



DoD Autonomy Roadmap Autonomy Community of Interest

Larry Schuette
Autonomy COI Lead

**NDIA 18th Annual Science & Engineering
Technology Conference/Defense Tech Exposition**



Setting the Stage

Defense Science Board July 2012 Task Force Report



Autonomy is a capability (or set of capabilities that enables a particular action of a system to be automatic or, within specified boundaries “self-governing.”

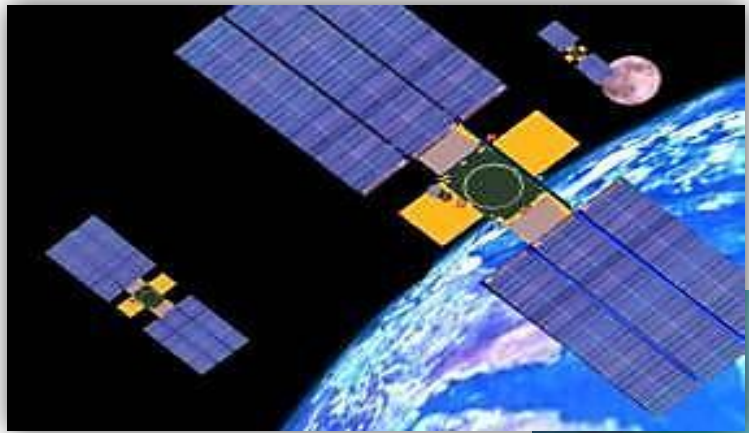
- **The DoD should embrace a three facet autonomous systems framework**
 - Cognitive echelon – scope of control
 - Mission timelines – dynamic redistribution of responsibility
 - Human-machine trade spaces
- **Structure autonomous systems acquisition programs to separate autonomy software from the vehicle platform**
- **Create developmental and operational test and evaluation (T&E) techniques that focus on the unique challenges of autonomy**

Neither Warfighter nor machine is truly autonomous

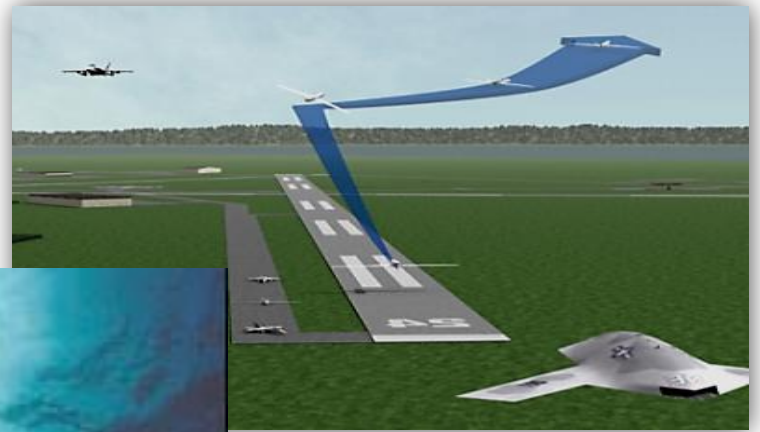


Breadth of Autonomy

Air, Land, Sea, Cyber, Non-Physical Systems



Space



Air



Sea

Cyber



Land





Autonomy Community of Interest (COI)



Purpose: Closely examine the DoD's S&T investments in the enabling of autonomous systems, to include the strategic assessment of the challenges, gaps, and opportunities to the development and advancement of autonomous systems, and identification of potential investments to advance or initiate critical enabling technology development.

The Autonomy COI provides a framework for DoD scientists, engineers, and acquisition personnel to:

- Engage in multi-agency coordination and collaboration
- Report on the "state-of-health"
- Identify emerging research opportunities
- Measure progress

Autonomy COI Steering Group:





Technology Portfolio

What's driving Autonomy S&T?

- Manpower efficiencies (reduce human footprint and personnel cost)
- Rapid response and 24/7 presence (timely, persistent, enduring)
- Harsh environments (day, night, hot, cold, bad weather, rubble, barriers)
- New mission requirements (increasing competence enables new capabilities)
- Advanced medical applications (critical response, end-to-end critical care)
- Logistical support (reduce logistics burden: hold, transport, carry, watch)

Technology Taxonomy (Tier 1)

**Machine Perception, Reasoning
and Intelligence**

**Scalable Teaming of
Autonomous Systems**

**Human/Autonomous System
Interaction and Collaboration**

**Test, Evaluation
Validation and Verification**



Tier 1 Brief Descriptions



Machine Perception, Reasoning and Intelligence (MPRI):

Perception, reasoning, and intelligence allows for entities to have existence, intent, relationships, and understanding in the battle space relative to a mission.

Human/Autonomous System Interaction and Collaboration (HASIC):

The keys to maximizing the human-agent interaction are: instilling confidence and trust among the team members; understanding of each member's tasks, intentions, capabilities, and progress; and ensuring effective and timely communication. All of which must be provided within a flexible architecture for autonomy; facilitating different levels of authority, control, and collaboration.

Scalable Teaming of Autonomous Systems (STAS):

Collaborative teaming is a fundamental paradigm shift for future autonomous systems. Such teams are envisioned to be heterogeneous in size, mobility, power, and capability.

Test, Evaluation, Validation, and Verification (TEVV):

The creation of design based verification and validation (V&V) methods and novel developmental and operational test and evaluation (T&E) techniques that focus on the unique challenges of autonomy, including state-space explosion, unpredictable environments, emergent behavior, and human-machine communication.



Tier 2

Technical Challenges and Objectives

Machine Perception, Reasoning and Intelligence (MPRI):

- Common Representations and Architectures
- Learning and Reasoning
- Understanding the Situation/Environment
- Robust Capabilities



Learning

Behaviors



Architectures



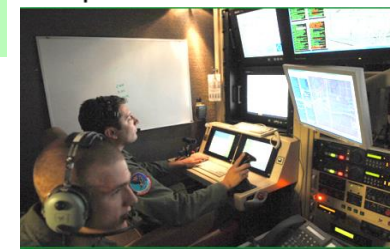
Teaming with Humans & other agents



Semantic Perception

Human/Autonomous System Interaction and Collaboration (HASIC):

- Calibrated Trust and Transparency
- Common Understanding of Shared Perceptions
- Human-Agent Interaction
- Collaboration



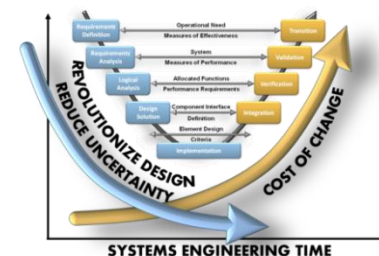
Scalable Teaming of Autonomous Systems (STAS):

- Decentralized mission-level task allocation/assignment
- Robust self-organization, adaptation, and collaboration
- Space management operations
- Sensing/synthetic perception



Test, Evaluation, Validation, and Verification (TEVV):

- Methods & Tools Assisting in Requirements Development and Analysis
- Evidence based Design and Implementation
- Cumulative Evidence through Research, Development, Test, & Evaluation (RDT&E), Developmental Testing (DT), and Operational Testing (OT)
- Run time behavior prediction and recovery
- Assurance Arguments for Autonomous Systems





Enduring Gaps for Autonomy



- **Open, cognitive architectures that facilitate interaction between intelligent systems and human**
- **Planning and reasoning for dynamic, uncertain operational and physical environments**
- **Concepts for decentralized perception, planning, and collaboration among large groups of heterogeneous, autonomous agents**
- **Robust supervised and unsupervised learning**
- **Natural, intuitive communications between humans and intelligent agents/systems**
- **Creation of “common ground” and communicating intent (abstract reasoning)**
- **Means for assessing the safety and performance of systems that learn and alter behavior over time**