Commercial off the Shelf
Design of a Digital and Analog I/O Acquisition System

ELECOMP Capstone Design Project 2021-2022

https://web.uri.edu/elecomp-capstone/project-details-by-team/gdeb/
(This link will provide some work done on the project last year 2020-2021)

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.

Technical Directors:

Art Viola (URI Class of 1984)
Principal Engineer
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Adam White (URI Class of 2014)
Systems Engineering Supervisor
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Project Motivation:

Utilizing Consumer Off-the-Shelf (COTS) products are an effective approach to reducing cost and schedule while designing systems, particularly for Military applications. COTS allows for a rapid and agile system design at a fraction of the cost of a custom designed product.

For this project, students will investigate alternative technologies to the antiquated Versa Module Europa (VME) computer bus standard. This topic is applicable to both electrical and computer engineering disciplines. Currently, militarized systems are heavily dependent on the circa 1981 standard known as VME. Industry support is rapidly disappearing for this standard with no clear suitable replacement of a similar signal acquisition density.

Anticipated Best Outcome:

Goals:

1. Juxtapose competing technology standards
2. Identify and document technical performance measures (TPM). Examples of which may be cost per input, data acquisition speed, form factor, etc.
3. Down select and purchase hardware of various technologies
4. Construct a prototype system to evaluate the chosen technologies
5. Design and implement a set of hardware and software based tests to evaluate system performance
6. Collect and analyze TPM results
7. Present results to Technical Directors

Deliverables:

1. Project schedule
2. Requirements documents (System Level; Hardware Level; Software Level)
3. System design description and schematic
4. Bill of Materials / budget
5. Prototype units, test equipment, and computer client.
6. Software design documentation and well documented code including code complexity analysis
7. Test procedures
8. Test report with analyzed metrics and clear recommendation

Project Details:

Overall system concept:

System architecture should be comprised of three units. Test equipment, the I/O acquisition unit, and a Windows based client server to receive and display the acquired data. We will leverage the results from the 2020 project that successfully utilized a Raspberry PI system and extend the investigation to other technologies potentially including Virtual Reality integration.

Progress was made in the previous year to establish 3 different circuits focused on the raspberry pi. These circuits can be used moving forward or new circuits can be created with a similar intent of providing both digital and analog signals for data acquisition. An intel NUC was selected as an alternative approach but never used which can be a starting point for the project. Improvements to documentation should be made or new documents created depending on the direction the students want to take the project. Virtual Reality will be a new addition to the project. An interaction between the user and the virtual world will be needed to successfully accomplish the project. The students will be afforded the liberty of deciding how that interaction will occur to satisfy the requirements. All previous year's components will be supplied to the new team for familiarization, reverse engineering, and inclusion on the project moving forward.

Two software programs will be created. One piece of software will be written for installation on the test equipment to provide test vectors ensuring all hardware components are tested in a consistent manner. The second program will be written as the command and status program which will be installed on the server portion of the system architecture.

Project Management will be necessary to establish a budget, schedule, and requirements document.

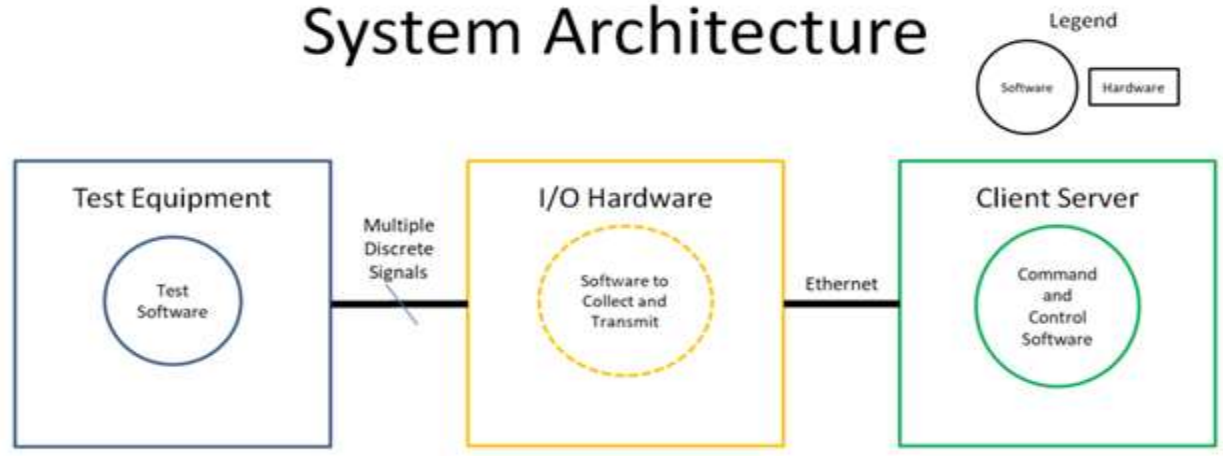
System Engineering will be necessary to establish requirements, determine interfaces, and trade off technologies slated for prototyping. Additionally, System Engineering will be necessary to establish test procedures for validating and verifying requirements and to write a test report.

Project management and System Engineering should be divided amongst the Electrical and Computer engineers as determined by the team of engineering students.

Electrical Engineering Student(s) will be responsible for writing the hardware design document, creating the schematic, developing a bill of materials, assembling the prototype hardware, and participate in the development of technical performance metrics.

Computer Engineering Student(s) will be responsible for developing a software design document, writing two software executables, and participate in the development of technical performance metrics.

Block Diagram:



Composition of Team:

1 or 2 Electrical Engineers & 1 or 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Hardware development leveraging COTS components
- Ability to create schematics
- Critical Thinking Skills
- Strong Organizational Skills
- Project Management understanding

Computer Engineering Skills Required:

- Ability to generate code installing on windows or linux based environment
- Knowledge of TCP/IP communications
- Knowledge of signal acquisition from firmware based software
- Critical Thinking Skills
- Strong Organizational Skills
- Project Management understanding