



Joint Ground Robotics Enterprise



Developing Autonomous Vehicles to Standards...

Presented at the Intelligent Vehicle Technology Transfer

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Agenda



- **Joint Ground Robotics Enterprise Organization**
- **Joint Ground Robotics “Top 10”**
- **Wrap Up**



Joint Ground Robotics Enterprise Organization



JGRE Oversight



Senior Steering Group

- Convened as needed
- Enable Service commitment
- Advise Chair on funding priorities and allocations

Flag Level Reps

- Army
- Marines
- Navy
- Air Force
- J8

- Guidance for shaping JGR to the O-6 Council
- Resolve JGR issues submitted by O-6 Council

Chair: Dep Dir, LW&M

Strategic

O-6 Council

- Represent Service Positions
- Generate Departmental Strategy for advancing Ground Robotics
- Proponents for JGR Roadmapping
- Set priority of Robotic Enablers informed by Capability Mapping & Technology Assessments from JGRE TAB

O-6 Combat Dev, Materiel Dev Reps

- Army
- Marines
- Navy
- Air Force
- J8
- Defense Threat Reduction Agency
- JIEDDO
- COCOMs

- Provide guidance to TAB to drive which Capabilities and Technologies to assess
- Executability implies Service Commitment can be secured
- Resolve issues

Chair: ED, JGR

Operational

- Assess maturity of Emerging Technologies
- Identify Opportunities for Warfighter leverage
- Recommends Robotic Enablers Based on assessment of maturity, Linkage to Capability Gaps/ Opportunities

Technology Advisory Board

- Service SMEs
- DDR&E rep
- J8 rep
- Defense Threat Reduction Agency

- TAB Products:
 - Technology & Capability Mapping
 - Technology Maturity & Funding Assessment

Chair: ED, JGR

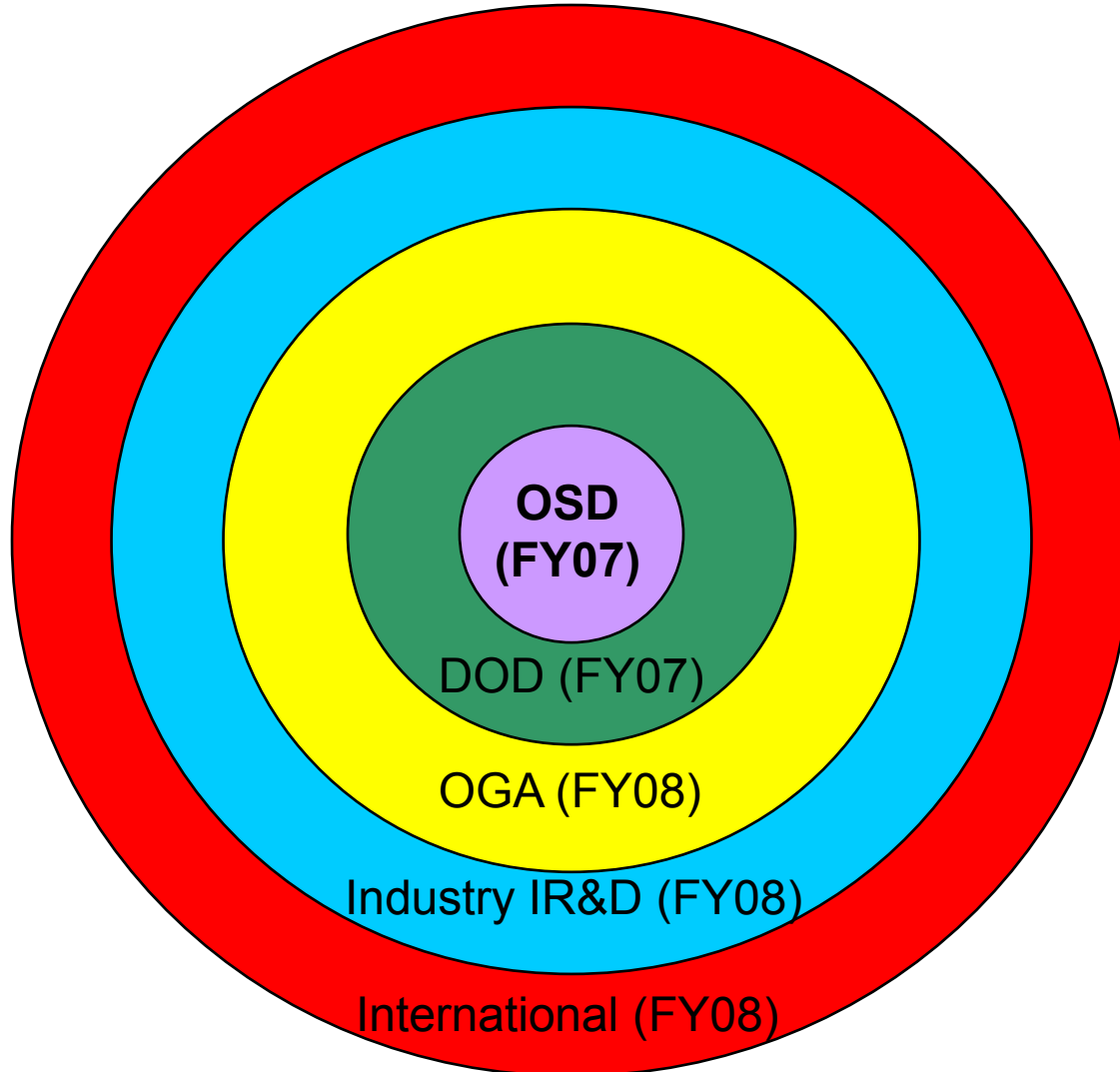
Tactical



Joint Ground Robotics Enterprise Portfolio Synchronization



(Funded Efforts Taken into Account in Portfolio Strategy)





Joint Ground Robotics Enterprise “Top 10”



“Top 10”: #1 Roadmap



The Unmanned Systems Integrated Roadmap is a master plan that describes the intended future state of the Unmanned Systems Product Line Portfolios and the actions to be undertaken to achieve that future state.

The Roadmap will serve to inform future decision making associated with the management of the Unmanned System Portfolios as they provide needed capabilities to the joint Warfighter.



Purpose



- The Purpose of the Unmanned Systems Integrated Roadmap is to project a future vision for how unmanned systems will be developed, acquired, and sustained as part of the materiel employed by the DoD.
- The Roadmap will:
 - Identify recommended intermediate states of advancement along the way to achieving that vision
 - Identify Strengths, Weakness, Opportunities, Challenges, and Risks associated with achieving that future vision
 - Identify those actions and responsible organizations that will capitalize on the strengths and opportunities, and mitigate the challenges and risks
 - Be responsive to plans, concerns, and issues of DoD, Services and organizations as well as Statute and Congressional Intent



Scope



The Scope of the Roadmap will address:

- The 3 Product Line Portfolios:
 - Unmanned Aircraft Systems
 - Unmanned Ground Vehicles
 - Unmanned Maritime Systems (Surface and Undersea)
- from 2009 – 2034
- technology development, standardization, interoperability, joint acquisition, policy

The Roadmap will not address:

- detailed operational concepts for employing unmanned systems
- operational requirements for unmanned systems



Addressing Capability Needs via Unmanned “Means” (notional)



2009

2034

<p>JCA 1- Battlespace Awareness</p>	<p>RECONNAISSANCE-UAS</p> <p>MAN-PORTABLE EOD-UGV</p> <p>GLOBAL HAWK-UAS</p> <p>SIGINT COLLECTION-UAS</p> <p>INFORMATION OPERATIONS-UUS</p>
<p>JCA 4- Force Application</p>	<p>TACTICAL STRIKE-UAS</p> <p>MINE WARFARE-USV</p> <p>PENETRATING STRIKE-UAS</p> <p>INTEGRATED STRIKE-UAS</p> <p>TIME CRITICAL STRIKE-UUS</p>
<p>JCA 5- Protection</p>	<p>MARITIME PATROL-UUS</p> <p>HULL UUV LOCALIZATION SYSTEM-UUV</p> <p>ACTIVE RANGE CLEARANCE-UGV</p> <p>MINE NEUTRALIZATION-UGV</p> <p>COUNTERAIR-UAS</p> <p>MULE-UGV</p> <p>SUGV-UGV</p>
<p>JCA 6- Logistics</p>	<p>CONVOY OPERATIONS-UGV</p> <p>AIRLIFT-UAS</p> <p>AERIAL REFUELING-UAS</p> <p>MANUEVER SUPPORT & SUSTAINMENT-UGV</p> <p>MULE-UGV</p>



Unmanned Systems Performance Evolution (notional)



2009

Evolutionary Adaptation

20??

Revolutionary Adaptation

2034

Individual System	Teaming w/in Domain		Collaboration across domains		Teamed Collaboration
Spectrum Constrained RF			Spectrum Independent - Hopping		
Mission Endurance in hours		Mission Endurance in days		Mission Endurance in weeks	
Mission Complexity – operator controlled		Route Planning	Obstacle Avoidance	Adaptive Tactical Behaviors	
Limited Environmental Difficulty			Expanded Environmental Difficulty		
Mission Package Product Line Dependant			Product Line Independent		
OPSEC – Signature High			OPSEC – Signature Low		
Operational Control N:1	1:1	1:# w/in Domain	1:# across domains	1:# Teamed	

Human Intervention High

Autonomy /Intelligence High



Unmanned Systems Technology Enablers (notional)



2009 Evolutionary Adaptation **20??** Revolutionary Adaptation **2034**

[Blue Bar]			
Battery Powered	Hybrid Electric	Fuel Cell	Solar Powered
Spectrum Constrained RF	Frequency Hopping		Non-RF Comms
Mild Weather	All Weather		
Passive Signature Management		Active Signature Management	
Architecture Proprietary/Limited	Architecture Standard	Architecture Standard Unlimited	
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“Top 10”: #2 Consortium



- **Provide opportunity for non-government organizations to participate in DoD research planning, resulting in a plan based on industry expert knowledge of evolving technologies**
- **Allow for better leveraging of IR&D funding through insights gained as a result of this mutual planning process**
- **Lower the entry barriers for small companies to enter into the government acquisition process**



Ground Robotics Enterprise

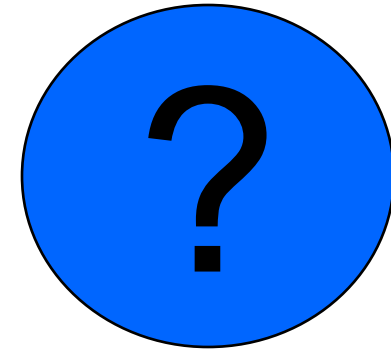


Joint Ground Robotics Enterprise

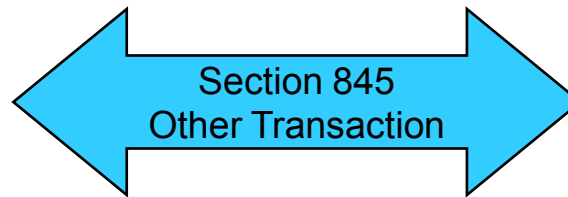


- OUSD(AT&L) PSA/LW&M
- Department of the Army
- Department of the Navy
- Department of the Air Force
- Defense Treat Reduction Agency
- J8
- Other Agencies and Departments

Ground Robotics Consortium



- Defense Contractors
- Small Businesses
- Academic Institutions
- Non-Profit Organizations
- Not-for-Profits Organizations



DoD and GRC ... Partnering to Leverage Capabilities and Investment



Scope



- **The OTA will encompass**
 - Technology Development and Maturation
 - Performance Improvement
 - Autonomous Tactical Behavior Development
 - Standard Maturation and Evolution
 - Mission Equipment Package Integration
 - Technology Transition Preparation
- **The OTA will not encompass**
 - Policy Development
 - Operational Concept Development
 - TTP Development
- **Only US firms as members of the Consortium**



Roles and Responsibilities



- **Joint Ground Robotics Enterprise (JGRE)**
 - Provides Oversight and Guidance
 - Conducts Planning and Budgeting
 - Manages Acquisition Process
 - Liaison with Other Organizations
 - Ensures Development of Annual Research Plan, Requirements and Source Selection Plan
 - Conducts Source Selection
- **Ground Robotics Consortium (GRC)**
 - Liaison among Industry and with JGRE
 - Participates in Development of Annual Research Plan
 - Conducts Technology Development and Maturation, Performance Improvement, Autonomous Tactical Behavior Development, Standards Maturation and Evolution, and Mission Equipment Package Integration



“Top 10”: #3 Test Implications



- **Are we ready to support the Warfighter to test and evaluate ground robots (infrastructure, instrumentation, e-stop, GPS coverage, wireless data collection, etc.)?**
- **What are the Standards/Test Operating Procedures for characterizing robotic performance (how do I generate compelling evidence for which is the best mechanism for traversing complex terrain (e.g. legs or tracks)?**
- **Can we leverage robots to support tests (e.g. autonomous threats, targets, logistics support, etc.)?**



Effective Tests



Computer vision may not be as good as thought, according to MIT study

Cathryn M. Delude, McGovern Institute
January 24, 2008

- Apparent success may be misleading because the tests being used are inadvertently stacked in favor of computers
- Caltech101 database, intended to test computer vision algorithms against the variety of images seen in the real world
- Caltech101 'natural' images fail to adequately capture real-world variability

The human brain easily recognizes that these cars are all the same object, but the variations in the car's size, orientation and position are a challenge for computer-vision algorithms. Image / Nicolas Pinto





“Top 10” (cont.)



- **Joint Architecture for Unmanned Systems (JAUS)/ STANAG 4586**
 - What should AN interoperability standard be?
 - Systematically fuse JAUS and the STANAG?
- **Homeland Defense and Homeland Security**
 - Better partnering between OGAs to achieve mutual benefit and efficiencies.
 - Implications of using DoD robotic capabilities on US soil (airspace, weapons, safety, spectrum, etc.)
 - UGVs on national highways (engage with DOT)
- **WarFighter Experimentation**
 - Collaboration between Combatant Command and Combat Developer
 - Institutional process for experimentation to underpin requirements analysis for “game changing” robotic technologies



“Top 10” (cont.)



- **SUGV Product Line Portfolio**

- MTRS
- Advanced EOD Robotic System
- Blow-in Place “Bots” for Engineers
- FCS SUGVs (Block 1, Spin Out 3, Core)

- **Armed Ground Robots**

- Are technology advances outpacing policy, rules of engagement, statute?

- **International Engagement**

- UK-Grand Challenge
- Germany-ELROB (European Land Robotics)



Wrap Up



- **Integrated Unmanned Systems Roadmap: Future Vision ... what will the future Unmanned System Portfolios look like?**
 - Resolution of some Top 10 issues may result in actions captured in the Integrated Unmanned System Roadmap
- **The Consortium provides an opportunity for non-government organizations to participate in DoD research planning, resulting in a plan based on industry expert knowledge of evolving technologies**
- **For the test community, its no longer a question of “if”, but “when”**
- **Each Top 10 issue represents an area of engagement for OSD**

There is much to be done, and DoD is organized and committed to do it