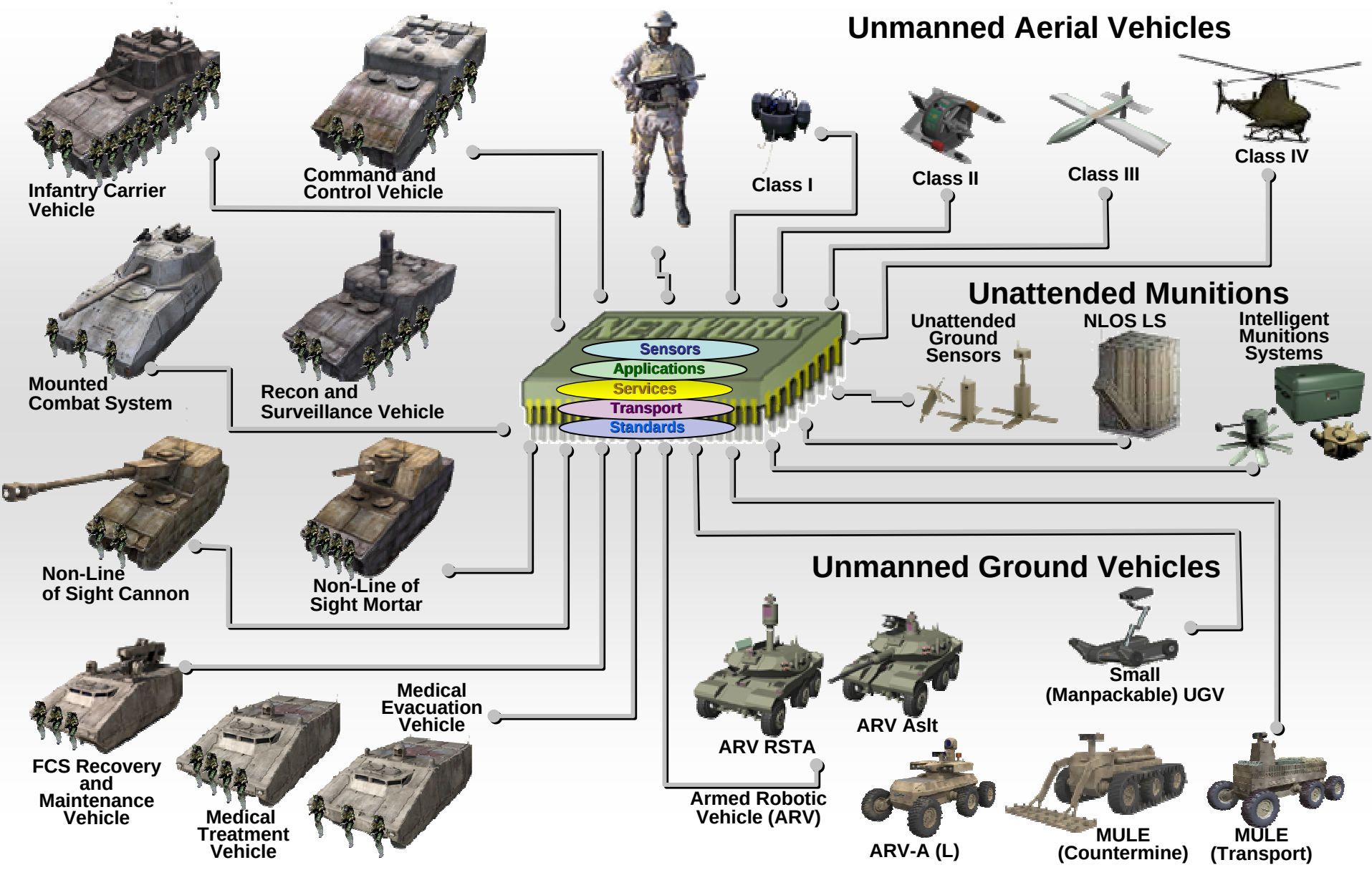
National Defense Authorization
Act for Fiscal Year 2001
H.R.4205, Sec. 220

Robotics Research & Development

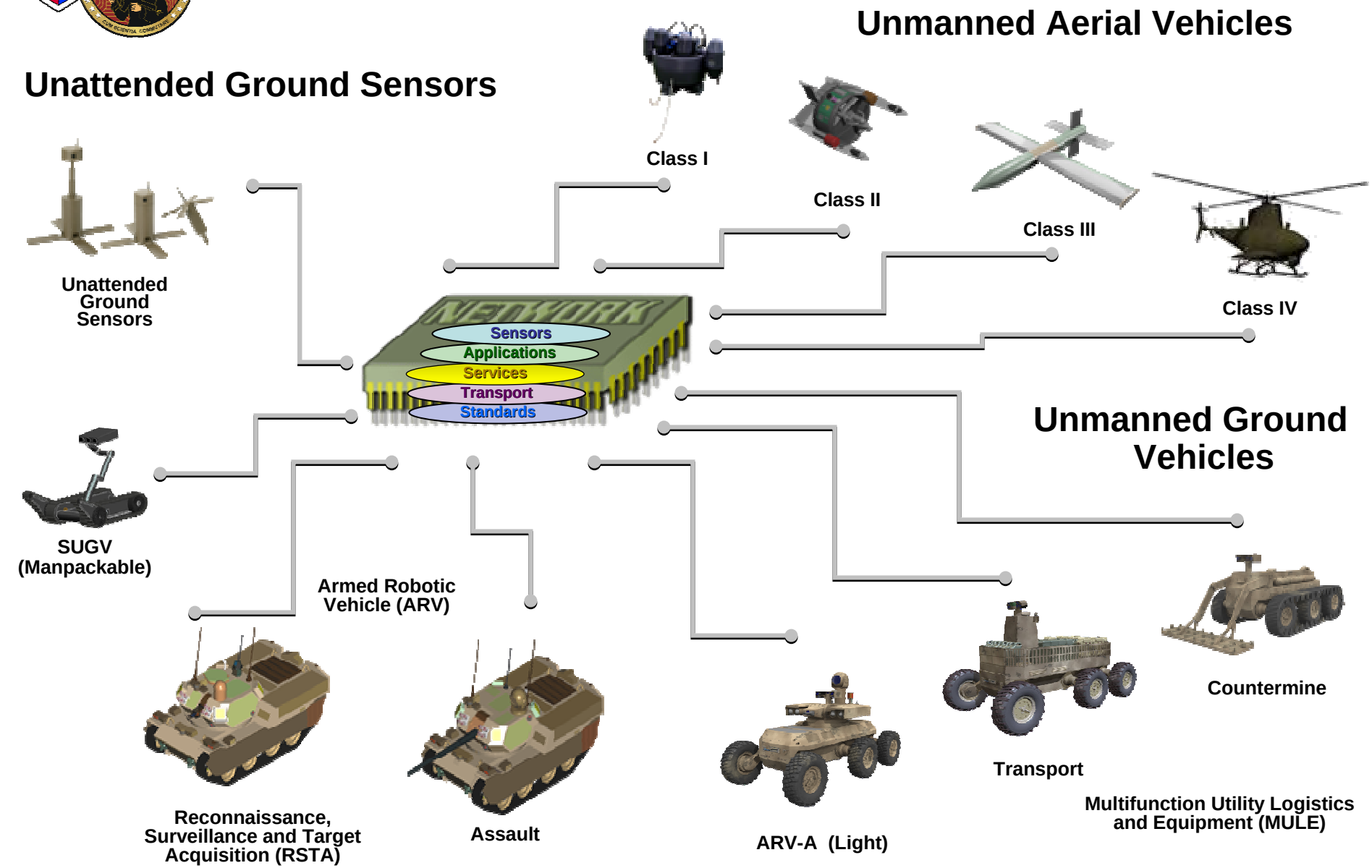
Technology for the Future Force



Future Combat System a System-of-Systems



Unmanned Systems – Key Part of FCS



Joint Architecture for Unmanned Systems

The Joint Architecture for Unmanned Systems addresses interoperability with an emphasis on the logical communications between heterogeneous computing systems used for Unmanned Systems command and control.

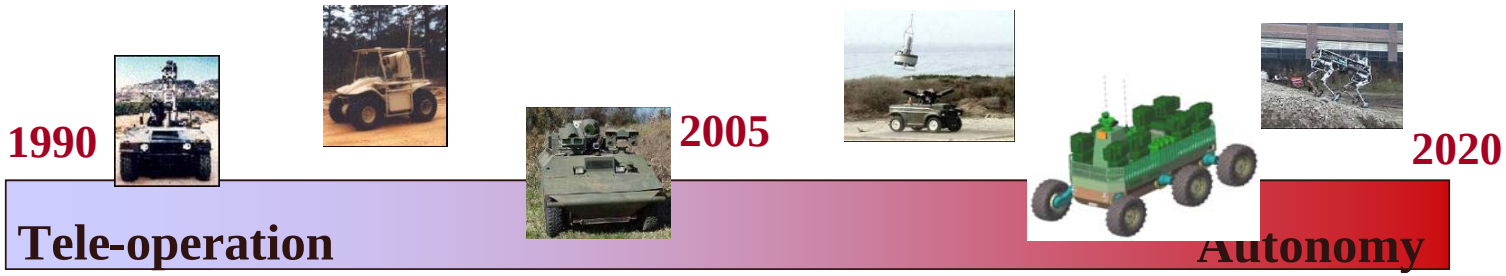
WWW.JAUSWG.ORG

JAUS Migrating to SAE

The Aerospace Council of the Society of Automotive Engineers (SAE) has voted to establish AS-4, an Unmanned Systems Standards Committee. JAUS will become an Aerospace Standard within the next twelve months.

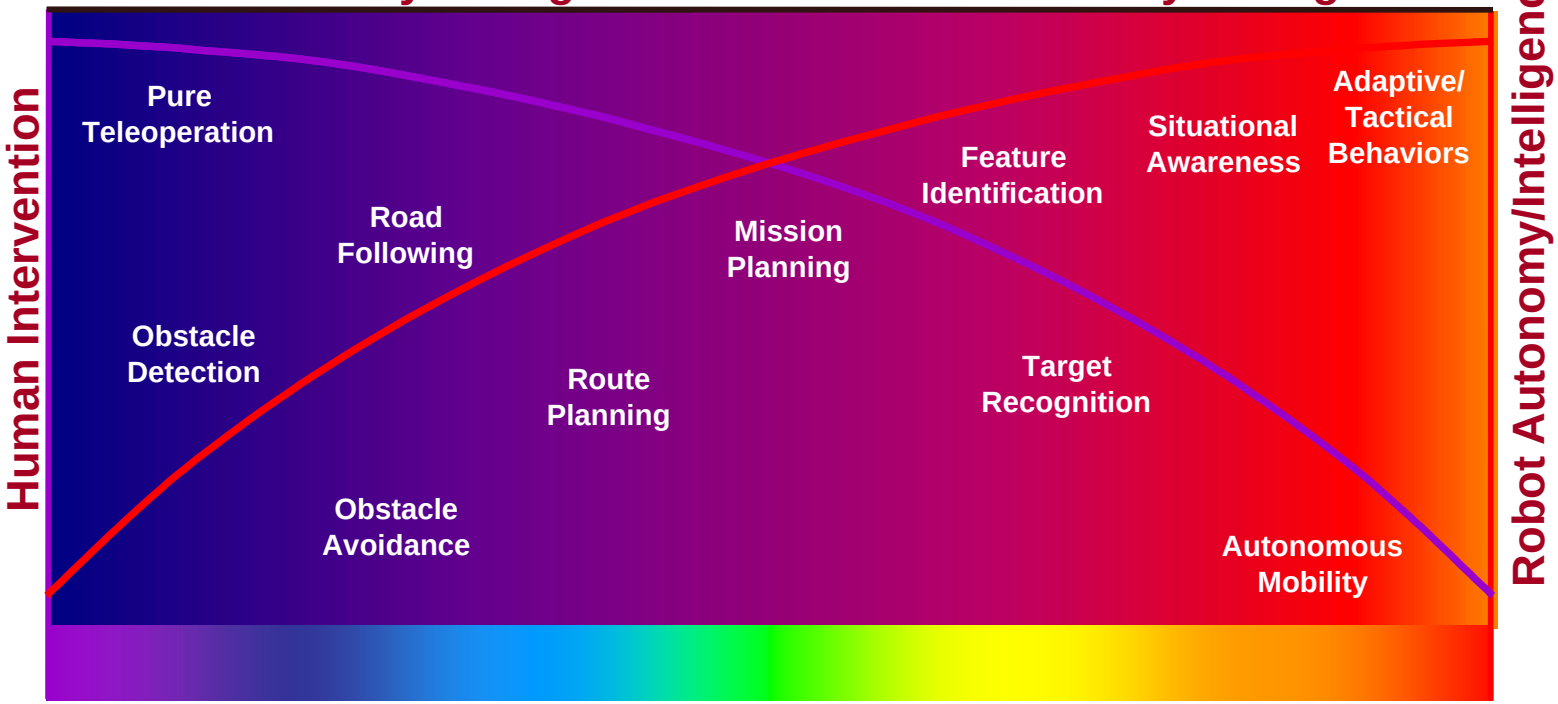
JAUS is a requirement for all FCS unmanned systems.

Robotic Technologies Development



Evolutionary Change

Revolutionary Change



Mapping the Challenges

Critical Technologies

- *Machine Perception*
- *Control System Architectures*
- *Tactical Behaviors*
- *Collaborative Engagement*
- *Communication/ Beyond Line of Sight Connectivity/ Bandwidth*
- *Command and Control*

Operational Capabilities

- *Battle Command*
- *Mounted/Dismounted Maneuver*
- *Air Maneuver*
- *LOS/BLOS Lethality*
- *Maneuver Support*
- *Human Engineering*

Other Operational Considerations

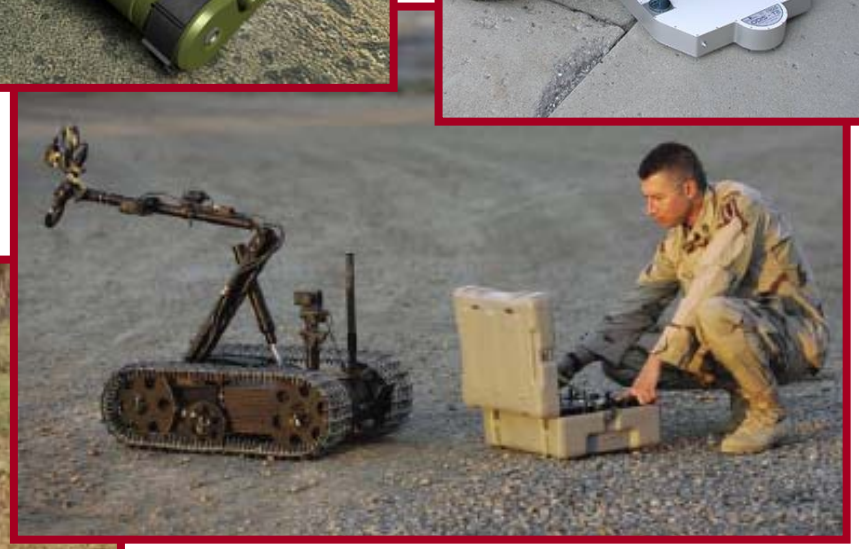
- *Unknown TTPS*
- *Soldier workload*
- *Control of heterogeneous systems*
- *OPTEMPO*
- *Reconstitution*
- *Bandwidth/ network operations*
- *Safety of unmanned vehicles near humans*
- *Fratricide*
- *Survivability*
- *Impact on Tactical/ Strategic decision making*

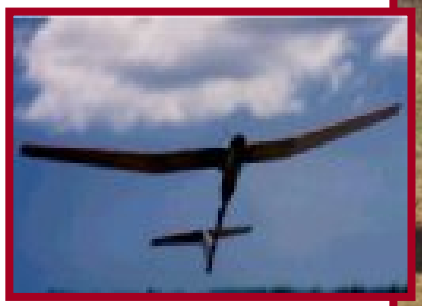
Current Unmanned Ground Systems Missions

- Explosive Ordnance Disposal
  - Combating Terrorism
  - UXO/IED Defeat
- Remediation
- Combat Engineering
  - Mine Clearing
  - Obstacle Breaching
  - Emplacing Charges
- Reconnaissance
  - Persistent EO/IR Surveillance
  - CBRN
  - BDA
- Direct Fire Weapons
- Obscuration
- Physical Security
- Force Protection
- Casualty/Medical Evacuation

Current Capabilities

- Remote Controlled
- Obstacle Detection and Avoidance
- Pattern Recognition
- Lane Detection
- Road Following
- GPS Way Point Navigation
- Rudimentary Terrain Recognition and Following
- Semi-Autonomous Behavior





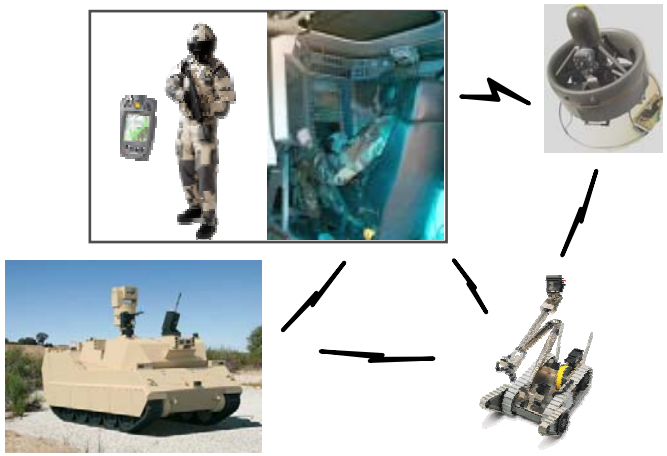
Critical Robotic Technology Gaps

- Power and Energy
  - Battery Life
  - Short burst of Power
  - All Weather Conditions
- Survivability
  - Anti-Tamper Security
  - Destroying or Blocking Sensors
  - Electronic Jamming
- Reliance on GPS for Navigation
  - Military Operations in Urban Terrain
  - Tunnel and Cave Operations
- Communications and Control
  - Range and Bandwidth
  - Human-Robot Interface
  - Autonomous Tactical Behaviors
  - Security
- Negative Obstacle Navigation
  - Water
  - Holes
  - Foliage
- Auto Target Recognition
  - Determining Friend from Foe
  - Spoof Prevention

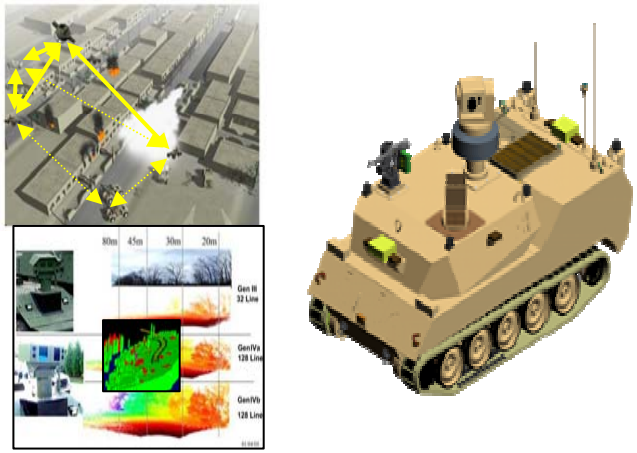
Army Technology Objectives for Unmanned Systems

Technologies for the Future & Current Force

Leader/Follower



Robotics Collaboration



Near Autonomous Unmanned Systems

Unmanned Aerial Vehicle Systems Technologies

Leader/Follower

Mature & Demonstrate Robotics Technology Required for Early Insertion into FCS

Autonomous Mobility Sensor Suite

Robotic Follower ATD

Technologies:

- ***Decision Aids***
- ***Advanced Warfighter Interfaces (AWI)***
- ***Unmanned Asset Controls***
- ***Multi-mission FCS Crew stations***
- ***Embedded Simulation System***
- ***Advanced System Architecture***
- ***HFE (MANPRINT)***

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

Crew Integration and Automation Testbed ATD

Robotic Follower ATD

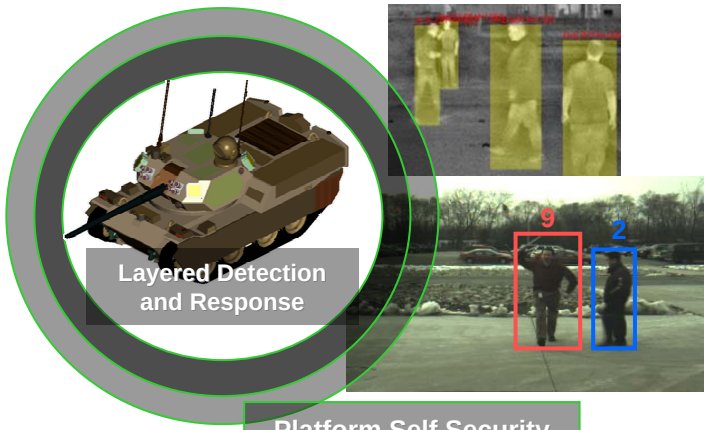
- **Robotic Follower develops, matures, and transitions to PM UA and the LSI the following capabilities:**
  - MMW Radar for vehicle tracking and collision avoidance.
  - Road and trail following.
  - High speed autonomous convoy on narrow roads.
  - Baseline convoy in live traffic.
  - Terrain/obstacle registration for leader-follower operations in GPS denied areas.
  - Human odometry dismounted follower.
  - Baseline safety procedures.
  - Robotic follower procedures, safety procedures, and TTP development.
  - Robotic Follower Testbed

Crew Integration and Automation Testbed (CAT) ATD

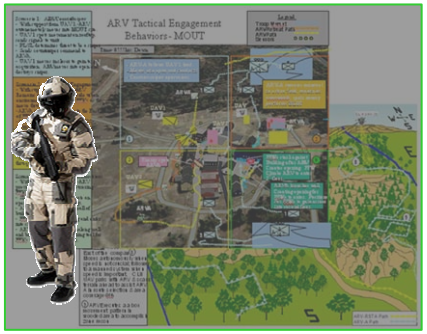
- **CAT develops, matures, and transitions to PM UA and the LSI the following capabilities:**
  - Advanced Warfighter Interfaces (AWI) for efficient multi-task execution.
  - Unmanned asset controls for UGVs, UAVs, and UGSs.
  - Multi-mission crew stations that provide the capability to perform all the tasks of a fight, scout, or carrier mission.
  - Embedded simulation system for in vehicle mission rehearsal, mission planning, and embedded training.
  - Crew aiding behaviors for assistance with manned and unmanned mission planning and execution.
  - Advanced system architecture provides that an order of magnitude performance increase over currently fielded systems.

Near Autonomous Unmanned Systems

UAV-UGV Collaborative Reconnaissance Missions



Platform Self Security



Tactical Behavior Development (Increase Platform Intelligence)

FCS Risk Areas Program Is Addressing

- Distributed Collaboration of Manned/Unmanned Platforms (FCS Risk 68)
- Safe UGV Mobile Operations in FCS UA (FCS Risk 213)
- Safe UGV Weapons Operations in FCS UA (FCS Risk 214)
- Transfer of Technology to Skid Steer Vehicles (UGV Risk 0032)
- UGV Situational Awareness (ARV Risk 0006)
- UGV Tactical Behaviors (ARV Risk 0007)
- UGV Self Security (ARV Risk 0008)

HRI for air and ground assets

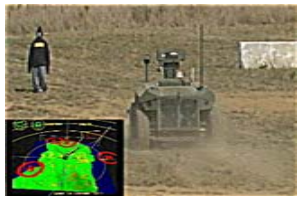
Point A to Point B Autonomous Mobility

Advanced Remote Armament System (ARDEC)

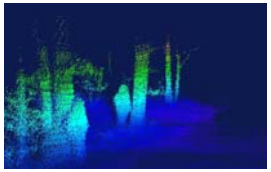
Near Autonomous Unmanned Systems

2005	2006	2007	2008	2009

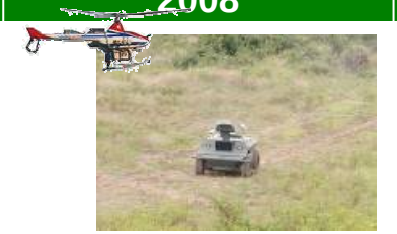
Delivery of GEN V LADAR (under IV.GC.2000.03)



Initial demonstration of detection & avoidance of moving vehicles & people



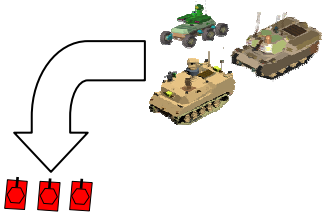
Perception Algorithms



Autonomous Cooperative Behaviors

ART testbed development

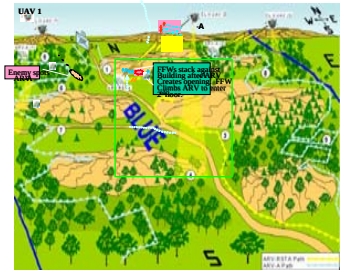
Platform Self Security System
(pedestrian detection/tracking/intent system)



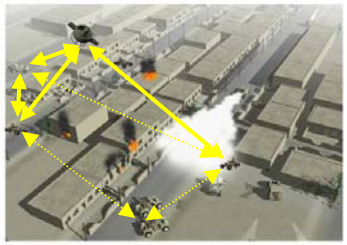
Platform Level Tactical Behaviors

Advanced Remote Armament System Demonstration

Advanced Remote Armament System Development

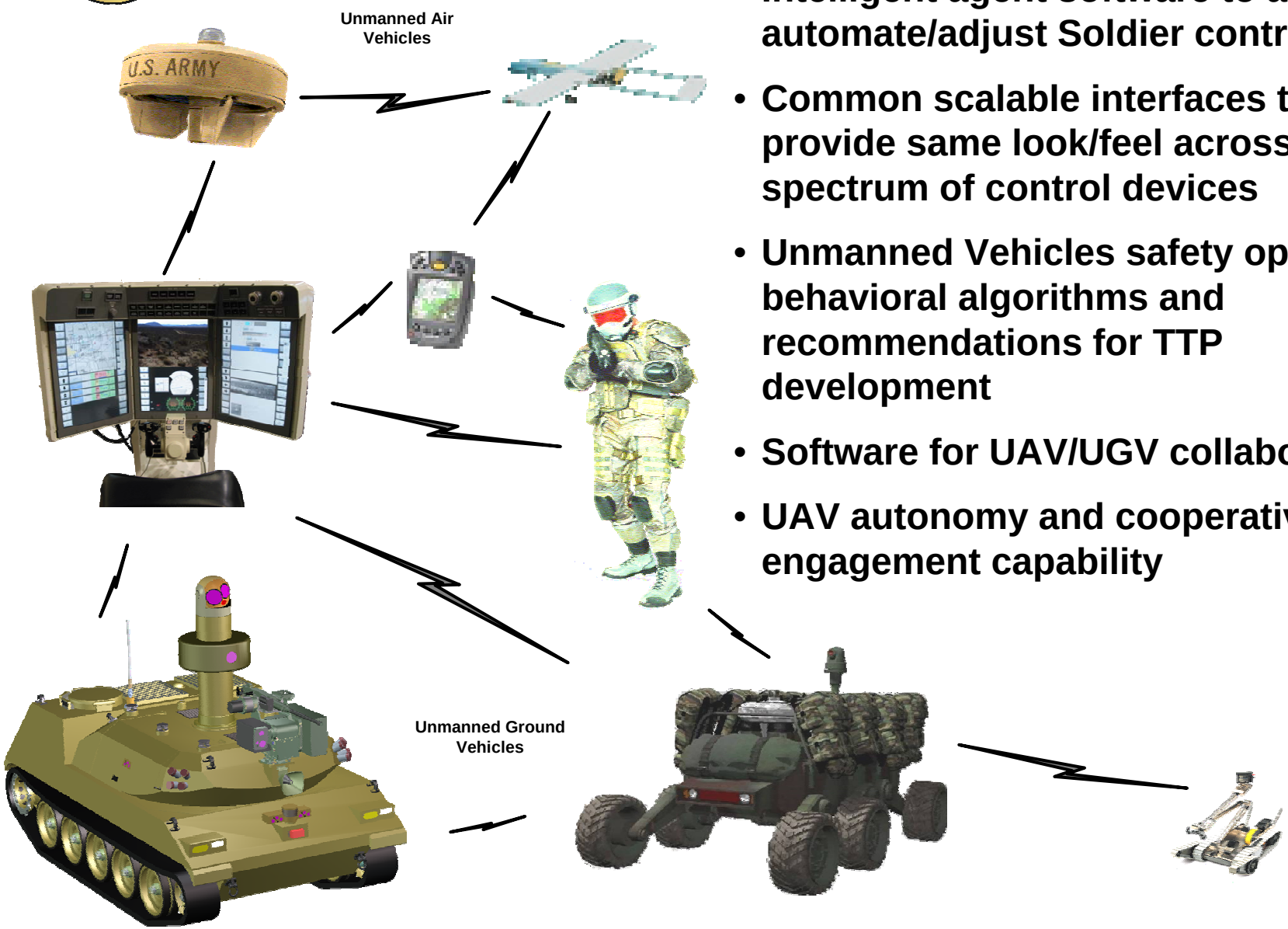


Initial Integrated Experiment



Final Integrated Experiment

Robotics Collaboration



- Intelligent agent software to adaptively automate/adjust Soldier control tasks
- Common scalable interfaces that provide same look/feel across spectrum of control devices
- Unmanned Vehicles safety operational behavioral algorithms and recommendations for TTP development
- Software for UAV/UGV collaboration
- UAV autonomy and cooperative engagement capability

Scalable Interface Configuration & Implementation

Soldier Tasks

- Dismount
- C2V
- ICV
- RSV
- MCS soldier tasks

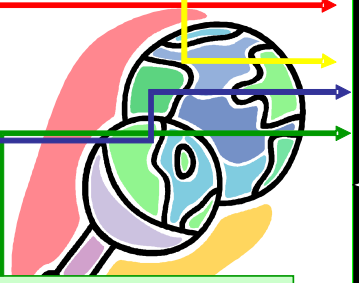
Platform Capability

- UGS
- SUGV
- UAV
- MULE
- ARV specific

Configuration (Requirements) ⟵ | ⟶ Operation

Environment

- Time of day
- Motion
- Constraints (ex MOPP gloves)



SOLDIER PREFERENCES (Biometrics)

- Role/security (MCS commander, access levels, comms config, etc.)
- Physical characteristics (i.e. left handed, health, glasses, etc)
- Mental (thresholds, baseline)

Processor 1
EX: Agent execution

R&SV

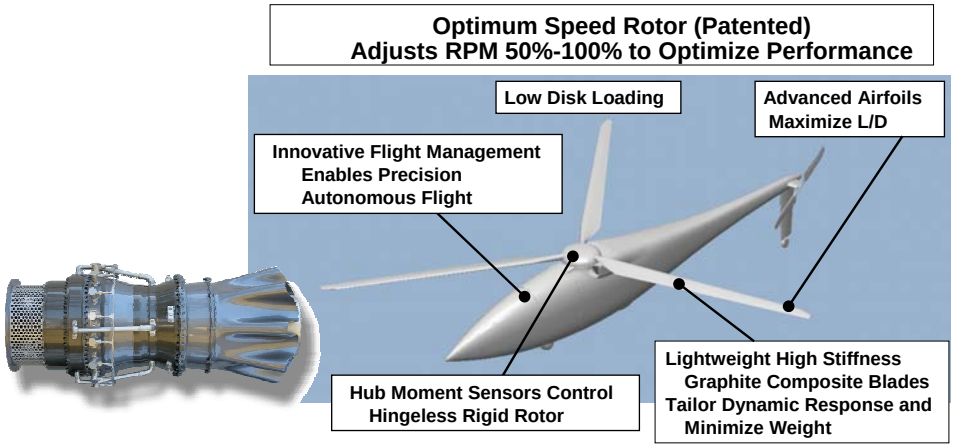
Processor 2
EX: Re-planning w/ MCS mounted Soldier, COP update

MCS

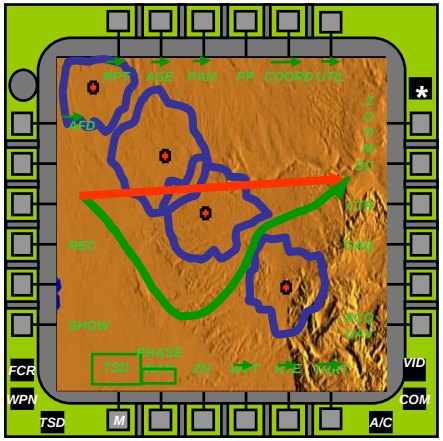
Processor 3
EX: Communications relay

Dismount Goal: Headsup, Hands-free Operations

Unmanned Aerial Vehicle Systems Technologies



- Five Phase I air vehicles with various engines
- Two full-size and one man-portable ground control stations
- Demonstration of a small, reliable, turbine engine for application to A-160 Hummingbird / ARH and other future force rotorcraft with:
  - -20% fuel consumption rate
  - +50% HP to weight ratio
  - -35% cost
- SHFE provides efficient operation at part power and variable power turbine speeds (50-100%) which is needed for A160 optimum speed rotor



Manned-Unmanned Rotorcraft Enhanced Survivability

Real-time Survivability Associate Re-Router software

Cooperative Manned-Unmanned Team Survivability

Summary

- Unmanned Systems Needed for Transformation
  - Congressional Directive
  - Future Combat System
- Defining Standards for Communications and Control
- Assisting Current Fight
  - Need to Capture Lessons Learned
  - Need to Refine Concept of Operations
- Current R&D Efforts to Fill Some Technology Gaps
- Will Require New Technology and New Means of Employment to Achieve Transformation