

Topic: N15A-T022

Charles River Analytics Inc.

Embedded Architecture for Cyber-resilience (EAC)

For 30+ years, Charles River Analytics Inc. has provided intelligent systems technology, software tools, and design/analysis services for government and private industry. We are developing an Embedded Architecture for Cyber-resilience (EAC) to protect cyber-physical systems from cyber threats, ensuring fault isolation for both system- and application-level software components and using novel machine learning algorithms to detect, locate, and automatically recover from compromises due to cyber-attacks. EAC is directly applicable to a number of military and commercial systems including satellites (e.g. CubeSat), avionics, unmanned systems, and industrial control systems. Early versions of EAC have successfully detected component faults and predictably and efficiently recovered from these faults to achieve mission success. We seek to license to large system integrators and integrate into Navy embedded control systems.

Technology Category Alignment:

Satellite Communications (SATCOM)

Robotics/Automated Material Handling Equipment

Shipyards/Shipbuilding

Supply; Storage

Satellite Communications (SATCOM)

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Supply; Storage

Supply; Storage

Satellite Communications (SATCOM)

Satellite Communications (SATCOM)

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
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EO/IR Components for sensing, transmission and communication
Rotary Wing Vehicles

Protection, Sustainment, and Warfighter Performance
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Fixed Wing Vehicles (includes UAS)
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Electro-Optical/Infrared (EO/IR)
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Machine Perception, Reasoning and Intelligence
Assuring Effective Missions
Modular/Open/Reconfigurable Architectures
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Machine Perception, Reasoning and Intelligence
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Acoustic, Seismic and Magnetic
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Fixed Wing Vehicles (includes UAS)
Information Collection/Management

Electro-Optical/Infrared (EO/IR)
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Scalable Teaming of Autonomous Systems
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Combat Casualty Care
Military Infectious Diseases
Military Operational Medicine
Readiness
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Mobility
Modularity
Survivability
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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
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Advanced Electronic Protection Techniques and Technology
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Survivability

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Networks and Communications
Personalized Assessment, Education, and Training
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Modular/Open/Reconfigurable Architectures
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Fixed Wing Vehicles (includes UAS)
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Survivability
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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
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Synthesis/Analytics/Decision Tools
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Information Collection/Management
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Maintainability/Sustainability
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Aircraft Propulsion, Power and Thermal
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Fixed Wing Vehicles (includes UAS)
Corrosion
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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
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Manufacturing Technology for Affordability
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Radio Frequency (RF) (non-EW)
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RF Components for sensing, transmission and communication
Sensors, Electronics and Photonics
Sensors, Electronics and Photonics

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Sensors, Electronics and Photonics
RF Components for sensing, transmission and communication
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Acoustic, Seismic and Magnetic
Power Control and Distribution
Acoustic, Seismic and Magnetic
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Aircraft Propulsion, Power and Thermal
Rotary Wing Vehicles
Aircraft Propulsion, Power and Thermal
Aircraft Propulsion, Power and Thermal
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RF Components for sensing, transmission and communication
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Medical Chem-Bio Defense
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EO/IR Components for sensing, transmission and communication
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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

Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-3252-17

Topic # N15A-T022

Embedded Architecture for Cyber-resilience (EAC)

Charles River Analytics Inc.

WHO

SYSCOM: ONR

Sponsoring Program: ONR Code 31

Transition Target: Unmanned Aircraft Systems or security-critical cyber-physical systems

TPOC:

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Other transition opportunities:

Product may be integrated into the Navy's embedded control systems for various ship-board naval applications or any number of military and commercial systems that must defend cyber physical systems from attack such as satellite (e.g. CubeSat), unmanned underwater vehicles, weapons systems, ISR platforms, avionics, and industrial control systems.

Notes: As an example of an alternate SBIR transition path successfully pursued on another program, Charles River developed a tool to guide the war-fighter through a formalized approach to assessing, analyzing, and forecasting human behavior (Contract Number FA8650-04-C-6403). The tool eventually underwent a successful Military Utility Assessment in 2008 and an Extended User Assessment with a Joint agency; it is now in use by DoD war-fighters worldwide.



Photo courtesy of U.S. Navy, 131031-N-SW486-022.JPG

WHAT

Operational Need and Improvement: Navy warfighters rely heavily on critical real-time cyber-physical systems to successfully complete mission objectives. As these systems become more interconnected, they are also more vulnerable to cyber-attacks by malicious adversaries. Fielded cyber-physical control systems must be resilient to faults caused by cyber-attacks as well as transient failures, because a successful attack on key control systems could result in physical catastrophic consequences for the mission and personnel. Therefore, these systems need to be extended with capabilities to (1) prevent faults affecting individual system software components from spreading throughout the entire system; (2) detect system compromises and determine which software components are affected; and (3) recover compromised components to a trusted state upon detection of faults without adversely affecting overall real-time system performance.

Specifications Required: Real-time control systems must provide predictable response times for real-time tasks. Cyber-physical systems can tolerate transient loss of control signals (i.e., software operation) for a limited amount of time as allowed by physical system properties and laws of physics, and fault tolerance capabilities must take such physical tolerance characteristics into account.

Technology Developed: We are developing an Embedded Architecture for Cyber-resilience (EAC) to protect cyber-physical systems from cyber threats, ensuring fault isolation for both system- and application-level software components and using novel machine learning algorithms to detect, locate, and automatically recover from compromises due to cyber-attacks. Early versions of EAC have successfully detected component faults and predictably and efficiently recovered from these faults to achieve mission success.

Warfighter Value: EAC is directly applicable to a number of military and commercial systems including satellites (e.g. CubeSat), avionics, unmanned systems, and industrial control systems. EAC will give warfighters assurance that mission-critical information and control systems will continue to operate in the presence of malicious cyber-attacks without disrupting mission activities.

WHEN

Contract Number: N68335-17-C-0153 **Ending on:** January 16, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Design and evaluate proof-of-concept prototype	N/A	Proof of concept of fault detection algorithms and recovery mechanism	3	November 2016
Develop and evaluate full-scope prototype in simulated environment	Med	Performance evaluation of fault resilience mechanisms	5	January 2019
Field test prototype on Navy platform in an operational scenario	High	Performance requirements met in an operational scenario	7	July 2020
Transition technology into FNC Program and/or integrate with commercial platform	Med	Operational requirements met in developmental test and evaluation	8	April 2021

HOW

Projected Business Model: Charles River has over 30 years of steady growth providing innovative, cost-effective solutions through intelligent systems R&D. Over 100 Charles River projects have produced a wealth of advanced-technology prototype software that can facilitate the rapid integration of critical technology into operational systems. Charles River will license EAC technology to large system integrators and integrate into Navy platforms, such as unmanned aircraft and embedded control systems. Once integrated, Charles River will provide users with full documentation on how to use features of EAC. For example, we have licensed our VisionKit®, partly funded by DoD and NASA SBIRs, to developers of image and video analysis solutions.

Company Objectives: Cyber security, system resilience, and machine learning are core business areas for Charles River, making the success of this effort fall squarely within our corporate interests and competencies. Charles River expertise will ensure the success of the innovations developed under the EAC program beyond the STTR contract. In particular, Charles River plans to pursue a multi-part plan to transition this technology to the U.S. Navy and other U.S. Government customers, as well as provide benefits to commercial markets and customers seeking to enhance security and resilience of IT systems.

Potential Commercial Applications: We expect the full-scope EAC to have immediate and tangible benefits for a number of commercial systems that rely on defending cyber physical systems from attacks. In particular, EAC will help defend commercial satellite, avionics, and industrial control systems from attacks and enable them to fight through the effects of the attacks with minimal disruptions. Augmenting commercial avionics control systems with EAC will enable users to securely execute mission-critical applications.

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