

Autonomous Operations

Let robots do the dangerous work. Naval forces can enhance their capabilities with technologies that increase the autonomy, performance and affordability of their organic uninhabited vehicle systems. Autonomous systems will let Sailors and Marines disperse throughout the battlespace and still operate effectively, influencing the action over great distances and long spans of time.

Why is this Future Naval Capability important?

Autonomous systems greatly extend the reach and capability of Naval forces while substantially reducing the risk to Sailors and Marines. They promise us significantly increased access to areas the enemy would deny us. They also promise us the means of denying areas to our enemies.

What's our investment strategy?

In developing our core investment program, we focused on identifying and filling capability gaps, fulfilling commitments to funded acquisition programs, and designing a strategy that would provide the wherewithal to execute the program. Five enabling capabilities will get us there:

- **First priority.** We need to provide access under all conditions to areas of responsibility through organic uninhabited systems that can be dynamically retasked to perform reconnaissance, surveillance, target acquisition, target designation, tactical oceanography, and battle damage assessment.
- **Second priority.** We need to enable automated surveillance and reconnaissance in all environmental conditions through miniaturized, low energy sensors and payloads in unmanned systems.
- **Third priority.** We must enable automated surveillance and reconnaissance data processing, including sensor data fusion, to provide combat identification, automatic target recognition, target discrimination and onboard platform decision-making, and to reduce operator workload.
- **Fourth priority.** We must enable secure, jam-resistant network centric warfare at extended ranges through data relay and sensor-to-shooter-to-weapon connectivity.



- **Fifth priority.** We must minimize human intervention by automating operating functions, and by enabling the operations and interoperability of both manned and unmanned platforms.

How are we filling the gaps in those enabling capabilities? Each enabling capability will have a set of milestones and

transition opportunities, we find that five spike programs provide the enabling capabilities of Autonomous Operations: an Uninhabited Aerial Vehicle (UAV) autonomy program, an Uninhabited Ground Vehicle (UGV) program, an Uninhabited Underwater Vehicle (UUV) program, and a UAV propulsion program.

First Priority: Provide access under all conditions to areas of responsibility through organic uninhabited systems that can be dynamically retasked.

- *In FY 2004:* Integrated motor propulsor, high-density energy storage, intelligence-surveillance-reconnaissance (ISR) sensor suite, and autonomy development for UUVs.
 - *In FY 2005:* Autonomous path and mission replanning for UUVs. Multi-vehicle environmentally adaptive network communications for UUVs. Reconnaissance and surveillance for UGVs.
 - *In FY 2006-2007:* Submarine Track and Trail ASW sensors, autonomous target motion analysis (TMA), and cueing.
- Transition Opportunities:**
- UGV Reconnaissance and Surveillance sensor modules and modular mission payloads—transition to the Tactical UGV program in FY 04.
 - Autonomy, multi-vehicle cooperation, environmentally adaptive communication and ISR sensor suites—transition to Mission Reconfigurable (MR) UUV Block 1 in FY05, Semi-Autonomous Hydrographic Reconnaissance Vehicle (SAHRV) Pre-planned Product Improvement (P3I) in FY06, EOD SCM in FY 06.
 - Antisubmarine warfare (ASW) sensor suites and autonomous TMA, trail and cueing—transition to MR UUV Block 2 in FY 08.

- Advanced UAV propulsion systems—transition to Vertical Tactical Unmanned Air Vehicle Operations Requirements Document (VTUAV ORD) Objective, Tactical Tomahawk, Multiple Endurance UAV, and Unmanned Combat Aerial Vehicles in FY 08.

Second Priority: Enable automated surveillance and reconnaissance in all environmental conditions through miniaturized, low energy sensors and payloads.

- *In FY 2004:* Miniaturized, modular, power efficient sensors for UGVs.
- *In FY 2002-2005:* Sensor data processing technologies that provide UAVs with situational awareness necessary for surveillance and reconnaissance missions.
- *In FY 2004:* Intelligence, surveillance, and reconnaissance payload for maritime reconnaissance UUVs.
- *In FY 2005:* Undersea search, survey, classification and identification sensor for small UUVs, environmentally adaptive acoustic modems, and cooperative navigation technologies for small UUVs.

Transition Opportunities:

- UGV Reconnaissance and Surveillance sensor modules and modular mission payloads—transition to the Tactical UGV program in FY 04.
- ISR sensor payloads, multi-vehicle search, survey, adaptive acoustic modems, and navigation technologies—transition to MR UUV Block 1 in FY 05; SAHRV P3I in FY 06; Explosive Ordnance Disposal Search, Classify, Map / Reacquire, Identify, Neutralize (EOD SCM/RIN) in FY06; Long-term Mine Reconnaissance System (LMRS) P3I in FY 06.
- UAV vehicle awareness with its surrounding and general operational environment—transition to Tactical Control System (TCS)/VTUAV P3I in FY 05.

Third Priority: Enable automated surveillance and reconnaissance data processing.

- *In FY 2002-2005:* Sensor data processing technologies that provide UUVs and UAVs with situational awareness necessary to surveillance and reconnaissance missions.
- *In FY 2002-2005:* UAV multi-vehicle adaptive network communication and cooperative navigation technologies.
- *In FY 2005:* Cooperative multi-vehicle undersea search, survey, classification and identification, adaptive network communication, and cooperative navigation technologies for UUVs.

Transition Opportunities:

- UAV awareness with its surrounding and general operational environment—transition to TCS/VTUAV P3I in FY 05.
- UUV autonomous awareness of its surrounding and general operating environment with onboard threat detection and classification transition to—MR UUV Block 1 in FY 05 and EOD SCM/RIN in FY 06.

Fourth Priority: Enable secure, jam-resistant network centric warfare at extended ranges through data relay and sensor-to-shooter-to-weapon connectivity.

- *In FY 2005-2007:* Secure jam-resistant, networking links for sensors, shooters, weapons, and vehicles.

- *In FY 2005:* Multi-vehicle environmentally adaptive acoustic modems with underwater and RF network communications capabilities for UUVs.

- *In FY 2005:* Direct and indirect fire mission modules for UGVs.

Transition Opportunities:

- UGV reconnaissance and surveillance sensor modules and modular mission payloads—transition to the Tactical UGV program in FY 04.
- Time critical strike command and control, ship-to-objective maneuver, and multi-vehicle network communications—transition to MR UUV Block 1 in FY 05, LMRS P3I in FY 06, EOD SCM/RIN and SAHRV in FY 06.

Fifth Priority: Minimize human intervention by automating operating functions, and by enabling the operations and interoperability of both manned and unmanned platforms.

- *In FY 2005:* Semi-autonomous UGV operations.
- *In FY 2005:* Dynamic autonomy for unmanned vehicles, allowing the vehicle's level of autonomy to depend on current situation, including available bandwidth, and availability of human intervention.
- *In FY 2005:* High-level command and control with autonomous path and mission replanning, multi-vehicle environmentally adaptive network communications, and cooperative navigation for UUVs.
- *In FY 2007:* Intelligent Autonomy: vehicle management, fault tolerant control systems, and multi-agent planning for UAVs, UGVs, and UUVs.
- *In FY 2007:* Technologies (including sensor fusion) for far-forward mobile anti-submarine warfare cueing under all rules of engagement for submarine track and trail.

Transition Opportunities:

- UGV reconnaissance and surveillance sensor modules and modular mission payloads—transition to the Tactical UGV in FY 04.
- Data fusion, and collective information and navigation transitions—transition to EOD SCM/RIN in FY 06. Robust surveillance and reconnaissance mission capability with greatly reduced human interaction—transition to SAHRV and EOD SCM/RIN in FY 06, transition to MR UUV Block 2 in FY 10.
- Submarine track and trail sensors, autonomy, data fusion, and energy sources—transition to MR UUV Block 2 in FY 08.

What's some of the sustaining discovery and invention science and technology? Exploitation and delivery depend upon discovery and invention. In ONR's vertically integrated program, we will continue to exploit basic work that proves relevant to autonomous operations.

- *Autonomous control theory* will improve system performance and our ability to control multiple vehicles.
- *Automation of human decision-making* remains vital to autonomous and semi-autonomous systems.
- *Advanced materials and nanoelectronics* will be crucial to the development of autonomous vehicles—for their structures, their propulsion plants, and their electronics.