DARPA wants Secure, Jam Resistant and Adaptable Airborne Networks for Collaborative team of Manned & Unmanned Platforms

Modern airborne warfare is becoming increasingly complex, with manned and unmanned systems having to rapidly share information in a volatile environment where adversaries use advanced, commercially available electronic systems to disrupt U.S. and allied communications. Complicating the communications challenge for allied warfighters, many current airborne radio networks are incompatible with each other, the result of security and radio frequency (RF) format differences between aircraft types. Specialized data-link gateways facilitate communication across network divides, but these gateways have limited capability and don't allow high-data-rate information to flow freely and seamlessly among multiple types of manned and unmanned aircraft.

DARPA's Dynamic Network Adaptation for Mission Optimization (DyNAMO) program seeks novel technologies that would enable independently designed networks to share information and adapt to sporadic jamming and mission-critical dynamic network bursts in contested RF environments.The program seeks technology that can interconnect existing static networks and be able to connect future adaptive networks as well. Beside facilitating communications between legacy fourth generation and advanced fifth-generation aircraft, technology developed under DARPA's DyNAMO programme will also enable radios to operate in contested environments. The network technology will be tested on radios developed under DARPA's C2E project.

Simulation testing is set to begin for DARPA's Dynamic Network Adaptation for Mission Optimization (DyNAMO) project. The new airborne information sharing system allows the free flow of data between aircraft, including the fifth-generation F-22 and F-35. 'The primary challenge is to achieve the desired flexibility and adaptability without a prohibitive increase in processing or communication overhead,' explained Wayne Phoel, programme manager at DARPA's Defense Sciences Office.

Chinese military has been engaged in comprehensive modernization of its air, naval, and ground forces, while incorporating a variety of anti-access/area denial (A2/AD) systems and capabilities. "To operate against adversaries with "anti-access / area denial" capabilities the U.S. needs to disperse its forces, disaggregate its capabilities, confuse enemy sensors through decoys and deception, and swarm enemy defenses with large numbers of expendable assets," says Paul Scharre, Senior Fellow and Director 20YY Future of Warfare.

DARPA's System of Systems Integration Technology and Experimentation program aims to disaggregate aircraft capabilities into a swarm of cooperative, low cost expendable air vehicles to operate in this A2/AD environment. It aims to develop and demonstrate concepts for maintaining air superiority through novel Systems of Systems (SoS) architectures—combinations of aircraft, weapons, sensors and mission systems—that distribute air warfare capabilities across a large number of interoperable manned and unmanned platforms.

"What we would like to enable is a future scenario in which a smaller number of manned aircraft would combine with unmanned aircraft to do [a] total job," says Sandell, according to a Defense Department News article. "They would be networked together … and the unmanned aircraft could venture into the more dangerous territory, providing some degree of risk avoidance for the pilots. The unmanned platforms would be

simpler and could do individual jobs like carry weapons, electronic warfare systems or sensors – the last allowing the manned aircraft to be silent and harder to detect."

"Current airborne networks are not designed to handle the complexities of modern distributed and dynamic combat missions, and the challenge is only going to increase in the years ahead," said Wayne Phoel, DARPA program manager. "DyNAMO's goal is to enable pilots in one type of aircraft with a specific suite of sensors to easily share information with different types of manned and unmanned systems and also receive sensor information from those various platforms for a comprehensive view of the battlespace. We aim to develop technology that dynamically adapts networks to enable instantaneous free-flow of information among all airborne systems, at the appropriate security level and in the face of active jamming by an adversary."

This will involve an information-based framework technical area and a network optimisation technical area. Final testing is set to be carried out in 2019. 'The plan is to show radios adapting in real time to dynamic jamming and changes in the characteristics of the information being passed, such as data distribution patterns and delivery requirements,' he explained. 'The goal is to demonstrate that the new technology shares information more efficiently and reliably than today's approaches.'

Need of Secure, Jam Resistant and Adaptable Airborne Networks for Collaboration of Manned & Unmanned Platforms

"Modern airborne warfare is becoming increasingly complex, with manned and unmanned systems having to rapidly share

information in a volatile environment where adversaries use advanced, commercially available electronic systems to disrupt U.S. and allied communications.” Says DARPA

With an eye toward overcoming this increasingly critical challenge, DARPA published the Broad Agency Announcement solicitation for its Dynamic Network Adaptation for Mission Optimization (DyNAMO) program. DyNAMO seeks novel technologies that would enable independently designed networks to share information and adapt to sporadic jamming and mission-critical dynamic network bursts in contested RF environments. The program seeks technology that can interconnect existing static networks and be able to connect future adaptive networks as well.

“DyNAMO’s goal is to enable pilots in one type of aircraft with a specific suite of sensors to easily share information with different types of manned and unmanned systems and also receive sensor information from those various platforms for a comprehensive view of the battlespace. We aim to develop technology that dynamically adapts networks to enable instantaneous free-flow of information among all airborne systems, at the appropriate security level and in the face of active jamming by an adversary.”

The program will initially focus on interoperability among existing networks (Link 16, Tactical Targeting Network Technology (TTNT), Intra-Flight Data Link (IFDL) and Multifunction Advanced Data Link (MADL)) and will evolve to develop adaptive network technologies and demonstrate interoperability across legacy and future dynamic networks/waveforms.

The network technology developed through the DyNAMO program is to be demonstrated on radio hardware being developed by DARPA’s Communications in Contested Environments (C2E) program.

Vencore Labs to Work With DARPA to Optimize Airborne Communications

Vencore, Inc. announced that its innovative research arm, Vencore Labs, has been awarded a prime contract on the U.S. Defense Advanced Research Projects Agency's (DARPA) Dynamic Network Adaptation for Mission Optimization (DyNAMO) program. Under this new contract, Vencore Labs will be focused on optimizing network and radio functionality in adverse environments.

Specifically, the Vencore Labs team will develop and deliver an innovative framework to enable adaptation of networks and systems while maintaining scalability and stability. This new approach will provide a means to incorporate a wide set of mission objectives at all adaptation stages in order to ensure that the utility of information to the mission is maximized.

Vencore Labs' unique approach is designed to maintain connectivity in spite of jamming, singular outages or aircraft motion by dynamically shifting and re-routing the flow of information to alternate paths to ensure delivery. The framework will dynamically select connection points between different waveforms and then adaptively shift the communication over those alternative network paths, much as modern traffic applications will dynamically reroute automobile traffic across a variety of road networks to optimize transportation.

Raytheon to develop new technologies for airborne communications

Raytheon is developing new technologies to allow seamless communication between next-generation manned and unmanned

flying vehicles. The company's wholly-owned subsidiary Raytheon BBN Technologies has secured two contracts totalling $9m to facilitate seamless airborne communications even in hostile environments.

The contracts will require Raytheon BBN to provide new networking solutions as part of the US Defense Advanced Research Projects Agency's (DARPA) Dynamic Network Adaptation for Mission Optimisation (DyNAMO) programme.

Raytheon BBN Technologies Networking and Communications unit vice-president Jason Redi said: "First, we will adapt radio parameters in reaction to changing information needs and conditions, so current and future airborne networks can communicate with each other.

"Second, we will create an efficient way to share information across and between networks that are currently incompatible so that applications operating on them can share relevant data."

Dynamic Network Adaptation for Mission Optimization (DyNAMO) program

With an eye toward overcoming this increasingly critical challenge, DARPA published the Broad Agency Announcement solicitation for its Dynamic Network Adaptation for Mission Optimization (DyNAMO) program. DyNAMO seeks novel technologies that would enable independently designed networks to share information and adapt to sporadic jamming and mission-critical dynamic network bursts in contested RF environments. The program seeks technology that can interconnect existing static networks and be able to connect future adaptive networks as well.

"DyNAMO's goal is to enable pilots in one type of aircraft with a specific suite of sensors to easily share information

with different types of manned and unmanned systems and also receive sensor information from those various platforms for a comprehensive view of the battlespace. We aim to develop technology that dynamically adapts networks to enable instantaneous free-flow of information among all airborne systems, at the appropriate security level and in the face of active jamming by an adversary."

The program will initially focus on interoperability among existing networks (Link 16, Tactical Targeting Network Technology (TTNT), Intra-Flight Data Link (IFDL) and Multifunction Advanced Data Link (MADL)) and will evolve to develop adaptive network technologies and demonstrate interoperability across legacy and future dynamic networks/waveforms.

The three elements forming the three technical areas of the program defined to achieve the goals of DyNAMO are:

TA-1: An Information-based Network Framework that enables critical information to be shared between networks that differ in characteristics such as format, security levels, protocols and capacity. The framework's interface should capture both the information content and context such that the information transfer can be matched to the networks' protocol and capacity constraints

TA2: The Network Optimizer technical areawill create techniques to configure radios in reaction to changing information needs and environmental conditions. The technologies will operate at two levels: 1) the network-of-networks level which requires an overlay of routing and spectrum allocation on top of distinct networks; and 2) the individual network level which requires configuring radios/networks (transmit frequencies, power, jam-resistance, slot assignments, etc.) in order to meet the time-varying application needs given the RF environment. TA-2 technologies should meet objectives such as operating through dynamic

jamming, adapting to outages due to aircraft motion, and desire to reduce emissions in general, or in a particular direction.

TA3: A third program element integrates the two technology developments into a system of real radios. The System Integration area will develop candidate system designs to interconnect applications and information across different networks throughout dynamic missions. Successful proposals should follow an open systems architecture approach to facilitate integration of new technologies.

The network technology developed through the DyNAMO program is to be demonstrated on radio hardware being developed by DARPA's Communications in Contested Environments (C2E) program.

C2E is designing flexible new development architectures so aircraft won't be limited to communicating with aircraft using the same radio and waveform. C2E also aims to leverage the proven commercial smart-phone architectural model in which the application processing, real-time processing, and hardware functions of a software-defined radio are separately managed, validated, and updated to ensure rapid deployment of capabilities.

DyNAMO is designed to pick up where C2E leaves off, ensuring that raw RF data successfully communicated between previously incompatible airborne systems is not only conveyed but also translated into information that all the systems can understand and process, whether that information relates to time-sensitive collaborative targeting, imagery or networked weapons.

DARPA’s Communications in Contested Environments (C2E) program

The continued growth in unmanned, sensor, and networked devices is expected to drive the need for larger, more capable and more diverse communications systems.

Adversary systems designed to intercept, deny and exploit U.S. tactical communications continue to evolve with increased capability and decreased cost of fielding, creating a highly contested region of the battle space for U.S. forces

To counter this threat, the communication systems must be enhanced by improving jam-resistance, data rate, latency and low probability of detection to keep pace with adversaries’ growing electronic sophistication and must adapt to fast-changing operational environments. By contrast, today’s military communications architectures are static and inflexible.

C2E is designing flexible new development architectures so aircraft won’t be limited to communicating with aircraft using the same radio and waveform. C2E also aims to leverage the proven commercial smart-phone architectural model in which the application processing, real-time processing, and hardware functions of a software-defined radio are separately managed, validated, and updated to ensure rapid deployment of capabilities.

DyNAMO is designed to pick up where C2E leaves off, ensuring that raw RF data successfully communicated between previously incompatible airborne systems is not only conveyed but also translated into information that all the systems can understand and process, whether that information relates to time-sensitive collaborative targeting, imagery or networked weapons.

Software developed for interoperability among separate

networks will address near-term needs for various platforms to communicate and facilitate future integration of networks as needed. ‘Similarly, the adaptive radio configuration software will be built to improve any wireless system needing to operate efficiently in a contested and congested spectrum,’ Wayne Phoel, programme manager at DARPA’s Defense Sciences Office continued. ‘Furthermore, the hardware architecture, with the flexibility being demonstrated, should usher in a new generation of much more adaptable and upgradable communication systems.

BAE Systems awarded $3.2m DARPA C2E programme contract

BAE Systems has been awarded a $3.2m contract to work on the first phase of the US Defense Advanced Research Projects Agency’s (DARPA) Communications in Contested Environments (C2E) programme. “The company will develop a new open system architecture (OSA), designed to enable new and more effective communications platforms to support allied forces in highly contested environments.”

BAE Systems business development director Michael Beltrani said: “With our role in the C2E programme, we’re not only addressing technological threats that we anticipate our adversaries will use tomorrow, we’re looking decades into the future and building a system that can adapt and flex to support a high level of change and advancement in the years ahead.

Apart from the new OSA, the programme is expected to seek innovative ideas in two additional technical domains, the first of which is a heterogeneous networking capability to enhance pervasive services while accommodating legacy platform capabilities.

DARPA awards contract for development of new radio chip

Virginia-based company Exelis has been awarded a $10.7 million contract by the Defense Advanced Research Projects Agency for development of multifunctional chips for airborne radios, according to anannouncement from the company. The award falls under the scope of DARPA's Communications in Contested Environments or C2E program, which has undergone several phases.

In terms of the recent contract awarded, Exelis will provide security and jam-resistant airborne radio communications improvements. Additionally, the company will build upon its innovative architecture called "interface awareness" – a new standardization that will retrofit improvements to radio subsystems without having to replace them.

Communications in Contested Environments (C2E) program

The Communications in Contested Environments (C2E) program seeks to enable the development and deployment of adaptive communication systems through a three-part approach that is motivated by processes in the commercial world, which allow incorporation of third-party technologies that are from neither the hardware developer nor the core software provider.

At the base of the C2E approach, modular hardware architecture provides the flexibility to refresh capabilities and outpace application demands and adversary threats without requiring wholesale system overhauls. Networking capability to improve pervasive services while accommodating legacy platform capabilities; communication technologies to increase data

rate, improve jamming resistance, reduce detectability and decrease latency; development and demonstration of communication and networking technologies.

In addition, a new waveform-development model leverages re-usable waveform processing elements and formal methods to enable faster development across multiple hardware platforms.

Thirdly, the C2E network vision fully embraces the diversity and multiplicity of radio types across platforms in the airborne battle space, to provide highly reliable, networked and scalable information distribution to every element of the fighting force.

TA1 – Heterogeneous Networking and Advanced Communication Technologies Development and Demonstration

The C2E program solicits research on networking methods to create a pervasive communication environment allowing communication to, from, and between the wide variety of airborne platforms, both existing and expected, in a variety of situations and in support of a variety of missions. A typical airborne “network” is a shared channel—all receivers must be in range of the transmitter and there is no support for forwarding of data traffic.

Existing MANET protocols based on linkstate routing, with its heavy dependence on globally propagated data, collapse relatively quickly, particularly when dynamic characteristics of airborne platforms are considered. The ground MANET research results are not sufficient for the airborne environment as they lack the scalability required for the future airborne network.

The goals of this technical area are twofold – a) to develop networking technology to improve pervasiveness while accommodating legacy and emerging communications capability (heterogeneous networking) and b) to develop new

communications technology for increased capacity, improved jamming resistance, reduced probability of detection and reduced latency.

The platforms of interest are small and large, manned and unmanned, and with all combat and support roles. Vehicles may include manned fighters, bombers, command and control (surface or airborne), and support vehicles (such as tankers) and unmanned vehicles (surface or airborne) acting as sensors or weapons. The C2E program expects the network architecture to support the pervasive communications among heterogeneous ground and airborne platforms at the intended scale of more than 300 nodes.

Communications between air vehicles, to and from air vehicles and ground platforms, and to and from sea vehicles are included in the scope of this program.

Technical Area 2: Reference Hardware Architecture

Existing networking and node architectures are monolithic, stove-piped, and rigid; over constraining innovation, technology insertion, and interoperability. A new approach is needed to support diverse platforms with the flexibility to evolve in relevant timeframes.

The C2E architecture divides radio functions into three parts – Applications Processing, Waveform Processing, and Transceivers. The Applications Processing combines all of the nonreal-time processing functions that are needed by a collection of waveforms. The Waveform Processor provides the real-time processing functions needed to create, synchronize and/or receive a collection of waveforms needed by a platform. Finally, individual transceivers convert the waveforms to/from the frequencies and beams needed to support the platform’s operation.

Technical Area 3: Software Architecture, Development Environment and Tool Set, Verification Environment, and Repository

The C2E program develops software technology to allow rapid development, verification, insertion, and operation of communication technology in new and existing systems.

The key areas are the following:

1. A Software Architecture, that allows applications, protocols, and waveforms to be developed and verified independently from other applications, protocols, and/or waveforms.
2. A Development Environment that provides all tools required to develop software or firmware for C2E systems.
3. A Verification Environment that supports the testing and verification of newly developed applications meets functional and quality metrics.
4. An Application Repository for the storage and refresh of new and innovative applications.

References and Resources also include:

http://www.darpa.mil/news-events/2015-10-14

http://www.airforce-technology.com/news/newsraytheon-to-develop-new-technologies-for-airborne-communications-4959783

http://www.darpa.mil/news-events/2015-10-14

http://www.f-16.net/forum/download/file.php?id=23552

https://www.vencore.com/news/2017/1/12/vencore-labs-to-work-with-darpa-to-optimize-airborne-communications