



Team Controller

**NORTHROP
GRUMMAN**

Weapon System Support Software

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NAU NORTHERN ARIZONA UNIVERSITY

Our Clients & Business

Aerospace & Defense Contractor

- Armament Systems
- \$30 billion in revenue / year

Harlan Mitchell

- Sr. Systems Engineering Manager

Laurel Enstrom

- Principal Systems Engineer



B-2 Spirit Stealth Bomber
Source: Northrop Grumman



RQ-4 Global Hawk
Source: Northrop Grumman



The Problem

Advanced Weapon Systems



Faults with these weapon systems produce a lot of data




NG must dispatch engineers with a tool to collect data



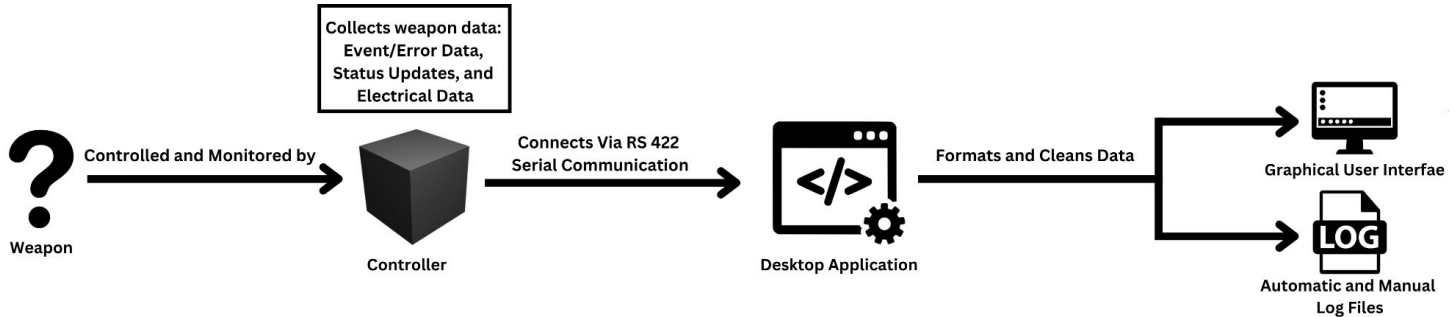
NG will work to resolve the problem, traveling to and from as much as needed

 No end-user diagnostic tool

 Complex, or insignificant data in existing tool

 Expensive to dispatch engineers

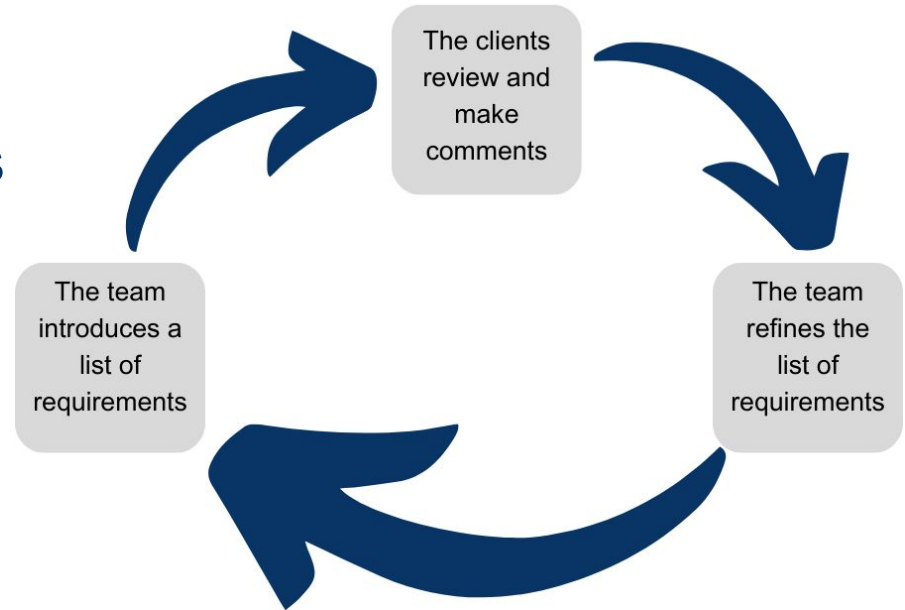
Solution Overview



- Controller will send data to the software application via RS 422 serial communication
- The application will display the data into GUI and log file if selected by user
- The application will be installed by an installer that does not require administrator rights

Key Requirements

- **Key Requirements**
 - Must be able to filter weapon events and errors
 - Must be a desktop application
 - Read data via RS 422 serial communication
 - Must be able to output to logfile



Implementation Overview

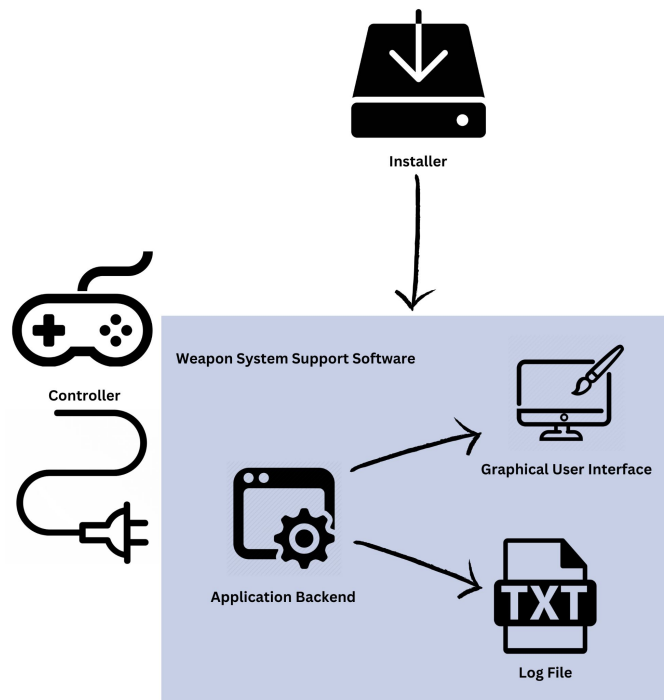
QT Framework

- QT Serial Bus
- QT Serial Port
- QT Graphical User Interface support

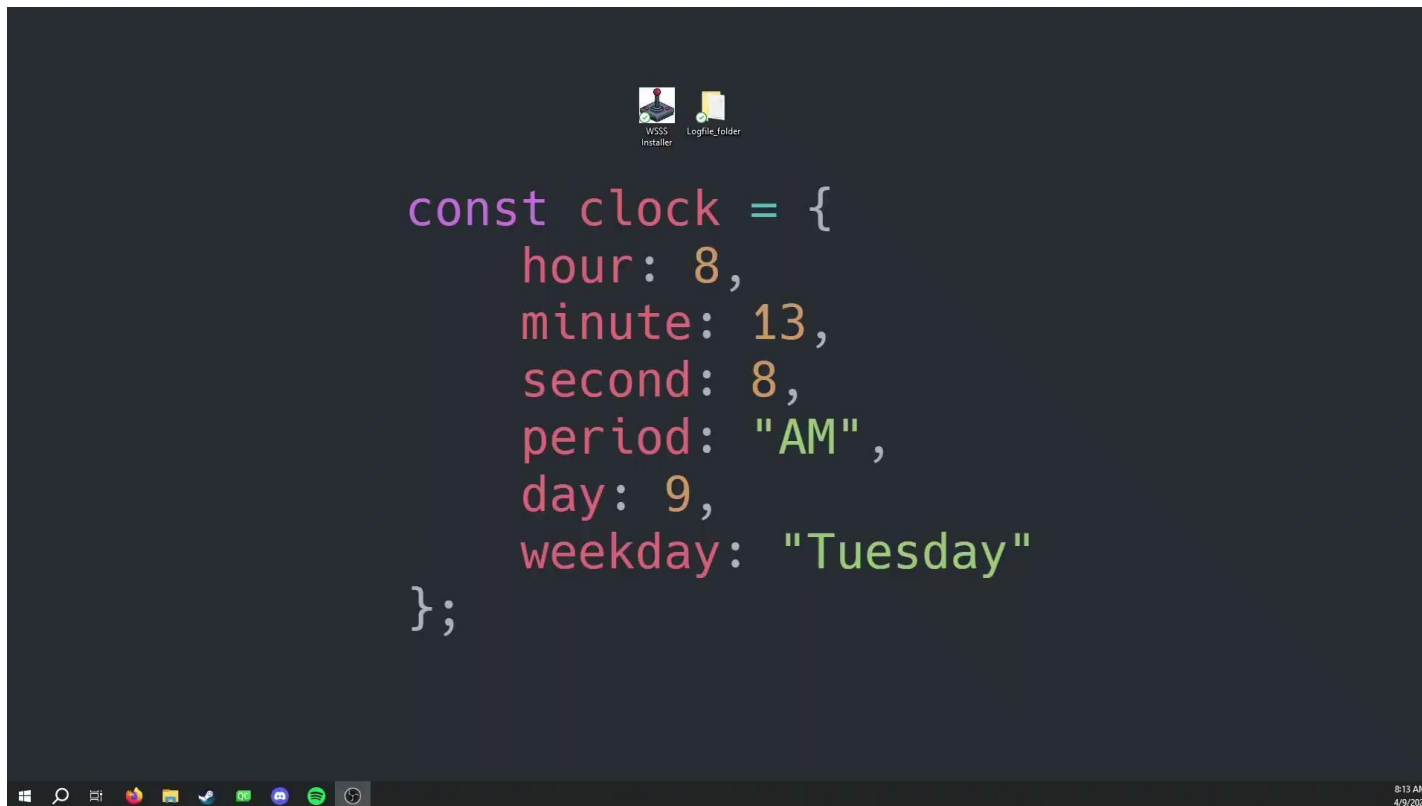


C++ Backend

- OOP based classes
- Dynamic memory management



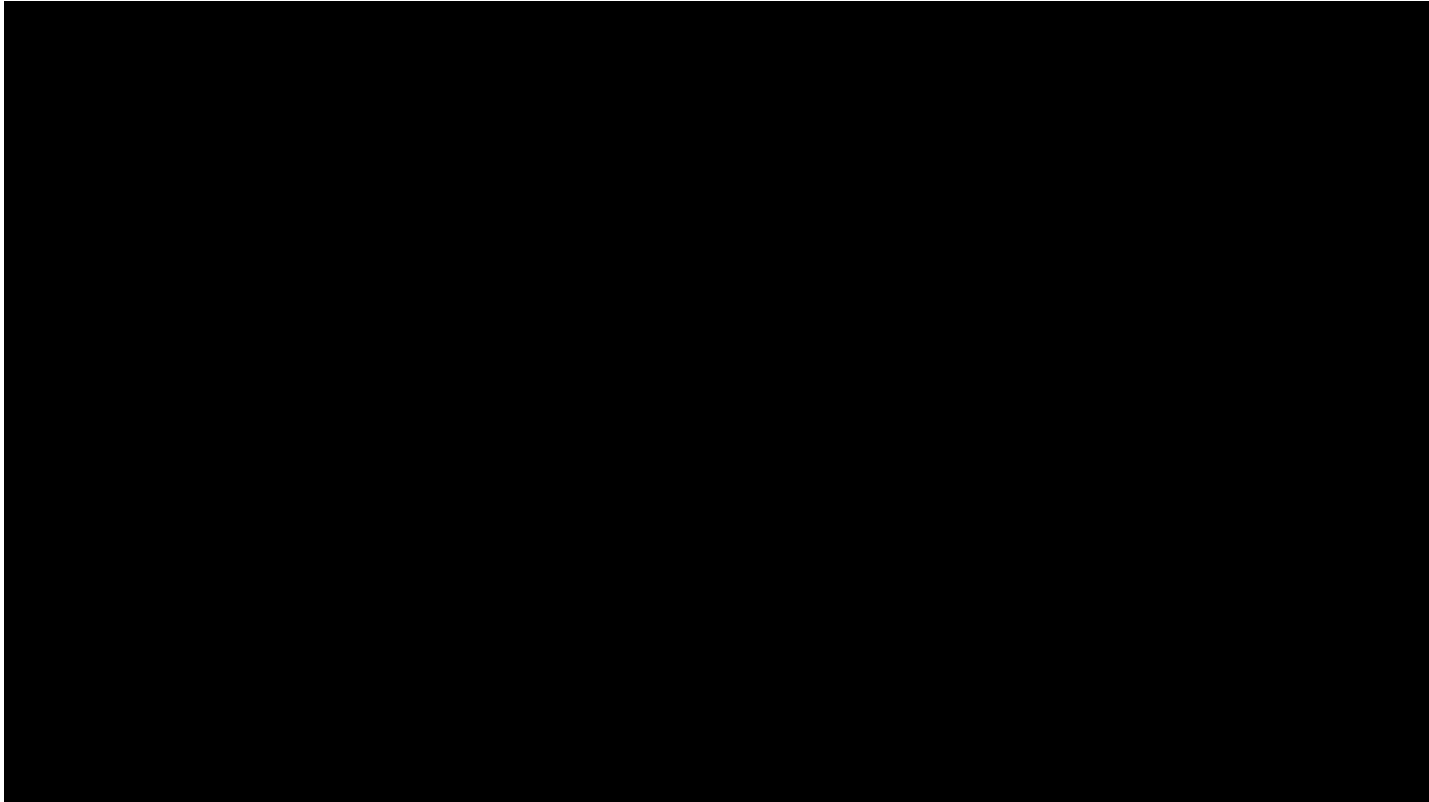
Demonstration: Installer



```
const clock = {  
  hour: 8,  
  minute: 13,  
  second: 8,  
  period: "AM",  
  day: 9,  
  weekday: "Tuesday"  
};
```

8:13 AM
4/9/2024

Demonstration: Connection Page



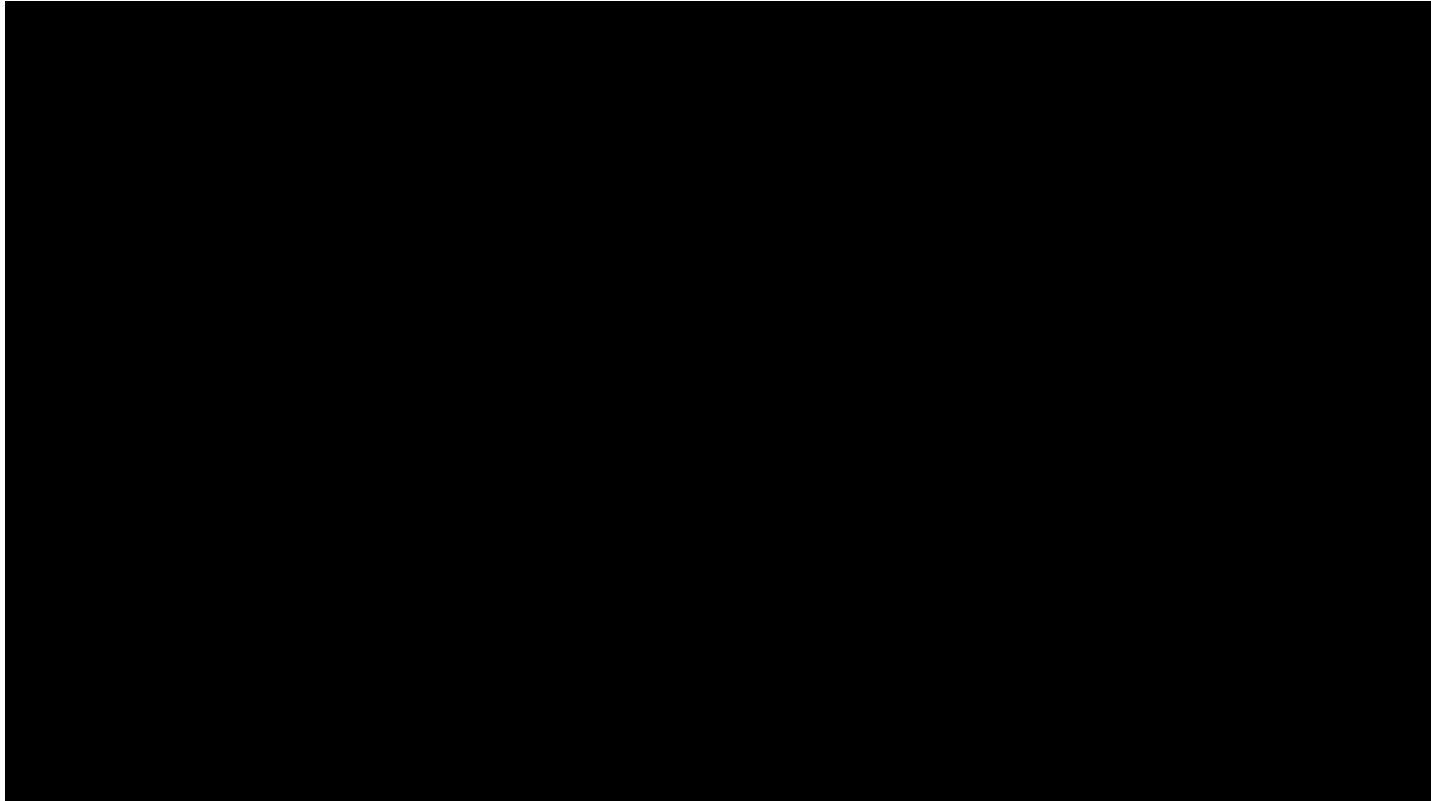
Demonstration: Events Page

The screenshot displays the 'Events' page of the 'Weapon System Support Software'. The interface includes a top navigation bar with tabs for 'Events', 'Status', 'Electrical', 'Developer', and 'Connection'. On the right, there are icons for a notification bell, settings, and a 'Connected' status indicator. The main content area is titled 'Events' and features a search icon and a dropdown menu set to 'Default'. Below this is a list of 12 events, each with an ID, timestamp, and description. The events are color-coded: green for event messages and red for error messages. The error messages are further categorized as 'CLEARED' or 'ACTIVE'. At the bottom of the event list, there is a summary table with four columns: 'Total Events', 'Total Errors', 'Cleared Errors', and 'Active Errors'. Below the summary table are four buttons: 'Open Log File Folder', 'Set Log File Folder', 'Load Events From Log File', and 'Download'. The footer of the application shows the controller version (6.7.2), CRC (2F5A1D3E7B9), elapsed time (00:00:14), and time since the last message (00:00:00).

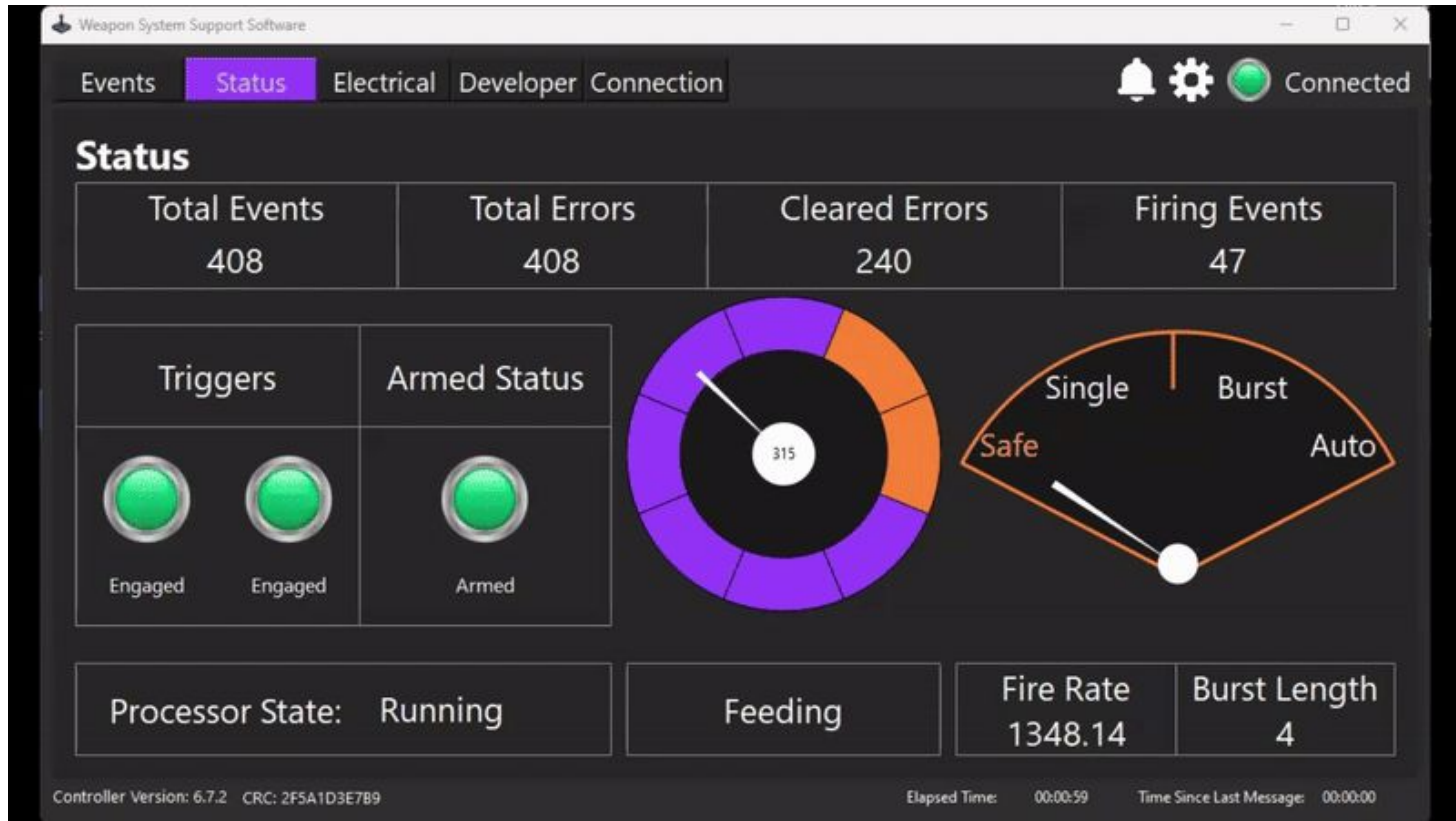
Total Events	Total Errors	Cleared Errors	Active Errors
12	12	9	4

Controller Version: 6.7.2 CRC: 2F5A1D3E7B9 Elapsed Time: 00:00:14 Time Since Last Message: 00:00:00

Demonstration: Events Page



Demonstration: Status Page



Demonstration: Electrical Page

Weapon System Support Software

Events | Status | **Electrical** | Developer | Connection

🔔 ⚙️ 🟢 Connected

Electrical

Fuel Injector	Alternator
Voltage: 27.5 Amps: 1.12	Voltage: 96.5 Amps: 3.33
Voltage Regulator	Servo Motor
Voltage: 19.4 Amps: 3.3	Voltage: 20.2 Amps: 4.9
Rotor 3.22	Piston

Controller Version: 6.7.2 CRC: 2F5A1D3E7B9

Elapsed Time: 00:00:14 Time Since Last Message: 00:00:00

Demonstration: Settings Page

Weapon System Support Software

Events Status Electrical Developer Connection

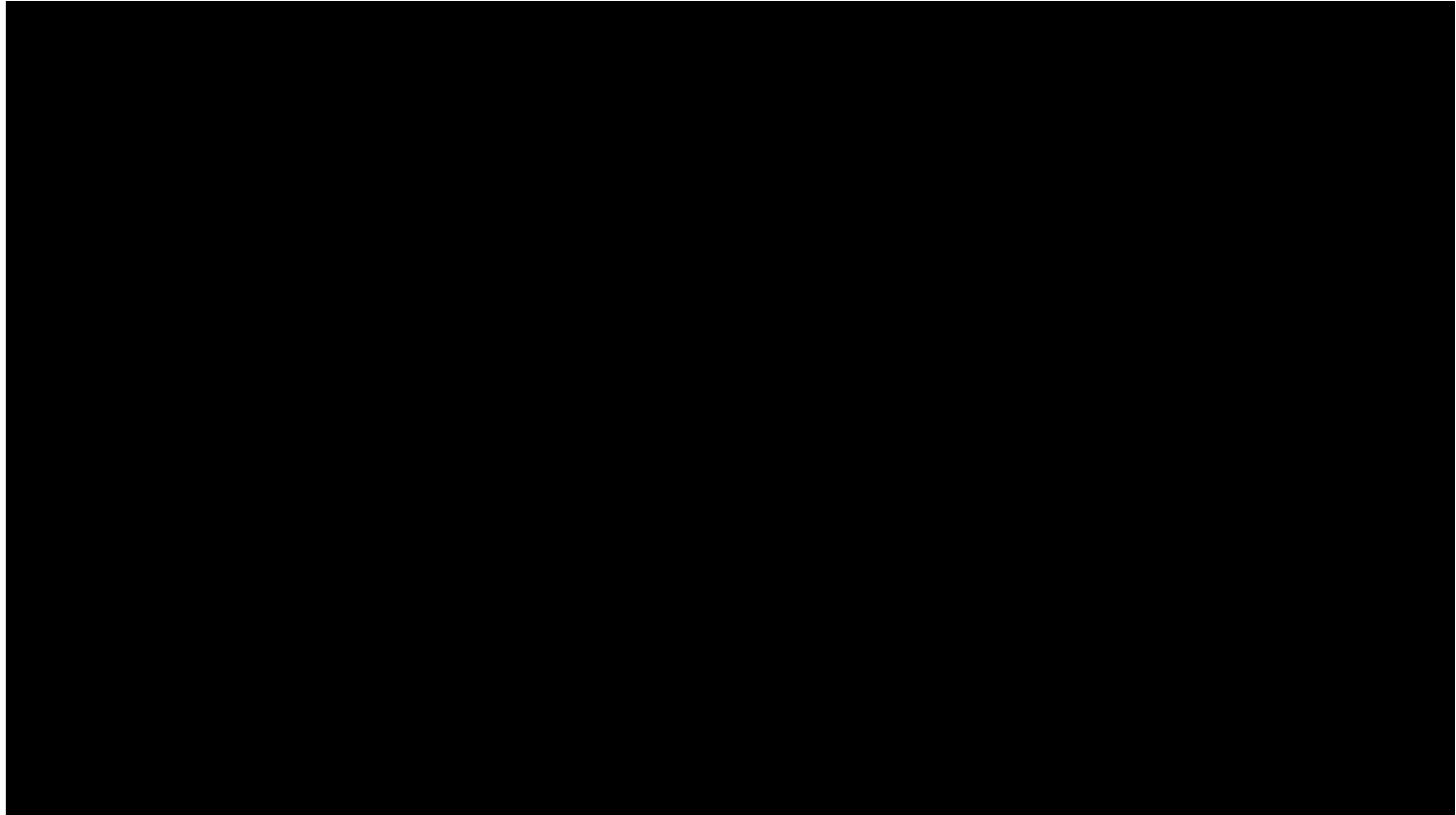
Connected

User Settings

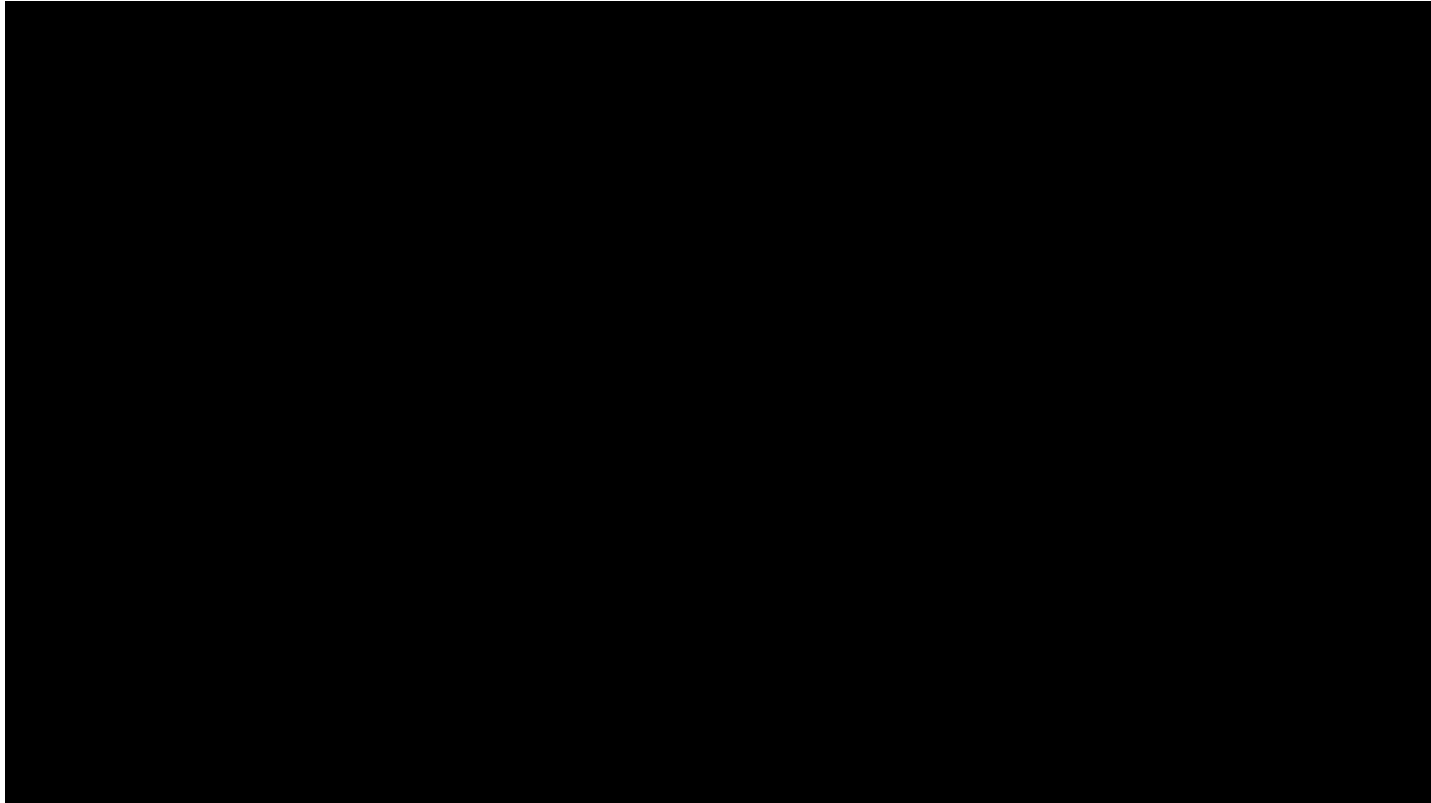
- Colored Events Output
- Advanced Log File
- Notify on Error Cleared
- 10000 Connection Timeout Duration (msec)
- 7 Auto Saved Log File Limit
- RAM Clearing 1500 Max Data Nodes

Controller Version: 6.7.2 CRC: 2F5A1D3E7B9 Elapsed Time: 00:00:06 Time Since Last Message: 00:00:00

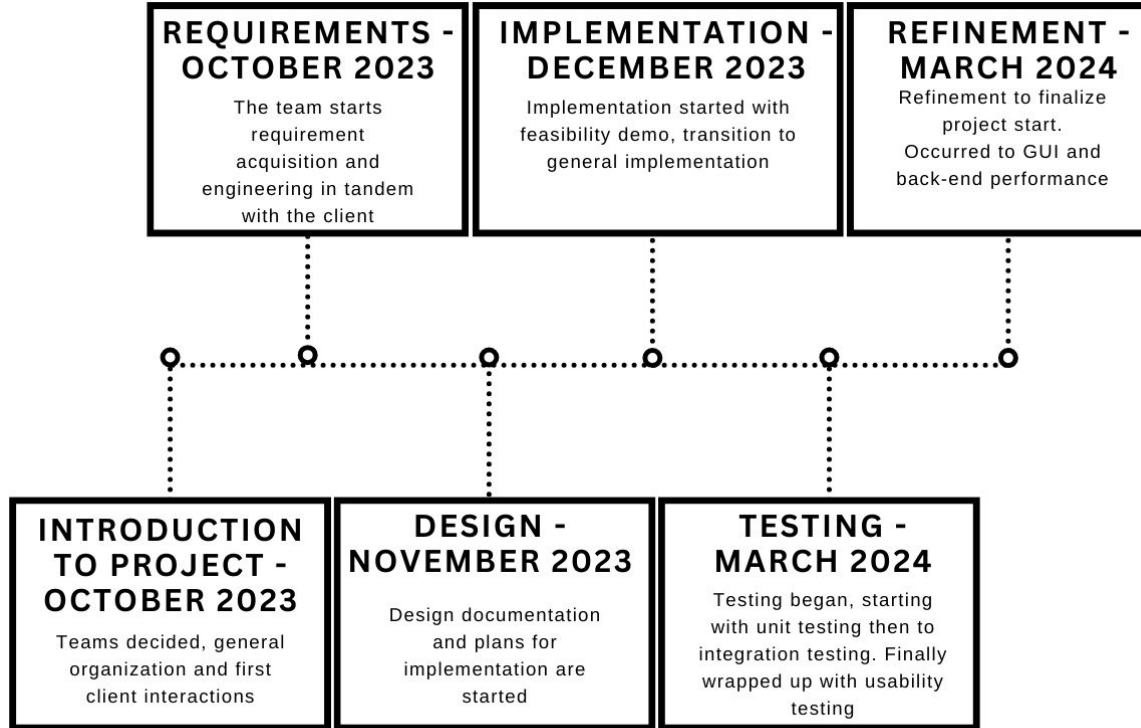
Demonstration: Developer Page



Demonstration: Notifications Page



Project Stage Overview

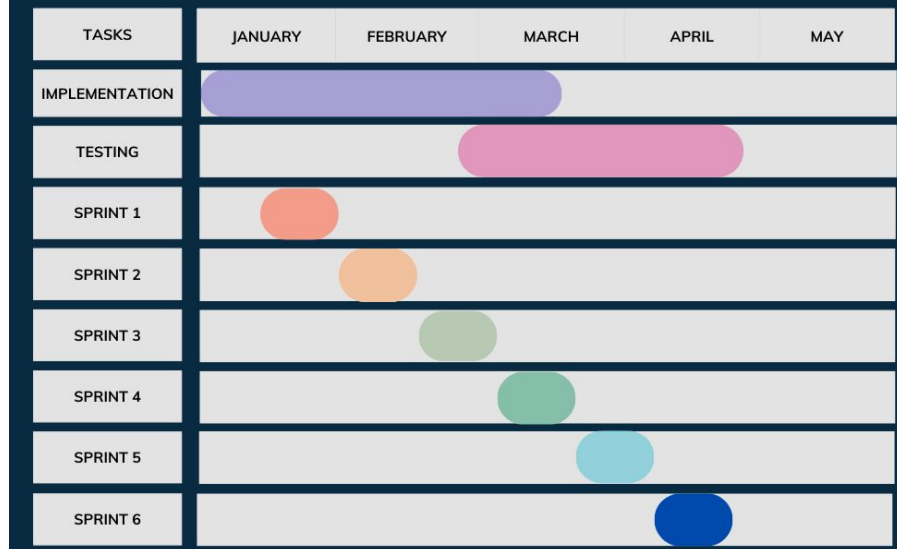


Deliverables Overview

TEAM CONTROLLER
SEMESTER 1 PLAN

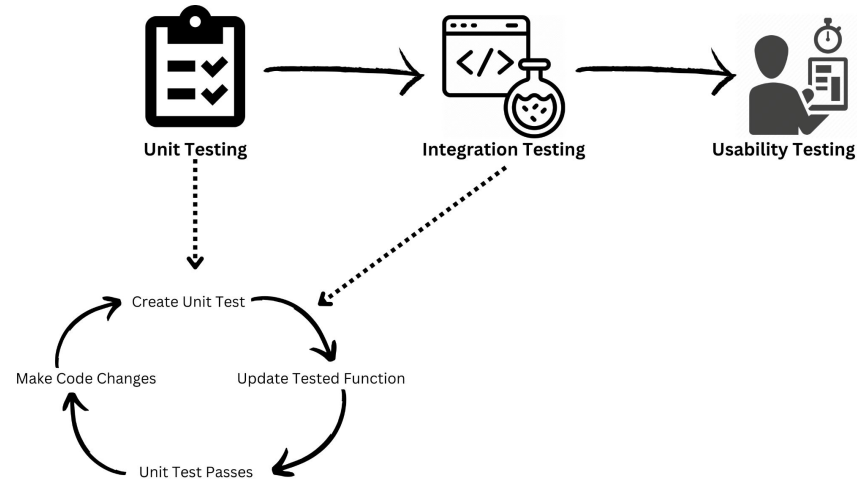


TEAM CONTROLLER
SEMESTER 2 PLAN



Testing Plan

- Linear testing path
 - **Unit testing** - 39 total test cases
 - **Integration test** - 2 total test cases
 - **Usability testing**
- QTest library
 - QCOMPARE()
 - QVERIFY()



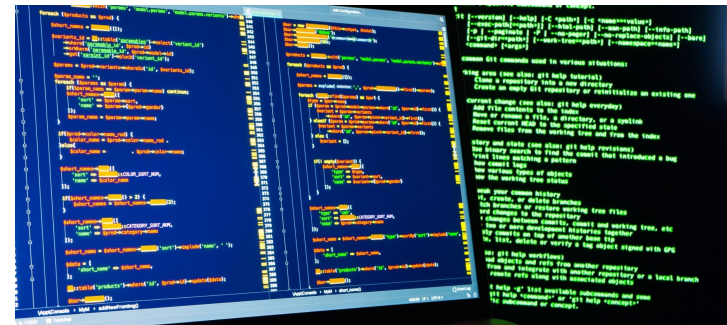
- Testing made robust code segments
- Testing paradigms increased standardization

Challenges and Solutions

Challenge	DESCRIPTION	SOLUTION
Front end custom widgets	Needed a custom feed position and fire mode	Sub classing the QT dial widget
Simulated Serial Communication	Needed to simulate serial connection to test program	QT serial communication libraries
Installer	Needed a working installer with no admin rights	Inno setup
Device to Device serial Communication	Needed a test to simulate the weapon to laptop connection	Laptop to laptop connection via RS422
Testing	Needed to integrate unit tests, integration tests, and usability tests.	QTest library

Future Work

- Deliver our work to Northrop Grumman
 - Software documentation
 - Source code
 - Installer
 - Guides
- Northrop Grumman engineers will continue our work
 - Have access to the actual weapon controller
 - Modify our framework



Conclusion

Our clients are Northrop Grumman and the main issues are:

- Long travel times
- Complex data
- (Lack of) End user tool

Our goal is to provide our clients with an easy to use desktop application so a non-engineer can diagnose weapon data

We met weekly to showcase what has been accomplished with our clients during our two week sprints