

Topic: N143-129

## Charles River Analytics Inc.

Sensor system for Precise Automatic Relative-position Keeping (SPARK)

When escorting ballistic missile submarines (SSBNs), Type Auxiliary Combat General Escorts (T-AGSEs) maintain their relative position using their dynamic positioning (DP) systems, which rely on scanning lasers to measure positions of targets mounted on SSBNs. Laser sensors performance degrades with rain, snow, fog, smoke, bright lights/sun, and/or excessive vessel motion.

Charles River Analytics, a leading provider of innovative R&D solutions for increasingly complex/important human-systems challenges developed Sensor system for Precise Automatic Relative-position Keeping (SPARK) using short-wavelength infrared (SWIR) and covert radiofrequency (RF) sensors to track surfaced SSBNs under all plausible environmental conditions, doesn't require Sailors to go on deck when underway, and meets regulatory standards for system redundancy by incorporating independent systems based on two different physical principles. Opportunities also exist for SPARK in the commercial maritime industry.

### Technology Category Alignment:

Satellite Communications (SATCOM)

Robotics/Automated Material Handling Equipment

Shipyards/Shipbuilding

Supply; Storage

Satellite Communications (SATCOM)

Satellite Communications (SATCOM)

Supply; Storage

Supply; Storage

Satellite Communications (SATCOM)

Satellite Communications (SATCOM)

Shipyards/Shipbuilding

Robotics/Automated Material Handling Equipment

Robotics/Automated Material Handling Equipment

Robotics/Automated Material Handling Equipment

Robotics/Automated Material Handling Equipment

Protection, Sustainment, and Warfighter Performance

Medical Chem-Bio Defense

Military Infectious Diseases

Propulsion and Extreme Environments

Fixed Wing Vehicles (includes UAS)

Survivability

Maintainability/Sustainability

Unmanned Ground and Sea Vehicles

Corrosion

Advanced Computing/Software Development

Networks and Communications

Modular/Open/Reconfigurable Architectures

RF Components for sensing, transmission and communication

Electronics Integration

Broadband/Multispectral Components and Systems

Sensors, Electronics and Photonics

Radio Frequency (RF) (non-EW)

Survivability

Broadband/Multispectral Components and Systems

RF Components for sensing, transmission and communication

Radio Frequency (RF) (non-EW)

Networks and Communications  
Guidance, Navigation & Control (GN&C) and Data Links  
RF Components for sensing, transmission and communication  
Networks and Communications  
Cognitive/Adaptive Capabilities  
Preemptive/Proactive Effects  
Broadband/Multispectral Components and Systems  
Advanced Computing/Software Development  
Networks and Communications  
Personalized Assessment, Education, and Training  
System Interfaces & Cognitive Processes  
Aircraft Propulsion, Power and Thermal  
Modeling, Simulation & Test Infrastructure  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Fixed Wing Vehicles (includes UAS)  
Acoustic, Seismic and Magnetic  
Rotary Wing Vehicles  
Structures and Protection  
Energy storage  
Unmanned Ground and Sea Vehicles  
Mobility  
Power and Energy  
Synthesis/Analytics/Decision Tools  
Information Collection/Management  
Advanced Computing/Software Development  
Survivability  
Unmanned Ground and Sea Vehicles  
Radio Frequency (RF) (non-EW)  
Power Generation/Energy Conversion  
Energy storage  
Power and Energy  
Sensors, Electronics and Photonics  
Maintainability/Sustainability  
Advanced Computing/Software Development  
EO/IR Components for sensing, transmission and communication  
Microelectronics and Nanoelectronics  
Networks and Communications  
Mobility  
Broadband/Multispectral Components and Systems  
Sensors, Electronics and Photonics  
Structures and Protection  
Electro-Optical/Infrared (EO/IR)  
Human/Autonomous System Interaction and Collaboration  
Maintainability/Sustainability  
System Interfaces & Cognitive Processes  
Aircraft Propulsion, Power and Thermal

Power Generation/Energy Conversion  
High Energy Lasers (HEL)  
Propulsion  
Biomedical Informatics / Health Information Systems & Technology  
Protection, Sustainment, and Warfighter Performance  
Modeling, Simulation & Test Infrastructure  
Maintainability/Sustainability  
Mobility  
Personalized Assessment, Education, and Training  
RF Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Sensors, Electronics and Photonics  
Radio Frequency (RF) (non-EW)  
Radio Frequency Weapons (RFW)  
Energy storage  
Power Generation/Energy Conversion  
Thermal Transport and Control  
Unmanned Ground and Sea Vehicles  
Acoustic, Seismic and Magnetic  
RF Components for sensing, transmission and communication  
Guidance, Navigation & Control (GN&C) and Data Links  
Survivability  
High-Speed/Hypersonics  
Power Generation/Energy Conversion  
Acoustic, Seismic and Magnetic  
Radio Frequency Weapons (RFW)  
Electronic Materials  
Electronics Integration  
RF Components for sensing, transmission and communication  
Electromechanical conversion  
Energy storage  
Power Control and Distribution  
Power Generation/Energy Conversion  
Thermal Transport and Control  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Fixed Wing Vehicles (includes UAS)  
Distributed/Coordinated/Net-Enabled Systems  
High-Speed/Hypersonics  
Propulsion and Extreme Environments  
Energy storage  
Ordnance  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
EO/IR Components for sensing, transmission and communication

Rotary Wing Vehicles  
Protection, Sustainment, and Warfighter Performance  
System Interfaces & Cognitive Processes  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Broadband/Multispectral Components and Systems  
Radio Frequency Weapons (RFW)  
Maintainability/Sustainability  
Propulsion and Extreme Environments  
Electro-Optical/Infrared (EO/IR)  
Modeling, Simulation & Test Infrastructure  
Radio Frequency (RF) (non-EW)  
Machine Perception, Reasoning and Intelligence  
Assuring Effective Missions  
Modular/Open/Reconfigurable Architectures  
Personalized Assessment, Education, and Training  
Fixed Wing Vehicles (includes UAS)  
Machine Perception, Reasoning and Intelligence  
System Interfaces & Cognitive Processes  
Electro-Optical/Infrared (EO/IR)  
Fixed Wing Vehicles (includes UAS)  
Power Generation/Energy Conversion  
Unmanned Ground and Sea Vehicles  
Power and Energy  
Modeling, Simulation & Test Infrastructure  
Ordnance  
Aircraft Propulsion, Power and Thermal  
Test, Evaluation, Validation, and Verification  
Power Generation/Energy Conversion  
Mobility  
Maintainability/Sustainability  
Power Generation/Energy Conversion  
Maintainability/Sustainability  
Acoustic, Seismic and Magnetic  
Test, Evaluation, Validation, and Verification  
Maintainability/Sustainability  
Corrosion  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
EO/IR Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)

Information Collection/Management  
Electro-Optical/Infrared (EO/IR)  
Aircraft Propulsion, Power and Thermal  
Aircraft Propulsion, Power and Thermal  
Propulsion and Extreme Environments  
Modeling, Simulation & Test Infrastructure  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Fixed Wing Vehicles (includes UAS)  
Distributed/Coordinated/Net-Enabled Systems  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Scalable Teaming of Autonomous Systems  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Combat Casualty Care  
Military Infectious Diseases  
Military Operational Medicine  
Readiness  
Maintainability/Sustainability  
Survivability  
Energy storage  
Power Generation/Energy Conversion  
Unmanned Ground and Sea Vehicles  
Propulsion  
Undersea Weapons  
Human Computer Interfaces (HCI) for Decision Making  
Personalized Assessment, Education, and Training  
System Interfaces & Cognitive Processes  
Acoustic, Seismic and Magnetic  
Fixed Wing Vehicles (includes UAS)  
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Information Collection/Management  
Networks and Communications  
Survivability  
Modeling, Simulation & Test Infrastructure  
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Human/Autonomous System Interaction and Collaboration  
Scalable Teaming of Autonomous Systems  
Test, Evaluation, Validation, and Verification  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Fixed Wing Vehicles (includes UAS)  
Human/Autonomous System Interaction and Collaboration  
Human Computer Interfaces (HCI) for Decision Making

System Interfaces & Cognitive Processes  
Electronics Integration  
Aircraft Propulsion, Power and Thermal  
Energy storage  
Thermal Transport and Control  
Maintainability/Sustainability  
Personalized Assessment, Education, and Training  
Human Aspects of Operations in Military Environments  
Electronics Integration  
RF Components for sensing, transmission and communication  
Electromechanical conversion  
Energy storage  
Power Generation/Energy Conversion  
Acoustic, Seismic and Magnetic  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Fixed Wing Vehicles (includes UAS)  
Broadband/Multispectral Components and Systems  
RF Components for sensing, transmission and communication  
Preemptive/Proactive Effects  
Survivability  
Modeling, Simulation & Test Infrastructure  
Mobility  
Modularity  
Survivability  
Unmanned Ground and Sea Vehicles  
Radio Frequency Weapons (RFW)  
Aircraft Propulsion, Power and Thermal  
Power Generation/Energy Conversion  
Modeling, Simulation & Test Infrastructure  
Propulsion  
Biomedical Informatics / Health Information Systems & Technology  
Biomedical Informatics / Health Information Systems & Technology  
Electro-Optical/Infrared (EO/IR)  
High Energy Lasers (HEL)  
EO/IR Components for sensing, transmission and communication  
Networks and Communications  
Sensors, Electronics and Photonics  
Electro-Optical/Infrared (EO/IR)  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Human Aspects of Operations in Military Environments  
System Interfaces & Cognitive Processes  
Clinical & Rehabilitative Medicine  
Combat Casualty Care

Military Operational Medicine  
Protection, Sustainment, and Warfighter Performance  
System Interfaces & Cognitive Processes  
Fixed Wing Vehicles (includes UAS)  
Information Collection/Management  
Personalized Assessment, Education, and Training  
Modeling, Simulation & Test Infrastructure  
Synthesis/Analytics/Decision Tools  
System Interfaces & Cognitive Processes  
Electronics Integration  
RF Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Acoustic, Seismic and Magnetic  
Advanced Computing/Software Development  
Advanced Electronic Protection Techniques and Technology  
Survivability  
Modeling, Simulation & Test Infrastructure  
Ordnance  
Biomedical Informatics / Health Information Systems & Technology  
Protection, Sustainment, and Warfighter Performance  
Biomedical Informatics / Health Information Systems & Technology  
Survivability  
Protection, Sustainment, and Warfighter Performance  
Modeling, Simulation & Test Infrastructure  
Ordnance  
Propulsion  
Undersea Weapons  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Mobility  
Protection, Sustainment, and Warfighter Performance  
Modularity  
Survivability  
Structures and Protection  
Advanced Computing/Software Development  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Protection, Sustainment, and Warfighter Performance  
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Personalized Assessment, Education, and Training  
Power Generation/Energy Conversion  
Fixed Wing Vehicles (includes UAS)  
Survivability  
Personalized Assessment, Education, and Training  
Undersea Weapons  
Personalized Assessment, Education, and Training

Power Generation/Energy Conversion  
Energy storage  
High Energy Lasers (HEL)  
Power Generation/Energy Conversion  
Energy storage  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
RF Components for sensing, transmission and communication  
EO/IR Components for sensing, transmission and communication  
Preemptive/Proactive Effects  
Broadband/Multispectral Components and Systems  
Advanced Computing/Software Development  
Trust Foundations  
Preemptive/Proactive Effects  
Fixed Wing Vehicles (includes UAS)  
Personalized Assessment, Education, and Training  
Manufacturing Technology for Affordability  
Protection, Sustainment, and Warfighter Performance  
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Personalized Assessment, Education, and Training  
Broadband/Multispectral Components and Systems  
Manufacturing Technology for Affordability  
Broadband/Multispectral Components and Systems  
Personalized Assessment, Education, and Training  
Manufacturing Technology for Affordability  
Guidance, Navigation & Control (GN&C) and Data Links  
Unmanned Ground and Sea Vehicles  
Fixed Wing Vehicles (includes UAS)  
Acoustic, Seismic and Magnetic  
Manufacturing Technology for Affordability  
High Energy Lasers (HEL)  
Energy storage  
Power Generation/Energy Conversion  
Energy storage  
Unmanned Ground and Sea Vehicles  
High Energy Lasers (HEL)  
Fixed Wing Vehicles (includes UAS)  
Trust Foundations  
Personalized Assessment, Education, and Training  
Unmanned Ground and Sea Vehicles  
Fixed Wing Vehicles (includes UAS)  
Acoustic, Seismic and Magnetic  
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Unmanned Ground and Sea Vehicles  
Fixed Wing Vehicles (includes UAS)  
Survivability  
Protection, Sustainment, and Warfighter Performance



Survivability  
Preemptive/Proactive Effects  
EO/IR Components for sensing, transmission and communication  
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Personalized Assessment, Education, and Training  
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Survivability  
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Energy storage  
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Maintainability/Sustainability  
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Survivability  
Undersea Weapons  
Fixed Wing Vehicles (includes UAS)  
Maintainability/Sustainability  
Manufacturing Technology for Affordability  
Personalized Assessment, Education, and Training  
Acoustic, Seismic and Magnetic  
Unmanned Ground and Sea Vehicles  
Trust Foundations  
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Broadband/Multispectral Components and Systems  
High Energy Lasers (HEL)  
Personalized Assessment, Education, and Training  
Microelectronics and Nanoelectronics  
Preemptive/Proactive Effects  
Microelectronics and Nanoelectronics  
Networks and Communications  
Personalized Assessment, Education, and Training

Networks and Communications  
Microelectronics and Nanoelectronics  
Networks and Communications  
Energy storage  
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Broadband/Multispectral Components and Systems  
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Survivability  
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Maintainability/Sustainability  
Manufacturing Technology for Affordability  
Maintainability/Sustainability  
Manufacturing Technology for Affordability  
Maintainability/Sustainability

Protection, Sustainment, and Warfighter Performance  
Personalized Assessment, Education, and Training  
Maintainability/Sustainability  
Personalized Assessment, Education, and Training  
Power Generation/Energy Conversion  
Fixed Wing Vehicles (includes UAS)  
Maintainability/Sustainability  
EO/IR Components for sensing, transmission and communication  
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Fixed Wing Vehicles (includes UAS)  
Fixed Wing Vehicles (includes UAS)  
Personalized Assessment, Education, and Training  
Protection, Sustainment, and Warfighter Performance  
Maintainability/Sustainability  
Acoustic, Seismic and Magnetic  
Fixed Wing Vehicles (includes UAS)  
Personalized Assessment, Education, and Training  
Broadband/Multispectral Components and Systems  
Preemptive/Proactive Effects  
Modular/Open/Reconfigurable Architectures  
Modular/Open/Reconfigurable Architectures  
Fixed Wing Vehicles (includes UAS)  
Guidance, Navigation & Control (GN&C) and Data Links  
Guidance, Navigation & Control (GN&C) and Data Links  
Fixed Wing Vehicles (includes UAS)  
Manufacturing Technology for Affordability  
Guidance, Navigation & Control (GN&C) and Data Links  
Survivability  
Manufacturing Technology for Affordability  
Power Generation/Energy Conversion  
Energy storage  
Power Generation/Energy Conversion  
Unmanned Ground and Sea Vehicles  
Fixed Wing Vehicles (includes UAS)  
Acoustic, Seismic and Magnetic  
Energy storage  
RF Components for sensing, transmission and communication  
Maintainability/Sustainability  
Protection, Sustainment, and Warfighter Performance  
Personalized Assessment, Education, and Training  
RF Components for sensing, transmission and communication  
Modular/Open/Reconfigurable Architectures  
Advanced Computing/Software Development  
Survivability  
Manufacturing Technology for Affordability  
Survivability  
Manufacturing Technology for Affordability

Manufacturing Technology for Affordability  
Propulsion  
Manufacturing Technology for Affordability  
Personalized Assessment, Education, and Training  
Manufacturing Technology for Affordability  
Trust Foundations  
Trust Foundations  
Distributed/Coordinated/Net-Enabled Systems  
Survivability  
Agile Operations  
Personalized Assessment, Education, and Training  
Protection, Sustainment, and Warfighter Performance  
Human/Autonomous System Interaction and Collaboration  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Information Collection/Management  
Human Aspects of Operations in Military Environments  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Synthesis/Analytics/Decision Tools  
Machine Perception, Reasoning and Intelligence  
System Interfaces & Cognitive Processes  
Human/Autonomous System Interaction and Collaboration  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
EO/IR Components for sensing, transmission and communication  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
Electronic Materials  
Manufacturing Technology for Affordability  
Preemptive/Proactive Effects  
Electro-Optical/Infrared (EO/IR)  
Broadband/Multispectral Components and Systems  
EO/IR Components for sensing, transmission and communication  
Test, Evaluation, Validation, and Verification  
Radio Frequency Weapons (RFW)  
Manufacturing Technology for Affordability  
Power and Energy  
RF Components for sensing, transmission and communication  
Electronic Materials  
Human/Autonomous System Interaction and Collaboration  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Information Collection/Management  
Unmanned Ground and Sea Vehicles  
Power Generation/Energy Conversion

Undersea Weapons  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Maintainability/Sustainability  
Propulsion and Extreme Environments  
Structures and Protection  
Aircraft Propulsion, Power and Thermal  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Corrosion  
Manufacturing Technology for Affordability  
Electronics Integration  
Power Generation/Energy Conversion  
Power Control and Distribution  
Personalized Assessment, Education, and Training  
Radio Frequency Weapons (RFW)  
RF Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Power Generation/Energy Conversion  
Power and Energy  
Combat Casualty Care  
Biomedical Informatics / Health Information Systems & Technology  
Biomedical Informatics / Health Information Systems & Technology  
Military Operational Medicine  
Machine Perception, Reasoning and Intelligence  
RF Components for sensing, transmission and communication  
Electronics Integration  
Propulsion and Extreme Environments  
Readiness  
Structures and Protection  
Fixed Wing Vehicles (includes UAS)  
Machine Perception, Reasoning and Intelligence  
Resilient Infrastructure  
Trust Foundations  
Unmanned Ground and Sea Vehicles  
Protection, Sustainment, and Warfighter Performance  
Readiness  
Combat Casualty Care  
Networks and Communications  
Broadband/Multispectral Components and Systems  
RF Components for sensing, transmission and communication  
Information Collection/Management  
Advanced Electronic Protection Techniques and Technology  
Sensors, Electronics and Photonics  
Radio Frequency (RF) (non-EW)  
Machine Perception, Reasoning and Intelligence

Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Trust Foundations  
Trust Foundations  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Survivability  
Corrosion  
Structures and Protection  
Manufacturing Technology for Affordability  
Manufacturing Technology for Affordability  
Undersea Weapons  
Human/Autonomous System Interaction and Collaboration  
Test, Evaluation, Validation, and Verification  
Sensors, Electronics and Photonics  
Electro-Optical/Infrared (EO/IR)  
High Energy Lasers (HEL)  
Information Collection/Management  
Personalized Assessment, Education, and Training  
Human Aspects of Operations in Military Environments  
System Interfaces & Cognitive Processes  
Rotary Wing Vehicles  
Unmanned Ground and Sea Vehicles  
Maintainability/Sustainability  
Corrosion  
Structures and Protection  
Modeling, Simulation & Test Infrastructure  
RF Components for sensing, transmission and communication  
Cognitive/Adaptive Capabilities  
Modular/Open/Reconfigurable Architectures  
Unmanned Ground and Sea Vehicles  
Radio Frequency (RF) (non-EW)  
Power Control and Distribution  
Clinical & Rehabilitative Medicine  
Combat Casualty Care  
Military Operational Medicine  
Preemptive/Proactive Effects  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
Manufacturing Technology for Affordability  
Fixed Wing Vehicles (includes UAS)  
Advanced Computing/Software Development  
Information Collection/Management  
RF Components for sensing, transmission and communication  
Machine Perception, Reasoning and Intelligence  
Advanced Computing/Software Development  
Cognitive/Adaptive Capabilities

Modular/Open/Reconfigurable Architectures  
Synthesis/Analytics/Decision Tools  
Unmanned Ground and Sea Vehicles  
Modeling, Simulation & Test Infrastructure  
RF Components for sensing, transmission and communication  
Synthesis/Analytics/Decision Tools  
Modeling, Simulation & Test Infrastructure  
Trust Foundations  
Trust Foundations  
Modular/Open/Reconfigurable Architectures  
Test, Evaluation, Validation, and Verification  
Military Infectious Diseases  
Radio Frequency (RF) (non-EW)  
Aircraft Propulsion, Power and Thermal  
Power Generation/Energy Conversion  
Propulsion and Extreme Environments  
EO/IR Components for sensing, transmission and communication  
Electro-Optical/Infrared (EO/IR)  
High Energy Lasers (HEL)  
Thermal Transport and Control  
Mobility  
Protection, Sustainment, and Warfighter Performance  
Test, Evaluation, Validation, and Verification  
Advanced Computing/Software Development  
Modeling, Simulation & Test Infrastructure  
Fixed Wing Vehicles (includes UAS)  
Human/Autonomous System Interaction and Collaboration  
Scalable Teaming of Autonomous Systems  
System Interfaces & Cognitive Processes  
Human/Autonomous System Interaction and Collaboration  
Scalable Teaming of Autonomous Systems  
Advanced Computing/Software Development  
Human Computer Interfaces (HCI) for Decision Making  
Networks and Communications  
Electronics Integration  
Information Collection/Management  
Microelectronics and Nanoelectronics  
RF Components for sensing, transmission and communication  
Networks and Communications  
Advanced Electronic Protection Techniques and Technology  
Radio Frequency Weapons (RFW)  
Human/Autonomous System Interaction and Collaboration  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Test, Evaluation, Validation, and Verification  
Acoustic, Seismic and Magnetic  
Modeling, Simulation & Test Infrastructure

Aircraft Propulsion, Power and Thermal  
Aircraft Propulsion, Power and Thermal  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Electronic Materials  
Aircraft Propulsion, Power and Thermal  
Energy storage  
Power and Energy  
Mobility  
Modularity  
Unmanned Ground and Sea Vehicles  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Propulsion and Extreme Environments  
Modeling, Simulation & Test Infrastructure  
EO/IR Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Distributed/Coordinated/Net-Enabled Systems  
High Energy Lasers (HEL)  
Aircraft Propulsion, Power and Thermal  
Energy storage  
Power and Energy  
Energy storage  
Power Generation/Energy Conversion  
Power and Energy  
RF Components for sensing, transmission and communication  
Advanced Electronic Protection Techniques and Technology  
Radio Frequency (RF) (non-EW)  
Guidance, Navigation & Control (GN&C) and Data Links  
RF Components for sensing, transmission and communication  
Radio Frequency (RF) (non-EW)  
Radio Frequency Weapons (RFW)  
Sensors, Electronics and Photonics  
Acoustic, Seismic and Magnetic  
EO/IR Components for sensing, transmission and communication  
Machine Perception, Reasoning and Intelligence  
Electro-Optical/Infrared (EO/IR)  
Advanced Computing/Software Development  
Synthesis/Analytics/Decision Tools  
Acoustic, Seismic and Magnetic  
Maintainability/Sustainability  
Propulsion and Extreme Environments  
Structures and Protection  
Maintainability/Sustainability  
Mobility  
Corrosion  
Structures and Protection



Machine Perception, Reasoning and Intelligence  
Advanced Computing/Software Development  
Assuring Effective Missions  
Trust Foundations  
Modular/Open/Reconfigurable Architectures  
Test, Evaluation, Validation, and Verification  
Maintainability/Sustainability  
Modeling, Simulation & Test Infrastructure  
Fixed Wing Vehicles (includes UAS)  
Manufacturing Technology for Affordability  
Ordnance  
Propulsion  
Electronics Integration  
RF Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Manufacturing Technology for Affordability  
Radio Frequency (RF) (non-EW)  
RF Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Distributed/Coordinated/Net-Enabled Systems  
Radio Frequency (RF) (non-EW)  
Distributed/Coordinated/Net-Enabled Systems  
Modular/Open/Reconfigurable Architectures  
Rotary Wing Vehicles  
Test, Evaluation, Validation, and Verification  
Maintainability/Sustainability  
Corrosion  
Acoustic, Seismic and Magnetic  
Acoustic, Seismic and Magnetic  
RF Components for sensing, transmission and communication  
Networks and Communications  
Unmanned Ground and Sea Vehicles  
Manufacturing Technology for Affordability  
Manufacturing Technology for Affordability  
EO/IR Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency Weapons (RFW)  
EO/IR Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency Weapons (RFW)  
EO/IR Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency Weapons (RFW)  
EO/IR Components for sensing, transmission and communication

Sensors, Electronics and Photonics  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency Weapons (RFW)  
Sensors, Electronics and Photonics  
Acoustic, Seismic and Magnetic  
Advanced Computing/Software Development  
Acoustic, Seismic and Magnetic  
Advanced Computing/Software Development  
Acoustic, Seismic and Magnetic  
Machine Perception, Reasoning and Intelligence  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Distributed/Coordinated/Net-Enabled Systems  
Acoustic, Seismic and Magnetic  
Machine Perception, Reasoning and Intelligence  
Information Collection/Management  
Networks and Communications  
Synthesis/Analytics/Decision Tools  
RF Components for sensing, transmission and communication  
Aircraft Propulsion, Power and Thermal  
High-Speed/Hypersonics  
Propulsion and Extreme Environments  
Guidance, Navigation & Control (GN&C) and Data Links  
Maintainability/Sustainability  
RF Components for sensing, transmission and communication  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Maintainability/Sustainability  
Power and Energy  
Personalized Assessment, Education, and Training  
Acoustic, Seismic and Magnetic  
Modeling, Simulation & Test Infrastructure  
Human/Autonomous System Interaction and Collaboration  
Advanced Computing/Software Development  
Maintainability/Sustainability  
System Interfaces & Cognitive Processes  
Structures and Protection  
Survivability  
Acoustic, Seismic and Magnetic  
Guidance, Navigation & Control (GN&C) and Data Links  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Information Collection/Management  
Maintainability/Sustainability  
Electro-Optical/Infrared (EO/IR)

Modeling, Simulation & Test Infrastructure  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Structures and Protection  
EO/IR Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
Structures and Protection  
Fixed Wing Vehicles (includes UAS)  
Aircraft Propulsion, Power and Thermal  
Rotary Wing Vehicles  
Fixed Wing Vehicles (includes UAS)  
Power Generation/Energy Conversion  
Propulsion and Extreme Environments  
RF Components for sensing, transmission and communication  
Maintainability/Sustainability  
Fixed Wing Vehicles (includes UAS)  
Aircraft Propulsion, Power and Thermal  
High-Speed/Hypersonics  
Propulsion  
Aircraft Propulsion, Power and Thermal  
Electro-Optical/Infrared (EO/IR)  
RF Components for sensing, transmission and communication  
Networks and Communications  
Distributed/Coordinated/Net-Enabled Systems  
Radio Frequency (RF) (non-EW)  
EO/IR Components for sensing, transmission and communication  
Networks and Communications  
Sensors, Electronics and Photonics  
RF Components for sensing, transmission and communication  
Networks and Communications  
Distributed/Coordinated/Net-Enabled Systems  
Radio Frequency (RF) (non-EW)  
EO/IR Components for sensing, transmission and communication  
Test, Evaluation, Validation, and Verification  
Electro-Optical/Infrared (EO/IR)  
Modeling, Simulation & Test Infrastructure  
Fixed Wing Vehicles (includes UAS)  
Fixed Wing Vehicles (includes UAS)  
Structures and Protection  
Modeling, Simulation & Test Infrastructure  
Networks and Communications  
Trust Foundations  
Fixed Wing Vehicles (includes UAS)  
Test, Evaluation, Validation, and Verification  
Unmanned Ground and Sea Vehicles  
Modeling, Simulation & Test Infrastructure

Machine Perception, Reasoning and Intelligence  
Synthesis/Analytics/Decision Tools  
Cognitive/Adaptive Capabilities  
Preemptive/Proactive Effects  
Propulsion and Extreme Environments  
Manufacturing Technology for Affordability  
Manufacturing Technology for Affordability  
Ordnance  
Propulsion  
Machine Perception, Reasoning and Intelligence  
Networks and Communications  
Assuring Effective Missions  
Trust Foundations  
Cognitive/Adaptive Capabilities  
High-Speed/Hypersonics  
Corrosion  
Power and Energy  
Sensors, Electronics and Photonics  
Acoustic, Seismic and Magnetic  
Structures and Protection  
Human Computer Interfaces (HCI) for Decision Making  
Maintainability/Sustainability  
Corrosion  
Structures and Protection  
Energy storage  
Power and Energy  
Survivability  
Propulsion and Extreme Environments  
Sensors, Electronics and Photonics  
Ordnance  
Aircraft Propulsion, Power and Thermal  
Fixed Wing Vehicles (includes UAS)  
Power Generation/Energy Conversion  
Power and Energy  
RF Components for sensing, transmission and communication  
Radio Frequency (RF) (non-EW)  
Protection, Sustainment, and Warfighter Performance  
Readiness  
Structures and Protection  
Undersea Weapons  
Machine Perception, Reasoning and Intelligence  
Broadband/Multispectral Components and Systems  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency (RF) (non-EW)  
Electronics Integration  
RF Components for sensing, transmission and communication  
Sensors, Electronics and Photonics

Sensors, Electronics and Photonics  
Maintainability/Sustainability  
Sensors, Electronics and Photonics  
RF Components for sensing, transmission and communication  
Preemptive/Proactive Effects  
Power Control and Distribution  
Acoustic, Seismic and Magnetic  
Power Control and Distribution  
Acoustic, Seismic and Magnetic  
Fixed Wing Vehicles (includes UAS)  
Aircraft Propulsion, Power and Thermal  
Rotary Wing Vehicles  
Aircraft Propulsion, Power and Thermal  
Aircraft Propulsion, Power and Thermal  
Power Control and Distribution  
Propulsion and Extreme Environments  
Propulsion  
EO/IR Components for sensing, transmission and communication  
Satellite Communications (SATCOM)  
Networks and Communications  
Trust Foundations  
Electro-Optical/Infrared (EO/IR)  
RF Components for sensing, transmission and communication  
Networks and Communications  
Advanced Electronic Protection Techniques and Technology  
Distributed/Coordinated/Net-Enabled Systems  
Radio Frequency (RF) (non-EW)  
Unmanned Ground and Sea Vehicles  
Maintainability/Sustainability  
Modularity  
Survivability  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Networks and Communications  
Broadband/Multispectral Components and Systems  
Electronics Integration  
Protection, Sustainment, and Warfighter Performance  
Clinical & Rehabilitative Medicine  
Combat Casualty Care  
Medical Chem-Bio Defense  
Energy storage  
Protection, Sustainment, and Warfighter Performance  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Undersea Weapons

Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Power and Energy  
Propulsion and Extreme Environments  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Broadband/Multispectral Components and Systems  
Preemptive/Proactive Effects  
Radio Frequency (RF) (non-EW)  
Energy storage  
Manufacturing Technology for Affordability  
Power and Energy  
Structures and Protection  
Synthesis/Analytics/Decision Tools  
Fixed Wing Vehicles (includes UAS)  
Advanced Computing/Software Development  
Trust Foundations  
Integrating Architecture and Capability Demonstrations  
Unmanned Ground and Sea Vehicles  
Aircraft Propulsion, Power and Thermal  
Synthesis/Analytics/Decision Tools  
EO/IR Components for sensing, transmission and communication  
Networks and Communications  
Preemptive/Proactive Effects  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
Scalable Teaming of Autonomous Systems  
Networks and Communications  
Unmanned Ground and Sea Vehicles  
Acoustic, Seismic and Magnetic  
Test, Evaluation, Validation, and Verification  
Propulsion and Extreme Environments  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Mobility  
Unmanned Ground and Sea Vehicles  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Manufacturing Technology for Affordability  
Readiness  
Lower Atmosphere Battlespace Environments  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Human Computer Interfaces (HCI) for Decision Making  
Survivability  
Unmanned Ground and Sea Vehicles

Aircraft Propulsion, Power and Thermal  
Propulsion  
Protection, Sustainment, and Warfighter Performance  
Individual Warfighter  
Synthesis/Analytics/Decision Tools  
Collaborative Analysis and Decision-making  
Survivability  
Modeling, Simulation & Test Infrastructure  
Fixed Wing Vehicles (includes UAS)  
Human/Autonomous System Interaction and Collaboration  
Scalable Teaming of Autonomous Systems  
Synthesis/Analytics/Decision Tools  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
Frameworks for Interoperability  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Maintainability/Sustainability  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Protection, Sustainment, and Warfighter Performance  
RF Components for sensing, transmission and communication  
Networks and Communications  
Advanced Electronic Protection Techniques and Technology  
Survivability  
Sensors, Electronics and Photonics  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
High-Speed/Hypersonics  
Synthesis/Analytics/Decision Tools  
Electromechanical conversion  
Energy storage  
Power Control and Distribution  
Power Generation/Energy Conversion  
Electronics Integration  
Energy storage  
Power Control and Distribution  
Power Generation/Energy Conversion  
Survivability  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Energy storage  
Power Generation/Energy Conversion  
Unmanned Ground and Sea Vehicles

Electromechanical conversion  
Energy storage  
Power Control and Distribution  
Power Generation/Energy Conversion  
Thermal Transport and Control  
Thermal Transport and Control  
Protection, Sustainment, and Warfighter Performance  
Modeling, Simulation & Test Infrastructure  
Microelectronics and Nanoelectronics  
RF Components for sensing, transmission and communication  
Modularity  
Acoustic, Seismic and Magnetic  
EO/IR Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Guidance, Navigation & Control (GN&C) and Data Links  
Sensors, Electronics and Photonics  
Maintainability/Sustainability  
Manufacturing Technology for Affordability  
Corrosion  
Readiness  
Test, Evaluation, Validation, and Verification  
Advanced Computing/Software Development  
Synthesis/Analytics/Decision Tools  
Distributed/Coordinated/Net-Enabled Systems  
Aircraft Propulsion, Power and Thermal  
Energy storage  
Thermal Transport and Control  
High Energy Lasers (HEL)  
Power and Energy  
Mobility  
Modularity  
Electronic Materials  
RF Components for sensing, transmission and communication  
Manufacturing Technology for Affordability  
Personalized Assessment, Education, and Training  
Protection, Sustainment, and Warfighter Performance  
System Interfaces & Cognitive Processes  
Propulsion and Extreme Environments  
Structures and Protection  
Test, Evaluation, Validation, and Verification  
Electronics Integration  
RF Components for sensing, transmission and communication  
Acoustic, Seismic and Magnetic  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
Electronics Integration  
Information Collection/Management



Maintainability/Sustainability  
Acoustic, Seismic and Magnetic  
Structures and Protection  
Protection, Sustainment, and Warfighter Performance  
Manufacturing Technology for Affordability  
Readiness  
Electronics Integration  
Rotary Wing Vehicles  
Test, Evaluation, Validation, and Verification  
Maintainability/Sustainability  
Acoustic, Seismic and Magnetic  
EO/IR Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Guidance, Navigation & Control (GN&C) and Data Links  
Sensors, Electronics and Photonics  
Fixed Wing Vehicles (includes UAS)  
Human/Autonomous System Interaction and Collaboration  
Personalized Assessment, Education, and Training  
EO/IR Components for sensing, transmission and communication  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency Weapons (RFW)  
Sensors, Electronics and Photonics  
RF Components for sensing, transmission and communication  
EO/IR Components for sensing, transmission and communication  
Scalable Teaming of Autonomous Systems  
Test, Evaluation, Validation, and Verification  
Biomedical Informatics / Health Information Systems & Technology  
Information Collection/Management  
Protection, Sustainment, and Warfighter Performance  
Individual Warfighter  
Readiness  
Acoustic, Seismic and Magnetic  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Corrosion  
Readiness  
Structures and Protection  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Networks and Communications  
Maintainability/Sustainability  
Test, Evaluation, Validation, and Verification  
Maintainability/Sustainability  
Modularity  
Networks and Communications  
Cognitive/Adaptive Capabilities  
Unmanned Ground and Sea Vehicles

System Interfaces & Cognitive Processes  
Human/Autonomous System Interaction and Collaboration  
Test, Evaluation, Validation, and Verification  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
System Interfaces & Cognitive Processes  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Test, Evaluation, Validation, and Verification  
Maintainability/Sustainability  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Fixed Wing Vehicles (includes UAS)  
Personalized Assessment, Education, and Training  
Electronic Materials  
RF Components for sensing, transmission and communication  
Manufacturing Technology for Affordability  
Radio Frequency (RF) (non-EW)  
Sensors, Electronics and Photonics  
RF Components for sensing, transmission and communication  
EO/IR Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Human/Autonomous System Interaction and Collaboration  
System Interfaces & Cognitive Processes  
EO/IR Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Survivability  
High Energy Lasers (HEL)  
EO/IR Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Survivability  
High Energy Lasers (HEL)  
Manufacturing Technology for Affordability  
Ordnance  
Corrosion  
EO/IR Components for sensing, transmission and communication  
Electro-Optical/Infrared (EO/IR)  
Propulsion and Extreme Environments  
Fixed Wing Vehicles (includes UAS)  
High-Speed/Hypersonics  
Guidance, Navigation & Control (GN&C) and Data Links  
Protection, Sustainment, and Warfighter Performance  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Computational Research Engineering Acquisition Tools and Environment

Maintainability/Sustainability  
Frameworks for Interoperability  
EO/IR Components for sensing, transmission and communication  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Electro-Optical/Infrared (EO/IR)  
Guidance, Navigation & Control (GN&C) and Data Links  
Fixed Wing Vehicles (includes UAS)  
Advanced Computing/Software Development  
Unmanned Ground and Sea Vehicles  
Advanced Computing/Software Development  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Test, Evaluation, Validation, and Verification  
EO/IR Components for sensing, transmission and communication  
Manufacturing Technology for Affordability  
Electro-Optical/Infrared (EO/IR)  
Guidance, Navigation & Control (GN&C) and Data Links  
High-Speed/Hypersonics  
Collaborative Analysis and Decision-making  
Integrating Architecture and Capability Demonstrations  
Corrosion  
Propulsion and Extreme Environments  
Guidance, Navigation & Control (GN&C) and Data Links  
Machine Perception, Reasoning and Intelligence  
Test, Evaluation, Validation, and Verification  
Synthesis/Analytics/Decision Tools  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
Networks and Communications  
Assuring Effective Missions  
Resilient Infrastructure  
Trust Foundations  
Advanced Computing/Software Development  
Trust Foundations  
Advanced Electronic Protection Techniques and Technology  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Radio Frequency (RF) (non-EW)  
Guidance, Navigation & Control (GN&C) and Data Links  
EO/IR Components for sensing, transmission and communication  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Electro-Optical/Infrared (EO/IR)  
Guidance, Navigation & Control (GN&C) and Data Links

Propulsion and Extreme Environments  
Structures and Protection  
RF Components for sensing, transmission and communication  
Sensors, Electronics and Photonics  
RF Components for sensing, transmission and communication  
Information Collection/Management  
Preemptive/Proactive Effects  
Radio Frequency (RF) (non-EW)  
Sensors, Electronics and Photonics  
Microelectronics and Nanoelectronics  
RF Components for sensing, transmission and communication  
Radio Frequency (RF) (non-EW)  
Radio Frequency Weapons (RFW)  
Machine Perception, Reasoning and Intelligence  
Advanced Computing/Software Development  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Machine Perception, Reasoning and Intelligence  
Advanced Computing/Software Development  
Assuring Effective Missions  
Trust Foundations  
Modular/Open/Reconfigurable Architectures  
Advanced Computing/Software Development  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Networks and Communications  
Synthesis/Analytics/Decision Tools  
Human/Autonomous System Interaction and Collaboration  
Human Computer Interfaces (HCI) for Decision Making  
Personalized Assessment, Education, and Training  
System Interfaces & Cognitive Processes  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Maintainability/Sustainability  
RF Components for sensing, transmission and communication  
Synthesis/Analytics/Decision Tools  
Collaborative Analysis and Decision-making  
Electronics Integration  
Survivability  
Acoustic, Seismic and Magnetic  
Sensors, Electronics and Photonics  
Electronics Integration  
Test, Evaluation, Validation, and Verification  
Advanced Computing/Software Development  
Conceptual, Computational, and World-Wide Environmental Representation

Simulation Information Technology  
Aircraft Propulsion, Power and Thermal  
Fixed Wing Vehicles (includes UAS)  
Information Collection/Management  
Survivability  
Guidance, Navigation & Control (GN&C) and Data Links  
Space and Terrestrial Environmental Monitoring  
EO/IR Components for sensing, transmission and communication  
Advanced Electronic Protection Techniques and Technology  
Unmanned Ground and Sea Vehicles  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
Energy storage  
Unmanned Ground and Sea Vehicles  
Aircraft Propulsion, Power and Thermal  
High-Speed/Hypersonics  
Power Generation/Energy Conversion  
Manufacturing Technology for Affordability  
Radio Frequency Weapons (RFW)  
Energy storage  
High Energy Lasers (HEL)  
Radio Frequency Weapons (RFW)  
Power and Energy  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Corrosion  
Readiness  
Structures and Protection  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Maintainability/Sustainability  
Readiness  
Maintainability/Sustainability  
Structures and Protection  
Power and Energy  
Propulsion and Extreme Environments  
Readiness  
Maintainability/Sustainability  
RF Components for sensing, transmission and communication  
Electro-Optical/Infrared (EO/IR)  
Radio Frequency (RF) (non-EW)  
Guidance, Navigation & Control (GN&C) and Data Links  
EO/IR Components for sensing, transmission and communication  
Microelectronics and Nanoelectronics  
EO/IR Components for sensing, transmission and communication  
Microelectronics and Nanoelectronics  
Electronics Integration

Aircraft Propulsion, Power and Thermal  
Power Generation/Energy Conversion  
Propulsion and Extreme Environments  
Maintainability/Sustainability  
Unmanned Ground and Sea Vehicles  
Corrosion  
Readiness  
Structures and Protection  
RF Components for sensing, transmission and communication  
Networks and Communications  
Broadband/Multispectral Components and Systems  
Radio Frequency (RF) (non-EW)  
Radio Frequency Weapons (RFW)  
RF Components for sensing, transmission and communication  
Advanced Electronic Protection Techniques and Technology  
Cognitive/Adaptive Capabilities  
Modular/Open/Reconfigurable Architectures  
Radio Frequency (RF) (non-EW)  
Propulsion and Extreme Environments  
Structures and Protection  
Modularity  
Energy storage  
Power Generation/Energy Conversion  
Rotary Wing Vehicles  
Survivability  
Manufacturing Technology for Affordability  
Structures and Protection  
Electronic Materials  
Electronics Integration  
RF Components for sensing, transmission and communication  
Advanced Electronic Protection Techniques and Technology  
Electronics Integration  
Power Control and Distribution  
Mobility  
Power and Energy  
RF Components for sensing, transmission and communication  
Survivability  
Protection, Sustainment, and Warfighter Performance  
Sensors, Electronics and Photonics  
Protection, Sustainment, and Warfighter Performance  
Energy storage  
Power Control and Distribution  
Power Generation/Energy Conversion  
Power and Energy  
Readiness  
Structures and Protection  
Maintainability/Sustainability

Readiness  
Structures and Protection  
Electromechanical conversion  
Fixed Wing Vehicles (includes UAS)  
Guidance, Navigation & Control (GN&C) and Data Links  
Corrosion  
Power Generation/Energy Conversion  
Modularity  
Survivability  
Unmanned Ground and Sea Vehicles  
Power and Energy  
Aircraft Propulsion, Power and Thermal  
Fixed Wing Vehicles (includes UAS)  
Energy storage  
Power and Energy  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
System Interfaces & Cognitive Processes  
RF Components for sensing, transmission and communication  
Survivability  
Radio Frequency (RF) (non-EW)  
Machine Perception, Reasoning and Intelligence  
Personalized Assessment, Education, and Training  
System Interfaces & Cognitive Processes  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Synthesis/Analytics/Decision Tools  
Acoustic, Seismic and Magnetic  
Synthesis/Analytics/Decision Tools  
Unmanned Ground and Sea Vehicles  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
Synthesis/Analytics/Decision Tools  
Advanced Electronic Protection Techniques and Technology  
Broadband/Multispectral Components and Systems  
Cognitive/Adaptive Capabilities  
Fixed Wing Vehicles (includes UAS)  
Ordnance  
Propulsion  
Propulsion and Extreme Environments  
Survivability  
Human/Autonomous System Interaction and Collaboration  
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System Interfaces & Cognitive Processes  
Acoustic, Seismic and Magnetic  
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Power Generation/Energy Conversion  
Maintainability/Sustainability  
Unmanned Ground and Sea Vehicles  
Machine Perception, Reasoning and Intelligence  
Synthesis/Analytics/Decision Tools  
Acoustic, Seismic and Magnetic  
Modeling, Simulation & Test Infrastructure  
Undersea Weapons  
Computational Research Engineering Acquisition Tools and Environment  
Design and Integration  
Manufacturing Technology for Affordability  
Structures and Protection  
Energy storage  
Power Generation/Energy Conversion  
EO/IR Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Advanced Electronic Protection Techniques and Technology  
Electro-Optical/Infrared (EO/IR)  
Human Computer Interfaces (HCI) for Decision Making  
Synthesis/Analytics/Decision Tools  
Synthesis/Analytics/Decision Tools  
Maintainability/Sustainability  
Biomedical Informatics / Health Information Systems & Technology  
Combat Casualty Care  
Military Operational Medicine  
Personalized Assessment, Education, and Training  
System Interfaces & Cognitive Processes  
Ordnance  
Propulsion  
Propulsion and Extreme Environments  
Electronic Materials  
EO/IR Components for sensing, transmission and communication  
Microelectronics and Nanoelectronics  
Electro-Optical/Infrared (EO/IR)  
Test, Evaluation, Validation, and Verification  
EO/IR Components for sensing, transmission and communication  
Microelectronics and Nanoelectronics  
Networks and Communications  
Networks and Communications  
Aircraft Propulsion, Power and Thermal  
Electro-Optical/Infrared (EO/IR)  
EO/IR Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Unmanned Ground and Sea Vehicles



Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
Broadband/Multispectral Components and Systems  
Cognitive/Adaptive Capabilities  
Electro-Optical/Infrared (EO/IR)  
Biomedical Informatics / Health Information Systems & Technology  
Advanced Computing/Software Development  
Synthesis/Analytics/Decision Tools  
Biomedical Informatics / Health Information Systems & Technology  
Personalized Assessment, Education, and Training  
Protection, Sustainment, and Warfighter Performance  
Modeling, Simulation & Test Infrastructure  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Human Computer Interfaces (HCI) for Decision Making  
System Interfaces & Cognitive Processes  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Human Aspects of Operations in Military Environments  
System Interfaces & Cognitive Processes  
Rotary Wing Vehicles  
Machine Perception, Reasoning and Intelligence  
Synthesis/Analytics/Decision Tools  
Unmanned Ground and Sea Vehicles  
Fixed Wing Vehicles (includes UAS)  
Machine Perception, Reasoning and Intelligence  
Scalable Teaming of Autonomous Systems  
Unmanned Ground and Sea Vehicles  
Personalized Assessment, Education, and Training  
Electronics Integration  
Power Control and Distribution  
Design and Integration  
Maintainability/Sustainability  
Modularity  
Biomedical Informatics / Health Information Systems & Technology  
Survivability  
Protection, Sustainment, and Warfighter Performance  
EO/IR Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Design and Integration  
Mobility  
Human Computer Interfaces (HCI) for Decision Making  
Design and Integration  
Modularity  
Unmanned Ground and Sea Vehicles

System Interfaces & Cognitive Processes  
Fixed Wing Vehicles (includes UAS)  
Information Collection/Management  
Electro-Optical/Infrared (EO/IR)  
Broadband/Multispectral Components and Systems  
Power Control and Distribution  
Power Generation/Energy Conversion  
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Radio Frequency Weapons (RFW)  
EO/IR Components for sensing, transmission and communication  
Networks and Communications  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
EO/IR Components for sensing, transmission and communication  
Survivability  
Unmanned Ground and Sea Vehicles  
Electro-Optical/Infrared (EO/IR)  
Undersea Weapons  
Personalized Assessment, Education, and Training  
System Interfaces & Cognitive Processes  
Acoustic, Seismic and Magnetic  
Undersea Weapons  
RF Components for sensing, transmission and communication  
Networks and Communications  
Networks and Communications  
Electronic Materials  
RF Components for sensing, transmission and communication  
Broadband/Multispectral Components and Systems  
Energy storage  
EO/IR Components for sensing, transmission and communication  
RF Components for sensing, transmission and communication  
Networks and Communications  
Broadband/Multispectral Components and Systems  
RF Components for sensing, transmission and communication  
Power Control and Distribution  
Assuring Effective Missions  
Resilient Infrastructure  
EO/IR Components for sensing, transmission and communication  
Preemptive/Proactive Effects  
Electro-Optical/Infrared (EO/IR)  
Guidance, Navigation & Control (GN&C) and Data Links  
Scalable Teaming of Autonomous Systems  
Networks and Communications  
Trust Foundations  
Guidance, Navigation & Control (GN&C) and Data Links  
Electronics Integration  
EO/IR Components for sensing, transmission and communication

Design and Integration  
Mobility  
Sensors, Electronics and Photonics  
Machine Perception, Reasoning and Intelligence  
Information Collection/Management  
Synthesis/Analytics/Decision Tools  
Collaborative Analysis and Decision-making  
RF Components for sensing, transmission and communication  
Information Collection/Management  
Networks and Communications  
Broadband/Multispectral Components and Systems  
Radio Frequency (RF) (non-EW)  
Microelectronics and Nanoelectronics  
Broadband/Multispectral Components and Systems  
Electro-Optical/Infrared (EO/IR)  
Sensors, Electronics and Photonics  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Machine Perception, Reasoning and Intelligence  
Collaborative Analysis and Decision-making  
Human/Autonomous System Interaction and Collaboration  
Machine Perception, Reasoning and Intelligence  
Advanced Computing/Software Development  
Information Collection/Management  
Maintainability/Sustainability  
Aircraft Propulsion, Power and Thermal  
Combat Casualty Care  
Military Infectious Diseases  
Power Generation/Energy Conversion  
Acoustic, Seismic and Magnetic  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Machine Perception, Reasoning and Intelligence  
Synthesis/Analytics/Decision Tools  
Assuring Effective Missions  
Survivability  
Maintainability/Sustainability  
EO/IR Components for sensing, transmission and communication  
Machine Perception, Reasoning and Intelligence  
Unmanned Ground and Sea Vehicles  
Electro-Optical/Infrared (EO/IR)  
Propulsion  
Power and Energy  
Propulsion and Extreme Environments  
Machine Perception, Reasoning and Intelligence  
Networks and Communications  
Unmanned Ground and Sea Vehicles

Acoustic, Seismic and Magnetic  
Protection, Sustainment, and Warfighter Performance  
Machine Perception, Reasoning and Intelligence  
Information Collection/Management  
Maintainability/Sustainability  
Electro-Optical/Infrared (EO/IR)  
Integrated Weapon Demonstrators (IWD)  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Cognitive/Adaptive Capabilities  
Distributed/Coordinated/Net-Enabled Systems  
Radio Frequency (RF) (non-EW)  
Electronics Integration  
Machine Perception, Reasoning and Intelligence  
Scalable Teaming of Autonomous Systems  
Test, Evaluation, Validation, and Verification  
Information Collection/Management  
Unmanned Ground and Sea Vehicles  
Information Collection/Management  
Biomedical Informatics / Health Information Systems & Technology  
Human Computer Interfaces (HCI) for Decision Making  
Information Collection/Management  
Personalized Assessment, Education, and Training  
Protection, Sustainment, and Warfighter Performance  
Modular/Open/Reconfigurable Architectures  
Human Computer Interfaces (HCI) for Decision Making  
Assuring Effective Missions  
System Interfaces & Cognitive Processes  
Modeling, Simulation & Test Infrastructure  
Electronics Integration  
Fixed Wing Vehicles (includes UAS)  
Readiness  
Sensors, Electronics and Photonics  
EO/IR Components for sensing, transmission and communication  
High Energy Lasers (HEL)  
Sensors, Electronics and Photonics  
Information Collection/Management  
Networks and Communications  
Modular/Open/Reconfigurable Architectures  
Modularity  
Computational Research Engineering Acquisition Tools and Environment  
Design and Integration  
Manufacturing Technology for Affordability  
Structures and Protection  
Sensors, Electronics and Photonics  
Personalized Assessment, Education, and Training  
Protection, Sustainment, and Warfighter Performance

RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Networks and Communications  
Distributed/Coordinated/Net-Enabled Systems  
Survivability  
Electronics Integration  
Collaborative Analysis and Decision-making  
Computational Research Engineering Acquisition Tools and Environment  
Design and Integration  
Modeling, Simulation & Test Infrastructure  
EO/IR Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Electro-Optical/Infrared (EO/IR)  
Fixed Wing Vehicles (includes UAS)  
Maintainability/Sustainability  
Readiness  
Microelectronics and Nanoelectronics  
Machine Perception, Reasoning and Intelligence  
Information Collection/Management  
Electro-Optical/Infrared (EO/IR)  
Protection, Sustainment, and Warfighter Performance  
Sensors, Electronics and Photonics  
Protection, Sustainment, and Warfighter Performance  
System Interfaces & Cognitive Processes  
Advanced Computing/Software Development  
Computational Research Engineering Acquisition Tools and Environment  
Fixed Wing Vehicles (includes UAS)  
Rotary Wing Vehicles  
Acoustic, Seismic and Magnetic  
RF Components for sensing, transmission and communication  
Fixed Wing Vehicles (includes UAS)  
Acoustic, Seismic and Magnetic  
Radio Frequency (RF) (non-EW)  
Protection, Sustainment, and Warfighter Performance  
Aircraft Propulsion, Power and Thermal  
Fixed Wing Vehicles (includes UAS)  
Power Generation/Energy Conversion  
Rotary Wing Vehicles  
Protection, Sustainment, and Warfighter Performance  
Energy storage  
Power Control and Distribution  
Power and Energy  
Propulsion and Extreme Environments  
Ordnance  
Energy storage  
Power and Energy  
Test, Evaluation, Validation, and Verification



# Department of the Navy SBIR/STTR Transition Program

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SSP 2 Jan 2018

Topic # N143-129

Sensor system for Precise Automatic Relative-position Keeping (SPARK)

Charles River Analytics Inc.

## WHO

**SYSCOM:** SSP

**Sponsoring Program:** Strategic Systems Programs - ACAT I

**Transition Target:** Type Auxiliary Combat General Escorts (T-AGSEs) escorting submarines

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**Other transition opportunities:**

Precision, covert, jam-resistant radar, which could be used in covert air-to-air refueling, harbor defense, tracking traffickers/smugglers, covert underway replenishment. Computer vision capability that enables storing compact representations of 3-D objects, and enables re-creating 3-D objects from 2-D images. Useful for computer gaming, augmented reality, and computer-aided design (CAD).

**Notes:** We expect the full-scope SPARK system—and its RF and vision-based tracking and localization components—to provide immediate and tangible benefits for the Submarine Force.



<http://www.navy.mil/management/photodb/webphoto/webphoto/N-FG395-055.jpg>

## WHAT

**Operational Need and Improvement:** T-AGSEs utilize a modified Dynamic Positioning (DP) software package to automatically maintain position during their escort mission where a key component is a Relative Reference Sensor System (R2S2) which provides the relative positioning data of the SSBN to the T-AGSEs DP Software which thereby adjusts the T-AGSE's control mechanisms to maintain position at a given set point. The components of a R2S2 typically consist of sensors (installed on the T-AGSEs), targets (installed on the SSBN) and other associated hardware (marine PCs, cables, etc.). However, there is an inherent safety risk in that sailors onboard the SSBN must go topside while underway to install/uninstall the targets (three 10' tall, stanchion-mounted reflector poles). The current system's performance is also unreliable in adverse weather conditions.

**Specifications Required:** The next generation R2S2 should meet the following system requirements: no equipment installed or stored on the SSBN; send data in a NMEA0183R data format to the DP System using a serial connection; have a redundant capability; be accurate within +/- 12 inches of true target vessel position; be accurate within +/- 0.5 degrees of the true target vessel bearing; provide updated data to the DP System once per second; be able to track the target vessel from a range of 10ft – 500ft; and have an all-weather capability and meet performance requirements in environmental conditions up to Sea State 4.

**Technology Developed:** Sensor system for Precise Automatic Relative-position Keeping (SPARK) uses novel short-wavelength infrared (SWIR) and covert radiofrequency (RF) sensors to precisely track surfaced SSBNs under all plausible environmental conditions. Includes precision, covert, jam-resistant radar and computer vision capability that enables storing compact representations of 3-D objects, and enables re-creating 3-D objects from 2-D images.

**Warfighter Value:** SPARK system -- and its RF and vision-based tracking and localization components -- does not require Sailors to go on the SSBN's deck when underway, helps safeguard operational security, and meets regulatory standards for system redundancy by incorporating independent systems based on two different physical principles.

## WHEN

**Contract Number:** N00030-17-C-0009 **Ending on:** July 19, 2018

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Development of SPARK system prototype	Med	Operational test for static pier-side measurements	5	January 2018
Development of SPARK system simulator	Med	Test with dynamic positioning (DP) system simulator	6	May 2018

## HOW

**Projected Business Model:** Since 1983, Charles River Analytics has applied computational intelligence technologies to develop mission-relevant tools to transform our customers' data into knowledge that drives accurate assessment and robust decision making. SPARK will serve as an effective relative reference sensor system, replacing the problematic scanning laser systems currently used to provide sensor inputs to the DP systems on Type Auxiliary Combat General Escorts (T-AGSEs).

**Company Objectives:** Charles River would like to meet with government agencies and companies involved in specialty radar systems, video gaming, augmented reality, and computer-aided design.

**Potential Commercial Applications:** This sensor system has private sector commercial potential by reducing the maintenance of sensor systems in offshore oil operations. This system also has the potential for use during underway replenishments. Other opportunities exist for organizations responsible for escorting ballistic missile submarines (SSBNs) transiting on the surface in restricted waters and in the commercial maritime industry for improving DP system functionality for precision station keeping in a variety of applications.

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