Air Space Total Awareness for Rapid Tactical Execution (ASTARTE)

Paul G. Zablocky
Program Manager, DARPA STO

COL Chad Ward
Director, Army Joint Support Team

Proposers Day Briefing
21 April 2020

Growing Complexity of Airspace Operations Limits Joint Fires

Airspace usage forecasted to increase significantly; increased PGM use, autonomous technologies, and dynamic battle management initiatives such as Mosaic and Multi-Domain Operations will exacerbate problem.

ASTARTE will enable dynamic airspace operations in the most complex and challenging environments.
Current Airspace Operations

Current

- Digital exchange of 3D Common Operating Picture
  - Tracks, air corridors, ROZs are all **static**
- Planning and control mostly **manual** processes
  - Creation of airspace and fires plans, control measures, and mission/orders
  - Operator clearance of airspace
  - Change of plans, control measures, orders, and commander’s guidance
  - Verbal notification of clearance of airspace and fires
- Current techniques result in safety risks and missed mission opportunities
ASTARTE will enable dynamic spatial and temporal airspace management and operations

- Seamless, digitally-integrated automation of airspace & fires planning, processing, de-confliction and execution in 4D COP
- Optimized algorithms for airspace/fires clearance and deconfliction COA generation; considers A2/AD effects
- Detects and tracks BLUE, RED and WHITE
- Supports planning for long-range fires and effects (e.g. hypersonics)
- Dynamic mid-mission re-tasking (e.g. Air Interdiction to CAS)
ASTARTE Approach

ASTARTE data fed back into current systems

4D COP Data (Military & Commercial)

Orders and Missions

Data Feed 1
Data Feed 2
Data Feed N

De-conflicted Airspace

Open Interfaces and Services
New Sensors, Algorithms, and Data Feeds

Key
ASTARTE Inputs
ASTARTE Outputs
Joint Systems/Assets
Army Systems/Assets

IFF: Identification Friend or Foe
TAIS: Tactical Airspace Integration System
UAS: Unmanned Aerial Systems

**Technical Area 1 – Understanding and Decision Algorithms**

- Development of physics-guided algorithms to estimate airspace entities position, forecasts future position with an error ellipse, identify conflicts, assess risk and provides recommendations
  - Develops and executes sensor scheme to monitor airspace operations in real time
  - Refines airspace entity position and forecasts future position
  - Resolves conflicts identified in airspace and fire mission by providing COAs and modifying operations
  - Alerts operators to conflicts during operations, offers resolution, and provides risks and rationale

**Technical Area 2 – Sensors**

- Development of innovative sensor feeds to detect and track aircraft and weapons in A2/AD environment

**Technical Area 3 – Virtual Lab Testbed**

- Development of Virtual Machine implementation of existing Army and Air Force systems and interface specifications to sensor network supporting seamless transition from virtual environment to real-world operations

*Graphic source: Army Research Laboratory*
Why now?

- Resurgence of Artificial Intelligence (AI) resulted in:
  - New software architectures for solving large, incomplete problems
  - A variety of software development tools to rapidly implement and experiment with new concepts
- Processing power is now sufficient for problems on the scale of airspace management
- DoD emphasis on Joint All-Domain Command and Control (JADC2)

Capabilities

- Develops and executes sensor collection plans to monitor airspace operations against the plan, monitors plan and execution
- Refines airspace entity position and forecasts future position
- Resolves conflicts identified in airspace and fires plans by providing COAs and modifying plans
- Alerts operators to conflicts during operations, offers resolution, and provides risks and rationale

Potential Approaches

- Graph theory
- Reinforcement learning
- Global optimization with PSO
- Game theory to generate courses of action
TA2: Sensors

Why now?
- Proliferation of electronic sensors and sources in the battlespace
- High-quality, low cost, commercial sensors
- DoD emphasis on Joint All-Domain Command and Control (JADC2)

Capabilities
- Layered sensor coverage leveraging a variety of traditional and non-traditional sensors to refine entity location
  - Radars leveraging diverse sources
  - Electro-optic and infrared sensors
  - Electronic warfare sensors to detect communication
  - IFF, ADS-B, and PLI transitions
  - Intelligence, joint data feeds
- System interrogates sensors in real-time to verify predicted conflicts
- Planned and opportunistic sensor networks
Why now?

- Computer processing power is now sufficient to handle the complexity of division airspace
- DEVOPS and virtual environments have reached a level of maturity capable of addressing the most complex airspace challenges
- DoD emphasis on Joint All-Domain Command and Control (JADC2)

Capabilities

- Physics-based world model
- Virtual implementations of airspace planning tools for operator input and output, federated with legacy systems
- Open software framework to allow rapid insertion and experimentation with algorithms, sensors
- Simplifies transition path from laboratory to field
ASTARTE Development Concept

**Phase 1: Component Development**
- Virtual Machine implementations of TAIS, AFATDS, TBMCS and other joint systems
- Algorithm development
- Sensor models and specifications
- Performance metric development and measurement approach

**Phase 2: Virtual Environment**
- Integration of algorithms and sensor models into Virtual Lab Testbed
- Improvements to algorithms and sensor models
- Performance assessments against metrics

**Phase 3: Live Environment**
- Mission planning and operations with live TAIS, AFATDS, TBMCS and other joint systems in virtual world model
- Incorporate live sensor feeds into virtual world model
- Experiments at Combat Training Centers to demonstrate scenarios

**Component Diagram**
- Algorithms
- Sensors
- Virtual Lab Testbed
- TAIS: Tactical Airspace Integration System
- AFATDS: Advanced Field Artillery Tactical Data System
- TBMCS: Theatre Battle Management Core Systems

# ASTARTE Schedule and Milestones

<table>
<thead>
<tr>
<th>Tasks</th>
<th>FY20</th>
<th>FY21</th>
<th>FY22</th>
<th>FY23</th>
<th>FY24</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
</tr>
<tr>
<td>TA1 Understanding and Decision Algorithms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA2 Sensor Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TA3 Virtual Lab Testbed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government/Army/AF SETA Team</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## TA1 Understanding and Decision Algorithms

- **Phase 1**: Algorithm Development (3 Months)
- **Phase 2**: Algorithm Integration (3 Months)
- **Phase 3**: Algorithms in Live Environment (3 Months)

## TA2 Sensor Development

- **Phase 1**: Sensor Development (3 Months)
- **Phase 2**: Sensor Integration (3 Months)
- **Phase 3**: Sensor Feeds in Live Environment (3 Months)

## TA3 Virtual Lab Testbed

- **Phase 1**: Virtual Testbed Development (3 Months)
- **Phase 2**: Virtual Testbed Integration (3 Months)
- **Phase 3**: Virtual Testbed in Live Environment (3 Months)

## Government/Army/AF SETA Team

- **Phase 1**: Component Development (14 Months)
- **Phase 2**: Virtual Environment (14 Months)
- **Phase 3**: Live Environment (18 Months)

---

• Proposers must propose to all three technical areas in a single proposal
  • TA-1 Understanding and Decision Algorithms
  • TA-2 Sensors
  • TA-3 Virtual Lab Testbed

• It is strongly encouraged that proposers team with organizations that have specialized expertise in each technical area

• Proposers must have the ability to execute the entire program at the collateral SECRET level as a minimum
  • This requirement does not apply to organizations such as universities that may participate as a subcontractor
BAA Evaluation Criteria

Evaluation Criteria:

<table>
<thead>
<tr>
<th>Overall Scientific and Technical Merit</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Technical approach is innovative, feasible, achievable, and complete</td>
</tr>
<tr>
<td>- Identification of major technical risks and planned mitigation effort</td>
</tr>
<tr>
<td>- Quality of proposed team must have experience and expertise</td>
</tr>
<tr>
<td>- Description of prior experience including identification of government sponsors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Contribution and Relevance to the DARPA Mission and Plans and Capability to Accomplish Technology Transition</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Must show support for DARPA Mission to make pivotal early technology investments</td>
</tr>
<tr>
<td>- Capability to transition the technology to research, industrial, and/or operational military communities to enhance U.S. defense</td>
</tr>
<tr>
<td>- Data rights and intellectual property ownership must be disclosed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost and Schedule Realism</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Proposed cost, labor categories and labor hours are consistent with statement of work</td>
</tr>
<tr>
<td>- Fully scoped plan and schedule</td>
</tr>
<tr>
<td>- Cost Risk</td>
</tr>
</tbody>
</table>

HR001120S0039 Important Dates

- Posting Date: April 7, 2020
- Proposers Day: April 21, 2020
- Abstract Due Date: April 28, 2020 4:00 PM (Eastern)
- Deadline to Notify Security of Intent to Submit Classified Data: May 28, 2020 4:00 PM (Eastern)
- Proposal Due Date: June 23, 2020 4:00 PM (Eastern)
- Security Classification Guide, DD254s, and Technical Interface Specifications will be mailed to proposers in a classified package after May 8th

- Deadline to Submit Questions: May 14, 2020 4:00 PM (Eastern)
- Submit Questions to: HR001120S0039@darpa.mil
- Frequently Asked Questions (FAQ) will be posted under HR001120S0039 summary on http://www.darpa.mil/work-with-us/opportunities

If there is any discrepancy between what is presented today and the BAA, the BAA takes precedence.