High Reliability Dynamically Reconfigurable Optical Networks

ELECOMP Capstone Design Project 2024-2025

Sponsoring Company:

General Dynamics – Electric Boat
75 Eastern Point Road
Groton, CT 06340
http://www.gdeb.com

Company Overview:

Electric Boat has a distinguished history, tracing its roots to February 7th, 1899, when the company was established to complete a vessel that would revolutionize naval warfare. Named Holland for its inventor, the visionary Irishman John Phillip Holland, this 54-foot vessel in 1900 became the first commissioned U.S. Navy submarine.

Since then, the Holland's successors have been employed to radically reshape naval warfare and maritime strategy, while contributing to the successful outcome of World War II and play an indispensable role in the country's Cold War victory.

Today, Electric Boat is the design yard and prime contractor for the Virginia-class submarine program. The Virginia class is the first major warship completely designed in a virtual environment, a capability pioneered by the people of Electric Boat. Employing many of the best practices used in the Virginia program, Electric Boat is currently engaged in the development of the Ohio Replacement, the third generation ballistic-missile submarine, which will provide strategic deterrence for the nation well into the remainder of this century. The Ohio Replacement Program represents the future of our company, as we develop new tools and processes to design submarines for the U.S. Navy. Key to our future success will be the new employees who come aboard and learn how to design, build and support nuclear submarines and their undersea systems.

Throughout its distinguished history, Electric Boat has been defined by its people, their skills and the legendary commitment they bring to their jobs. A tangible sense of pride runs through the entire workforce - shipyard trades, designers, engineers and the rest of the disciplines required to produce what is arguably the most complex product built by man.

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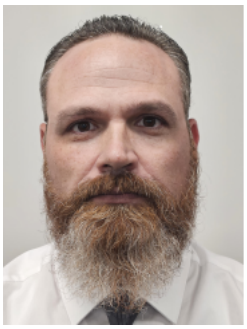


Project Motivation:

This project will investigate and assess technology options and develop a simulation model and prototype of capabilities for enabling on-demand networked components and flexible distributed architectures.

Next generation add-drop networking technologies are emerging and can enable the desired capabilities.

Goal is to develop simulation model(s) and a scaled prototype of an on-demand, reconfigurable network that can enable high reliability system flexibility.

The investigations will include identification and assessment of applicable technologies and components', systems Readiness Level (TRL) and potential risks for maturity of that technology.

Anticipated Best Outcome:

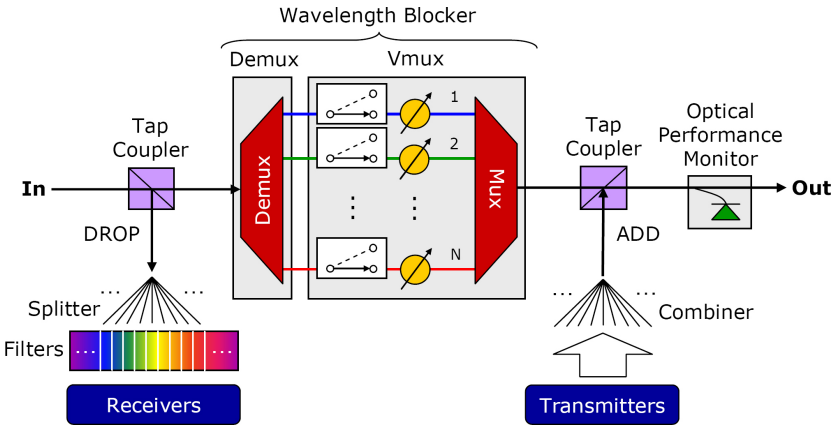
The team will gain hands on engineering experience in the areas of system design, technology investigation and assessment, prototype simulation and modeling and fabrication including software development.

The team will be provided with system requirements, CONOPs and guidance and will be expected to develop, model and build a prototype of a dynamically reconfigurable data network.

Project Details:

This project will investigate and assess technology options and develop a simulation model and prototype of capabilities for enabling on-demand networked components and flexible distributed architectures. Areas of interest include:

- Next generation add-drop networking technologies are emerging and can enable the desired capabilities. Goal is to develop simulation model(s) and a scaled prototype of an on-demand, reconfigurable network that can enable high reliability system flexibility
- Investigations will include identification and assessment of applicable technologies and components', systems Readiness Level (TRL) and potential risks for maturity of that technology
- Opportunities to reduce platform integration costs and complexities for integration of next generation systems
- Increasing the use of optical add-drop capabilities can enable a "Tactical Middleware" approach to providing a flexible, robust and high-reliable interface boundary between system providers and the ship networks



Hardware/Electrical Tasks:

- Development of System Performance Requirements
- Technology Investigations and Assessments
- System Design and Component Selections
- Prototype Plan Development
- Prototype Fabrication and Demonstration

Firmware/Software/Computer Tasks:

- Routing Protocol(s) Development
- System Simulation(s) Development
- Prototype Plan Development
- Prototype Fabrication and Demonstration

Composition of Team:

1 or 2 Electrical Engineers & 1 or 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Optical Conversion
- Optical Multiplexing
- Network Routing
- MatLab and Simulink

Computer Engineering Skills Required:

- MatLab and Simulink

- Network Routing Protocol(s) Development

In Phase I (Fall Semester) of the Project

1. The team shall present a Project Plan within the first 30 days of Project start, for approval by the Sponsor's Project POCs, that includes the following:
    a. Interpreted goals
    b. Additional Information required from the Sponsor
    c. Project Schedule
    d. Project Milestones to Track Progress
2. The team shall develop a presentation that will be used to document the following:
    a. Research and findings of RF to Optical technologies and devices including commercially available systems
    b. The system concept model including applicable components' TRL for new technologies and potential risks for maturity of that technology
    c. Approach to use of MATLAB and Simulink for concept modeling
    d. Show the engineering and analysis work used in developing the system concept model including recommended further investigations and analysis
    e. Proposed prototype and test approach

In Phase II (Spring Semester) of the Project

1. Development of detailed models and simulation
2. The team shall continue to develop their presentation with the following:
    a. Additional engineering analysis results
    b. As possible, document the concept build progress and test results
3. Final Deliverable to the Sponsor shall include the following:
    - The team shall present the final presentation, for approval by the Sponsor in electronic format in its native software (i.e., Microsoft Power Point)
    - Analysis models of the concept including projected heat generated
    - Any ancillary hardware/components that the system may require to provide the desired capabilities
    - Recommendation for next steps and further work

The project team shall have weekly correspondence (i.e., email, phone calls) with the Sponsor's Project POCs at a time that is mutually agreed upon. In addition to the weekly correspondence, a monthly virtual, or if possible, in person, meeting will be held to discuss project status.

(see the ELECOMP Capstone Program's website for reports due:

https://web.uri.edu/elecomp-capstone/resources-for-students/course-informationdocumentation

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

Opportunities to reduce platform integration costs and complexities for system integration.

Increasing the use of Fiber Optics improves system performance, increases platform compatibility and enables longer cable paths and platform flexibility. Electric Boat will benefit by increasing our system design and concept development capabilities and enabling next generation systems to be integrated into platforms with manageable impacts.

Understanding the options and limitations of this capability and platform integration dependencies will enable Electric Boat to help guide its development and concept of operation.

Broader Implications of the Best Outcome on the Company's Industry:

In today's shipbuilding environment, shipbuilders must deliver more innovative products and services, reduce costs, improve quality, and shorten time to market, while achieving their targeted return on investment (ROI). To reach these goals, shipbuilders must continually improve how they integrate payloads and systems in order to become more efficient and productive. Innovation must occur in all dimensions—product, process, and collaboration. The broader implication is for the Navy to save dollars on new system integration while improving system performance.