Advancing Unmanned Systems Capabilities in Multi-Domain Environments

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Presented by:
RADM Mark Darrah, USN
Program Executive Officer for Unmanned Aviation and Strike Weapons

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COOPERATIVE TRACKER
- NTM capability
- Search, detect and target moving target with ownship sensor
- Characterize latency and accuracy, and transmit

COOPERATIVE SHOOTER
- Receive tracks, ID, accuracy, and latency from offboard source
- Transfer control to offboard source

WEAPON CONTROLLER
- Receive track, re-target and abort messages via offboard source
- Transmit track updates, retargeting and abort messages to weapon

WEAPON
- Send and receive in flight target updates
- Weapon to weapon coordination

Mission & Platform Independent Functional Capability
Platforms & Weapons that can Perform Role

Notional Assets
- Space
- Air
- Surface
- Subsurface

TACTICAL CLOUD
- Send and receive in flight target updates
- Weapon to weapon coordination

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# Unmanned Challenges & Opportunities

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<th>Unmanned Attributes</th>
<th>Unmanned Domains</th>
<th>Cross-Domain Challenges &amp; Opportunities</th>
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<td>Persistence</td>
<td>Air</td>
<td>➢ Autonomy</td>
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<tr>
<td>Expendability</td>
<td>Surface</td>
<td>➢ Common Control Architecture</td>
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<tr>
<td>Precision</td>
<td>Sub-Surface</td>
<td>➢ Interoperability Standards</td>
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<td>Scalability</td>
<td>Ground</td>
<td>➢ TCPED</td>
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<td></td>
<td>Space</td>
<td>➢ Manned-Unmanned Teaming</td>
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<td></td>
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<td>➢ Open Architecture / Modularity</td>
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<td>➢ Sensor and Component Reuse</td>
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<td>➢ Collision Avoidance</td>
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<td>➢ Cyber Vulnerability</td>
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<td>➢ Propulsion/Power Endurance</td>
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<td>➢ Miniaturization</td>
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<td>➢ Swarming / Net-Enabled</td>
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<td></td>
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<td>➢ Training, Support, Culture</td>
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<td>➢ Acquisition Velocity (Speed to Fleet)</td>
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- **Unmanned Attributes**
  - Persistence
  - Expendability
  - Precision
  - Scalability

- **Unmanned Domains**
  - Air
  - Surface
  - Sub-Surface
  - Ground
  - Space
### Kill Chain

<table>
<thead>
<tr>
<th>Surveillance</th>
<th>Detect</th>
<th>Track</th>
<th>ID</th>
<th>Launch</th>
<th>Control</th>
<th>Weapon</th>
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<tr>
<td>MQ-4 Triton</td>
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<td>MQ-8B/C Firescout</td>
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<td>MQ-25 Stingray</td>
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<td>Class I - III UAV</td>
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- **Overarching Technology Needs**
  - Cyber Security
  - Data Management / Data Fusion
  - Open Architectures / Modularity
  - Assured navigation and communications in A2/AD environments
  - Non-GPS precision navigation and geolocation for maritime domain
  - Operational dynamic resource management

- **Unmanned Air Systems Technology Needs**
  - Autonomy
  - High bandwidth, low profile/drag, through the rotor, Beyond Line Of Sight (BLOS) communications for rotary wing aircraft
  - Multi-vehicle, multi-sensor planning and control
  - Reducing bandwidth and/or operator workload by converting sensor data into actionable information
  - Sensors for small UAS to detect and avoid non-cooperative airborne contacts

- **Weapon Technology Needs**
  - Net enabled/ interoperable weapons
  - Multi-mission capability
  - Seeker capabilities in day/night, all weather environments
  - Expanded engagement envelope
    - Speed / Range -- ENERGETICS
  - Insensitive Munitions Improvements
  - Alternative weapons (e.g., directed energy) for airborne applications