

Topic: N143-127

Propel LLC

Electrically Functional Garment Systems: Developing a Smart Integrated Uniform™ Prototype Garment

Propel, a textile technologies design and development company, has developed knit textiles with embedded electrically functional networks (E-textiles). Our innovations include electrically functional engineered yarns (E-yarns), textile electrodes and textile-electronics integration methods. Using these innovations, together with 3-D knitting, we engineer electrically-enabled textile structures which retain their textiles properties without compromising electrical functionality. The demonstration prototype is a sensor-enabled base layer shirt for Navy SEALs, permitting continuous real-time monitoring of the wearer's physiology. Beyond this prototype, electrically functional textiles are applicable within any military platform for which the scalable distribution of sensors over a broad surface area is a game changer. Additional applications for the E-textile technology include, but are not limited to, structural health monitoring, RF monitoring, chemical-biological monitoring, antennas, heating, and lighting.

Technology Category Alignment:

Satellite Communications (SATCOM)

Robotics/Automated Material Handling Equipment

Shipyards/Shipbuilding

Supply; Storage

Satellite Communications (SATCOM)

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Supply; Storage

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Satellite Communications (SATCOM)

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Shipyards/Shipbuilding

Robotics/Automated Material Handling Equipment

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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
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Fixed Wing Vehicles (includes UAS)
Rotary Wing Vehicles
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Fixed Wing Vehicles (includes UAS)

Information Collection/Management
Electro-Optical/Infrared (EO/IR)
Aircraft Propulsion, Power and Thermal
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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
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
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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
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
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
Fixed Wing Vehicles (includes UAS)
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
Advanced Computing/Software Development
Personalized Assessment, Education, and Training
Manufacturing Technology for Affordability
Acoustic, Seismic and Magnetic
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
Preemptive/Proactive Effects
Acoustic, Seismic and Magnetic
High Energy Lasers (HEL)
Fixed Wing Vehicles (includes UAS)
Energy storage
Fixed Wing Vehicles (includes UAS)
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
Acoustic, Seismic and Magnetic
Unmanned Ground and Sea Vehicles
Trust Foundations
Distributed/Coordinated/Net-Enabled Systems
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
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
RF Components for sensing, transmission and communication
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
Advanced Computing/Software Development
Unmanned Ground and Sea Vehicles
Fixed Wing Vehicles (includes UAS)
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)
Maintainability/Sustainability
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
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
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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
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
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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
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Distributed/Coordinated/Net-Enabled Systems
Radio Frequency (RF) (non-EW)
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Modular/Open/Reconfigurable Architectures
Rotary Wing Vehicles
Test, Evaluation, Validation, and Verification
Maintainability/Sustainability
Corrosion
Acoustic, Seismic and Magnetic
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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)
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Sensors, Electronics and Photonics
Electro-Optical/Infrared (EO/IR)
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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
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Information Collection/Management
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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
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Information Collection/Management
Maintainability/Sustainability
Electro-Optical/Infrared (EO/IR)

Modeling, Simulation & Test Infrastructure
Fixed Wing Vehicles (includes UAS)
Rotary Wing Vehicles
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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
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
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
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Department of the Navy SBIR/STTR Transition Program

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Topic # N143-127

Electrically Functional Garment Systems: Developing a Smart Integrated Uniform™

Prototype Garment

Propel LLC

WHO

SYSCOM: NAVSUP

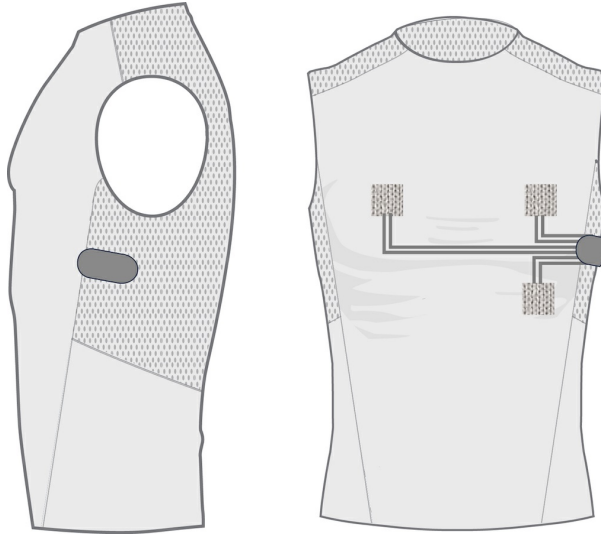
Sponsoring Program: Naval Surface Warfare Center Carderock Division Disruptive Technologies Lab Code 00T

Transition Target: United States Navy Special Warfare Command SEAL Delivery Vehicle

TPOC:
(508)233-1340

Other transition opportunities: US Army PM Air Warrior, US SOCOM TALOS program, Defense Health Agency, US Army Integrated Soldier Sensor System. Other DOD applications that can benefit from scalable distribution of sensors over a broad surface area. These applications include, but are not limited to, human, structure, asset and environmental monitoring, antennas, heating and lighting.

Notes: Illustration shows the 3D knitted Smart Integrated Uniform™ (SIU) physiological status monitoring (PSM) base layer prototype using SBIR developed technologies including electrically enabled yarns (e-yarns), electrically enabled textile (e-textile) electrodes, data and power textile circuits.



Prototype SIU-PSM Base Layer Copyright, 2018, Propel LLC.

WHAT

Operational Need and Improvement: The US Navy identified a need to develop an ensemble to advance human functionality, optimize personnel performance to account for reduced manning and to enhance the survivability of future warships by embedding technologies into the sailor's uniform to create a robust human/ship command and control interface. Naval uniforms do not exist to keep pace with evolving multi-functional human-system interface technologies envisioned for future ship command, control and operation therefore a need exists to advance the state of wearable technologies capable of seamlessly integrating with evolving ship systems.

Specifications Required: Regardless of the sailor's position, technologies will serve to wirelessly sense, process and receive/transmit information between the ship platform and the sailor. The resulting ensemble will also wirelessly communicate the sailor's position and track movement, as well as to monitor and relay the human state of health important for situations such as damage control events. Given the emergence of virtual displays, the embedded technologies shall be capable of communicating with them and leveraging their benefits. Incorporate proposed technology into preliminary demonstration models exhibiting multifunctional capabilities that are transparent to the wearer, are appropriate for clothing applications and capable of validating functionality suitable for shipboard use in a laboratory environment.

Technology Developed: Propel is developing and prototyping novel technologies to embed electrical system functionality into sailors' uniforms, permitting future integration of the sailor into the Navy's system of systems and enhancing the availability of mission-critical information for both the sailor and the Command. The Phase II demonstration prototype is a 3D knitted compression base layer garment for physiological monitoring (PSM), including measurement of wave form ECG, in an underwater operational environment.

Warfighter Value: Continuous real-time monitoring of operator physiological status to measure and predict physical and cognitive performance. Augmented operational effectiveness via uniforms with textile embedded data and power networks for enhanced Command, Control, Communications, Computing and Intelligence (C4I) capabilities. Electrically enabled textiles permitting reduced size and weight requirements for data and power networks.

WHEN

Contract Number: N00189-17-C-Z023 **Ending on:** January 11, 2019

| Milestone | Risk Level | Measure of Success | Ending TRL | Date |
|---|------------|--|------------|----------------|
| Development of washable textile electrodes | N/A | Textile electrodes sense and measure electrical signal | 4 | May 2018 |
| Development of knitted textile circuits | N/A | Functional data and power electrical circuit integrated into a wearable knit textile structure | 4 | September 2018 |
| Demonstration Prototype #1 (2 samples) delivered to NCTRF | Med | Form, fit and function meet the technical objectives | 5 | December 2018 |
| Testing by the Navy in a relevant simulated environment | Med | Reliable, high quality sensor data captured | 5 | January 2019 |
| Demonstration Prototype #2 (6 samples) delivered to NCTRF | High | Form, fit and function meet technical objectives under water | 6 | TBD |

HOW

Projected Business Model: Propel will sell physiological monitoring base layer garments, teaming with a highly qualified military contractor for initial low-rate as well as follow on full-rate manufacture. Propel will seek further RDT&E contracts leveraging the SBIR developed e-yarn and e-textile technologies and in-house prototyping 3D knitting coding and design capabilities. Propel will also license e-textile products, circuits, and electrodes as well as the associated manufacturing know-how. Propel will sell and/or enter into licensing agreements for the sale of the component e-textile technologies, such as the e-yarns.

Company Objectives: Propel's objective is to connect with Navy and other DOD programs for whom the developed e-textile technologies will be a game changer. These include opportunities for the SIU PSM garments for use in other demanding operational environments, such as when wearing the Joint Service Lightweight Integrated Suit Technology (JSLIST) for chemical and biological agent production, as well as the Explosive Ordnance Disposal (EOD) suits for bomb disposal. There are many other applications beyond PSM garments that would be enhanced by replacing traditional circuits with textile-based data and power circuits. Propel will develop the e-textile technology to be the industry leader in the design and manufacture of textile-based sensor arrays and data and power circuits.

Potential Commercial Applications: Propel's commercial opportunities for the SIU PSM base layer garment include first responder and medical patient monitoring. Athletic wear and equipment companies are also commercial targets for the highly innovative textile-based sensors developed specifically for compression e-garments. Propel will pursue market opportunities to sell subsystem components for integration for smart garments and e-textiles across a broad array of markets, including outdoor recreation products, interior textiles, automotive textiles, medical textiles, and space textiles. Opportunities in industrial products include e-textiles for integration into composite structures.

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