



# Autonomy Community of Interest

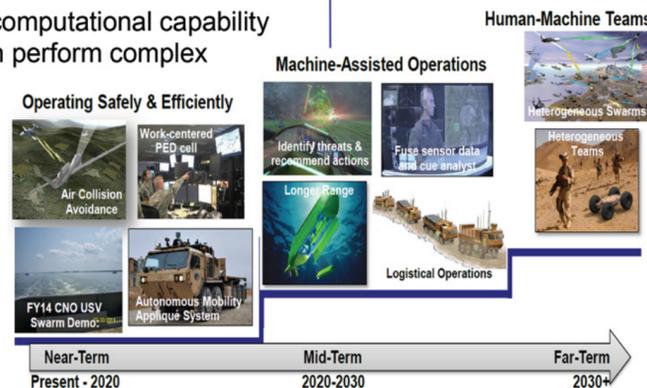


## Autonomy Science and Technology

**GOAL:** Advancement of autonomous systems, and identification of potential investments to advance or initiate critical enabling technology development.

**Autonomy** is defined as the computational capability for intelligent behavior that can perform complex missions in challenging environments with greatly reduced need for human intervention, while promoting effective man-machine interaction. This includes the ability to sense, comprehend, predict, communicate, plan, make decisions, and take sequential actions to achieve goals as determined through interaction with humans and between units that compose the autonomous system.

An **autonomous vehicle system** consists of sensors, the platform, communications, power, autonomy, and weapons.



*Autonomy seeks the benefits of complementary strengths in human-machine teaming*

## Technical Challenges

- Interact with individuals, teams, and leaders in an intuitive, trustworthy, and thoroughly human-like fashion.
- Understand immediate situations and risks, and use that to make good immediate decisions & long-term plans.
- Team quickly and effectively with friendly systems and humans to enable merged perception, planning, and action.
- Learn diverse new tasks with minimal human help, both by observing examples and by learning on their own.
- Interact with humans not just in words, but also in gestures and signs, while learning the unique signals of each team.
- Understand perspectives of both humans and other machines, and use that to reason abstractly about them.
- Always provide proof of reliability and trustworthiness to team mates, even as they change and learn over time.

## Industry Engagement Opportunities

Autonomy presents **powerful opportunities for new forms of cooperation**

- Commercial markets** are pushing Autonomy at an ever-accelerating pace.
- Hard-edged, globe-spanning Defense needs** have sparked leading-edge autonomy results in the past, and show where autonomy must go in the future.

**Deeper Industry-Defense Autonomy engagements benefit both groups.**

## Engagement Mechanisms

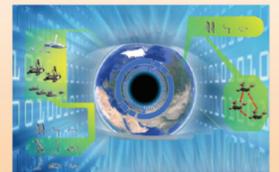
- CRADAs** – These no-cost resource sharing agreements allow access to the unique experimental and testing capabilities of DoD and national labs.
- Defense Innovation Marketplace** – This centralized, online resource for market research provides information on DoD S&T, R&D investment priorities, capability needs, & technology interchanges.
- Defense Innovation Unit Experimental (DIUx)** – DIUx is the nexus between non-traditional companies operating at the bleeding edge, and the DoD.
- DoD Labs** – Companies can partner with DoD Labs to develop technology and methodologies within a cost-effective open architecture.
- Sharing Experience and Data** – Open exchanges of experiences, needs, and performance results enrich participants and help shape future opportunities.

## Technology Taxonomy

### INTELLIGENCE: Machines That Are Team Players

#### Machine Perception, Reasoning & Intelligence (MPRI):

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



### COLLABORATION: Combining Diverse Strengths

#### Human/Autonomous System Interaction and Collaboration (HASIC):

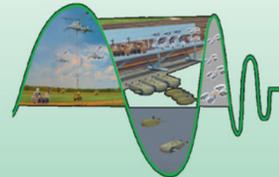
- Calibrated Trust
- Common Understanding of Shared Perceptions
- Human-Agent Interaction



### SCALABLE TEAMING: Teams Without Size Limits

#### Scalable Teaming of Autonomous Systems (STAS):

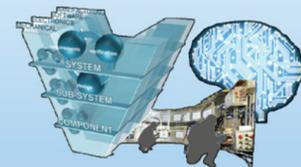
- Decentralized mission-level task allocation/assignment
- Robust self-organization, adaptation, and collaboration
- Space management operations
- Sensing/synthetic perception



### VERIFICATION: Smart Machines You Can Trust

#### Test, Evaluation, Validation, & 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



## Industry Engagement Opportunities

**Defense Drivers**  
**NEEDS:** Long term; maximum complexity; dangerous; scalable; full spectrum; teaming intensive.  
**FUNDS:** Limited; future focused; multiscale cooperative is best.

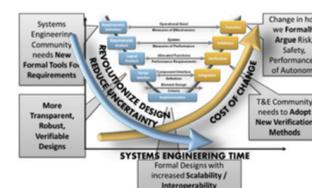
**Defense Outcomes**  
 Improved security; reduced human risk; lower cost; faster deployment; faster scaling; efficient operations; leveraging of commercial products; combinatorial development.

**Public + DoD Research Synergy**

**Commercial Drivers**  
**NEEDS:** Nearer term; niche first; low legal risk; interface intensive.  
**FUNDS:** Vast for mass market opportunities; small otherwise; often leverages federal research.

**Commercial Outcomes**  
 "First to market successes" as new leading-edge niches emerge; new hard-to-foresee products; higher production efficiencies and yields; improved opportunities foresight.

## COI Impact and Success Stories



*The Autonomy COI works in the front lines of identifying new mission-critical needs*

#### Defined National Strategy:

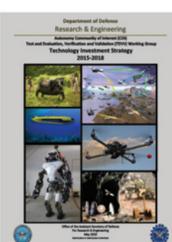
- Identified major challenges and shortfalls in autonomy V&V methods
- Defined five research goals to help align Services
- Initiated efficient cross-group cooperation, starting with AFRL, ARL, NRL, ONR, AFIT, TRMC, DTRA

#### Identified Major Gaps. We need:

- Verifiable system requirements for all forms of autonomy
- Versatile standards for autonomy modeling, design, and interfaces
- Powerful new capabilities for testing and evaluating autonomy
- Improved approaches to using humans to offset brittleness
- Continuous, real-time V&V of autonomy as it adapts in the field
- Cumulative tracking of V&V evidence as autonomy adapts

#### Set Up Specific V&V Goals. We need:

- Ways to develop and analyze requirements
- Evidence-based design and implementation
- Ways to capture and reuse RDT&E, DT, & OT
- Prediction and recovery from run-time failures
- Assurance arguments for autonomous systems



**ASD(R&E): Test and Evaluation, Verification and Validation Investment Strategy**