

Topic: N161-054

Dakota Ridge R & D

Passive Characterization of the Refractivity Environment and Temperature and Water Vapor Vertical Distributions Afloat

Dakota Ridge R&D is developing, prototyping, and patenting a passive shipboard capability to characterize refractivity environments, temperature, and water vapor vertical distributions. This rapid-cycle low size, weight and power (SWAP), low-maintenance device leverages oceanic horizon and upward high-resolution long-wave infrared images to characterize thermal structures (radio/RADAR ducting) into refractivity, meteorological temperature, and relative humidity profiles. Dakota Ridge's capability supports acquisition of rapid sequence observations in the vicinity of the ship, to predict battlespace EM/EO propagation characteristics. Currently, no other passive/covert technology produces such resolute results. Extensive modeling and processing of CASPER West R/V Sally Ride Sea Trial observational data has been leveraged to demonstrate the technology's viability. Dakota Ridge has an established strategic partnership and is collaborating with Ball Aerospace to support development and integration.

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)

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
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Maintainability/Sustainability
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Acoustic, Seismic and Magnetic
Test, Evaluation, Validation, and Verification
RF Components for sensing, transmission and communication
Fixed Wing Vehicles (includes UAS)
Networks and Communications
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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
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Fixed Wing Vehicles (includes UAS)
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Distributed/Coordinated/Net-Enabled Systems
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
Fixed Wing Vehicles (includes UAS)
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Information Collection/Management
Networks and Communications
Survivability
Modeling, Simulation & Test Infrastructure
Electronics Integration
RF Components for sensing, transmission and communication
Electromechanical conversion
Energy storage
Power Generation/Energy Conversion
Acoustic, Seismic and Magnetic
RF Components for sensing, transmission and communication
Preemptive/Proactive Effects
Survivability
Modeling, Simulation & Test Infrastructure
Mobility
Modularity
Survivability
Unmanned Ground and Sea Vehicles
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
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
Protection, Sustainment, and Warfighter Performance
Protection, Sustainment, and Warfighter Performance
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
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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
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Survivability
Protection, Sustainment, and Warfighter Performance
Survivability
Preemptive/Proactive Effects
EO/IR Components for sensing, transmission and communication
Advanced Computing/Software Development
Personalized Assessment, Education, and Training
EO/IR Components for sensing, transmission and communication
Maintainability/Sustainability
Energy storage
RF Components for sensing, transmission and communication
Guidance, Navigation & Control (GN&C) and Data Links
Undersea Weapons
Fixed Wing Vehicles (includes UAS)
Survivability
Undersea Weapons
Unmanned Ground and Sea Vehicles
Fixed Wing Vehicles (includes UAS)
Distributed/Coordinated/Net-Enabled Systems
Preemptive/Proactive Effects
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Acoustic, Seismic and Magnetic
High Energy Lasers (HEL)
Fixed Wing Vehicles (includes UAS)
Energy storage
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Protection, Sustainment, and Warfighter Performance
Maintainability/Sustainability
Protection, Sustainment, and Warfighter Performance
Survivability
Undersea Weapons
Fixed Wing Vehicles (includes UAS)
Maintainability/Sustainability
Manufacturing Technology for Affordability
Personalized Assessment, Education, and Training
Unmanned Ground and Sea Vehicles
Trust Foundations
Distributed/Coordinated/Net-Enabled Systems
Personalized Assessment, Education, and Training
Microelectronics and Nanoelectronics
Networks and Communications
Personalized Assessment, Education, and Training
Microelectronics and Nanoelectronics

Networks and Communications
Energy storage
Guidance, Navigation & Control (GN&C) and Data Links
Microelectronics and Nanoelectronics
Trust Foundations
Fixed Wing Vehicles (includes UAS)
Microelectronics and Nanoelectronics
Networks and Communications
Personalized Assessment, Education, and Training
Broadband/Multispectral Components and Systems
Survivability
Acoustic, Seismic and Magnetic
Energy storage
Acoustic, Seismic and Magnetic
Fixed Wing Vehicles (includes UAS)
Manufacturing Technology for Affordability
Manufacturing Technology for Affordability
Advanced Computing/Software Development
Microelectronics and Nanoelectronics
Survivability
Microelectronics and Nanoelectronics
Guidance, Navigation & Control (GN&C) and Data Links
EO/IR Components for sensing, transmission and communication
Networks and Communications
High Energy Lasers (HEL)
Energy storage
Power Generation/Energy Conversion
Fixed Wing Vehicles (includes UAS)
Maintainability/Sustainability
Energy storage
Personalized Assessment, Education, and Training
EO/IR Components for sensing, transmission and communication
Acoustic, Seismic and Magnetic
Maintainability/Sustainability
Fixed Wing Vehicles (includes UAS)
Personalized Assessment, Education, and Training
Maintainability/Sustainability
Manufacturing Technology for Affordability
Maintainability/Sustainability
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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)

EO/IR Components for sensing, transmission and communication
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Fixed Wing Vehicles (includes UAS)
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Personalized Assessment, Education, and Training
Protection, Sustainment, and Warfighter Performance
Maintainability/Sustainability
Personalized Assessment, Education, and Training
Modular/Open/Reconfigurable Architectures
Fixed Wing Vehicles (includes UAS)
Guidance, Navigation & Control (GN&C) and Data Links
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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
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)
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)
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
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
RF Components for sensing, transmission and communication
Networks and Communications
Unmanned Ground and Sea Vehicles
Manufacturing Technology for Affordability
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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)
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Sensors, Electronics and Photonics
Electro-Optical/Infrared (EO/IR)
Radio Frequency Weapons (RFW)
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Sensors, Electronics and Photonics
Electro-Optical/Infrared (EO/IR)
Radio Frequency Weapons (RFW)
Advanced Computing/Software Development
Acoustic, Seismic and Magnetic
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Acoustic, Seismic and Magnetic
Machine Perception, Reasoning and Intelligence
Information Collection/Management
Synthesis/Analytics/Decision Tools
Distributed/Coordinated/Net-Enabled Systems
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
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
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)

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Test, Evaluation, Validation, and Verification
Electro-Optical/Infrared (EO/IR)
Modeling, Simulation & Test Infrastructure
Fixed Wing Vehicles (includes UAS)
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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
Machine Perception, Reasoning and Intelligence
Networks and Communications
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Trust Foundations
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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
EO/IR Components for sensing, transmission and communication
Satellite Communications (SATCOM)
Networks and Communications
Trust Foundations
Electro-Optical/Infrared (EO/IR)
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
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
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
Networks and Communications
Cognitive/Adaptive Capabilities
Unmanned Ground and Sea Vehicles
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
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
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
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
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
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
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
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
Synthesis/Analytics/Decision Tools
System Interfaces & Cognitive Processes
Acoustic, Seismic and Magnetic
Undersea Weapons

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
Modeling, Simulation & Test Infrastructure
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
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
Synthesis/Analytics/Decision Tools
Modular/Open/Reconfigurable Architectures
Collaborative Analysis and Decision-making
Readiness
Structures and Protection
Aircraft Propulsion, Power and Thermal
Corrosion

Propulsion and Extreme Environments

Readiness

Sensors, Electronics and Photonics

Structures and Protection

Electronics Integration

Networks and Communications

None

None

None

None

None

None

None

None

None

None

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None

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None

None

Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-5915-19/43-6031-19

Topic # N161-054

Passive Characterization of the Refractivity Environment and Temperature and Water Vapor Vertical Distributions Afloat

Dakota Ridge R & D

WHO

SYSCOM: ONR

Sponsoring Program: Division 322 Ocean, Atmosphere and Space Research Division

Transition Target: Real-Time Spectrum Operations (RTSO), PEO-IWS1, PEO-IWS2, PEO-IWS5

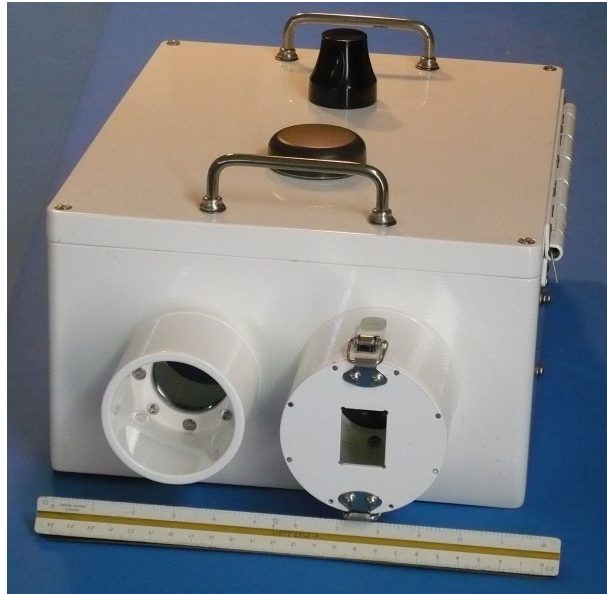
TPOC:

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Other transition opportunities:

Electromagnetic Warfare Battlespace Management, Future Me, Mk 20 Electro-Optical Sensor System, Maritime EMW Environmental Sensing, Battle scene weather, air operations, domestic atmospheric profiling for weather nowcasting, forecasting, trending, numeric weather models input

Notes: Pictured at right is the prototype passive autonomous low SWAP-C, <1 cu.ft. high-fidelity meteorological Temperature, relative humidity, and refractivity profiler 12 x 7 x 15 inches, 15 kg, 30 watts, No emissions, impervious to RFI.



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WHAT

Operational Need and Improvement: The Navy seeks methods to characterize and predict the performance of radar, electronic warfare, laser, and communicators systems. Current present weather and forecast conditions and refractivity and electromagnetic/electro-optical (EM/EO) ducting characterizations afloat are obtained through numeric weather modeling, radiosondes, and RADAR sea clutter return. This passive long-wave infrared (LWIR) system being developed provides higher skill and performance battlespace EM/EO characterization and management. It also provides rapid sequence temperature, water vapor, and refractivity vertical profiles for weather.

Specifications Required: Very rapid (1 second) cycle time. Information is inverted mathematically into high vertical resolution tropospheric structure of temperature, relative humidity (RH), and refractivity to 10 km. The profile information obtained can be utilized to model the refractivity environment and evaporation duct in all EM wavebands, from low-frequency radio through ultraviolet. Simple implementation, Ethernet connection outputting Navy-defined results and for control, can be mounted on deck or superstructure. Hermetic and very low simple maintenance, low cost, compact, no expendables. Self-calibrating.

Technology Developed: Passive characterization of refractive effects upon visible, IR, and radio/RADAR electromagnetic propagation through passive relatively inexpensive IR camera observations is enabled with the apparatus and methods being developed. Passive remote sensing of profiles, structure, and gradients of refractivity, temperature, and water vapor in the troposphere are obtained through high thermal resolution and accuracy images of the atmosphere from the horizon upward. The methodology proposed herein is a new approach and utilizes heretofore unused infrared camera observations to obtain said tropospheric structures. The system augments or replaces existing active systems.

Warfighter Value: Atmospheric turbulence can distort and diminish the sensitivity of measurements of electromagnetic (EM) and Electro-Optic (EO) sensors. The Surface Navy has an interest in predicting EM and EO propagation and visibility from surface ships to support the prediction of radar, electronic warfare, laser, and communications systems performance. This passive IR imaging system produces the measurement of atmospheric profiles of temperature, water vapor, and refractivity. All three of these parameters affect EM/EO propagation. The temperature and relative humidity profiles serve weather nowcasting, forecasting, and trending, and also enable calculation of refractivity profiles in all wavebands.

WHEN

Contract Number: N68335-18-C-0261 **Ending on:** May 7, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Phase I contract completed	Low	Modeling and design accomplished	TRL 3	2nd QTR FY17
Oceanic sea trials on R/V Sally Ride	Low	Successful sea trials	TRL 5	1st QTR FY18
Phase I Option completed	Low	SOW successfully completed	TRL 6	1st QTR FY18
Phase II contract	Low		TRL 6	3rd QTR FY18
Phase II contract 1 year of 2 year contract	Low	partial completion of SOW	TRL 6	3rd QTR FY19
End Phase II, begin phase II Option if exercised	Low	Demonstrated performance in representative environment	TRL7 after Option	TBD

HOW

Projected Business Model: Dakota Ridge intends to bring the system to a marine worthy high TRL level while partnering with an Aerospace or Defense Contractor to oversee the design and fabrication and user interface late in the contract effort. This is to facilitate and streamline possible procurement. Dakota Ridge will produce a limited number of units for performance evaluation and field trials. The intent is to enter into technology and patent and other rights agreement with the Contractor to manufacture and deliver to the Navy and possibly other elements of the DoD. Dakota Ridge will enter into a transition consulting agreement with the Contractor to convey overall knowledge. Conversations have begun with Ball Aerospace and Lockheed Martin. The system will provide a simple, yet comprehensive, graphical user interface (GUI) for the low-skill user.

Company Objectives: Dakota Ridge will retain commercial rights to manufacture and market a non-Navy model for the commercial and government markets in meteorological measurements for weather nowcasting and forecasting. In 25 years as a principal in Radiometrics Corporation, PI has designed, patented, produced, and manufactured over \$30 million in passive microwave tropospheric profilers and knows the markets and customers. Field trials and demonstration are planned in Phase II. Commercial production is relatively simple. A work force of 10 can produce over 60 units/year.

Potential Commercial Applications: This system provides rapid (<1 second cycle time) passive autonomous remote sensing of the tropospheric thermodynamic parameters (T and RH) for meteorology, weather research, nowcasting and forecasting, for air quality (pollutant trapping and transport and scouring), wind energy (theta-E for air flow laminarity), aviation weather. It can also measure true sea surface temperature for climate modeling and other applications. Concurrent IR and visible images are captured, as well as surface meteorology. The system can also provide IR surveillance.

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