Ground & Sea Platform
COI Overview 2016
2016 NDIA S&T Conference

Dr. John Pazik
Head, Expeditionary Maneuver Warfare and Combating Terrorism Department, ONR
Chair, Ground and Sea Platforms COI Steering Group
Agenda

• GSP Overview
• Transition Opportunities
• Roadmap Process
• Roadmap Discussion by Technical Challenge Area
  – Opportunities
  – Challenges
  – Focus Areas
• Way Ahead
COI Portfolio Overview – COI Membership

**Steering Group**

Dr. John Pazik (USMC)
Dr. Thomas Fu (Navy)
Dr. Jennifer Hitchcock (Army)

**Deputies**

Mr. Sam Kirby (USMC)
Mr. Bob Lapolice (Army)

Executive AO:
Mr. Troy Hendricks (USMC)

**Working Groups**

**Survivability**
Thomas Meitzler (Army)
Roshdy Barsoum (Navy)
Rod Peterson (USMC)

**Modularity / Design & Integration**
Rob Maline (USMC)
Matt McMahon (Navy)
Chris Mocnik (Army)

**Mobility**
Dale Martin (Army)
Don Hoffman (Navy)
Al Schumacher (Army)

**Maintainability / Sustainability**
Billy Short (USMC)
John Szafranski (Army)
Airan Perez (Navy)

**Unmanned Platform Integration**
Greg Hudas (Army)
John Andrews (USMC)
Bob Brizzolara (Navy)
COI Portfolio Overview – Overall G&SP COI Investment Profile

COI Sub-Areas ($M)
- $174
- $66
- $107
- $47
- $207

Total = $602M

Component Investment
- 38% Army
- 28% Dept of Navy
- 28% DARPA
- 6% Other Components

COI Sub-Areas ($M)
- Unmanned Ground & Sea Vehicles
- Ground & Sea Platforms - General
- Survivability
- Maintainability/Sustainability
- Mobility
- Modularity

Budget Activity
- BA 2 53%
- BA 3 47%

Major Programs:
- Unmanned: LDUUV, ACTUV, Hydra
- Survivability: ORP, Multi-Axis Protection of Ships, Modular Active Protection System
- Modularity: Squad-X
- Mobility: CVP, GXV
- Maintainability: Hybrid Multi-Material Rotor

Source: DoD PB16 FY 2016

8% overall is USMC
Commercial-DoD Leverage in Ground & Sea Platform Technologies

**DoD looks for opportunities to leverage commercial technology where applicable**

- Identifying commercial technology suitability to military use/environment is a challenge
- It must be carefully evaluated to ensure requirements unique to DoD systems are met

### TECHNOLOGY LEVERAGE

<table>
<thead>
<tr>
<th>Weight/Size</th>
<th>Category</th>
<th>Platform Type</th>
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<tbody>
<tr>
<td>Light</td>
<td>Tactical Ground</td>
<td>LAV, HMMWV</td>
</tr>
<tr>
<td>Medium</td>
<td>Combat Support</td>
<td>Stryker, JLTV</td>
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<tr>
<td>Heavy</td>
<td>Ground</td>
<td>Abrams, Bradley</td>
</tr>
</tbody>
</table>

### Platform Technologies

- **Ground**
  - LAV
  - HMMWV (JLTV, MRAP)
  - Bradley

- **Sea**
  - Aircraft Carriers
    - Assault
    - Cruisers
    - Destroyers
  - Landing Craft
  - AAV/ACV

- **Unmanned**
  - Assault (e.g., TERRAMAS)
  - Dry Cargo/Ammunition RORO
  - Counter Mine/ISR (e.g., PACKBOT)
  - Home/Personal
  - Space Exploration
  - Logistics
  - ACTUV

### DoD, Commercial, DHS, NASA

- **DoD**
  - Ground
  - Sea
  - Unmanned

- **Commercial**
  - Ground
  - Sea
  - Unmanned

- **DHS**
  - Ground
  - Sea
  - Unmanned

- **NASA**
  - Space
  - Exploration
Other Navy Opportunities
- Repurpose decommissioning ships (USS PONCE, formerly LPD 15, repurposed as Afloat Forward Staging Base and hosted first deployed tactical laser weapon)
- Upgrade existing ships

Other Army Opportunities
- Modification to existing combat and tactical vehicle programs

Other USMC Opportunities
- Modification to existing vehicle programs
GSP COI Roadmap Process

Created and defined technical performance and schedule objectives

- Collected individual service projects and planned efforts

Grouped investments by technical approaches and identified overlaps, investment opportunities, and areas of collaboration

- Developed 19 Investment Plans to align all service investments with technical challenges

Evaluated Roadmap:
- Identify major efforts and flagship programs
- Conduct self assessment
- Identify and prioritize investment opportunities across the services
- Assess risks and issues
# Ground and Sea Platforms

## Technical Challenge Breakdown Structure

<table>
<thead>
<tr>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
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<tbody>
<tr>
<td><strong>Platform Protection</strong></td>
<td><strong>Lightweighting the Platform</strong></td>
<td><strong>Platform Maneuverability</strong></td>
<td><strong>Manned-Unmanned Teaming</strong></td>
<td><strong>Enhanced Platform Maintenance</strong></td>
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<tr>
<td>1.1 Improved Blast Protection</td>
<td>2.1 Reduced Weight of Armor and Structure</td>
<td>3.1 Unconstrained Mobility</td>
<td>4.1 Enhanced Platform Autonomy</td>
<td>5.1 Condition Based Maintenance</td>
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<tr>
<td>1.2 Directed Energy Threat Mitigation</td>
<td>2.2 Reduced Weight of Mobility Systems</td>
<td>3.2 Improved Design for Higher Speed</td>
<td>4.2 Optimized Platforms by/for Unmanned Operations</td>
<td>5.2 Advanced Manufacturing for Rapid Component Replacement</td>
</tr>
<tr>
<td>1.3 Enhanced Ballistic Protection</td>
<td>3.3 Enhanced Propulsion</td>
<td>3.4 Enhanced Energy Efficiency</td>
<td>4.3 Enable Configurable Autonomous &amp; Unmanned Payloads</td>
<td>5.3 Advanced Corrosion &amp; Wear Resistant Systems</td>
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<tr>
<td>1.4 Hit and Kill Avoidance</td>
<td></td>
<td></td>
<td>4.4 Enhanced Assured Trust in Unmanned Systems</td>
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<tr>
<td>1.5 Detection Avoidance (Signature Management)</td>
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<tr>
<td>1.6 Enhanced Cyber Defense</td>
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# Platform Protection

## Opportunities and Challenges

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<tbody>
<tr>
<td><strong>1.1 Improved Blast Protection</strong></td>
<td><strong>OPERATIONAL OPPORTUNITIES:</strong></td>
</tr>
<tr>
<td>1.1.1: Prevent Detonation</td>
<td>- Negate enemy threat “left of boom”</td>
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<tr>
<td>1.1.2: Structural Performance</td>
<td>- Adaptive, modular approach allows platform survivability to outpace threat lethality</td>
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<td>1.1.3: Internal Occupant Protection</td>
<td>- Protect personnel from weapons induced injuries and death</td>
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<tr>
<td><strong>1.2 Directed Energy Threat Mitigation</strong></td>
<td>- Operate in complex environment</td>
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<tr>
<td>1.2.1: Sensor Protection</td>
<td><strong>ENDURING CHALLENGES:</strong></td>
</tr>
<tr>
<td>1.2.2: System Protection</td>
<td>- Smart and lethal/non-lethal threats make armor-only solutions non-sustainable</td>
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<tr>
<td><strong>1.3 Enhanced Ballistic Protection</strong></td>
<td>- Leverage the power of new manufacturing and design processes and material science breakthroughs</td>
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<tr>
<td>1.3.1: Passive Armor</td>
<td>- Adapt to an evolving threat attacking across a variety of domains</td>
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<tr>
<td>1.3.2: Advanced Armor</td>
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<tr>
<td><strong>1.4 Hit and Kill Avoidance</strong></td>
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<tr>
<td>1.4.1: Hard Kill and Soft Kill</td>
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<tr>
<td>1.4.2: Sensing</td>
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<td><strong>1.5 Detection Avoidance</strong></td>
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<td>1.5.1: Signature Management</td>
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<td><strong>1.6 Enhanced Cyber Defense</strong></td>
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<tr>
<td>1.6.1: Enhance Platform Cyber Defense</td>
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**Vision:** A system-of-systems that allow the platform to react to and defeat the threat in real time with minimal impact to the occupant and on the mission
Key Focus Areas

- Cyber Defense of Vehicle Networks
- Hard and Soft Kill Options for Counter-UAS
- Adaptive Armor
- Directed Energy Defeat
- Active Protection
Ground Based Air Defense (GBAD) Directed Energy (DE) Future Naval Capability (FNC) provides an agile, cost effective, deep-magazine On-the-Move (OTM) Detect-to-Engage capability against low altitude Low Observable/Low radar cross section threats to enhance short-range air defense capabilities of the United States Marine Corps (USMC) Marine Air-Ground Task Force Air Combat Element. This effort will tie a High Energy Laser (HEL) integrated onto a USMC light tactical vehicle with a volume surveillance sensor via a command and control interface. This 5-year FNC includes three key milestones demonstrating increased capabilities culminating in an OTM end-to-end engagement of the primary threat in FY17. As depicted in the schedule, initial demonstrations will be on an interim vehicle platform in mid-FY15, followed by demonstration of the final objective system in FY17. Upon successful demonstration, this will transition to the GBAD Program of Record under PEO-Land Systems. Naval Surface Warfare Center Dahlgren Division serves as the Lead System Integrator, and will leverage several S&T development efforts from ONR, the HEL-Joint Technology Office (HEL-JTO), and U.S. Army.

**Laser Weapon System**
Tactical vehicle-mounted mobile/expeditionary/on-the-move system with full-power lasing capability of low altitude, low observable/low radar cross section threats. Objective system weight not to exceed 2,500 lbs, and fully contained within the vehicle's cargo area.

**On-The-Move Command, Control, and Communications**
Mobile/expeditionary/on-the-move command, control, and communications required to integrate elements of the GBAD FNC product, to include distribution of high-quality stills and/or video imagery, and fire-control quality data (including target position data to permit acquisition of target with local sensors) with ability to minimize latency and support Quality of Service (QoS).

**Radar On-The-Move Volume Search**
Mobile/expeditionary/on-the-move radar system capable of detecting and tracking targets of interest at operationally relevant ranges with acceptable false alarm rates.
Objective:
Develop and demonstrate an active seat suspension technology that incorporates a magnetorheological (MR) damper for the attenuation of energy from under body blast to protect the crew in military ground vehicles. Secondary objectives are to protect the seated occupant from whole body ground vehicle tactical vibration and adapt to higher energies.

Technology and Key Features:
- Occupant weight adaptation (5th percentile female to 95th percentile male)
- Blast adaptation
- Minimizes occupant loading by maximizing seat stroke
- Senses and calculates ‘real time’ input velocity and adapts MR output force accordingly
- Mitigates against low frequency chassis vibration to reduce occupant fatigue
- Triggering / timing loops
2.0 Lightweighting the Platform

Opportunities and Challenges

2.1 Reduced Weight of Armor and Structure

2.1.1 Reduced Weight of Armor

2.1.2 Reduced Weight of Structure

2.2 Reduced Weight of Mobility Systems

2.2.1 Reduced Weight of Fuel

2.2.2 Reduced Weight of Powertrains

**OPERATIONAL OPPORTUNITIES:**

- Improve transportability
- Smaller deployment, employment, and sustainment footprints
- Reduce fuel consumption rates and logistical support
- Enhance survivability of small boats and combatants operating in littoral areas
- Improve ship stability

**ENDURING CHALLENGES:**

- Reduce logistic burden of storing, transporting, distributing and retrograde of materials
- Achieve operational maneuverability in all environments and at high operational tempo

**Vision:** Provide a lethal and agile force that can be transported and/or deployed across the globe
2.0 Lightweighting the Platform

Key Focus Areas

- Lightweight track, suspension, powertrain, and other mobility systems
- Low cost, high mass efficiency passive armor
CVP MOVE Prototype Demonstrators

Component Integration to Subsystem

Next Gen Engine + ISG + Adv. Transmission
+ Adv. Thermal Mgmt + Adv. 6T Li-Ion

Validated Design Solutions (TRL 6)

MOVE Adv. Powertrain Demonstrator
Updated Mobility Requirements & Subsystem Data

APU Subsystem Demonstrator
Updated Silent Watch and Electrical Requirements & Subsystem Data

Track and Suspension Subsystem Prototype on Abrams chassis
Updated Track & Suspension Requirements & Vehicle Data

TRL 6 Component Validation
Next Gen Engine

ISG
Adv. Transmission
Adv. Thermal Mgmt
Adv. 6T Li-Ion
Adv. Auxiliary Power
High Capacity Track
External Suspension
### 3.0 Platform Maneuverability

#### Opportunities and Challenges

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<thead>
<tr>
<th>3.1 Unconstrained Mobility</th>
<th>3.3 Enhanced Propulsion</th>
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<tr>
<td>3.1.1: Soft Soil Mobility</td>
<td>3.3.1: Power Density</td>
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<td>3.1.2: Operations in High Sea State</td>
<td>3.3.2: Powertrain Efficiency</td>
</tr>
<tr>
<td>3.1.3: Operations in Extreme Environments</td>
<td>3.3.3: Multi-fuel Capability</td>
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<td>3.1.4: Mobility in Urban Terrain</td>
<td>3.3.4: Thermal Management</td>
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<tr>
<td>3.1.5: Terrain Transition / Adaptability</td>
<td>3.3.5: Operational Availability</td>
</tr>
<tr>
<td>3.1.6: Operations in Littoral Environments</td>
<td><strong>3.4 Enhance Energy Efficiency</strong></td>
</tr>
<tr>
<td><strong>3.2 Improved Design for Higher Speed</strong></td>
<td><strong>3.4.1: Energy Recovery</strong></td>
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<tr>
<td>3.2.1: Robust M&amp;S Tools</td>
<td>3.4.2: Fuel Economy</td>
</tr>
<tr>
<td>3.2.2: Reduce Drag</td>
<td>3.4.3: Power Density</td>
</tr>
<tr>
<td>3.2.3: Power to Weight Ratio</td>
<td>3.4.4: Hybrid / All-Electric Platform</td>
</tr>
<tr>
<td>3.2.4: Power to Weight Ratio</td>
<td>3.4.5: Onboard Power Generation</td>
</tr>
</tbody>
</table>

**Operational Opportunities**

- Provide access in all operational environments
- Extend platform range/endurance and reduce logistics burden

**Enduring Challenges**

- Improve fuel efficiency of platforms with increasing energy demands
- Maneuver a range of challenging terrains and threat environments

**Vision:** Provide global operational reach regardless of terrain or sea state at rapid speeds while minimizing the logistics footprint
3.0 Platform Maneuverability

Key Focus Areas

- Fuel efficiency and power enhancements
- High water speed for amphibious combat vehicles
- Higher power density and onboard power sources
USMC Amphibious Combat Vehicle (ACV) Ground Combat Tactical Vehicle Strategy

- **ACV 1.1**
  - 204 P Variants Only
  - ONR Lead

- **ACV 1.2**
  - 490 P/C/R Variants
  - OR

- **ACV 1.3 (Wheeled)**
  - ~700
  - OR

- **ACV 2.0**
  - (HWS Tracked or Wheeled)
  - OR

Legend:
- ▼ = Planned Initial Operating Capability
- ▶ = Planned Full Operating Capability
- ▼ = Divestiture
- ▶ = ONR Lead
- ▶ = 1.2 CDD Development JROC Staffing
- ▶ = Assess ACV 1.1 Water Mobility
- ▶ = HWS Decision

**High Water Speed (HWS) Capability Development Exploration**

**Legacy AAV**
- 666 C/R/P
- 486 C/R/P
- 74 C/R

**Test Vehicles**
- 17 PAX
- 10 PAX

**392 AAV SUP/SII + 74 AAV SUP/SII = 466 AAV SUP/SII**

**1,058 AAV – 392 SUP/SII = 666 AAV – 180 AAV = 486 AAV – 412 AAV = 74 AAV for SUP/SII (Sundown Phasing)**
Amphibious High Water Speed S&T Approach

- ONR will lead the HWS Capability Development Exploration phase
- The focus is on a “self-deployed high water speed amphibious vehicle” to enable seamless ship to objective maneuver
  - Explore new and novel “high water speed” technologies and concepts
    - Is a lower cost, more reliable and survivable HWS self-deployable vehicle possible?
    - Our aperture is wide open
  - Other considerations to inform ACV high water speed decisions:
    - Enhance Low Speed Platforms
      - Can we make the ACV 1.X a “higher” water speed vehicle?
    - Research Add-on, Jettisonable Technologies
# Manned-Unmanned Teaming

## Opportunities and Challenges

### 4.1 Enhanced Platform Autonomy
- **4.1.1: Perception and Control**
- **4.1.2: Human-Machine Interface**
- **4.1.3: Collaborative Tactical Behaviors**

### 4.2 Optimized Platforms for/by Unmanned Operations
- **4.2.1: Enable New Design Space**
- **4.2.2: Extend Reach**
- **4.2.3: Launch, Recovery, and Sustainment**

### 4.3 Enable Configurable Autonomous Payloads
- **4.3.1: Autonomous and Integrating Payloads**
- **4.3.2: Backbone (enabling) Architecture**
- **4.3.3: Providing Adequate SA**

### 4.4 Enhanced Assured Trust in Unmanned Systems
- **4.4.1: TEVV Methodology**
- **4.4.2: Hardware/Software Assurance**
- **4.4.3: Trusted Behavior**

### Operational Opportunities:
- Reduce physical and cognitive burden on warfighter
- Provide force multiplier in capability with limited manpower
- Improve ISR and situational awareness

### Enduring Challenges:
- Sensor and communications to support bandwidth constrained C2 in contested battlespace included GPS denied environment and electronic warfare attacks.
- Platform autonomy to conduct goal based tasking with imperfect information

**Vision:** An integrated family of unmanned air, ground, and sea vehicles that work collaboratively with the Warfighter to meet mission goals
Key Focus Areas

- Autonomous logistics and convoy operations
- Unsupervised unmanned surface operations
- Autonomous navigation in GPS denied, degraded visual, and complex terrain
- Enhancing trust in unmanned systems
Autonomous Systems Strategic Capability Progression

Unmanned Air Systems Autonomy (2020)

Synergistic Unmanned-Manned Intelligent Teaming (SUMIT) (2020-2025)

Dynamic Force & Mission Autonomy (2030-2040+)

Combined Arms Maneuver (2030-2035)

2035

2025

2020

Extend the Reach of the Warfighter (2020)

Active Safety Driver Assist Appliqué Kits (2015)

Unmanned Convoy Operations (2020-2025)

“Adapt, Evolve, and Innovate”

Near Term Capabilities:
- Leader Follower Convoy Technology Employment
- Autonomous Mobility Applique System (AMAS)
- Lighten the Soldier load
- Enhance stand-off from threats and improve situational awareness

Mid Term Capabilities:
- Improve the autonomy of unmanned systems
- Enable unmanned cargo delivery
- Act as a “teammates” rather than tools
- Micro autonomous air/ground systems will enhance Platoon, Squad, and Soldier situational awareness.

Far Term Capabilities:
- Enable manned and unmanned teaming in both air and ground maneuver through scalable sensors, scalable teaming, Soldier-robot communication, and shared understanding through advancements in machine learning.

UNCLASSIFIED: Distribution Statement A. Approved for public release; distribution is unlimited.
Security & Resiliency in Autonomous Systems

Background

• A significant increase in trust is required to provide fully functional, self-governing systems that enhance human warrior operational capability.

• Considerations must be made on how to evaluate the autonomous software agents within the context of the larger cyber-physical systems in which they are employed.

Challenges

State-Space Explosion
Because of its size, cyberspace cannot be exhaustively searched, examined or tested; it grows exponentially as all known conditions, factors and interactions expand.

Unpredictable Environments
The power of autonomous agents is the ability to perform in unknown, untested environmental conditions. This performance increase comes with the price of assuring correct behavior in a countless number of environmental conditions.

Emergent Behavior
Interactions between systems and system factor may induce unintended consequences.

Human-Machine Communication
Handoff, communication and interplay between operator and autonomous agents.

Gaps

Verifiable Cyber & Autonomous System Requirements
Modeling, Design and Interface Standards
Autonomy and Cyber Test & Evaluation Capabilities
Human Operator Reliance to Compensate for Brittleness
Run Time V&V during Deployed Autonomy Operations
Evidence Re-use for V&V
Navy Autonomous Swarm Boats

- Allow any unmanned surface vehicle (USV) to not only protect Navy ships, but also, for the first time, autonomously “swarm” offensively on hostile vessels

- Initially demonstrated over two weeks in August 2014 on the James River in Virginia

- Sensors and software enable swarming capability, giving naval warfighters a decisive edge.

- CARACaS (Control Architecture for Robotic Agent Command and Sensing)—is under development by ONR, and can be put into a transportable kit and installed on almost any boat.
Objectives:

• Address gap identified by the Survivability and Unmanned Platform Integration Taxonomy Areas of the Ground & Sea Platforms COI

• Increase survivability of ground vehicle systems against aerial threats

• Enhance the levels of active and passive protection

• Mitigate the effects of hostile Group 1 Unmanned Aerial Vehicles (UAV) in the vicinity of ground platforms

Operational Opportunities:

• Use of semi-autonomous system leveraging small, platform launched, unmanned air vehicles (e.g., quadrotor) integrated with the platform’s situation awareness (SA) and active protection systems (APS)

• Improved 360° SA achieved in a safety hemisphere around ground vehicle in cluttered environments

• Tailored countermeasures to the capabilities and specifications of the Group 1 systems

Technical Challenges:

• Size, weight and Power (SWAP) limitations of Group 1 ground vehicle compatible UAVs

• Installation limitation challenges on ground vehicles - little top side real estate available

• Broad capability range of hostile Group 1 UAVs

• Desire limitation on human supervision requirements

• Obstacle avoidance in complex terrain
5.0 Enhanced Platform Maintenance

Opportunities and Challenges

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<th>5.1 Condition Based Maintenance</th>
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<tr>
<td>5.1.1: Improved Sensors</td>
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<td>5.1.2: Accurate Component Failure Forecast</td>
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<td>5.1.3: Trusted Architecture</td>
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<table>
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<tr>
<th>5.2 Advanced Manufacturing for Rapid Component Replacement</th>
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<tr>
<td>5.2.1: Control of Microstructure Properties</td>
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<tr>
<td>5.2.2: Advanced Manufacturing Performance</td>
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<td>5.2.3: Accelerated Qualification and Certification</td>
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<tr>
<td>5.3.1: Corrosion Technologies</td>
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<td>5.3.2: Chemical Formulation Predictive Models</td>
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**Operational Opportunities:**
- Reduce Total Ownership Cost (TOC) of platforms and improve operational availability of platforms
- Reduce time spent conducting preventive maintenance and repair
- Improve equipment reliability, reduce the size of logistics support elements, and enhance maintenance responsiveness

**Enduring Challenges:**
- Harsh and dynamic operating environments
- Repair teams operating independently over extended distances
- Engineer platforms for improved maintainability, rapid repair, nominal tool requirements, redundancy, system bypass capability, and maximum use of plug-and-play modular components

**Vision:** S&T that enhances the maintainability of current and future combat systems while reducing lifecycle cost & logistics burden and increasing reliability & operational availability for ground and sea platforms.
Enhanced Platform Maintenance

Key Focus Areas

- Improved chemical agent and corrosion resistant coating techniques
- Condition-based maintenance
- Additive manufacturing for replacement parts
FY18-21 Program Goals

• Enhance quality and reliability of metal additive while addressing key Naval issues
  – Build confidence in material properties for critical metal parts
  – Improved design and quality control tools & processes
  – Support speedy qual/cert

• Improved AM design
  – Enhanced understanding of the correlation of materials properties to AM processes
  – Reduce required redesign iterations
  – Establish an upper and lower control limit for critical AM process parameters

• In situ sensors and closed loop process controls to ensure a quality build
  – Control AM process parameters to control microstructure, volume, and geometry
  – Collect build data to support qual/cert
Programmatic Challenges

- **Recruitment and Retention of Scientists and Engineers**
  - Difficult keeping Computer Science / Electrical Engineers to support autonomy and unmanned systems development due to self-driving car initiatives from within and beyond auto industry

- **Military needs continued industry engagement to focus on specialized needs**
  - Particularly advanced engines and transmissions (small volume for overly bureaucratic process)
  - Some industries actively avoid DoD for commercial edge or proprietary advantages

- **Ground and sea vehicles employ technologies optimized for commercial vehicles**
  - Divergence of commercial and tactical technologies: commercial emission requirements reduce fuel efficiency; military vehicles exempted but OEMs focused on meeting commercial standards
  - Different mission profiles for military (off road, significant idle time, time in port)
  - Commercial ships are constantly in motion so bio-fouling is not an issue

- **New technologies must consider interoperability within/amongst services and with allies**
  - Increases cost and time to field and fix systems

- **Push towards open architectures but understand potential vulnerability if security not adequately addressed**
G&SP Way Ahead

• Completed first GSP COI roadmap
  – Moving to execution

• Look for Cross-COI opportunities in focus areas
  – Cyber (Platform network defense)
  – Materials and Manufacturing (DEW defeat)
  – Autonomy (Trust in Unmanned Systems)

• Advocate for prototyping and experimentation in key technology areas
  – Unmanned ground vehicles
  – Cyber-protected, C2, and CBM-enabled Ground Vehicle