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Transition of GOES Enterprise Managed System (GEMS) to Operations

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Abstract – NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) provides timely access to global environmental data from satellites and other sources to promote, protect, and enhance the Nation's economy, security, environment, and quality of life. Since 1975, the Geostationary Operational Environmental Satellite (GOES) has been a critical component in providing a complete global weather monitoring system. The GOES Program continues to be paramount to the success of the NESDIS mission.

The Office of Systems Development (OSD) Ground Systems Division (GSD) is in the process of making significant architectural upgrades to the GOES ground system components in an effort to extend the longevity of the system, increase operational reliability, combine functional components into a single architecture, and reduce long-term operations and maintenance (O&M) costs. The GOES Operations Ground Equipment (OGE) and Spacecraft Support Ground System (SSGS) components, supporting the GOES I-M and GOES NOP series of satellites, respectively, must be maintained at least through 2020 after which the existing series of satellites are retired and GOES-R will be the primary GOES constellation. The transition of the OGE to next-generation architecture presents many challenges due to the variety of computing platforms, hardware, operating systems, and legacy applications.

The components that constitute the GOES Operations Ground Equipment (OGE) — including the Sensor Processing System (SPS), Replacement Product Monitor (RPM) Servers and Clients, Orbit and Attitude Tracking System (OATS), SPS Database Servers, and Consolidated Analysis Workstations (CAWS) — have evolved over the years. These various components use different hardware platforms and operating systems, some of which are outdated and in need of major upgrade. To keep these systems running for the foreseeable future and to enable them to handle larger data requirements, NOAA has planned a gradual migration of the OGE components to an enterprise-level, blade-based, and scalable architecture. This will lower operations and maintenance (O&M) costs by taking advantage of emerging hardware and software technologies.

An "As Is" IT assessment of the existing architecture of the GOES OGE was conducted and a roadmap and consolidation strategy to migrate the existing OGE components to a next-generation state-of-the-art architecture was laid out. Employing enterprise management capabilities and economies of scale, an enterprise managed system for the GOES constellation was developed under the acronym of GOES Enterprise Managed System (GEMS).

This paper describes the transition of a next-generation GOES Enterprise Managed System (GEMS) at WCDAS, FCDAS, WBU and NSOF.

Index Terms – GOES, Ground System Data Processing, Blades, Sensor Processing System (SPS), GOES Enterprise Managed System (GEMS)

I. INTRODUCTION

With the advent of newer instrument sensors and increased processing and storage requirements, the need for an orderly migration of the GOES OGE components to a next-generation state-of-the-art architecture that can support the upcoming requirements is paramount. Using a phased approach, NOAA has started to migrate the OGE components to a centralized low-maintenance blade-based architecture. An "As Is" IT assessment of the existing architecture of the GOES OGE was conducted followed by a road-map and consolidation strategy to migrate the existing OGE components to a next-generation state-of-the-art architecture employing enterprise management capabilities and economies of scale. We laid out and built the foundation for this architecture by designing and developing the GOES Enterprise Managed System (GEMS).

The GEMS architecture has tremendous potential for the Ground Systems Division (GSD) and the Continuity of Operations (CONOPS) for the GOES OGE. It significantly reduces ground system life-cycle costs, improves future standardization between component systems, standardizes O&M of OGE

components, provides reliable operations with hot backup and fault-tolerant component systems, enhances IT security, and provides enterprise management capabilities. The intent of the new architecture is to have an enterprise managed system that will host the entire GOES OGE components including the SPS, RPM Servers and Clients, SPS Database Servers, CAWS, and possibly the OATS.

The RPM Server was the first OGE component to be migrated to GEMS. Its role within the OGE is to provide landmark registration, and to monitor and analyze the quality of the image and non-image data broadcast in the GOES VARiable (GVAR) data stream. GEMS units consisting of RPM Servers were successfully deployed at NOAA Satellite Operations Facility (NSOF) and Wallops Command and Data Acquisition Station (WCDAS), and were transitioned to operations in October 2010.

The SPS is the second OGE component that has been migrated to GEMS. Its role within the OGE is to process Imager and Sounder instrument data from the GOES spacecraft and generate a GVAR-formatted data stream for real-time transmission back to the GOES spacecraft. There are currently 10 operational SPS units at NOAA facilities: seven at WCDAS, two at Fairbanks Command and Data Acquisition Station (FCDAS), and one at Wallops Backup Unit (WBU). Next-generation SPS units based on the GEMS architecture are currently deployed at WCDAS and have undergone parallel operations and regression testing with the goal of transitioning to operations in Spring of 2011.

The latest OGE component that is currently being migrated to GEMS is the Consolidated Analysis Workstation (CAWS). Currently, CAWS is installed on a single platform and hosts several OGE applications, including (1) RPM client used for real-time and archive data, landmarks, and image navigation and registration analysis, (2) Star Sense Data Archive (SSDA) client used for long-term archiving and analysis of imager and sounder star sense data, (3) SPS Modernized History Browser (MHBR) client used for display and analysis of historical data archived on the SPS, and (4) Dynamic Interactive Diagnostic (DID) software used for plotting and analysis of telemetry data received from the Multi-use Data Link (MDL) Receive System & Server (MRS&S) within the Spacecraft Support Ground System (SSGS) environment.

II. SYSTEM ARCHITECTURE

The GEMS is an enterprise architecture based on blade technology. It consolidates all system components into a single compact platform where electronic components, power, and cooling can be shared. This configuration allows a more unified, centralized, and efficient management and monitoring of the entire enterprise infrastructure. Various hardware elements such as hard disks, network switches, power supplies, and cooling fans have built-in redundancy that ensures uninterrupted operation and low maintenance costs. Most GEMS components are hot-pluggable, allowing their removal and installation during operation, which eliminates system downtime for parts replacement and maintenance. Advanced diagnostics can alert users of impending failure, allowing efficient and timely preventive or restorative action.

The GEMS provides enterprise data archiving and storage through its integrated Storage Area Network (SAN) implementation. In addition to SAN, a suite of enterprise-wide functions including system and network monitoring, rapid imaging and provisioning, system-wide security scanning, and two-factor authentication is provided. The following is a description of some of the main capabilities provided by the GEMS architecture:

Virtualization

The GEMS architecture uses virtualization to reduce costs by consolidating old, expensive, underutilized systems. Two virtualization technologies are used in the GEMS architecture – Solaris Zones for the SPS, and VMware ESXI Hypervisor for CAWS workstations.

Oracle Solaris Zones is a virtualization technology that is built into the Solaris-10 operating system. It is used to virtualize operating system services and provide an isolated and secure environment for hosting and running applications.

There are two types of zones – global and non-global, with each non-global zone abstracting a virtualized operating system environment created within a single instance of the Solaris Operating System provided by the global zone. Only one global zone can exist, and is the operating system used to boot the system hardware. Each non-global zone can be viewed as a separate virtual machine as it provides an abstract layer separating applications from the physical attributes of the machine on which they are deployed. Processes in a non-global zone are isolated from processes in other zones. Zones can be used on any machine that is supported on the Solaris-10 release.

Solaris Zones are used to consolidate SPS servers within the GEMS architecture. The benefits of using Solaris Zones within GEMS are:

- System resources such as CPU and network bandwidth can be shared between zones;
- Inter-zone communication occurs though standard network communication calls, as they would in physically separated servers;
- Application failure in a zone does not effect other zones;
- Each non-global zone has its own virtual identity, file system, devices, network, operating system resources, and security;
- Enhances maintenance of security patches, as only the global zone needs to be patched;
- Allows for consolidation of SPS servers, from three servers and one workstation, to two physical server blades;

- No changes are required to SPS software architecture, as each zone is a virtual machine and is isolated from other zones; and
- No changes are required to SPS operations, as all SPS components still exist as virtual machines.

VMware ESXi Hypervisor is another virtualization technology that is used within the GEMS architecture to consolidate applications into fewer servers, thus reducing hardware, power, cooling and administration costs.

VMware ESXI Hypervisor will be used to consolidate multiple CAWS workstations within GEMS. The benefits of using VMware ESXi are:

- Ability to run multiple applications in isolation on a single server;
- Backup and recovery applications can be performed more easily; and
- Provides provisions to migrate virtual machines to other physical servers.

Sun Ray Thin Clients

The GEMS architecture uses Oracle Sun Ray Thin Clients for displaying server-hosted virtual desktops. Oracle's thin client architecture consists of two main components - Sun Ray Thin Clients and Sun Ray Server Software.

Sun Ray Thin Clients are simple, low-cost and low-power devices that require minimal administration. They contain no resident operating system or applications, and are true thin clients. Because there are no mechanical devices inside a Sun Ray thin client, the device is highly reliable and inexpensive. They do not have any resident operating system and are therefore immune to viruses and service attacks, thus providing enhanced IT security. Sun Ray Thin Clients are compatible with Sun monitors and standard Video Graphics Array (VGA) or Digital Video Interface (DVI) monitors, thereby enabling NOAA to leverage existing monitors at NOAA facilities.

Sun Ray Server Software is a secure and cost-effective way to deliver a rich virtual desktop experience for Sun Ray Thin Clients. It provides access to server-hosted virtual desktops from any location, dramatically reducing the complexity and operational costs incurred in traditional stand-alone workstation deployments.

The benefits of using Sun Ray Thin Clients and Sun Ray Server Software within GEMS are:

- Significantly reduces the time and cost associated with the installation, administration, and maintenance of workstations for the SPS and CAWS;
- Sun Ray Thin Clients are plug-and-play devices, easy to configure, inexpensive, and highly reliable;
- Sun Ray Thin Clients are true thin clients where all computing and administration takes place on the server;
- Provides enhanced IT security – no data resides on the client and access to removable media can be centrally restricted as required;
- Users can move from any Sun Ray Thin Client to another, and resume their workstation sessions with instant access; and
- Supports smart card implementation, where a user can simply insert the smart card into any available Sun Ray Thin Client, and the Sun Ray technology provides instantaneous access to existing/new sessions.

III. IMPLEMENTATION

A. Sensor Processing System (SPS)

The SPS consists of four main components: the GOES Ingest Unit (GIU), the GOES Resampling Unit (GSU), the GOES Ranging Unit (GRU), and the Androgynous Machine Interface (AMI). The GIU ingests raw Imager and Sounder data from the spacecraft and performs low-level processing of the data that is sent to the GRU. For a spacecraft orbiting at high-orbit inclination, the data from the GIU is sent to the GSU (before it is sent to the GRU), where it is resampled and remapped to compensate for errors induced by the higher orbit inclination that cannot be corrected onboard the spacecraft. The data from the GSU is then passed on to the GRU. The GRU formats it into the GVAR data stream and uplinks it to the GOES spacecraft for rebroadcast to GVAR users. The GRU also performs ranging for the GOES satellite.

Each legacy SPS consists of three servers - one each for the GIU, GSU and GRU, and one workstation for the AMI, one GOES Gear Box (GGB), one Terminal Server, one Network Switch and Power Controller. There are ten operational SPS racks at NOAA facilities: seven at WCDAS, two at FCDAS, and one at WBU.

The SPS is integrated in the GEMS architecture using virtualization and thin-client technologies. Virtualization using Solaris zones is used to consolidate AMI, GIU, GSU, and GRU to run on two server blades, thus enabling multiple SPS servers and their associated components to reside in a single rack. In this design, the GEMS blade chassis houses all blades and network components at the bottom of the rack. The rest of the GEMS rack houses all other hardware components, such as the GOES Gear Box, Time Servers, and IOLAN Servers. Each SPS requires two server blades – the first server blade hosts the AMI and GIU in Solaris zones, while the second server blade hosts the GSU and GRU in Solaris zones. Each server blade is also associated with two Expansion blades for the Engineering Design team (EDT) cards used by the GIU and the GRU. Figure 1 illustrates the consolidation of a single SPS into GEMS. The GEMS hardware configuration for SPS includes many redundant components to ensure continuity of operations in case of hardware failure of a component within GEMS. Each GEMS SPS rack for WCDAS consists of the following components:

- HP c7000 Blade Chassis,

- 3 SPS Servers (2 server blades per SPS),
- Blade Expansion Modules for EDT cards (2 per SPS),
- 6 Redundant Power Supply Modules,
- 10 Redundant Fans,
- 2 Redundant Onboard Administrators with KVM capability for administration and monitoring,
- 2 CISCO 3020 Network Switches,
- Management Node,
- External KVM Switch (one per rack),
- Grounding Bar and Patch panels,

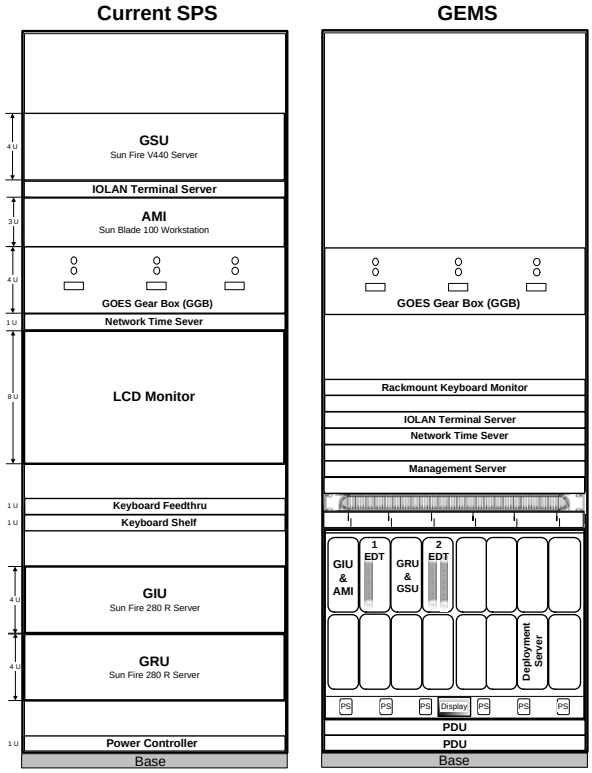

Figure 1. SPS Consolidation into GEMS. The GEMS hardware and rack layout offers considerably more space for later expansion and the capability to host multiple SPSs within a single rack of equipment.

At WCDAS, migrating the SPS to GEMS will consolidate all of the existing seven operational SPS units and one additional SPS into three separate GEMS-SPS racks. This will greatly reduce the space requirement from eight racks to three racks while providing the same SPS functionality with significantly enhanced reliability, maintainability, and scalability. This configuration also provides an additional SPS for testing software deployments and system/security changes at WCDAS. Figure 2 illustrates the hardware layout of the three GEMS-SPS racks at WCDAS.

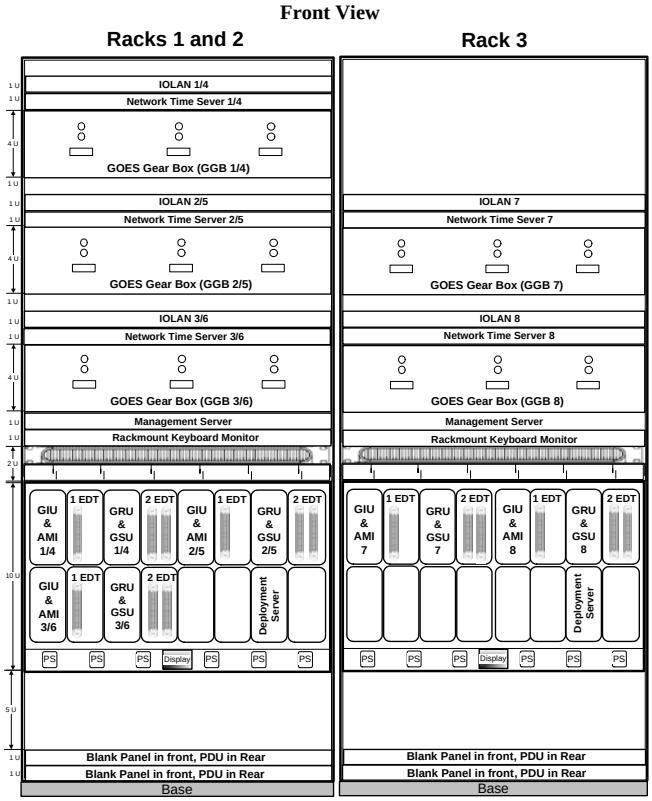

Figure 2. Hardware Layout for Three SPS GEMS Racks at WCDAS

The AMI provides a user interface for operators to view and control SPS operations on the GIU, GSU, and GRU. In the GEMS architecture, AMI is consolidated to reside on a virtual zone (with the GIU) on a server blade, and is remotely accessed using a Thin Client. Each SPS has a dedicated Thin Client with a video monitor, a mouse, a keyboard, speakers, and a network interface to connect to the AMI virtual zone located on a blade in the GEMS-SPS rack. All processing of data for the AMI is done on the server blade hosting the AMI application software, then relayed to the Thin Clients over the network. User interactions, such as mouse clicks and keystrokes on the Thin Clients, are also relayed back to the server blade over the network. For users and operators, using Thin Clients to access the AMI on an SPS perfectly compliments the consolidation of multiple SPS servers in a single GEMS rack, as illustrated in Figure 3.

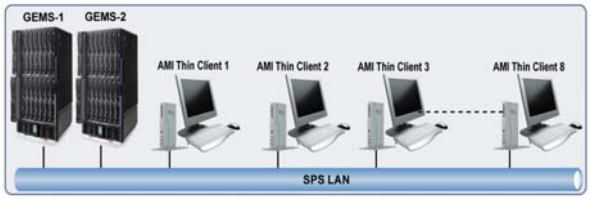

Figure 3. Use of Thin Clients to Access AMI on GEMS at WCDAS.

The architecture of the GEMS-SPS at FCDAS and WBU is similar to WCDAS, with the exception of the blade

chassis. Since there are fewer SPS units, a HP c3000 enclosure is used to host the SPS server blades. Each GEMS-SPS rack for FCDAS and WBU consists of the following components:

- HP c3000 Blade Chassis,
- 1 or 2 SPS Servers (2 server blades per SPS),
- Blade Expansion Modules for EDT cards (2 per SPS),
- 4 Redundant Power Supply Modules,
- 6 Redundant Fans,
- 2 Redundant Onboard Administrators with KVM capability,
- 1 CISCO 3020 Network Switch,
- External KVM Switch (one per rack), and
- Grounding Bar and Patch panels.

B. Rehosted Product Monitor (RPM) Server

The RPM Server ingests and archives GVAR data generated by the SPS for data quality monitoring. It provides landmark registration data to OATS for Orbit and Attitude (O&A) determination. It also provides Visible Normalization and IR co-registration data for the SPS. The legacy RPM software application used the Solaris-9 operating system and was hosted on an UltraSPARC Sun Fire v480 server with a PCI card for data ingest.

The RPM Server was migrated into the GEMS architecture by porting the RPM server software to the x86 architecture on Solaris-10 operating system. Each legacy RPM server was replaced with a single server blade and an expansion blade to hold the PCI card. Migrating the RPM servers to a blade-based x86 architecture provided the following benefits:

- Significantly lowered the life-cycle costs;
- x86 processors are based on a standard and widely used processor, therefore available at much lower cost than SPARC-based systems;
- lower cost for operations, maintenance, and replacement parts;
- Compatibility with a wide variety of current and future PCI I/O cards;
- Support for a wider selection of blade systems;
- Support for multi-CPU, multi-core architecture;
- Proven compatibility with Sun Solaris-10 operating system;
- Hardware assisted virtualization, for example through AMD Hypervisor; and
- Energy efficient design with reduced cooling costs.

Each GEMS-RPM rack delivered to WCDAS and NSOF consisted of the following components:

- Five operational RPM servers based on dual-CPU, dual-core AMD Opteron processors;
- One deployment server for imaging and provisioning purposes;
- One GOES Backup Solution (GBS) server for short-term and long-term data backup and recovery;
- 8 TB of Storage Area Network (SAN) for short-term online data storage;
- Two Tape libraries for long-term off-line data storage;
- One management server connected to a LCD monitor;
- Fibre channel switches for end-to-end connectivity between the blades and the SAN; and
- Ethernet CISCO switches.

Figure 4 illustrates the layout of the GEMS-RPM racks at WCDAS and NSOF.

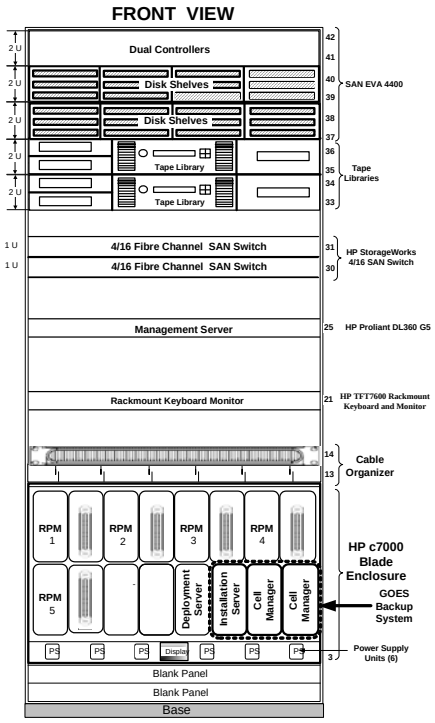

Figure 4. GEMS Hardware Configuration – Front View

C. Consolidated Analysis Workstations (CAWS)

The CAWS is a single platform that hosts multiple analysis software applications, associated with the OGE, within the same workstation. Software applications hosted on a CAWS are:

- **RPM Client –** Provides real-time and archived image display of the GOES VARiable (GVAR) as

well as analytical tools for Landmarking and Image Navigation and Registration (INR) through the RPM server;

- **SPS MHBR –** Provides a user interface to select and analyze historical data archived on the SPS;
- **Grid Database Utility –** Provides an offline tool to create and edit grid databases for the SPS; and
- **Star Sense Data Archive (SSDA) –** Provides long-term archiving of the imager and sounder star sense data.

The legacy CAWS is an UltraPARC Sun Blade 1500 workstation and uses the Solaris-10 operating system. Oracle has discontinued SPARC-based workstations since July 2008, effectively ending the production of workstations with an UltraSPARC processor.

The CAWS is integrated into GEMS using a combination of virtualization and Thin Client technologies. As x86/Opteron processors are significantly faster than SPARC-based processors, virtualization using VMware is used to consolidate multiple CAWS workstations onto a smaller number of server blades, thereby providing NOAA with greater manageability, better use of resources, tremendous cost savings, and lower total cost of ownership.

Virtualization using VMware provides the perfect platform to host the CAWS applications for the following reasons:

- COTS virtualization software is inexpensive and easy to manage from a centralized console;
- Allows consolidation of multiple CAWS workstations onto a single server blade;
- Allows configuration and testing of new software and patches in an isolated *sandbox* environment and improves software distribution. Mission-critical applications are unaffected during operating system upgrades and migrations;
- Provides significantly enhanced administrative capabilities through centralized management. A single image containing the operating system and application software can be deployed across all CAWS virtualized servers, thus enforcing consistency;
- Provides the same look and feel as the existing CAWS workstations and is transparent to users;
- Provides centralized data and application for greater IT security.

Thin Client technology is used to allow users to remotely access virtual machines on the server blades. A Thin Client simply provides a user interface to a remote server blade where the main processing activities take place. For the CAWS migration, Oracle's Sun Ray Thin Client technology is used to allow users to remotely access the virtualized CAWS workstations on server blades in GEMS. The VMware virtualization approach is fully compatible with the Sun Ray Thin Client solution.

As the CAWS is migrated to blades using x86/Opteron processors, all software applications hosted on it are being migrated to the x86 architecture. This includes the port to x86 version of PV-Wave, a commercially available third-party software used to support scientific data analysis visualization. Figure 5 shows the hardware and software architecture for the virtualized CAWS workstations within a single blade-based server.

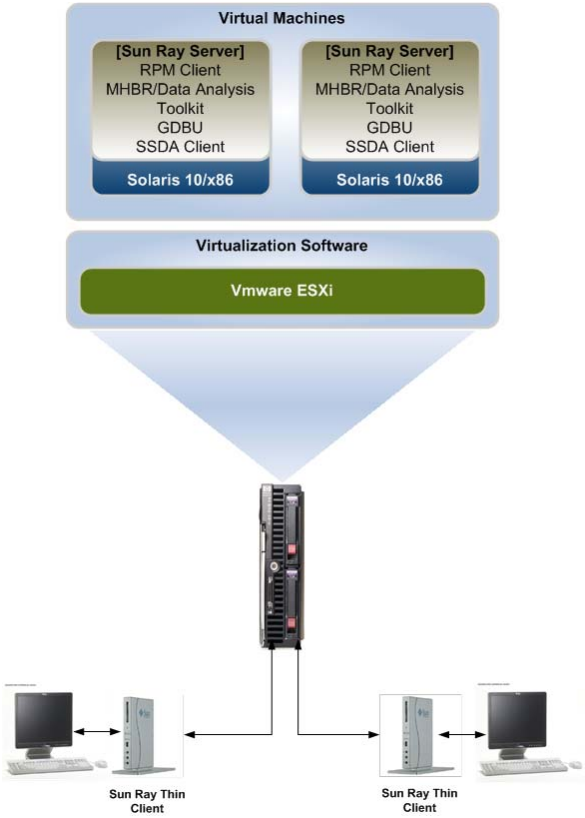

Figure 5. Hardware and Software Architecture of Virtualized CAWS Workstations Hosted Within the GEMS Architecture.

To integrate CAWS in GEMS, 14 CAWS workstations will be consolidated into 5 server blades at NSOF, 5 CAWS workstations at WCDAS will be consolidated into 3 servers, 2 CAWS workstation at FCDAS will be consolidated into 1 server, and the single CAWS workstation at WBU will be replaced with a blade server.

D. GEMS Enterprise Management

Data Archiving and Storage

The RPM GEMS provides enterprise data archiving and storage through its integrated Storage Area Network (SAN) implementation. In addition to SAN, data can also be transferred offline to a tape library for long-term storage. A GOES Backup System (GBS) installed in the same enclosure as the RPM servers allows the backup of OGE components in order to protect them against data loss in case of component failure, and provides total system recovery.. The SAN is shared by the RPM GEMS and the GBS.

System and Network Monitoring

The GEMS architecture offers several advantages including centralized management and monitoring of the entire rack through the onboard administrator and the management server. The onboard administrator is used to configure, manage, and monitor all enclosure components. It constantly monitors the health status of blade bays, interconnect bays, and power and thermal devices, and reports all abnormal configuration or operating conditions.

The role of the management server is to provide a single point of entry for management of GEMS components both inside and outside the blade enclosure. This is also where various GEMS applications are installed, including the deployment console (management software for imaging and provisioning server applications, operating systems, and security patching), Command View Enterprise Virtual Array (EVA) (management software to manage SAN access and configuration), and PatchLink Scan (vulnerability scanning software to assess the vulnerabilities on servers and network devices).

Imaging and Rapid Deployment

One of the advantages of the GEMS architecture is the consolidation of several server blades into a single blade enclosure. An HP c7000 enclosure has space for 16 half-height blade bays that can be populated with server blades. In addition, a large number of enclosures can be linked. A manual installation of operating systems and server applications on a large number of server blades can be time-consuming and may be prone to installation errors. A more efficient solution that is available on GEMS is the process of imaging and rapid deployment. An image that includes the operating system and software applications is first created on a single server. This image is then deployed to one or more servers on the same enclosure or other inked enclosures. A deployment server installed in the blade enclosure is used for the deployment of the image to other servers. Each of the GEMS RPM and SPS racks at WCDAS and NSOF has one deployment sever installed in one of the server blade bays. It is used to deploy the image of a working RPM or SPS server onto as many other server blades as necessary.

System-wide IT Security Scanning

IT security for GOES OGE components is a critical concern for NOAA. OGE hardware and software systems must meet the Federal Information Security Management Act (FISMA) and National Institute of Standards and Technology (NIST) requirements for High-Impact Security systems. Enhanced IT security is incorporated into the planning and design of all new and transitioned systems to make them fully compliant with all IT security requirements.

Integrated security scanning software including Lumension PatchLink Scan for network-based threat management and the Nessus vulnerability scanner was incorporated into GEMS. This enables rapid, adaptive, and comprehensive security vulnerability scanning of all network devices including servers, switches, and storage devices. A reporting capability provides confirmation of security policy and regulatory compliance. The scanning is performed from a single server – the management server – allowing the scans of all servers and clients on the network.

Two – Factor Authentication

The GEMS architecture provides an additional layer of authentication to ensure that all components are secure from unauthorized access. A two-factor authentication mechanism can be implemented on all components that are installed in the blade enclosure. In addition to the login name and password, access to the onboard administrator, server blades, and other components can be configured to require a second layer of authentication, which can be a digital or physical key.

GOES Backup System (GBS)

A GOES Backup System (GBS) for the GOES ground system components has been successfully developed, tested, and deployed at four different NOAA locations. It is used for backing up and restoring application data, configuration files, system files, and operating systems on all unique machines that make up the GOES Operations Ground Equipment (OGE) and Spacecraft Support Ground System (SSGS). The GBS is a fully managed and scalable system implemented as part of GEMS. This system is currently deployed at WCDAS and NSOF, where it is installed on the GEMS RPM racks, and at WBU and FCDAS. GBS can be used to automatically and on a regular schedule back up all data, such as the operating system, system configuration files, system images, database files, and other system specific files on any of the OGE ground system components. The main functions of the GBS include:

- Provide backup and recovery solution for the GOES ground system components;
- Provide short-term and long-term storage for online backup and restore;
- Meet NOAA IT security and Continuity of Operations (COOP) requirements; and
- Provide scalable and adaptable solution to allow for future growth and expandability.

The GBS provides data protection for a variety of platforms, including Unix, Linux, and Windows operating systems. The user can perform manual backups or set up periodic or calendar-based backup schedules to perform automatic, unattended backups for any client of the GOES network. The GBS architecture consists of two clustered HP Blade servers running Microsoft Windows Server 2008 Enterprise operating system. In addition to Ethernet connections, each server connects to the Storage Area Network (SAN) via a Fibre Channel switch. A Tape Library is also connected to the Fibre Channel switch. A Red Hat Linux server is used for the installation of GBS client software for all Unix clients.

IV. TRANSITION TO OPERATIONS

GEMS-RPM servers were transitioned to operations in November 2010. Two GEMS racks were deployed - one at NSOF and the other at WCDAS. Each rack hosts 5 RPM servers for processing and archiving GVAR in real-time.

GEMS-SPS servers have been deployed at WCDAS. GEMS-SPS includes three racks at WCDAS (for eight SPS servers), one rack for FCDAS (for a single SPS server), and one for WBU (for one SPS server). A planned transition of operations from legacy SPSs to GEMS-SPS will occur one SPS at a time, as legacy hardware components such as the GOES Gear Box, Time Server and IOLAN will be reused. The transition of GEMS-SPS to operations is expected to start in Spring of 2011.

GEMS-CAWS servers are currently being developed and integration level testing is scheduled to start in June 2011. The GEMS-CAWS deployment includes the replacement of 14 CAWS workstations with 5 server blades at NSOF; replacement of 5 CAWS workstations with 3 server blades at WCDAS; replacement of two CAWS workstations with one server blade at FCDAS; and replacement of one CAWS with one server blade at WBU. The plan is to reuse the empty slots in the chassis of the GEMS-RPM and GEMS-SPS racks at NSOF, WCDAS, FCDAS and WBU.

V. CONCLUSION AND FUTURE WORK

Using a phased approach, NOAA has started to migrate the OGE components to a centralized low-maintenance blade-based architecture, that is, the GOES Enterprise Managed System (GEMS). In this paper, we have described the GEMS architecture, its implementation for the Sensor Processing System (SPS), the Relacement Product Monitor (RPM), the Consolidated Analysis Workstations (CAWS), and the transition of the above components to an operational environment at WCDAS, FCDAS, WBU, and NSOF.

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