# CHALLENGE 2

Virtual Design Master – Season 2

Massey, Sean
seanm@seanmassey.net
@seanpmassey

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# 1 Executive Summary

Despite the efforts of Mr. Billionaire, the zombie outbreak has returned. The sudden appearance of a resurgent zombie horde has shattered resistance in many formerly secure areas. The position of the survivors on Earth has become untenable, and Project Galactica has been implemented to evacuate the survivors to a new home on Mars. The first production facilities for evacuation ships are coming online, and the next step is to prepare the infrastructure of Moonbase Alpha.

Mr. Billionaire has tasked the IT Infrastructure Team with scaling down the infrastructure implemented at the Cape Canaveral Pilot Production Facility so it can be used on Moonbase Alpha. This infrastructure will serve two purposes – to act as a test-bed system for developers as they are evacuated in the first waves and to potentially run a small-scale production facility for the colony ships that will transport humanity to Mars.

The workload will be similar to the workload deployed in the planetside production facilities. Unfortunately, there is a significant space constraint on both the launch vehicles and at Moonbase Alpha, and the deployed infrastructure must fit in 21 rack units.

# 2 Scope

The items that are in scope for this project are:

a. Design and implement the physical infrastructure for Moonbase Alpha utilizing the same components as the spacecraft production facilities
b. Implement IPv6 networking for Moonbase Alpha systems
c. Design and implement an automation strategy for the infrastructure

The design outlined in this document will be implemented at solely for Moonbase Alpha

# 3 Design Factors

The design factors section outlines the requirements, constraints, risks, and assumptions that the engineering team documented for the Moonbase Alpha infrastructure.

## 3.1 Requirements

The Moonbase Alpha infrastructure Project has the following requirements:

1. Must fit in 21 Rack Units
2. Must be power efficient
3. Must be thermal efficient or support another method of cooling
4. Must support application stack for spacecraft production facilities

## 3.2 Constraints

The Moonbase Alpha Infrastructure Project has the following constraints:

1. Must fit in 21 Rack Units
2. Vendors have been predetermined. The vendors are Cisco and NetApp
3. Network is IPv6 only

## 3.3 Risks

The project team has identified the following risks for the Moonbase Alpha Infrastructure:

1. Working outside of Earth's atmosphere and magnetic field can expose the equipment to damage and/or data loss due to cosmic radiation, solar flares, and other high-energy charged particles that may hit the equipment.
2. Limited physical redundancy
3. Physical security may be lax in the area where the equipment installed, leading to potential sabotage or theft.
4. No direct access to vendor technical support
5. Space constraints limit the options for backup
6. Limited water supplies prevent it from being used for cooling equipment
7. There is no baseline for application and storage resource usage and requirements

## 3.4 Assumptions

The project team has made the following assumptions:

1. There are an  adequate number of secure areas for installing equipment
2. Critical station systems are working on their own redundant infrastructure
3. The station has other IPv6 networks outside of the scope of this project
4. Core routing infrastructure and uplinks to Earth are provided by the station
5. Adequate storage areas for storing spare parts for deployed equipment
6. Separate Dev and Test/QA environments are not required
7. Application requirements are not defined.  All application requirements listed in Section 4.1 are assumptions on resource usage and server requirements.
8. Processor usage for application servers is about 30%
9. 350 users will be logging into Confluence
10. There is limited access to the Internet on Earth

## 3.5 Best Practices

This is a new implementation with no operational baselines.  Unless otherwise noted, vendor best practices will be followed.

# 4 Application Architecture

The application infrastructure used by the earthbound spacecraft production facilities are custom applications built on the vFabric platform.  Additional applications in the environment are Active Directory, OpenFire XMPP server for instant messaging, and Confluence for collaboration.

## 4.1 Server Standards

All servers will run the Windows Server 2012 R2 operating systems.  They will be configured with a 40GB drive for the operating system and a thin provisioned 50GB drive for application partitions.  Thin Provisioning was selected for this drive to preserve storage space.

## 4.2 vFabric Suite

Most of the components of the vFabric suite are open-source packages that VMware has customized and enhanced. Most of these packages are deployed to supported Windows or Linux servers, and any deployments will occur on Windows Server 2012 R2.

There is no baseline for the number of servers that are required, what roles they will have, or the hardware requirements for these servers. Therefore, it is impossible to determine if the scaled-down environment will have enough capacity to support all the required modules.

In order to determine the maximum capacity of the environment, a few assumptions will need to be made about the virtual machine configurations.

### 4.2.1 Application and Web Servers

The web server tier utilizes the vFabric Web Server application, and the application server is built on vFabric tc server. The virtual machine configurations for these servers are:

- Windows Server 2012 R2
- 2 vCPU
- 8GB RAM
- 40GB Hard Drive (OS)
- 50GB Hard Drive (Applications, thin provisioned)

### 4.2.2 Middleware Tier

The middleware tier utilizes the vFabric RabbitMQ application. The virtual machine configuration for these servers is:

- Windows Server 2012 R2
- 2 vCPU
- 8GB RAM
- 40GB Hard Drive (OS)
- 50GB Hard Drive (Applications, thin provisioned)

### 4.2.3 Database Tier

The database tier utilizes the vFabric Postgres database. Although this application can be deployed as a virtual appliance, it will be deployed on Windows 2012 R2 as that is the standard operating system for the environment. Database tier servers will be configured with reservations equal to 100% of their allocated CPU resources to ensure performance. The virtual machine configuration for these servers are:

- Windows Server 2012 R2
- 2 vCPU
- 12GB RAM
- 40GB Hard Drive (OS)
- 50GB Hard Drive (Applications, thin provisioned)
- 100GB Hard Drive (Database data, thick provisioned lazy zeroed)

### 4.3 OpenFire XMPP

OpenFire XMPP is an open-source messaging application built on Java and runs on Windows, Linux, and other operating systems. The virtual machine configuration for this application is:

- Windows Server 2012 R2
- 1 vCPU
- 4GB RAM
- 40GB Hard Drive (OS)
- 50GB Hard Drive (Applications, thin provisioned)

### 4.4 Atlassian Confluence

Atlassian Confluence is a team portal site similar to SharePoint. Confluence is sized for 350 users and has the following requirements:

- Windows Server 2012 R2
- 2 vCPU
- 4GB RAM
- 40GB Hard Drive (OS)
- 50GB Hard Drive (Applications, thin provisioned)

### 4.5 Active Directory

Active Directory domain controllers will provide authentication, stateless DHCPv6, and DNS services for clients on this segment of the network. The virtual machine configuration for domain controllers is:

- Windows Server 2012 R2
- 1 vCPU
- 4GB RAM
- 40GB Hard Drive (OS)
- 50GB Hard Drive (Applications, thin provisioned)

Domain controllers will be configured to run without the GUI after the initial configuration is performed.

## 5 Systems Architecture

The systems architecture for Moonbase Alpha is a greenfield implementation. It is built using equipment from the same vendors as the equipment in the Cape Canaveral facility.

### 5.1 Network

The network at the Cape Canaveral facility consists of four segments – a wide area connection, the local area network utilized for data services, an isolated industrial Ethernet network, and the data center network.

#### 5.1.1 Wide Area Connection

The wide area connection for Moonbase Alpha consists of a point-to-point IPv6 connection between the lunar colony and Earth. The bandwidth and latency on this connection vary due to local weather and magnetic field conditions near the ground station that is receiving the signal on Earth. IPv6 is

### 5.1.2 Local Area Network

The local area network provides access to data, voice, and application services. This network utilizes gigabit Ethernet Cisco switches to provide network data and voice services to users in the facility. An 802.11n wireless network is available for staff utilizing Cisco Aironet wireless access points and controllers. Communications on this network are primarily IPv6, although some unrouted local IPv4 traffic may exist.

### 5.1.3 Data Center Network

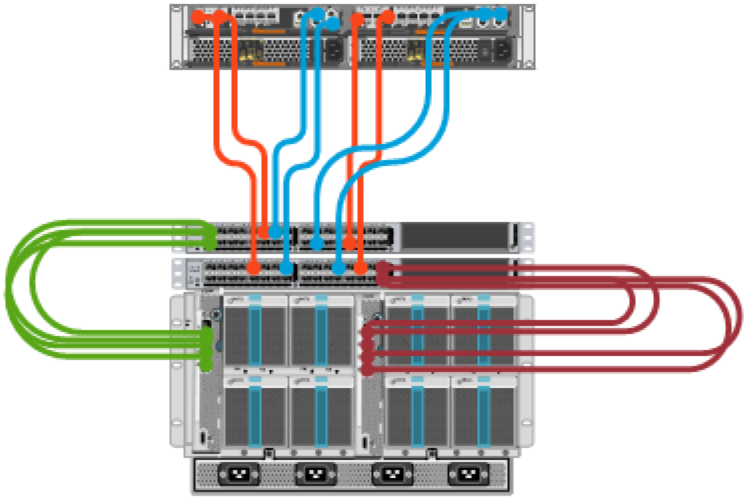
The data center network provides both data networking and storage network services to devices within the local facility's data center. This network consists of one fabric with two primary segments. The network fabric is built using Cisco Nexus 5672UP switches. VLANs will be configured for management, data, vMotion, and storage traffic.

The Nexus switches will be stacked using dual 40GbE virtual port channels connected with QSFP cables. Dual 10GbE uplinks will connect the core datacenter switches to the rest of the Moonbase Alpha Network.

The Nexus 5672UP switches will connect to the UCS chassis environment through a pair of 6324 Fabric Interconnect modules installed in the rear of each chassis.

The reasons for selecting the Nexus 5672UP switches are:

- Support for IPv6 on routing and management interfaces
- Support for 8GB FC and 10GB FCoe and ISCSI
- Integration with the Cisco UCS platform



The network has five VLANs – all of which are installed on the Nexus 5672 switches. The VLANs are:

| VLAN | IP Range | Switch | Description |
|---|---|---|---|
| Management (VLAN 100) | IPv6 /64 subnet<br>192.168.100.0/24 unrouted | Nexus | Management VLAN for ESXi hosts |
| Data (VLAN 104) | IPv6 /64 subnet | Nexus | Server Data VLAN for virtual servers |

|  |  |  |  |
|---|---|---|---|
| Private Cluster VLAN (192) | 192.168.0.x/22 | Nexus | VLAN for private cluster network |
| PernixData (VLAN 253) | 192.168.253.0/24 | Nexus | VLAN for PernixData traffic |
| vMotion (VLAN 250) | 192.168.250.0/24 | Nexus | Network for vMotion |

### 5.1.4 Network Cabling

All network device connections will be made using optical cabling.  The reason for this is that copper cabling can act as an antenna that picks up high energy charged particles and induce an unwanted current on the line.  This current can damage equipment and lead to downtime.

### 5.1.5 IPv6

The network at Moonbase Alpha is primarily an IPv6 environment.  Mr. Billionaire's organization has obtained two /32 IPv6 blocks from ARIN – one for systems located on Earth and Luna and the other for the future Mars colony.  This allocation provides Mr. Billionaire with over 8 billion potential IP addresses to allocate between the two planets.

The IPv6 allocation recommendation from ARIN is a /48 for a site, with each subnet being allocated a /64.  The datacenter will require two subnets for routable traffic.

Due to the length of an IPv6 address, a robust DNS architecture is required for managing this environment.  Stateless DHCPv6 will be configured to provide DNS and router information to IPv6 endpoints.

### 5.1.6 IPv4

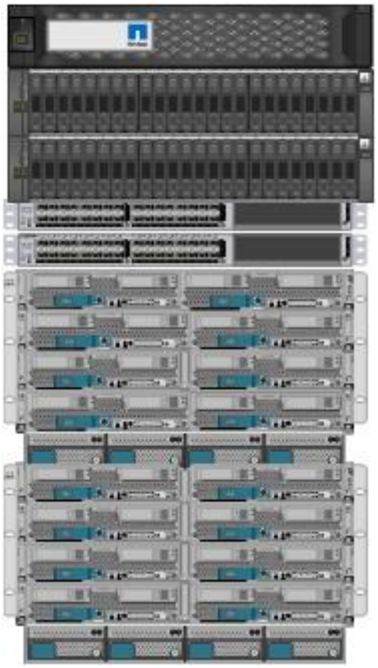
IPv4 connectivity will only be available for local traffic that cannot be routed.  This traffic will remain within the datacenter network and will only be used in instances where IPv6 is not supported or recommended by the vendor.

A private Class C subnet will be assigned to the management VLAN to support management components where IPv6 is not supported, where IPv4 is required for initial setup, or where documentation cannot be found to determine if IPv6 is supported or contradictory information is found.  This subnet will not be routed or translated, and a management server will be created to allow administrators to manage these components from outside of the subnet.

To the best of our knowledge, components that fall into one of these three categories include Single Sign-On, the vCenter Server Virtual Appliance, and the vCenter Web Client.  This is based on the available documentation provided by the vendor and other sources such as blogs.  It has not been tested in a proof of concept network and may not be accurate.  There may also be other components that are affected by the IPv6-only constraint.

## 5.2 Physical Server Infrastructure

The physical server infrastructure will be built using the Cisco UCS platform.  The components take up 20U, with the remaining rack unit left open for future needs.



### 5.2.1 Physical Server Infrastructure

The physical server infrastructure for Moonbase Alpha is built using Cisco UCS B-series blade servers and blade server chassis.  Cisco UCS blade servers were chosen over C-series rack servers because the blade servers have a higher density per rack unit.  Two fully populated chassis will be utilized to provide a total of 16 servers in 12 rack units of space.

The standard blade servers will be Cisco B200M3 blades with the following configuration:

- 2x E5-2697 v2 12 Core CPUs @ 2.7 GHz
- 768GB 1866Mhz RAM configured in memory mirroring mode for 384GB of usable RAM
- 2x 400GB Enterprise Performance SSDs
- VIC 1240 w/ VIC 1280 Expander Card for 8x 10GB Ports

This particular server configuration was selected to provide the most amount of computing resources in the smallest possible package.  The processor that was selected is the largest processor that Intel currently makes, which will allow a higher number of virtual machines per host.

RAM is configured in memory mirroring mode to ensure that RAM contents are not changed due to sustained radiation exposure.  This setting, which is not recommended by Cisco, will result in reducing each host's RAM being reduced by 50% and have performance impacts.  However, this is required for keeping the systems stable.

The solid state drives have been installed to support PernixData.  PernixData will be used as a storage acceleration layer to provide an additional storage performance boost.

### 5.2.2 Server Quantity

Two blade chassis and sixteen servers will be installed in the environment.  This is the maximum number of servers that can be installed due to the space constraints.

### 5.2.3 Environment Maximums

Environment maximums are described in section 6.3.1.

## 5.3 Storage Infrastructure

The storage infrastructure is built using the NetApp EF550 storage array. The EF550 is an all-flash array built on the SANtricity operating system and contains both high capacity and performance in a space efficient package. An all-flash array was selected over a traditional or hybrid array because the all-flash array is more efficient.

The EF550 contains two controllers and 24 disks in a 2U package, and it supports additional disk trays of 24 disks. The array will be configured with 1.6TB SSDs for a total about 27.5TB of raw storage. Two additional 2U trays of 1.6TB SSDs will be installed to provide additional capacity for a total of 82.5TB of raw storage. The array will be configured to use Dynamic Disk Pools instead of RAID pools. At least one hot spare will be configured per disk tray.

The array will be connected to the UCS infrastructure using the Fibre Channel protocol. Fibre Channel was selected over ISCSI due to the lower overhead of fibre channel and to avoid having to worry about layer 3 addressing. The selected array does not appear to support NFS, so that is not a storage option.

Details on the logical storage configuration can be found in Section 6.6.

The PernixData storage acceleration product will be utilized to provide local storage acceleration. PernixData will be configured in write-back mode with writes placed on two additional hosts for fault tolerance.

## 5.4 System Placement

The infrastructure will need placed in a secure location in the facility. This location should be shielded against electromagnetic interference and high-energy charged particles that may damage the system. Ideal locations may be the base command and control center or near the environmental systems as these locations would be secured against unauthorized access and have shielding to protect other systems.

The rack and all equipment will be properly grounded to avoid damage from electrostatic discharge.

# 6 vSphere Architecture

VMware vSphere 5.5 Update 1 will be the virtualization platform used to run spacecraft production facility infrastructure. vSphere was selected over competing platforms because it provides best feature set for virtualizing Windows-based workloads and includes a management platform and orchestration engine.

The vSphere 5.5 Update 1 components that will be implemented in this infrastructure are:

- ESXi 5.5 Update 1 hypervisor with Enterprise Plus licensing
- vCenter Server 5.5 Update 1 Standard

In addition to these components, the vCenter Orchestrator virtual appliance will be used as the Orchestration Engine for the environment. vCenter Orchestrator and the orchestration setup are described in

## 6.1 vCenter Configuration

vCenter Server is the management application for VMware vSphere environments. vCenter Server enables a number of features that will be utilized within this environment such as virtual Distributed Switch, HA Clusters, and Distributed Resource Scheduling (DRS).

vCenter includes a number of services that are deployed as part of the core vCenter Server install. These services are:

- Single Sign-On
- Web Client
- Inventory Service
- vCenter Server Core Application

The environment will contain a single vCenter server as a virtual machine running on Windows Server 2012 R2. All vCenter Server roles and the VMware Authentication Proxy will be installed on this VM. The vCenter databases will be SQL Server 2012 SP1 running on a separate server.

The vCenter Servers for all spacecraft production facilities will be installed in linked mode to allow administrators for remote management from a single vCenter Web Client.

### 6.1.1 vCenter Server Instance

The vCenter server instance deployed in this environment will be the vCenter Server Virtual Appliance. The appliance will use the onboard database and be configured with the following specifications:

- 2 vCPU
- 8GB RAM
- Appliance default hard drive sizes

This configuration will support up to 100 hosts and/or 1000 virtual machines.

The appliance was selected over the Windows Server vCenter application because it requires fewer compute resources, which will support more workloads.

### 6.1.2 vCenter Database Server

The vCenter Server database will be the embedded vPostgres database included with the vCenter Server Appliance.

## 6.2 vSphere Single Sign-On

Single Sign-On is a feature that was added with vSphere 5.1 to provide a central authentication source for vSphere environments. This feature is required for users to authenticate with vCenter and the vSphere Web Client. The Single Sign-On instance that is included with the vCenter Server Virtual Appliance will be used.

Multi-site Single Sign-On with replication is possible with the virtual appliance, but it is not supported. Because this lacks support in the current version, it will not be used. This instance of Single Sign-On will be

### 6.2.1 Active Directory Integration

The local Active Directory environment will be added as an authentication source within Single Sign-On. This will allow administrators in the environment to log into vCenter using their Active Directory user credentials.

The Active Directory domain will be configured as the default authentication provider within Single Sign-on so administrators. This allows administrators to log in without having to type the entire universal principal name for their username.

### 6.2.2 Single Sign-On Administrator

The Single Sign-On service includes a default administrator account called administrator@vsphere.local. This account has root level access to the entire vSphere environment. This account is the only account that can administer Single Sign-On when the environment is first configured.

This account will have a complex password.

For day-to-day administration of Single Sign-On, an Active Directory group will be created and added to the Single Sign-On Administrators through the vSphere Web Client.

## 6.3 vSphere Cluster Design

vSphere Clusters are a grouping of compute resources that are managed as one entity. Clusters enable VMs to be live migrated between hosts, and host that are in clusters usually have the same, or very similar, hardware and network configurations.

The environment will be configured with a single cluster. This will reduce management and setup overhead and enable resources to be utilized more effectively. The drawback, in this case, is that multiple host failures can cause critical workloads to go offline, but the lack of space for additional hosts prevents more hosts from being reserved for HA events. Since the nearest parts depot is at least three days away or more depending on the next launch, any protracted hardware outage would be catastrophic, and spare systems would need to be stored onsite to ensure the systems could be brought back online quickly.

### 6.3.1 Cluster Sizing

The cluster will initially be configured with 16 hosts. This is the maximum number of servers that can be installed given the existing space constraints. Since this environment is a scaled down version of a very large production environment on Earth, there is a risk that this environment may not be able to support all of the required workloads or that the required workloads will need to be scaled down and run without redundancy. This assumption cannot be determined at this time due to the lack of application sizing information.

The maximum capacity of the environment can be estimated based on a couple of factors: the number of physical CPU cores in the environment, the amount of RAM that can be allocated to virtual machines, the number of hosts, and the capacity reserved for HA failover events.

The resources currently in the cluster are:

- 15 available hosts, one host is reserved for HA events

- Each host has 2x 12 core processors with hyperthreading.  This provides 48 processing threads per host.
- 384GB of RAM that can be allocated per host.

The total amount of resources that can be allocated are 360 physical processors and 5760GB of RAM. This number does not include hyperthreading in the processor count.

The workload assumption that is being used to calculate maximum load is a pool of two database servers per eight other virtual machines. Database servers are assumed to have processor resoruces allocated on a 1 vCPU to 1 physical CPU basis with all other workloads assumed to be allocated at a ratio of 3 vCPU to 1 physical CPU.  The standard configuration for all database servers is 2 vCPU and 12GB of RAM, and the standard configuration for application servers is 2 vCPU and 8GB of RAM.  The hosts are assumed to use about 1GB of RAM for overhead.

Each application server will utilize about 1.62 GHz of CPU cycles, and each database server will utilize about 5.4 GHz of CPU cycles.  An application pod of eight application servers and two database servers will use 23.76 GHz of CPU.

Each host has two 12-core processors with a clock speed of 2.7 GHz for a total of 64.8 GHz, and the total CPU resources that can be allocated in the cluster are 972 GHz.  This allows for 40 application pools for a total of 320 application servers and 80 database servers with about 22GHz of CPU cycles left over for Active Directory, OpenFire, and Atlassian Confluence.

Higher consolidation ratios may be possible, but it could impact performance by increasing the CPU ready time for some virtual machines.

### 6.3.2 vSphere High Availability

vSphere High Availability will be utilized to restart servers in the event of a host failure. This feature will be enabled on all production clusters.

HA Admission control is the feature that prevents servers from powering on if there are not enough host resources available to satisfy a failover event.  This feature will be enabled, and failover capacity will be determined by a static number of hosts.  Reserved failover capacity will be set at one host.

This option is preferred option in this environment since all hosts have the same configuration.  If additional hosts are added, administrators will not need to figure out the new percentage of resources to reserve for HA.

### 6.3.3 vSphere Distributed Resource Scheduler

vSphere Distributed Resource Scheduler (DRS) is a feature that analyzes the current resource usage in the environment and balances computing capacity across hosts in a cluster.  DRS will be enabled in the environment.

DRS will be fully automated to allow the system to manage itself without intervention from an administrator and set to a migration threshold of 4.  This will enable DRS to execute most recommendation that provide a moderate improvement to the computing balance in a cluster.

In order to insure that two critical workloads are not placed on the same host for performance or fault tolerance reasons, DRS groups will be created.  The groups that will be created are:

| Group Type | Description | DRS Rule |
|---|---|---|
| Database Server Anti-Affinity Rule | Rule to keep SQL Servers in an application group on different hosts | Separate Virtual Machines |
| Application Server Anti-Affinity Rule | Rule to keep application servers in an application group on different hosts | Separate Virtual Machines |
| Domain Controller Anti-Affinity Rule | Rule to keep Active Directory Domain Controllers on different hosts | Separate Virtual Machines |
| RabbitMQ Anti-Affinity Rule | Rule to keep RabbitMQ servers on different hosts | Separate Virtual Machines |

Each application will have its own DRS rules for their SQL Servers and Application Servers. If additional servers are created for an application, they will be added to the correct DRS rule dynamically during provisioning.

### 6.3.4 vSphere Enhanced vMotion

vSphere Enhanced vMotion Compatibility is a feature that masks features on newer CPUs to ensure vMotion compatibility in clusters that have equipment with different processor generations. Enhanced vMotion Compatibility will be enabled and configured to use the “Intel Ivy Bridge” setting.

## 6.4 ESXi Host Configuration

All hosts in the vSphere environment will be running ESXi 5.5 Update 1 and primarily be managed by vCenter. The hosts will be configured as follows:

- Root Account will receive a complex password
- Hosts will not be joined to Active Directory, Authentication Proxy will be used for AD authentication
- Time Settings – NTP will be configured to start on host startup. NTP will be configured to receive time from us.pool.ntp.org.
- Syslog – A syslog server will be configured. The syslog server will be a LogInsight appliance cluster located at the DR site.

Lockdown will not be used on hosts.

## 6.5 Virtual Network Design

There are four networks on each host. These networks are:

- A virtual distributed switch
    - Port Group for VM Data Traffic
    - Port Group for vMotion
    - Port Group for Cluster VLAN
    - Port Group for Host Management
    - Port Group for PernixData Traffic

Each host has a Cisco VIC 1240 with a VIC1280 expansion port.  This provides a total of up to 8 10GB ports that can be used for Ethernet or Fibre Channel.  Two 10GbE ports will be configured for FCoE and presented to the ESXi hosts as Cisco FCoE HBAs.  Four will be configured as 10GbE ports and assigned to the virtual distributed switch to act as uplinks.  The remaining two ports will be reserved for future needs.

The virtual distributed switch uplink ports will be configured as trunk ports for VLANs 100, 104, 192, and 250.  The ports will be configured to use Load-Based Teaming to balance traffic across both uplinks.

## 6.6 Virtual Storage Design

The storage infrastructure for the vSphere environment will consist of multiple LUNs presented to the vSphere environment using the iSCSI protocol.  The LUNs presented to the environment will be 750GB in size to keep the number of VMs stored on a LUN to less than 20.

Storage DRS will be enabled and placed in fully automated mode to manage storage resources.  One large datastore cluster will be created with 12 LUNs.  Storage IO Control will be enabled on these LUNs and integrated with the SolidFire quality of service features to ensure that the servers are receiving the storage resources that they require.

## 6.7 VM Template

One VM template will exist in the environment.  This template will run Windows Server 2012 R2 and have the following hardware configuration:

- 2 vCPU
- 4GB RAM
- 40GB Hard Disk (OS Drive)
- 60GB Hard Disk (Application Drive)
- VMXNET3 Network Adapter

One customization specification will exist at each site to join the server to the domain and configure the IP address of the server.

Only one template is required because the deployment scripts will dynamically configure the server with the hardware, software, and Windows Server roles based on the role that it is assigned when it is deployed.

## 6.8 Monitoring

Monitoring of the vSphere environment will be performed by VMware LogInsight Manager and vCenter Operations Manager.  Application performance monitoring will be performed by vFabric Hyperic.

# 7 Orchestration and Automation

In order to manage an environment of this size with minimal staff, an orchestration and automation solution is required.  All orchestration and automation tasks will be performed by PowerShell scripts running from Server 2012 R2.

PowerShell was selected as the automation language because it will integrate with all components in the environment. Windows Server 2012 R2 was built with PowerShell management in mind, and, unlike previous versions of Windows Server, Windows remoting technologies are enabled by default. There are PowerShell commands for managing every feature in Windows, and many third parties have published their own sets of PowerShell commands or provide a REST API.

The modules that will need to be installed on the scripting server are:

- PowerCLI
- Windows Remote Server Administration Tools

If a script requires additional information, such as location IP settings, the information will be stored in a SQL database and queried at run-time. This prevents complicated Select-Case statements and having to modify the script if changes occur.

The developers of the spacecraft production facilities software have indicated that they would like to deploy updates as frequently as possible. PowerShell will be used to script these deployments.

# 8 Disaster Recovery

Due to the space constraints and high latency connections between Moonbase Alpha and Earth, a true disaster recovery solution is not feasible, and no site local backup solution has been introduced in the spacecraft production facilities. VMware Data Protection can be used to create local backups of virtual machines for temporary backup purposes, but these backups would exist on the local storage. A significant risk exists to the infrastructure and the data since it cannot easily be backed up and restored.