Launch Control System / Spaceport Command and Control System

Computer Hardware Internship

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Abstract

National Aeronautics and Space Administration (NASA) is currently developing the next generation launch vehicle that will take American astronauts, from American soil, even further into space. Our project for this semester dealt with the Spaceport Command and Control System (SCCS). SCCS provides a means of communication between the Firing Rooms and ground support equipment for the vehicle on the launch pad. For this internship, we became part of the Computer Systems Hardware Team. This team of engineers handle the computer and networking aspects of SCCS. During this internship, we learned about Linux operating systems and network configuration.

Nomenclature

CAD = Computer Aided Design

CAIDA = Customer Avionics Interface Development and Analysis

CLI = Command Line Interface

DVT = Design Verification Test

EM1 = Exploration Mission 1

FR = Firing Room

HVT = Hardware Verification Test

KDDMS = Kennedy Design and Data Management

KSC = Kennedy Space Center

LCC = Launch Control Center

ML = Mobile Launcher

MPCV = Multipurpose Crew Vehicle

SCCS = Spaceport Command and Control System

SLS = Space Launch System

ICPS = Interim Cryogenic Propulsion Stage

UI = User Interface

ULA = United Launch Alliance

VAB = Vehicle Assembly Building

I. Introduction

SCCS is being developed at the Kennedy Space Center (KSC) in order to perform the checkout and launch of NASA's next launch vehicle, Space Launch System (SLS) rocket, which will use the Interim Cryogenic Propulsion Stage (ICPS) to carry the Multipurpose Crew Vehicle (MPCV) deep into space. This is the focus of our internship; we have been working with the computer hardware and network systems team to support and sustain tasks on SCCS. In order to perform our daily responsibilities, we learned UNIX, cable running techniques, rack construction techniques, and the SCCS network architecture. We installed and configured software on the SCCS computers and network devices. Additionally, we learned the rack architecture and layouts which prepared us to complete our hardware tasks. During one such task, cables were incorrectly wired according to mislabeled drawings. We updated the drawings to reflect the rack after it was wired correctly and submitted the update to the Kennedy Design and Data Management System (KDDMS). After these racks were assembled and powered on, we also assisted with the configuration of these devices.

II. Objective

The objective of this internship was to support the hardware group on tasks within SCCS. These tasks could range from installation to configuring and testing devices. In order to accomplish this objective, we had to apply training and experiences that we learned from our mentor.

III. Experiences

A. SCCS Operating System

Our first part of training was watching and completing training videos on operating systems that are used in SCCS. We had to study them and complete tests at the end of each module. After completing this, we were assigned a project. We downloaded and installed a virtual operating system on our workstations to emulate the SCCS environment. We were only allowed to use our Command Line Interface (CLI) to complete the project. We learned how to set up and configure network interfaces. In order to reduce the effort required by manually setting up these interfaces, we created scripts to automate the process. This is actually one of the most common things that the Hardware team does. Once we were able to finish the project, we continued our network training by learning other specialized operating systems used to configure firewalls and routers.

B. Hardware Systems

We assisted members of the SCCS Hardware Engineering Team with the task of building server and network racks. These racks are necessary to develop and test computer systems that would handle the telemetry data provided by the Customer Avionics Interface Development and Analysis (CAIDA) team. This telemetry data would be used to simulate the command and control of the vehicle at the Launch Pad. Since this would deal with critical data that is instrumental in commanding the Space Launch System (SLS), Interim Cryogenic Propulsion Stage (ICPS), and Multi-Purpose Crew Vehicle (MPCV), there had to be redundancy in the connections in case of a failure. Therefore, every rack we helped construct had to have an identical build as well. When dealing with the server rooms behind the Firing Rooms, it is very important to reference what has previously been performed and to take good technical notes. Referencing design drawings/schematics in KSC's document repository became extremely crucial. Any change to hardware had to be red-lined and updated in the document repository. Furthermore, we documented everything about the devices we installed and would record the exact location and details about the connections. This assisted the drafters when updating the design documents. Along with design documents in the document repository, work orders in the ClearQuest task tracking system were crucial when it came to communicating work that was assigned to and completed by other SCCS employees.

C. Validation Testing

Another project that we were tasked to assist with, was helping to conduct the Hardware Verification Test (HVT) for the vehicle umbilical cables that extend from the Mobile Launcher (ML) to the Firing Room 1 system servers in the Launch Control Center (LCC). These cables

transmit all outgoing and incoming communications for the MPCV, ICPS, and SLS while it sits in the Vehicle Assembly Building (VAB) and at the Launch Pad. There are multiple connections between the vehicle and the servers in the firing room. The lines that run from the ML to the LCC have multiple hardware components between them such as media converters, servers, firewalls, switches, gateways, fiber-taps, and patch panels. To ensure there is a proper connection between the field hardware and firing rooms, tests needed to be performed in order to analyze latency, frame loss, throughput and bit error checks on vehicle umbilical data cables within the network system. After these tests were completed we had to verify that the results met or exceeded the SCCS requirements.

D. Latency Testing

An additional task that we were assigned was to support a NASA client with development hardware inside of the LCC. This task involved testing a simulated umbilical cable for packet loss, average latency, and maximum latency. When this test was first performed, only one time interval was tested. This original test had a packet loss that did not meet their requirements. More data was required for them at this point, 34 time intervals ranging from 0.02 - 0.00005 seconds was requested from the customer. The results were not acceptable toward the smaller time intervals. The next step in the testing was to try a different method of testing the latency. A tool for active measurements of the maximum achievable bandwidth on IP networks was added to our test equipment for further analysis on the hardware. After installing the tool the results were acceptable for the given requirements.

IV. Conclusion

This internship has given us a big look into the world of computer networking and hardware. Before this internship, we were not that familiar with Linux and working with command line interfaces. We are now both considered advanced in Linux and the CLI. We learned how to configure firewalls and update hardware schematics. We are familiar with how equipment racks are planned and how cables are routed between them. This internship has allowed us to understand and experience all the concepts of networking that we learned in our training. This internship has been an amazing experience. We have learned so much in such a short time. We will take this understanding and experience to school and be able to apply it to future jobs. This knowledge is important to know for all engineers.

V. Acknowledgement

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VI. References

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