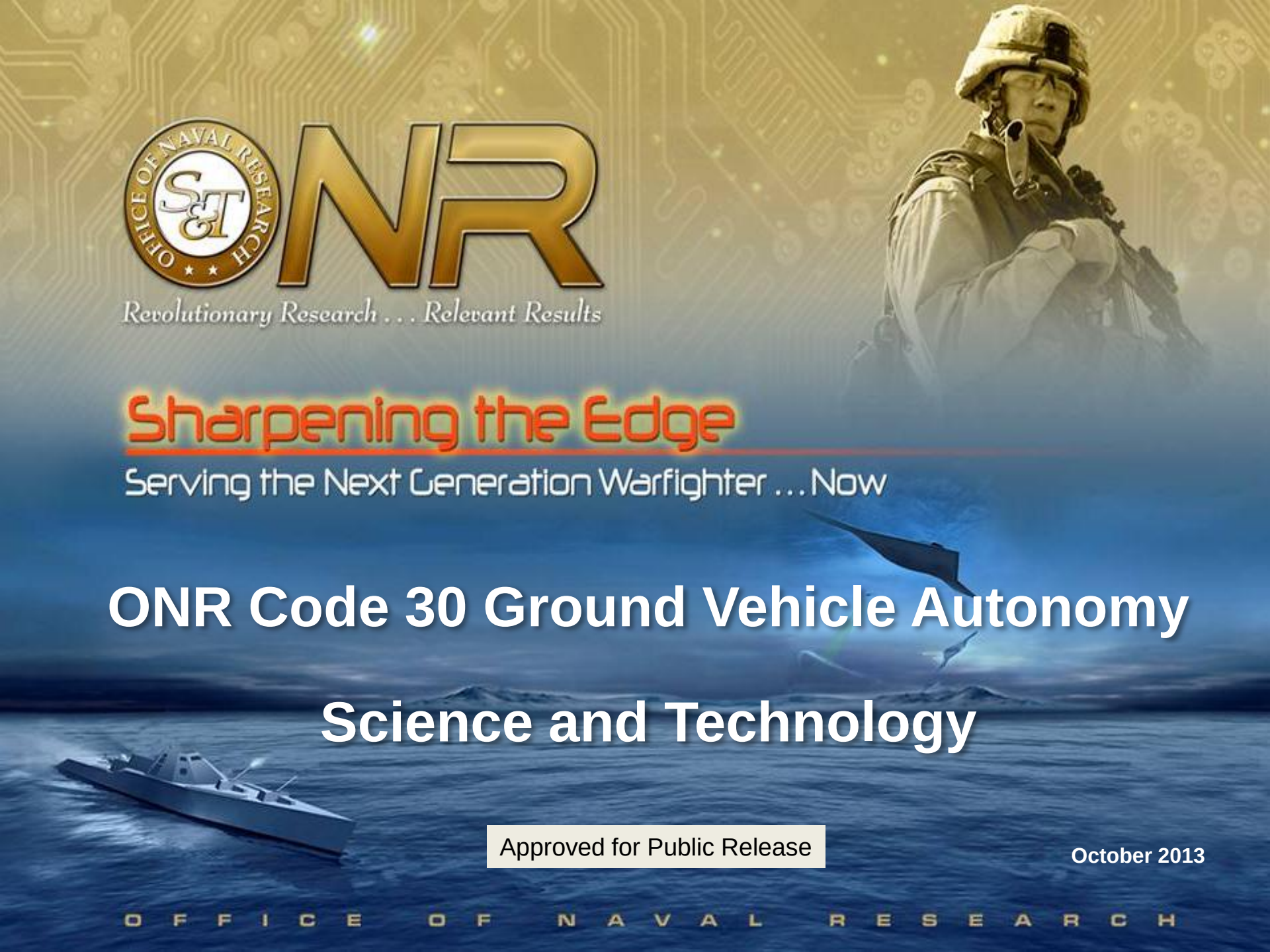


ONR Code 30 Ground Vehicle Autonomy

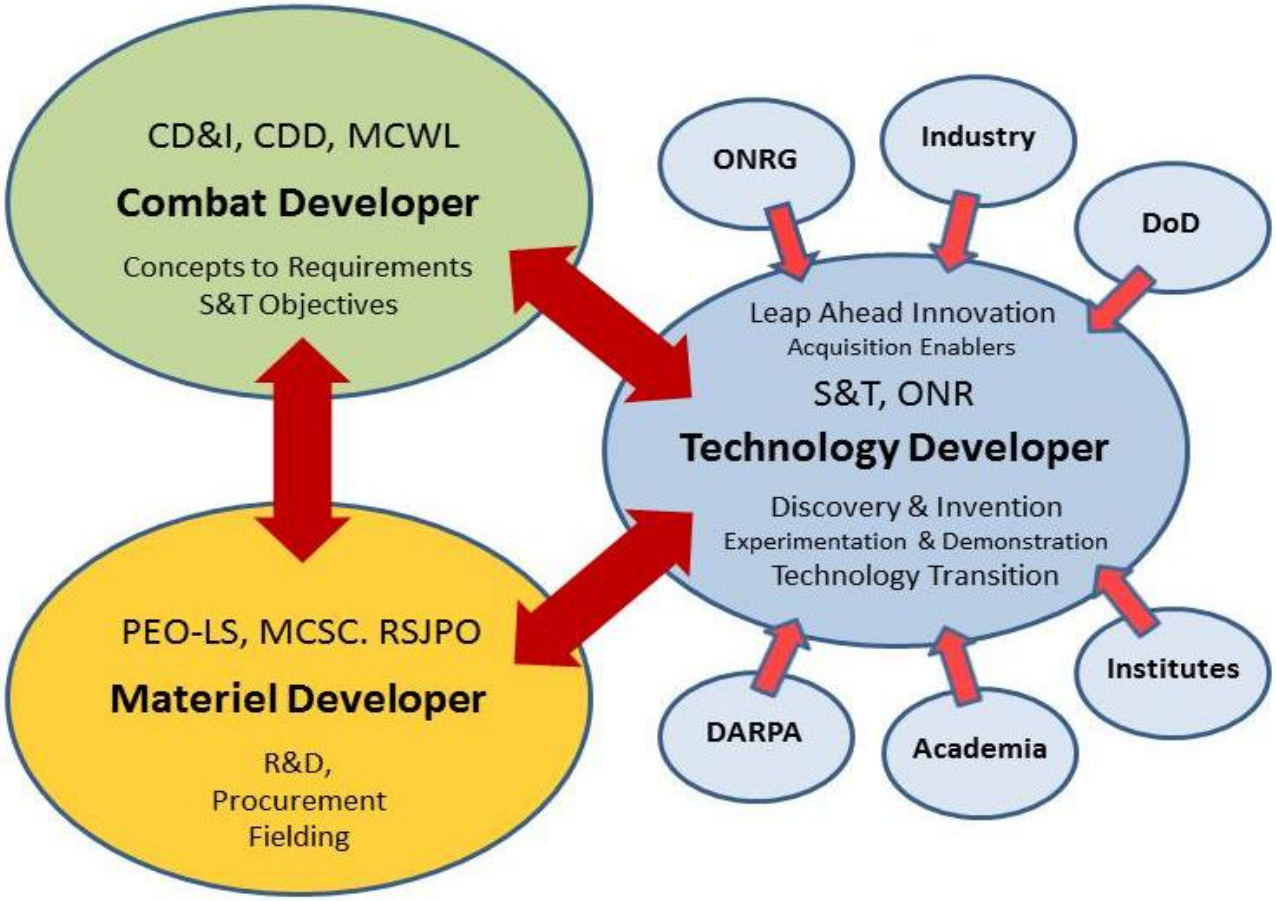
Science and Technology

Approved for Public Release

October 2013

OFFICE OF NAVAL RESEARCH

USMC Ground Robotics *Three Circles*



Focusing S&T investments on Marine Corps needs in coordination with our Acquisition and Requirements Partners

Ground Autonomy Vision

Current Capability: Remote control single purpose platform; line-of-sight operations; all manipulation and decisions made by the operator

S&T Solutions

S&T Challenges

- Affordability
- Contextual understanding
- Day/night perception
- GPS-denied navigation
- Path-planning in complex terrain
- Real-time adaptive behaviors
- Warfighter-UGS interaction

2010-2016

- Low-cost multi-modal perception systems
- Cognitive architectures to enable adaptive behaviors
- Advanced path planning algorithms for navigating complex terrain
- Absolute localization methods for GPS-denied navigation

Logistics-Connector
Appliqué Kit

2017-2022

- Autonomous reasoning for tactical behavior generation
- Dynamic path planning for operations with dismounted Marines
- Gesture and natural language interface

Wingman
Human-Robot Teaming

2022-2027

- Meta-level cognitive reasoning
- Machine intelligence for complex independent missions

Integrated Multi-Role Systems

Objective: Provide the USMC with affordable technologies that enable revolutionary advances in vehicular autonomy.

Approach

- **Affordability**: Bring low-cost autonomy for tactical ground vehicles to Technology Readiness Level (TRL) 6

Low-cost autonomy → *ubiquity* → *operational innovation*

- **Platform independence**: Develop enabling technologies and design concepts that can be adapted to existing vehicle platforms.

- **Expeditionary focus**: Concentrate test and development efforts on complex, highly cluttered, unimproved off-road, and austere environments.

- **Diverse participation**: Open, modular architecture with Government ownership/rights.

Carnegie Mellon University · V-SLAB Extend Your Vision · NASA · Lynntech · Battelle Putting Technology To Work · Robotic Research · SwRI · SOARTECH · SPAWAR Systems Center PACIFIC · MITRE · Penn State ARL · Ohio State University · Novateur Research Solutions · Toyon · NAVSEA Warfare Centers Dahlgren · TORC Robotic Building Blocks for Unmanned & Autonomous Systems · Polaris Sensor Technologies, Inc. · neya Systems

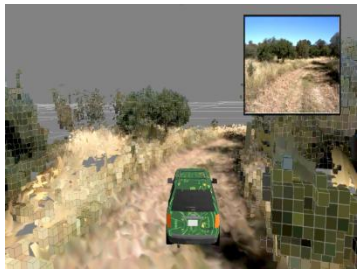
Key Investment Areas

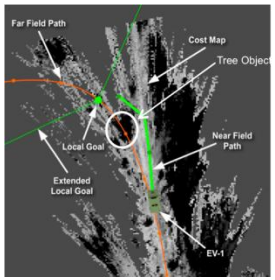
Perception

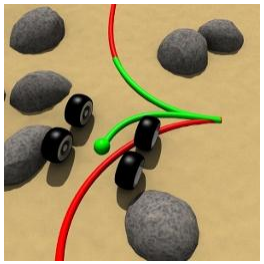
Intelligence Enablers and Architectures

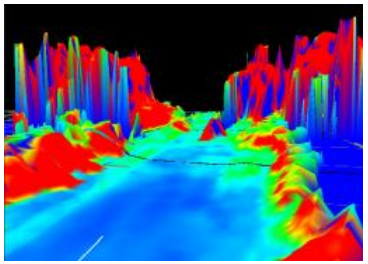
Human-Machine interaction

Systems Engineering





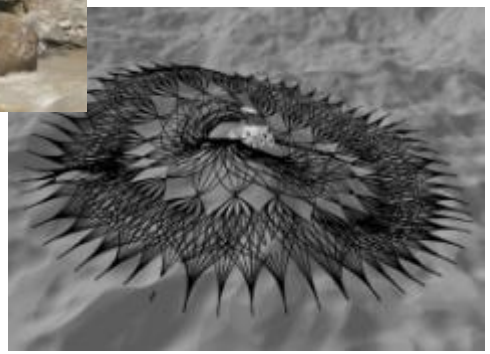




Perception

Robust Traversability in Complex Terrain

Adaptive and
Modular Multi-Terrain
Mobility Planner



- Improved autonomous navigation
- Platform independent

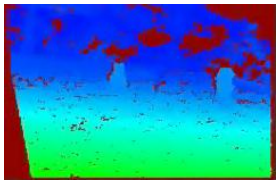
Faster autonomous tactical maneuver

Perception

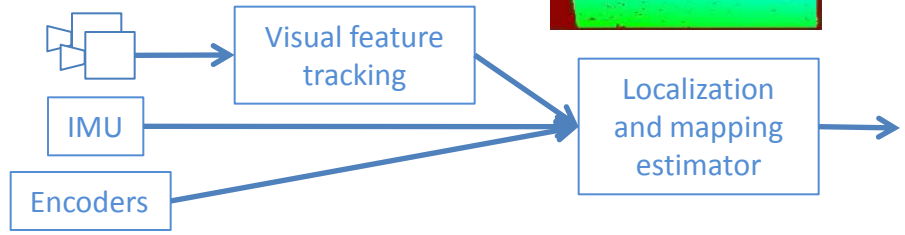
Night Ops with EO Perception

EO+illumination

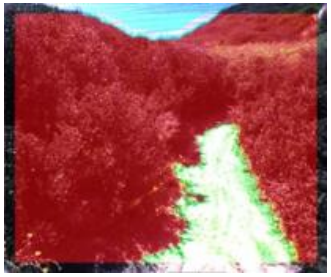
Low cost thermal

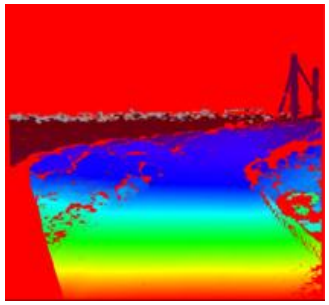


GPS Denied Navigation



Sensor Fusion for Robust Perception

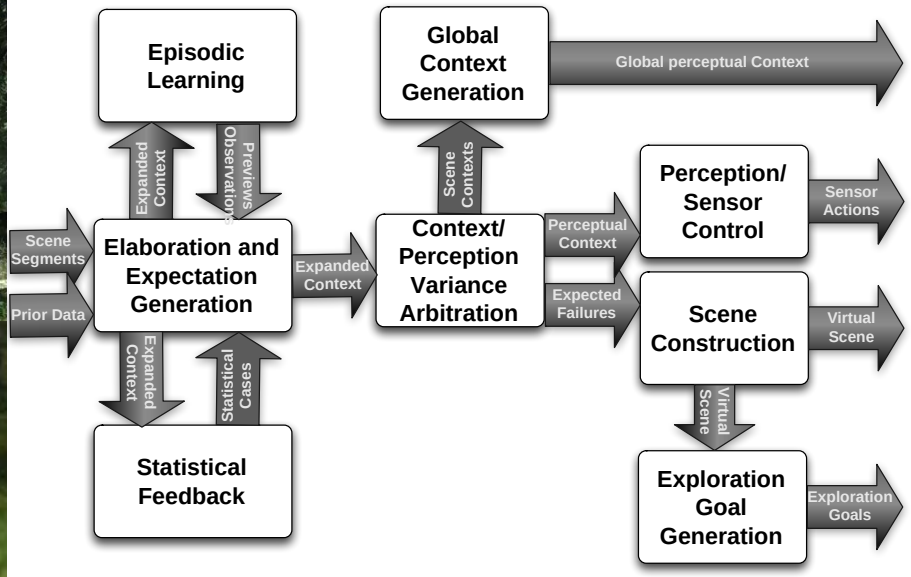




Low-cost, high fidelity, day/night perception

Intelligence Enablers

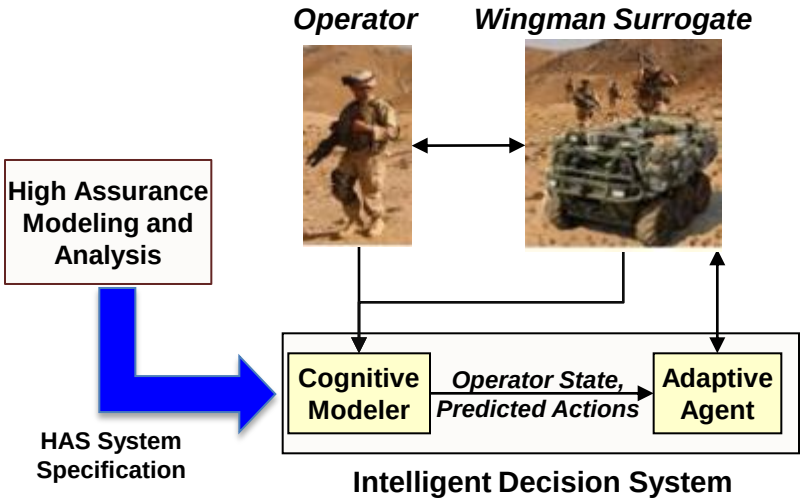
High-Level Reasoner



Contextual understanding and machine situational awareness/understanding

Human-Machine Collaboration

Trust in Adaptive Autonomous Systems



Integrates three key functionalities:

- human cognitive model
- adaptive agent to assist cognition
- high-assurance supervisor

CONTINUUM

Neuro-inspired cognitive architecture incorporating natural-language understanding and visual processing

Reduce cognitive load and enable trust

Capability Tests & Assessment

Logistics Connector UGV

2016 LMUA

Multimode perception (TRL 6)
Day/Night operation

Safe & Ready for
Operational Environment

2013 Test

- EO-only percep. (TRL 5)
- Daylight operation
- Material Classification
- SwRI test site

2014 Test

- Multimode percep. (TRL4)
- Fixed illumination
- GPS denied rel. local.
- Context-based reasoning

2015 Test

- Multimode percep. (TRL5)
- Dynamic illumination
- Complex Terrain Travers.
- High-level Reasoning

ONR

Revolutionary Research . . . Relevant Results

Sharpening the Edge

Serving the Next Generation Warfighter . . . Now

ONR Code 30 Ground Vehicle Autonomy

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