

ARCHIVED REPORT

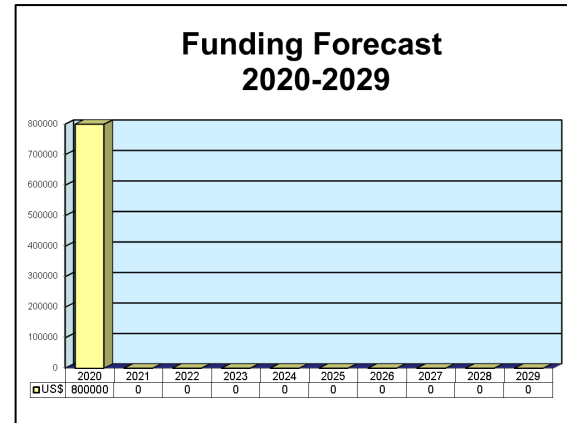
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Operational Awareness Technology

Outlook

- Project realigned to C4I Dominance Technology effort
- Expenditures being driven by the Air Force's push for a network-centric, collaborative intelligence analysis capability.



Orientation

Description. The U.S. Air Force's Operational Awareness Technology (now merged into C4I Dominance Technology – see separate report) project develops technologies that improve and automate the Air Force's capability to generate, process, manage, fuse, exploit, interpret, and disseminate timely and accurate information.

Status. Ongoing research and development.

Application. Intelligence gathering, processing, analysis, and dissemination.

Sponsor

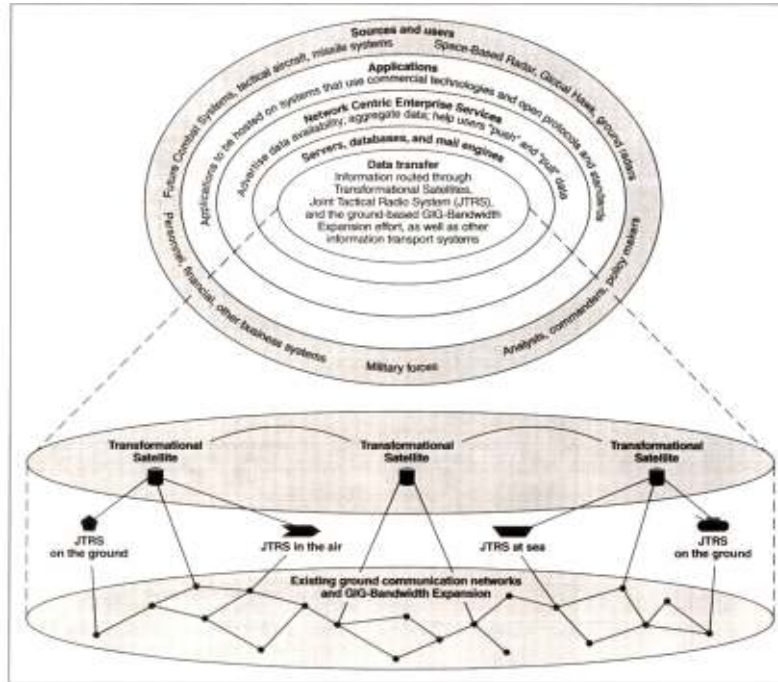
United States Air Force
Pentagon
Washington, DC

Contractors

Contractor(s) not selected or not disclosed.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Operational Awareness Technology



Operational Awareness Technology is a project of the U.S. Air Force.

Source: U.S. DoD

Technical Data

The Operational Awareness Technology project conducts research and development into technology that enables the fusion of multi-intelligence sources in order to provide accurate object tracking and identification of battlespace threats (air, ground, space, and cyber), along with situational awareness, understanding, and anticipation of those threats. The project also develops advanced exploitation technologies to maximize the intelligence gained from U.S. adversaries in the areas of spectral detection and geolocation, signal recognition and analysis, and data tagging, tracking, and tracing via the insertion of secure, imperceptible signal embedding.

The Operational Awareness Technology project is part of Program Element #0602788F (Dominant Information Technology). It consists of the following subprojects:

Assured Communications & Networks. This subproject develops communications, networking, and signal processing technologies with improved survivability and capacity to provide secure, adaptive, covert, anti-jam, and assured global battlespace connectivity tailored to anti-access and area-denial environments and contested operations.

Data to Decisions. This subproject investigates and develops technologies for dissemination by "decision quality information services via publish, subscribe, and

query" across the Global Information Grid to enterprise and tactical assets and coalition partners.

Processing Technologies. This subproject develops automatic and dynamically reconfigurable, scalable, affordable distributed peta-flop processing technologies for real-time global information systems.

Multi-Domain Command & Control (MDC2). This subproject develops advanced monitoring, planning, and assessment technologies enabling aerospace commanders to develop effects-based campaigns.

Artificial Intelligence / Autonomy/Machine Learning. This subproject conducts research and development to harness the speed and scale of computers and machines to address complex problems.

Nuclear C3 Modernization. This subproject performs research and development to advance existing nuclear-capable forces in order to ensure command, control, and connectivity for the president without constraints.

Quantum Information Science. This subproject performs R&D that utilizes quantum physics for the storage, transmission, manipulation, computing, or measurement of information in ways that offer advantages to "classical capabilities".

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Future AF Capabilities Applied Research. This subproject investigates and develops technologies supporting future Air Force capabilities "to provide compelling advantage to the warfighter." To the greatest extent practical, research efforts utilize modeling and

simulation and integrate cross-discipline systems (for example: air and space vehicles, avionics, propulsion, materials, cybersecurity, C4ISR, electronic warfare, and conventional/unconventional weapons).

Program Review

Summaries of the recent activity for each subproject of the Operational Awareness Technology project follow.

Multi-Source Fusion Technologies. In FY11, the Multi-Source Fusion Technologies subproject began the development and implementation of techniques that could be applied to increase the scalability of algorithms when tracking ground targets in a large rural-urban environment. This work continued through FY13.

During FY12, work focused on developing techniques and algorithms that could be applied to improve the analysis of multisensor data when mining data across multi-intelligence repositories. In FY14, the subproject worked on developing scalable pattern mining analytics for multi-intelligence data (static and streaming).

In an effort that began in FY15, the subproject is applying advanced reasoning techniques to Multi-INT data, including SIGINT and space surveillance network (SSN) data, to assess space objects and determine the significance of any activity.

From FY16-FY19, this subproject worked on developing techniques to provide a deeper understanding of the meaning of information extracted from open-source text, messages, reports, social media, and associated data sources and large-scale, time-dependent, network-based analytics. Other work involved developing space situational awareness and space protection domain applications. In addition, observations from sensors were analyzed and correlated to produce tracks, extract kinematic and non-kinematic features, and learn target object behavior. Toward the end of FY19, progress was made on advancing research and development of cloud-based data and information sharing environments in order to optimize processing and automated association capability.

In FY20, this effort was realigned with several newly created subprojects within PE#0602788F.

Exploitation Technologies. From FY11-FY19, the Exploitation Technologies subproject conducted research into advanced exploitation techniques that maximize the USAF's ability to gather, process, and display information from multi-INT sources identifying threats to warfighters across the physical and cyber domains.

In FY14, the subproject developed methods for enhancing the exploitation of emerging signals from contested environments. It incorporated machine learning approaches into event discovery in FY15.

During FY16, progress was made on improving extraction methods and performance across multiple data sets. In FY17, enhanced electronic signals intelligence "nontraditional feature" extraction capabilities were integrated into airborne platforms.

In FY18 and FY19, topological algorithm analytics continued to be developed to exploit features for anomaly and/or pattern detection. Also, research was conducted into "enhanced emitter feature" extraction capabilities and the development of automated electronics intelligence analysis toolsets.

In FY20, this effort was realigned with several newly created subprojects within PE#0602788F.

Next Generation Command Technologies. In FY11, the Next Generation Command Technologies subproject completed development of the "core" nation state model, to include both physical and social subsystems. Efforts continued through FY12 in developing an integrated set of possible adversary courses of action and intentions based on the adversary's abilities to perform activities associated with various domains. By FY13 work was completed on the identification of the degree to which a U.S. adversary can achieve hypothesized enemy courses of actions based on predicted goals.

From FY14-FY15, the subproject developed tools that could be used to effectively employ cyber, directed energy, and electronic warfare weaponry within a target folder environment, and designed/developed "import utility" allowing auto ingestion of DIA Fishnet data (for any country). Additional work focused on developing a CATALiST (Common Automated Targeting Architecture Linking integrated Solution Threads) framework, which includes data and user management, security, and role-based access.

During FY16-FY19, the subproject worked on developing the capability to identify targets with non-kinetic data, and to propose new workflows for such targets in support of situational awareness.

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In FY20, this effort was realigned with several newly created subprojects within PE#0602788F.

Assured Communications & Networks. After realignment in FY20, this subproject continued to research and develop technologies for robust, adaptive, and "mission-aware" airborne networks. Work focused on the investigation of high-frequency pathways (for example, the V and W band of the electromagnetic spectrum) to support aerial and space-based beyond line-of-sight communications. Additional work continues on ionospheric research, propagation modeling and simulation.

In FY21, a directional radio prototype will be developed with optimized user discovery and a "network interference control interface."

Data to Decisions. Up to FY19, project work was performed within Project 625318, Operational Awareness Tech, under the Multi-Source Fusion Technologies effort and Exploitation Technologies effort.

In FY20 and FY21, research will continue into the development of data analytics and "strategic indications and warnings technologies." Also, R&D will be conducted of a cloud-based data and information sharing environment toward development of an optimized processing and automated association capability.

Other work will include continued research into enhanced emitter feature extraction capabilities and the development of automated electronics intelligence analysis toolsets.

Processing Technologies. Up to FY20, project work was performed under numerous other subprojects. The project was then realigned.

FY21 plans call for developing novel neuromorphic systems for robust machine learning. More specifically, efforts will advance research and development of the neuromorphic processor and validate capabilities for dynamic learning on mobile and power-constrained platforms.

Multi-Domain Command & Control (MDC2). Up to FY19, project activities were performed within Project 625318, Operational Awareness Tech, under the Next Generation Command Technologies effort.

Activity during FY20 centers on leveraging prior efforts to develop plan assessment services and conduct quantitative evaluations of cyber assets in order to enable cyber operators to present viable cyber options to commanders for multi-domain (air, space, cyberspace, land, sea, undersea) integrated plans; to develop command and control system technologies in the area of

multi-domain command and control; and to apply machine learning techniques to enhance and optimize space operations.

In FY21 a system for distributed command and control will be developed, providing cyber operators with viable options for decision-making in the multi-domain arena.

Artificial Intelligence/Autonomy/Machine Learning. Up to FY19, project activities were performed within Project 625317, Information Decision Making Tech, under the Campaign Planning Technologies effort.

The agenda for FY20 called for continuing research into combat planning and tactical assessment software services.

During FY21, machine learning approaches for performing operations in complex adversarial environments will be explored, and the requirements of machine learning algorithms will be investigated. Also, demonstrations will be conducted of an analytical and simulation framework for large-scale swarms that considers potential constraints on communications, onboard processing, sensors, and flight systems.

Nuclear C3 Modernization. Up to FY19, the project activities were performed under the Advanced Connectivity Technologies effort.

Work during FY20 will include the development of a networking algorithm and a very low-frequency software-defined radio.

In FY21, an advanced airborne, high-frequency antenna/ionospheric structure will be developed and advanced waveforms will be tested. Efforts will also be made to develop and validate software-defined radio prototypes.

Quantum Information Science. Up to FY19, project activities were performed under the Advanced Connectivity Technologies effort.

In FY20, research will be conducted into supreme and quantum computing information sciences to establish memory-based network nodes, photon-based interconnects will be evolved, and an integration scheme to interface a quantum network will be developed. Also, the ability to teleport quantum information between network nodes and to establish two-way quantum communication between two memory nodes will be tested.

FY21 work will focus on research and development in the area of supreme and quantum computing information sciences; demonstrating entangling gates within a trapped ion-based network node and performing remote entangling operations between

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independent nodes; and developing compact memory- and photon-based network components to be used in future field demonstrations.

Future AF Capabilities Applied Research. In FY19, this work was performed under multiple projects within the following Air Force S&T programs: 0602102F, Materials; 0602201F, Aerospace Vehicle Technologies; 0602202F, Human Effectiveness Applied Research; 0602203F, Aerospace Propulsion; 0602204F, Aerospace Sensors; 1206601F, Space Technology; 0602602F, Conventional Munitions; 0602605F,

Directed Energy Technology; and 0602788F, Dominant Information Science and Methods.

During FY20 work will focus on investigating science and technology that enables future warfighting concepts to provide leap-ahead capabilities.

Starting in FY21, this work will be performed under PE#0602020F, Future AF Capabilities Applied Research, Project 620200, Enterprise Transformational Applied Research, Transformational Capability Incubator.

Funding

U.S. FUNDING								
	FY19 <u>QTY</u>	FY19 <u>AMT</u>	FY20 <u>QTY</u>	FY20 <u>AMT</u>	FY21 <u>QTY</u>	FY21 <u>AMT</u>	FY22 <u>QTY</u>	FY22 <u>AMT</u>
RDT&E (U.S. Air Force)								
PE#0602788F								
Project 625315	-	53.7	-	134.3	-	91.5	-	90.3
	FY23 <u>QTY</u>	FY23 <u>AMT</u>	FY24 <u>QTY</u>	FY24 <u>AMT</u>	FY25 <u>QTY</u>	FY25 <u>AMT</u>	FY26 <u>QTY</u>	FY26 <u>AMT</u>
RDT&E (U.S. Air Force)								
PE#0602788F								
Project 625315	-	87.1	-	89.0	-	90.6	-	N/A

All \$ are in millions.

N/A - Not Available

Source: U.S. Air Force FY21 RDT&E Budget Document

In FY20, Project 625318, Operational Awareness Technology efforts were transferred to Project 625315, C4I Dominance Technology, in order to realign technology areas that better support the National Defense Strategy and Air Force Future Operating Concept.

Contracts/Orders & Options

Because of the sensitive nature of the work conducted under the Operational Awareness Technology/C4I Dominance Technology project, specific contracts related to the project have not been made public.

Timetable

<u>Year</u>	<u>Major Development</u>
FY11	Develop and implement techniques to increase the scalability of algorithms when tracking ground targets in a large rural-urban environment
FY12	Develop, test, and evaluate real-time, tactical information exploitation software
FY13	Complete identification of the degree to which the adversary can achieve hypothesized enemy courses of actions based on predicted goals
FY14	Develop techniques for use in conveying indications and warnings, for pattern recognition, and for information fusion to enable information exploitation
FY15	Develop methods for enhanced exploitation of modern emerging signals expected from contested environments

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<u>Year</u>	<u>Major Development</u>
FY16	Analyze emerging activities across multiple domains in both tactical and strategic timelines
FY17	Build capabilities to support BDA and non-kinetic integration
FY18	Develop multiple-sourced intelligence techniques using context-based pattern of life analysis for permissive and contested environments
FY19	Research enhanced emitter feature extraction capabilities
FY20	Project realigned and merged into C4I Dominance Technology effort

Worldwide Distribution/Inventories

Operational Awareness Technology/C4I Dominance Technology is a U.S. Air Force project.

Forecast Rationale

The U.S. Air Force's Operational Awareness Technology/C4I Dominance Technology project is a multifaceted effort that will continue to be supported by the defense budget even in the face of pressures to lower costs. Driving these expenditures is the Air Force's push for a network-centric, collaborative intelligence analysis capability.

The Operational Awareness Technology/C4I Dominance Technology project conducts research into technology that enables the fusion of multi-intelligence sources in order to more accurately identify and track objects and improve situational awareness. This technology could be employed to better anticipate

battlespace threats – in the air, on the ground, and in space – and would also provide enhanced awareness of cybersecurity threats.

Another aspect of this project is the development of advanced exploitation technologies that help maximize the intelligence gained from U.S. adversaries. Special areas of study include spectral detection and geo-location, signal recognition and analysis, and data tagging, tracking, and tracing via the insertion of secure, imperceptible signal embedding.

This report will be archived next year and coverage continued under the "C4I Dominance Technology" report.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR RDT&E FUNDING (in US\$)												
Designation or Program		High Confidence				Good Confidence			Speculative			Total
	Thru 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
MFR Varies												
Operational Awareness Technology <> United States <> Air Force												
Note: In FY 2020, Project 625318, Operational Awareness Tech efforts was transferred to Project 625315, C4I Dominance Technology, in order to realign technology areas that better support the National Defense Strategy and Air Force Future Operating Concept.												
	205,760,000	800000	0	0	0	0	0	0	0	0	0	800,000
Total	205,760,000	800000	0	0	0	0	0	0	0	0	0	800,000