



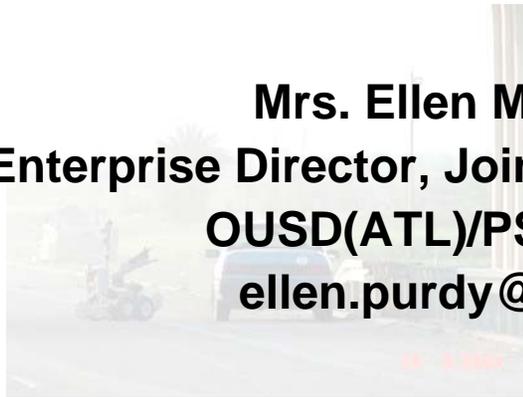
# 2008 Ground Robotics Capabilities Conference



## The State of the Enterprise

“...with the change of circumstances, institutions must advance also to keep pace with the times.” *T. Jefferson*

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# Agenda

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- Recap from Last Year's Conference
- Current Efforts
- Top 5 Initiatives
- Conclusion



# Recap from Last Year's Conference

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- **Technology Transfer**
  - Warfighter Experiments
- **Unmanned Aerial Systems Lessons Learned**
  - User Feedback
  - Up front and early with Other Government Agencies
- **Setting the Azimuth**
  - Technology Advisory Board
  - O-6 Council
  - Senior Steering Group



# Automated Perimeter Security (APS)



## Purpose

- To develop automated technologies to augment the security force mission.
- Is an automated system of robotic platforms providing perimeter security to vital installations.
- Integrates robotic ground, air, and sea systems into a seamless network with existing USAF security system architectures.



## Progress to Date

- Conducted successful experiments at Kirtland Underground Munitions Security facility and Eglin AFB.
- Demonstrated the adaptability and usefulness of system in a relevant environment.
- Integrated systems with Force Protection Joint Exercise participants.



# Computer Aided Manipulation (CARMAN)



## Purpose

- Assess the potential of existing automation technologies to enhance the military utility of robotic manipulator systems of fielded EOD solutions with emphasis on Improvised Explosive Device (IED) disposal and retrieval.

## Progress to Date

- Enhanced manipulator automation by reducing time for repetitive tasks.
- Algorithms and methodologies for increased precision of manipulator control and increased ease of operation.
  - e.g., converting 2-D location to 3-D location relative to system



# Robotic UXO Technologies



## Purpose

- Provides an interim capability to accelerate the integration of advanced robotics and the mine-clearing platform to facilitate full operational capability.

## Progress to Date

- 2nd generation robotics control system developed.
- Moving toward
  - automated driving behaviors - waypoint and pattern driving using GPS/INS guidance and automated and positive position control of the flail device.
  - a joint use system.





# Convoy Active Safety Technologies (CAST)



- Perception and planning for safe maneuver among people and other vehicles; active safety systems for collision detection and avoidance
- Integration of unmanned systems within the network
- Enhanced tele-operation
- Way point navigation
- Affordability: cost of future systems using projected technology
- System robustness



# Top 5 Initiatives

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- Integrated Unmanned Systems Roadmap
- Ground Robotics Consortium
- War Fighter Experimentation
- Test Implications
- Robotics Acquisition Standards and Policy



# Integrated Roadmap



- **The Unmanned Systems Integrated Roadmap...**
  - ... is a master plan**
  - ... describes the intended future state of the Unmanned Systems Product Line Portfolios**
  - ... and the actions to be undertaken to achieve that future state.**
- **Will account for Strengths & Opportunities; Challenges & Risks; Capabilities Matching; Responding to Plan, Concerns, Issues**
- **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.**



# Ground Robotics Enterprise

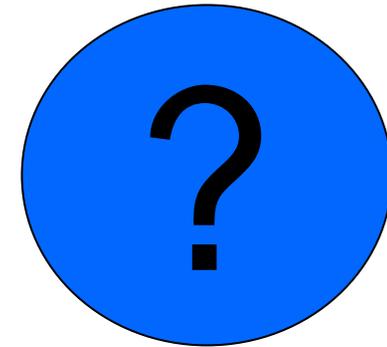


## Joint Ground Robotics Enterprise

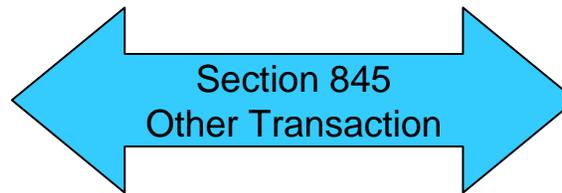


- OUSD(AT&L) PSA/LW&M
- Department of the Army
- Department of the Navy
- Department of the Air Force
- Defense Treat Reduction Agency
- J8
- Other Agencies and Departments

## Ground Robotics Consortium



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





# Ground Robotics Consortium



## Purpose...

- Provide opportunity for non-government organizations to participate in DoD research planning, resulting in a plan based on industry expert knowledge of evolving technologies

## Scope...

- Technology Development and Maturation
- Performance Improvement
- Autonomous Tactical Behavior Development
- Standard Maturation and Evolution
- Mission Equipment Package Integration
- Technology Transition Preparation



# War Fighter Experimentation



- **Collaboration between Combatant Command and Combat Developer**

- Institutional process for experimentation to underpin requirements analysis for “game changing” robotic technologies
- “UGVs are significantly more complicated than UAVs, and will require much more experimentation.” - *Army Science Board 2006 Summer Study*



# Considerations for the Future



“We must focus our energies beyond the guns and steel of the military, beyond just our brave soldiers, sailors, Marines, and airmen. ... I hear all the time from the senior leadership of our armed forces about how important these civilian capabilities are.”

**Secretary of Defense Robert Gates**



“It is DoD policy that stability operations are a core U.S. military mission that the

Department of Defense shall be prepared to conduct and support. They shall be given priority comparable to combat operations and be explicitly addressed and integrated across all DoD activities ...

**DoD Directive 3000.05, dated Nov 28, 2005**

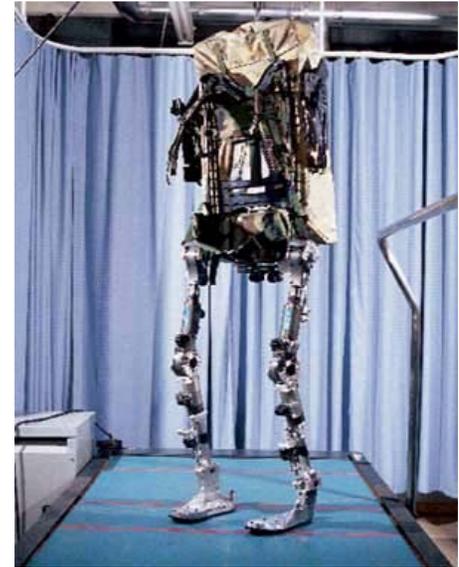


# Wearable Energetically Autonomous Robotics (WEAR)



- **Objective: Develop a class of robotic systems that are worn by humans, closely match the operator's motion in both space and time, and enable the wearer to carry heavy loads over rough terrain for extended periods of time.**
- **1995: DARPA exoskeleton effort begins**
- **2003: 1<sup>st</sup> powered lower extremity prototype**
- **2007: Responsibility transitioned to Natick**
- **Interest from the Requirement Developer (TRADOC)**

**What's it going to do?**



Sarcos's exoskeleton system



# Combat Autonomous Mobility System (CAMS)



## Problem:

- Special Operations Forces personnel are operating for extended periods in wider ranging, increasingly austere, non-permissive areas against larger forces; all with resource constrained manpower.
- They lack robust organic capability to conduct timely tactical insertion, ground-based Intelligence Surveillance and Reconnaissance, and tactical re-supply, and the technology to effectively force-multiply available manpower.



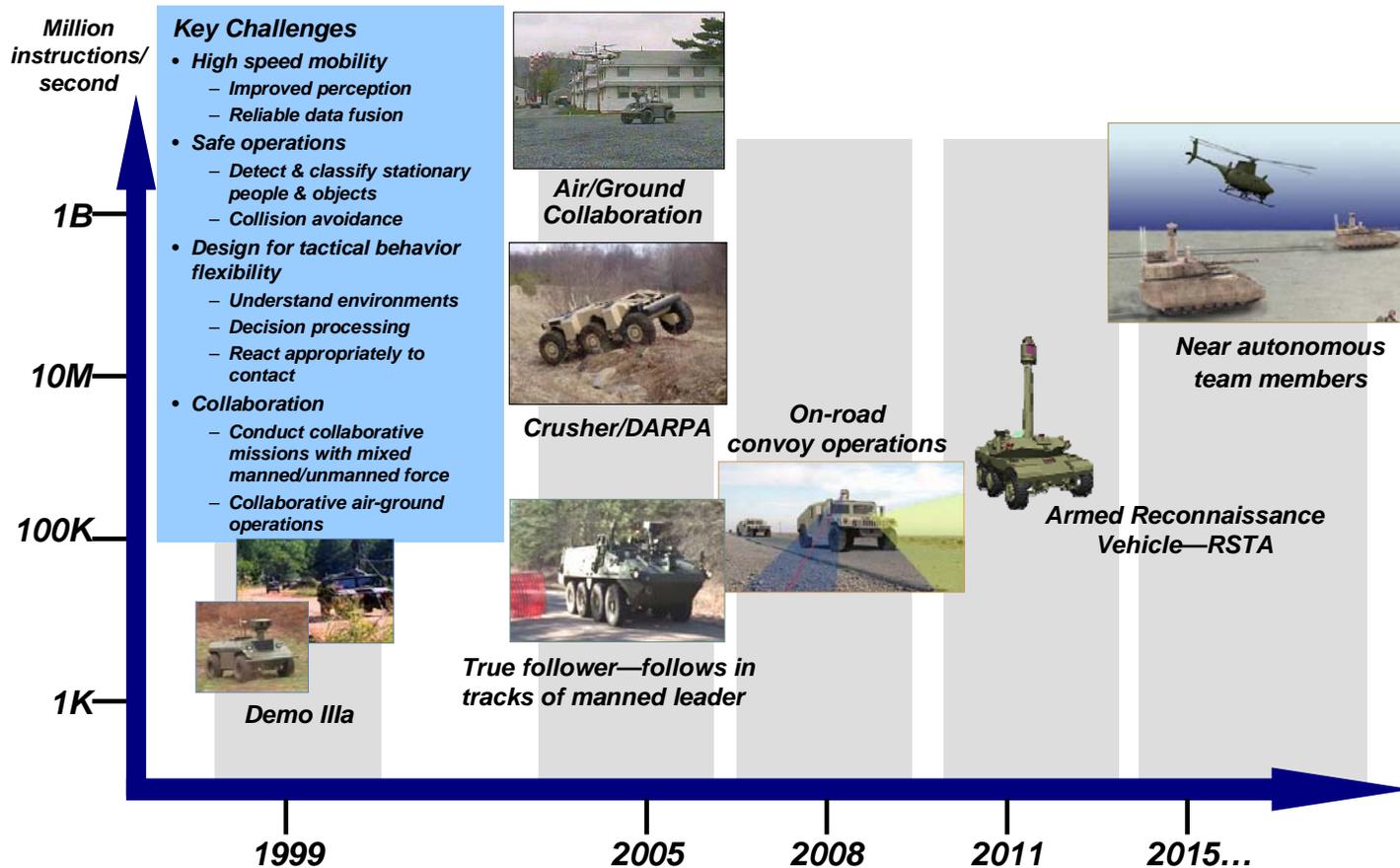
## Solution:

Develop an integrated, autonomous, tactical ground-based system to leverage current Special Operations Forces manpower.



# Test Implications

## Ground Robotics Test and Evaluation: Are We Ready?





# 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



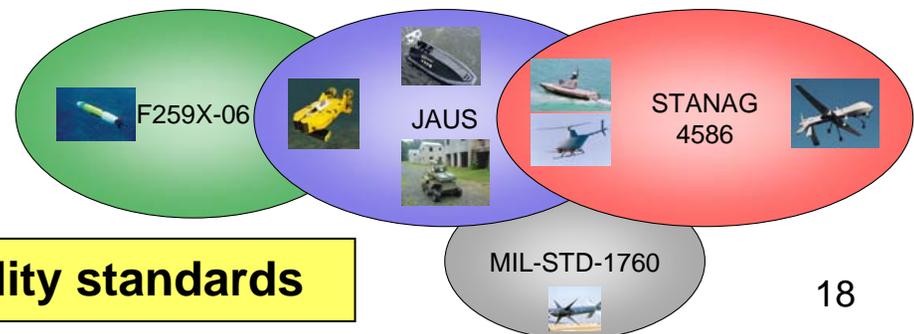


# Robotics Acquisition Standards and Policy



## JAUS and STANAG - Interoperability Standards Analysis (ISA)

- There is a clear need for Department to establish policy for UMS standards
- Must find a way to harmonize “commercial” and “military” standards
- Frame of reference - systematically fuse JAUS and STANAG
- What is the path forward?
  - Using ISA as a starting point, develop a strategy and recommended policy for DoD
  - Looking to the creation of a Task Force of stakeholders to accomplish above (pre-decisional)



**Bridge the gap between interoperability standards**



# Conclusion



- **A greater awareness of ground robotics is forming across the DoD:**
  - PACOM interested in for transport in complex terrain
  - SOCOM – CAMS JCTD
  - NORTHCOM looking to robotic tunnel exploration for border security
  - SOUTHCOM UXO - Range Clearance
- **Progress to Date**
  - Consortium
  - Integrated Roadmap
- **Technology is beginning to outpace concept development**
  - Experimentation is key
    - CAST War fighter Experiments 1 & 2
    - Exoskeleton Experiment

**There is much to be done, and we are organized and committed to do it**