Executive Summary

The world has been taken over by zombies and they have ravaged nearly everyone on the planet. A billionaire is providing the investment to create a highly scalable and full orchestrated environment which will be the backbone of a manufacturing facility. This facility is building ships to transport what's left of the human race to the moon before sending them to Mars for colonization.

Business Requirements

Application is required for the manufacturing facility that is:

- High reliable
- Easily deployed
- Cannot suffer significant downtime
- Has Web Front End
- Has Message queuing middle tier
- Has database backend

Document Purpose and Assumptions

This document serves a boilerplate template for the manufacturing facilities that will be used to build ships to transport humans off the planet. This serves as a reference architecture for the first and subsequent sites.

The orchestration application chosen is SAP Manufacturing Integration and Intelligence. It was chosen because it can be deployed in a scalable and deterministic manner. The first manufacturing facility will serve as the primer that will be able to be copied in subsequent facilities as needed. As the number of systems and sites grows, these can be controlled from a central location collectively to provide a unified view of all the manufacturing facilities.

There are assumptions made in this document:

On-site generator to supply power to the UPS system in case of power failure.

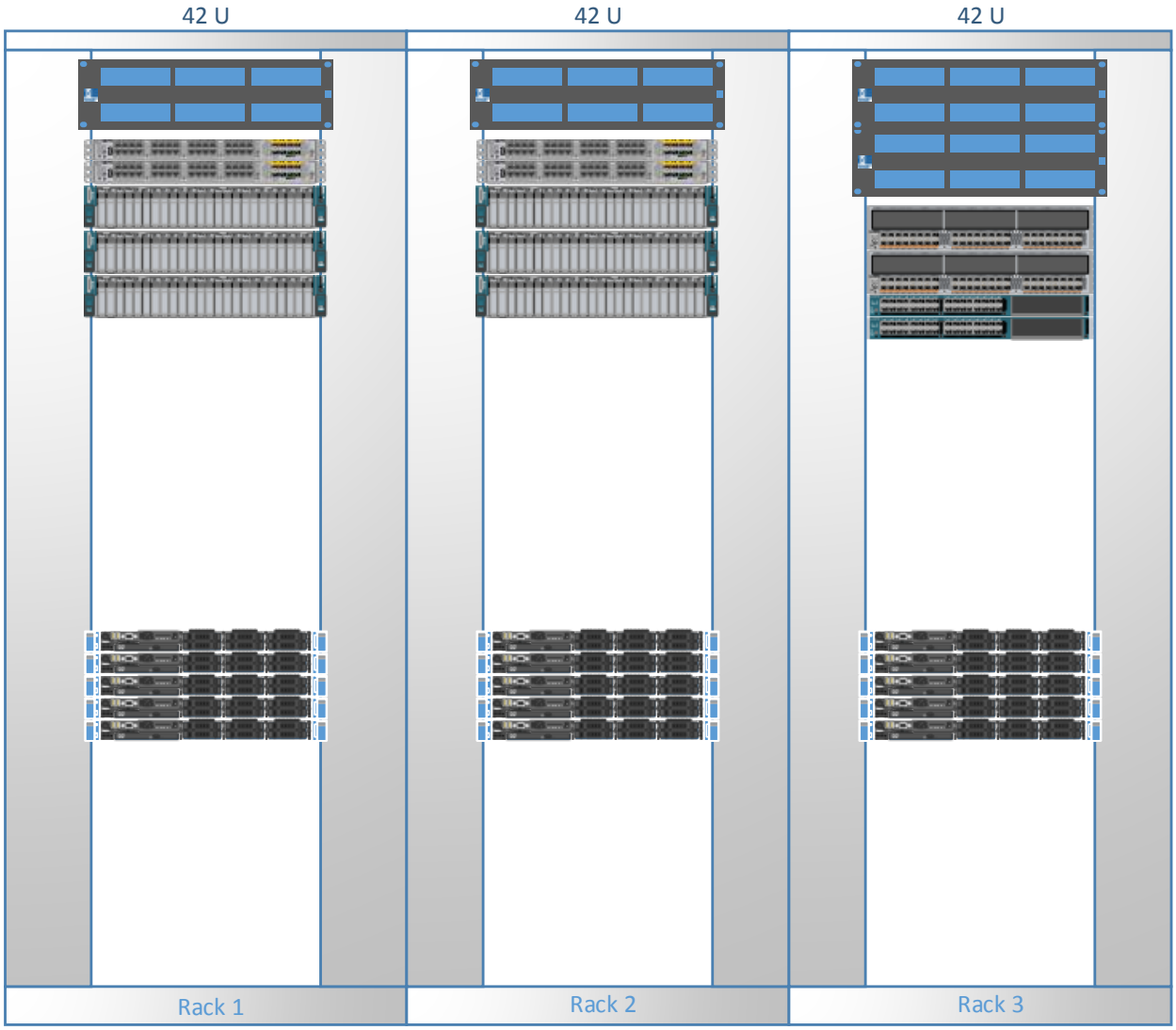
Manufacturing facility will have a room for the datacenter to reside in.

Manufacturing facility will have structured cabling that will connect the producing systems to the core network.

Manufacturing facility will not have any off-site DR capabilities. All disaster avoidance will have to be done internally.

Physical Datacenter Overviews

- Datacenter rack layout



The rack layout consists of two racks that will house the compute and storage infrastructures and one rack that will house the networking infrastructure. This separation is to allow the expansion of the compute and storage areas independently of the networking. Each rack will have structured cabling installed for fiber connectivity back to the networking rack. The racks consist of the following equipment:

- Networking
  - Cisco 5596UP – 2
  - Cisco 2232TM – 4
  - Cisco 6248 – 2
  - Solidfire SF610 – 5 (used as storage for backups)
- Compute
  - Cisco C240 M3 – 6
- Storage
  - Solidfire SF6010 – 5

    - Structured Cabling
        - 96 Strands of OM3 in Rack 1 and 2, terminated in Rack 3
    - Consumed rack space – 15U in Rack 1 and 2, 10U in Rack 3
- Power configurations

The installed equipment will draw the following power requirements. Some numbers are obtained from maximums from the vendor websites and some are actual tested numbers based on the vendor's documentation. The racks will consist of two power distribution units that will be connected to separate uninterruptible power supplies. There is an assumption that the facility will have a generator capable of supplying power in case of main grid failure. Each rack will have connections to UPS-A and UPS-B. The numbers are a best representation of the data provided:

Rack	Item	UPS-A Watts	UPS-B Watts
1	Cisco 2232TM	193W	193W
1	Cisco 2232TM	193W	193W
1	Cisco C240 M3	375W	375W
1	Cisco C240 M3	375W	375W
1	Cisco C240 M3	375W	375W
1	Solidfire SF6010	150W	150W
1	Solidfire SF6010	150W	150W
1	Solidfire SF6010	150W	150W
1	Solidfire SF6010	150W	150W
1	Solidfire SF6010	150W	150W
Totals		**2261**	**2261**
2	Cisco 2232TM	193W	193W
2	Cisco 2232TM	193W	193W
2	Cisco C240 M3	375W	375W
2	Cisco C240 M3	375W	375W
2	Cisco C240 M3	375W	375W
2	Solidfire SF6010	150W	150W
2	Solidfire SF6010	150W	150W
2	Solidfire SF6010	150W	150W

2	Solidfire SF6010	150W	150W
2	Solidfire SF6010	150W	150W
Totals		**2261**	**2261**
3	Cisco 5596UP	375W	375W
3	Cisco 5596UP	375W	375W
3	Cisco 6248	375W	375W
3	Cisco 6248	375W	375W
3	Solidfire SF6010	150W	150W
3	Solidfire SF6010	150W	150W
3	Solidfire SF6010	150W	150W
3	Solidfire SF6010	150W	150W
3	Solidfire SF6010	150W	150W
Totals		**2250**	**2250**
Total Consumed Power		**6772**	**6772**

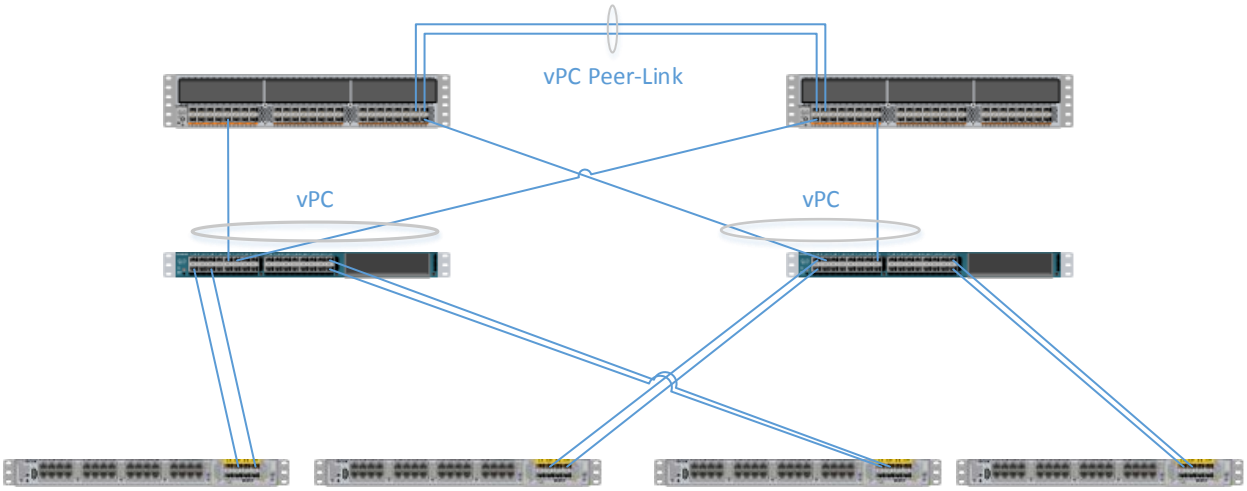
- HVAC configurations

The equipment will need to be cooled during operation. There is an assumption that the facility will have a room for the datacenter equipment to reside in. Using the Table 1 provided in this document, the amount of AC tonnage required to cool the equipment is as follows:

  - Formula – Total Watts * 0.000283 = Tons
  - Calculation – 13544 * 0.000283 = 3.832952 Tons

Physical Infrastructure Overviews

- Network Infrastructure



The network infrastructure consists of a core switching network composed of a pair of Cisco 5596UP switches. There are Cisco 6248 Fabric Interconnects connected via vPC to those switches to facilitate using UCS manager to provision the Service Profiles for the attached server components. Two Cisco 2232TM Fabric Extenders are attached to the Fabric Interconnects to allow 1/10Gbe connectivity for the Management network of the servers and storage devices. They are redundantly configured to prevent any one component causing an entire network outage.

- VLAN Design

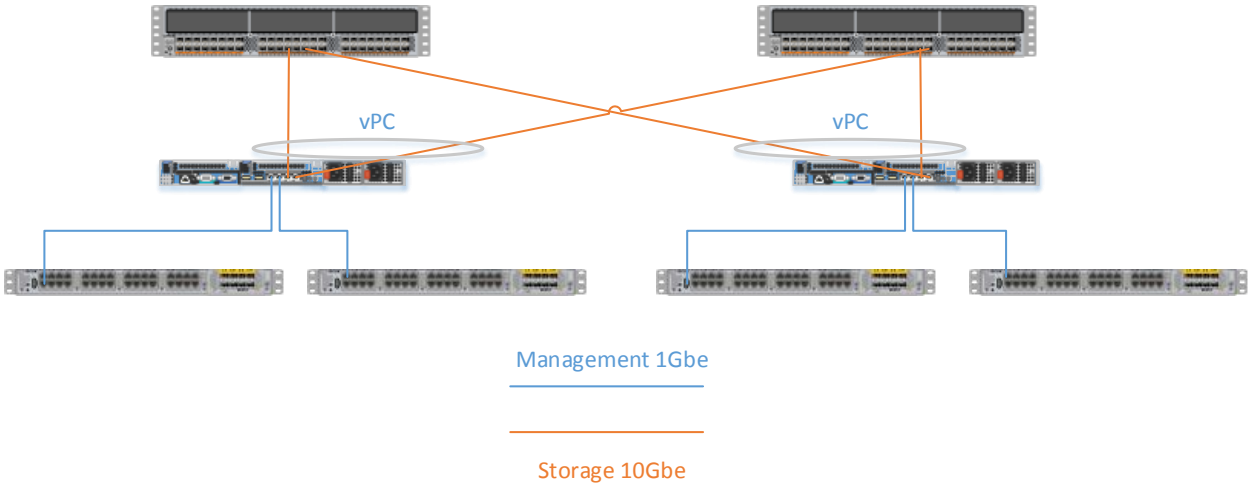
The following VLANs are required to split out traffic for broadcast domain purposes as well as ease of management and troubleshooting. One flat network has inherent limitations in terms of scalability. This configuration will allow maximum scaling and segregation of network traffic.

VLAN	Purpose
A	Management Network/CIMC/iDRAC
B	VM Network
C	vMotion
D	iSCSI
E	Replication

- Host Infrastructure
    - Cisco C240 M3 x6

CPU	RAM	NIC	Power	Storage
2.8Ghz E5-2680	384GB – 1866Mhz	VIC 1225	Dual 750W	Dual SD Card

- Storage Infrastructure



The storage infrastructure physical layout is shown above. Certain components have been removed for clarity of connectivity. Only one of the Solidfire SF6010's is being shown as the others connect in the same fashion to the 5596UP for 10Gbe storage and the 2232TM for 1Gbe Management. The two 10Gbe connections from each of the SolidFire controllers will be setup in a vPC between the two 5596UPs. The Management network connections will be plugged into both Fabric Extenders to allow connectivity in case of a Fabric Extender or 5596UP device failure.

Virtualization Infrastructure Overviews

- vSphere Definitions

vSphere Component	Description
VMware vSphere	The core products of the VMware vSphere environment include: • ESXi – 2 instances will compose the management cluster and 4 hosts will comprise the compute cluster for VM consumption • vCenter Server – 1 installed instance • vCenter Server Database – 1 instance for the single instance of vCenter Server • SSO – Single Sign-on component that is required for connecting to the vSphere Client and vSphere Web Client

- vSphere Client – Still needed to manage VMware Update Manager
- vSphere Web Client – Used to manager the vSphere environment
- vCenter Orchestrator – will be used to build workflows for adding new storage and compute resources as necessary.

- vSphere Component Definitions

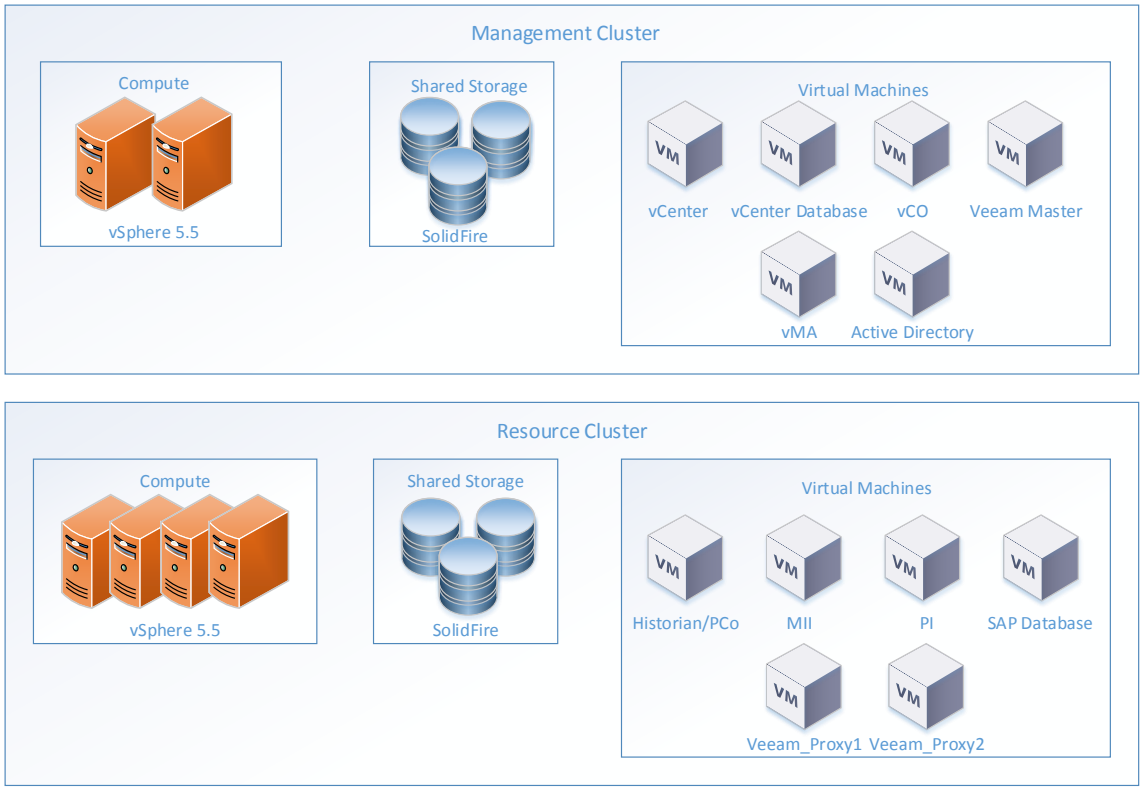
Design Section	vSphere Components
vSphere Architecture – Management Cluster	• vCenter Server and vCenter Database • vCenter Cluster and ESXi hosts • Single Sign-On • vCenter Orchestrator
vSphere Architecture – Compute Cluster	• vCenter Cluster and ESXi hosts

- vSphere Architecture Design Overview
- High level Architecture

The vSphere components are being split out to facilitate ease of troubleshooting of the management components without disruption of the resource components. They are split out as follows:

Management cluster that will host the management components of the vSphere infrastructure. They are split out to ensure they have dedicated resources in which to consume.

Compute cluster that will host the application layer of the deployment. The SAP architecture demands large amounts of resources to consume. Splitting the compute cluster from the management cluster helps facilitate adding more resources later if necessary to scale out the deployment.



- Site Considerations

The vSphere management and compute clusters are both residing within the same facility. This will provide the lowest latency for management as well as a consistent datacenter in which to manage the clusters. To provide the highest availability necessary as a business requirement, the clusters will be stretched between two separate racks within the same room to provide two separate fault domains.

There are no other sites that are in scope for this project.

- Design Specifications
- vSphere Architecture Design – Management Cluster
  - Computer Logical Design
    - Datacenter

One datacenter will be built to house the two clusters for the environment.

- vSphere Cluster

Below is the cluster configuration for the management cluster for the environment.

Attributes	Specification
Number of ESXi Hosts	2
DRS Configuration	Fully Automated
DRS Migration Threshold	Level 3
HA Enable Host Monitoring	Enabled
HA Admission Control Policy	Disabled
VM restart priority	Medium – vCenter and vCenter DB set High priority
Host Isolation response	Leave powered on
VM Monitoring	Disabled

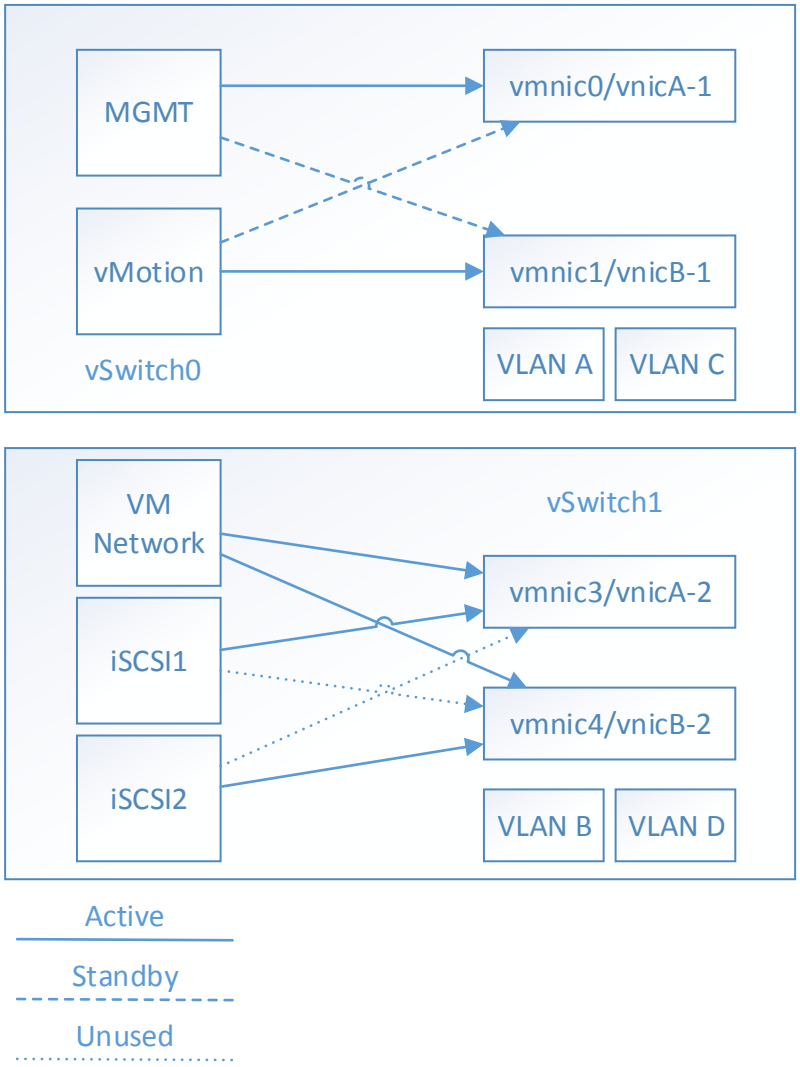
- Host logical Design

Attribute	Specification
Host Type and Version	VMware ESXi Installable
Processors	X86 Compatible
Storage	FlexFlash SD for local ESXi install, shared storage for VMs
Networking	Connectivity to all needed VLANS
Memory	Sized for workloads

- Network Logical Design

Switch Name	Switch Type	Function	# of Physical Ports
vSwitch0	Standard	Management vMotion	2x10Gbe
vSwitch1	Standard	VMs, iSCSI	2x10Gbe

The VIC 1225 in the Cisco C240 M3 allows the ability to split out 2 10Gbe Network connections into 256 vnics. The configuration is to create 4 vnics through the Service Profile, 2 with bindings to Fabric Interconnect A and Fabric Interconnect B. A pair of vnics, one going to either Fabric Interconnect, will compose the port group uplinks necessary for failover purposes and redundancy within the vSphere environment. This is illustrated below:



Port group configurations

Attribute	Setting
Load balancing	Route based on originating virtual port ID
Failover Detection	Link Status Only
Notify Switches	Yes
Failover Order	MGMT – Active vmnic0/Standby vmnic1 vMotion – Standby vmnic0/Active vmnic1 VM Network – Active vmnic3/Active vmnic4 iSCSI1 – Active vmnic3/Unused vmnic4 iSCSI2 – Unused vmnic3/Active vmnic4

- Shared Storage Logical Design

Attribute	Specification
Number of LUNs to start	2
LUN Size	500GB
VMFS Datastores per LUN	1
VMs per LUN	3

- Management Components

This is the list of Management components that will be running on the management cluster:

- vCenter Server
- vCenter Database
- vCenter Orchestrator
- vCenter Update Manager
- Veeam Master
- Veeam Proxy
- vSphere Management Assistant

- Management Components Resiliency Considerations

Component	HA Enabled?
vCenter Server	Yes
vCenter Database	Yes
vCenter Orchestrator	Yes
vCenter Update Manager	Yes – as result of vCenter Server
Veeam Master	Yes
Veeam Proxy	Yes
Active Directory	Yes

- Management Server Configurations

VM	vCPUs	RAM	NIC	Disk1	Disk2	Disk3	Controller
vCenter Server	2	16GB	VM Network	40GB	200GB	N/A	LSI Logic SAS
vCenter Database	2	16GB	VM Network	40GB	100GB	N/A	LSI Logic SAS
vCenter Orchestrator	2	16GB	VM Network	40GB	100GB	N/A	LSI Logic SAS
Veeam Master	2	16GB	VM Network	40GB	10TB	N/A	LSI Logic SAS
Veeam Proxy1	2	16GB	VM Network	40GB	N/A	N/A	LSI Logic SAS
Active Directory	1	4GB	VM Network	40GB	N/A	N/A	LSI Logic SAS

Solidfire QoS can be enabled if necessary, however the VMs most likely will not product IOPS numbers that would necessitate this feature enabled on this cluster at this time.

- vSphere Architecture Design – Compute Cluster
    - Computer Logical Design
        - Datacenter

One datacenter will be built to house the two clusters for the environment.

- vSphere Cluster

Attributes	Specification
Number of ESXi Hosts	4
DRS Configuration	Fully Automated
DRS Migration Threshold	Level 3
HA Enable Host Monitoring	Enabled
HA Admission Control Policy	Enabled
VM restart priority	Medium – SAP_DB and MII set to high
Host Isolation response	Leave powered on
VM Monitoring	Disabled

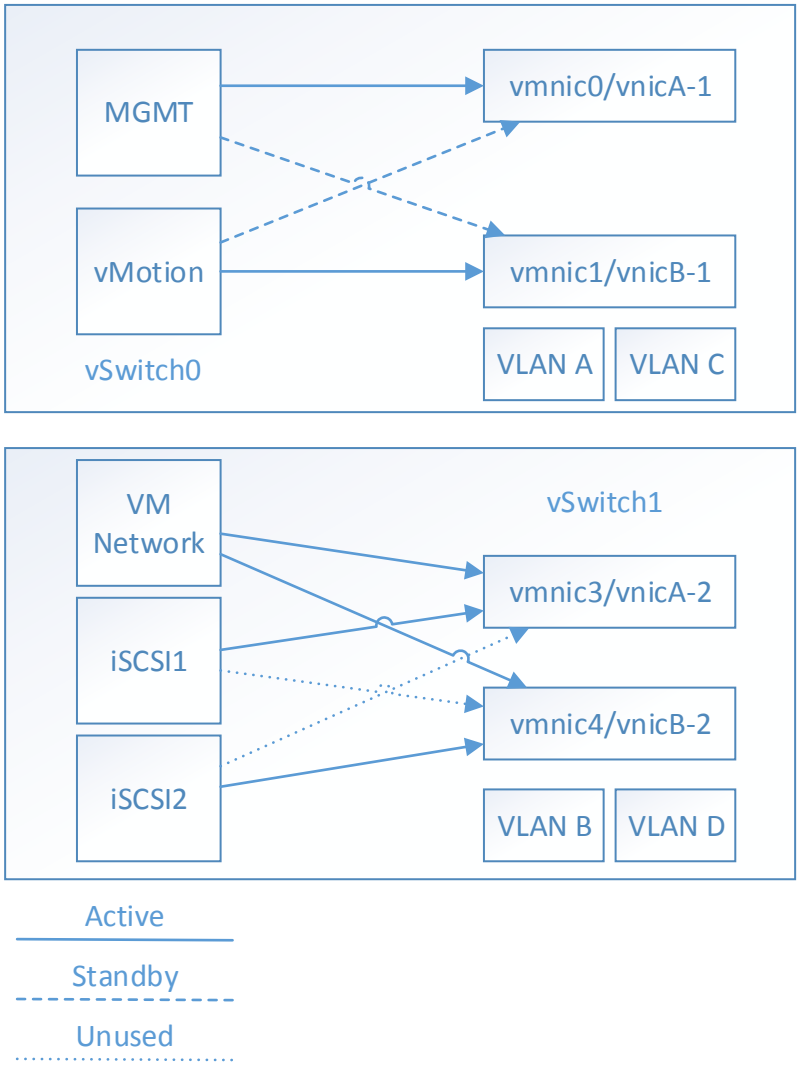
- Host Logical Design

Attribute	Specification
Host Type and Version	VMware ESXi Installable
Processors	X86 Compatible
Storage	FlexFlash SD for local ESXi install, shared storage for VMs
Networking	Connectivity to all needed VLANS
Memory	Sized for workloads

- Network Logical Design

Switch Name	Switch Type	Function	# of Physical Ports
vSwitch0	Standard	Management vMotion	2x10Gbe
vSwitch1	Standard	VMs, iSCSI	2x10Gbe

The network configuration for the Compute Cluster follows the exact same pattern as that of the Management cluster for simplicity.



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Load balancing	Route based on originating virtual port ID
Failover Detection	Link Status Only
Notify Switches	Yes
Failover Order	MGMT – Active vmnic0/Standby vmnic1 vMotion – Standby vmnic0/Active vmnic1 VM Network – Active vmnic3/Active vmnic4 iSCSI1 – Active vmnic3/Unused vmnic4 iSCSI2 – Unused vmnic3/Active vmnic4

- Shared Storage Logical Design

Attribute	Specification
Number of LUNs to start	1
LUN Size	2000GB
VMFS Datastores per LUN	1
VMs per LUN	6
Storage IO Control	Enabled
Solidfire QoS	Enabled

- Compute Components

This is a list of the components that will be running on the compute cluster for the environment:

- SAP MII Server
- SAP PI Server
- SAP Database Server
- SAP Data Historian/Plant Connectivity
- Veeam Proxy – 2 to maximize concurrent backups

- Compute Component Resiliency Considerations

Component	HA Enabled?
SAP MII Server	Yes
SAP PI Server	Yes
SAP Database Server	Yes
SAP Data Historian/Plant Connectivity	Yes
Veeam Proxy 1	Yes
Veeam Proxy 2	Yes

- Compute Server Configurations

SAP servers are based on SAPS, SAP Application Performance Standard. They are hardware-independent and describe the performance of the SAP system. The numbers are derived from SAP benchmarking. The formula is derived as follows:

Full Business Process = Create order, create delivery note for order, display order, change delivery, posting, listing order, creating invoice.

Since the sizing tool for SAP servers requires customer or partner access, the only estimation we can go on is the Average Dialogue Response Time should be less than 1 sec. The number of SAPS will be estimated using 16 vCPUs and 968GB of RAM on the SAP Database Server. Using the SAP Benchmarking site, we can found the following estimation:

Full Business Process – 235330

SAPS – 11770

Number of users – 2129

Average response time - 0.85 sec dialog response

VM	vCPUs	RAM	NIC	Disk1	Disk2	Disk3	Controller
SAP MII Server	4	32GB	VM Network	40GB	100GB	N/A	LSI Logic SAS
SAP PI Server	4	32GB	VM Network	40GB	100GB	N/A	LSI Logic SAS
SAP Database Server	16	96GB	VM Network	40GB	500GB	100GB	VMware Para-virtual Controller
SAP Data Historian/ PCo	4	32GB	VM Network	40GB	500GB	N/A	LSI Logic SAS
Veeam Proxy1	4	16GB	VM Network	40GB	N/A	N/A	LSI Logic SAS
Veeam Proxy2	4	16GB	VM Network	40GB	N/A	N/A	LSI Logic SAS

With putting all the VMs on one LUN we'll need to enable SolidFire QoS and Storage IO Control on a per VM basis with the following settings to protect against noisy neighbor and provide consistent performance for the applications. The IOPS numbers will be based on 4K IO size since we do not have direct access to the SolidFire interface to determine proper IO sizing. The 5-node is capable of 250K 4K Random read IOPS. These numbers are estimations and can be adjusted on the fly.

VM	Min IOPS	Max IOPS	Burst
SAP MII Server	10000	20000	2
SAP PI Server	10000	20000	2
SAP Database Server	25000	75000	2
SAP Data Historian/PCo	10000	20000	2
Veeam Proxy1	2500	7500	2
Veeam Proxy2	2500	7500	2
Total IOPS Commitment	**60000**	**150000**	**2**

- vSphere Security
    - Host Security

Hosts will be placed into lockdown mode to prevent root access. This would ensure that only access can be done through the DCUI or through the vMA appliance.

    - Network Security

All virtual switches will have the following settings:

Attribute	Setting
Promiscuous Mode	Management Cluster – Reject Compute Cluster - Reject
MAC Address Changes	Management Cluster – Reject Compute Cluster – Reject
Forged Transmits	Management Cluster – Reject Compute Cluster - Reject

- vCenter Security

By default when vCenter is added to an Active Directory domain, the Domain Administrators group is granted local administrator permissions to the vCenter Server. A new vCenter Admins group will be created, appropriate users will be added to the group and that group will become the new local administrators on the vCenter Server. The Domain Administrators group will be removed.

- vSphere Orchestration Framework

The infrastructure is highly scalable using vCenter Orchestrator to manage the workflows of the environment. The vCenter Orchestrator systems has plugins that can directly manage the Cisco UCS system and REST API calls can be done to the Solidfire system for creating storage LUNs in an automated fashion.

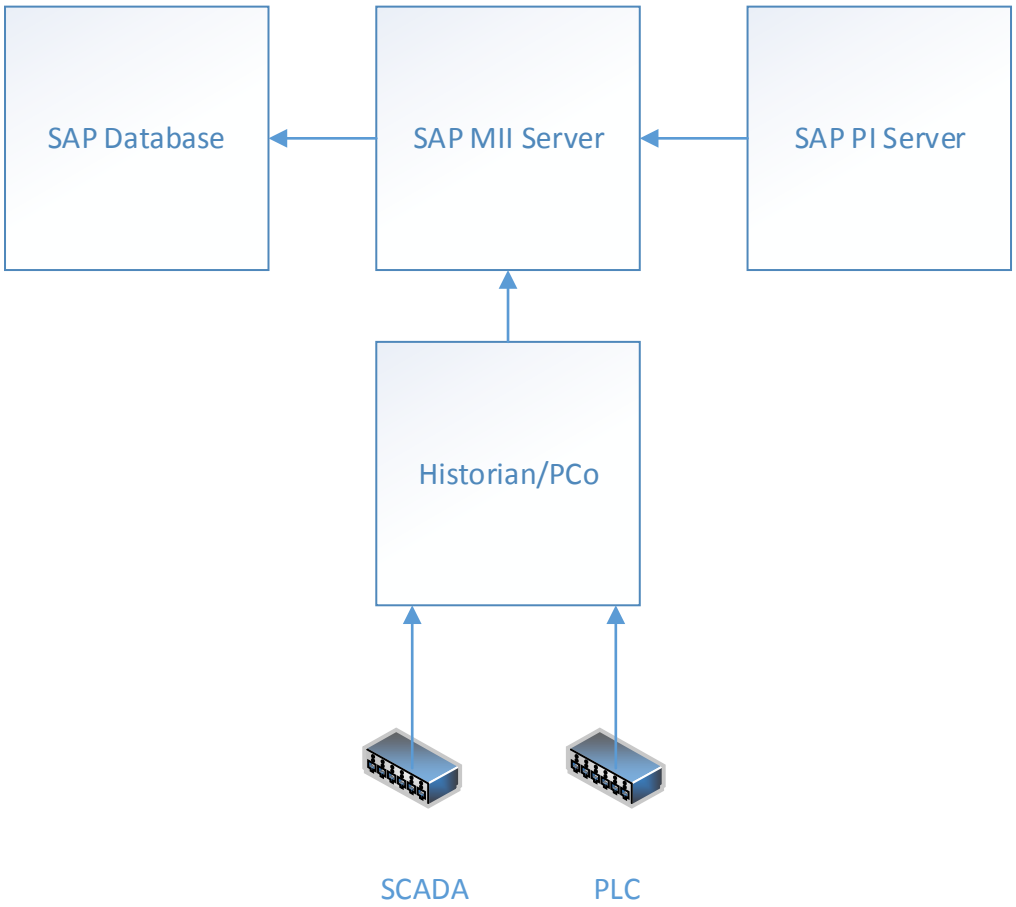
Application Overviews

- Application Definitions

Application Component	Description
SAP MII Server	Provides the development framework for the SAP manufacturing system. Can be replicated between facilities to provide a unified platform to interface with. Serves as the UI interface for the SAP MII application
SAP PI Server	The Process Integrator Server is used to interface with any 3rd party systems and bring the data into SAP for use or provide data to those 3rd party systems. Also provides message queuing.
SAP Database Server	Provides the database backend for holding all the data relating to the SAP system
SAP Historian/PCo	The Historian is the interface in which PLCs connect to and stores real-time data for the MII system to process. The Plant Connectivity agent can be installed on this system to reduce latency between the two systems and connects to the MII Server
Programmable Logic Controllers – PLC	Used to control the manufacturing equipment in automated fashion

Supervisory Control and Data Acquisition - SCADA	Provides remote systems with data from machines

- Application Design Overview



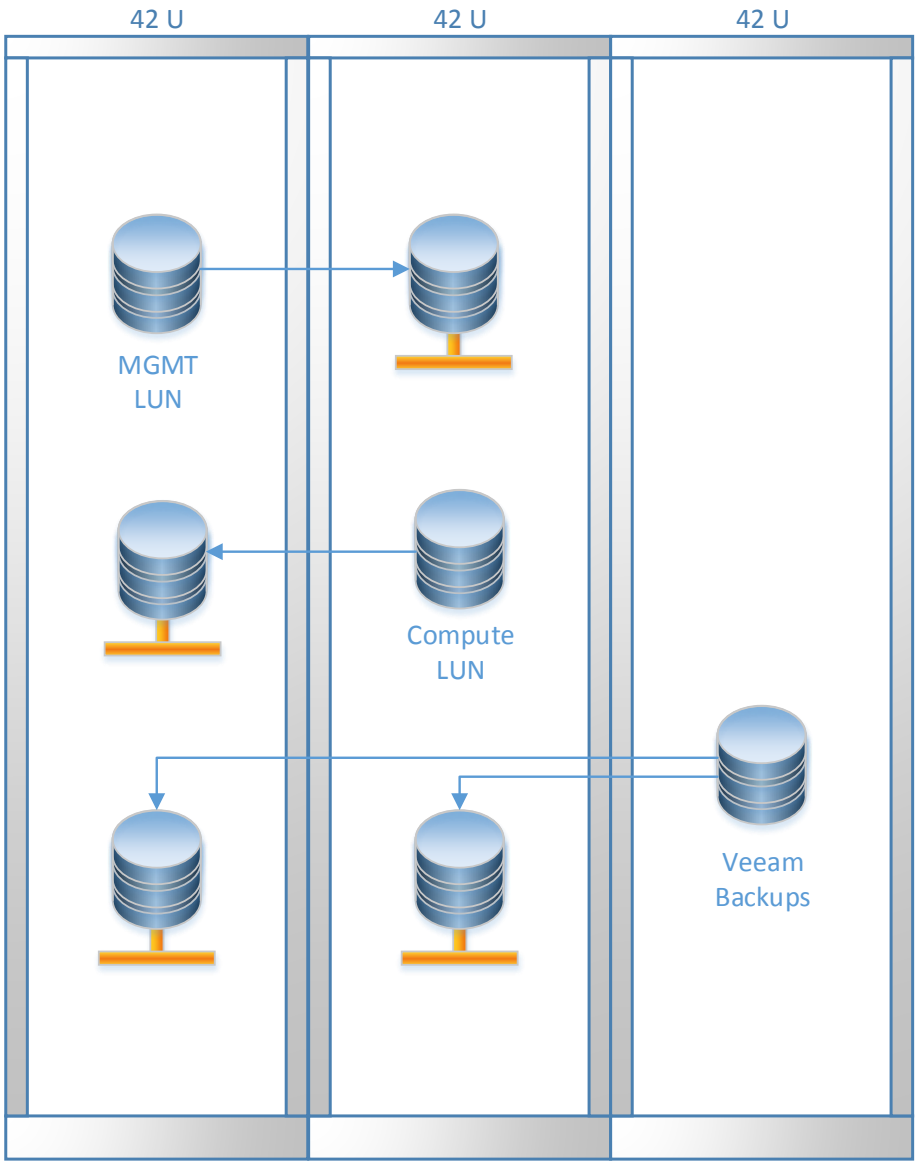
Backup, Recovery and Replication Overviews

- Veeam Backup Server
  - Master Server Configuration
    - Server storage will come from Rack 3
    - Attached 5TB disk to hold backups
    - Weekly Fulls, Nightly incrementals
  - Proxy Configuration
    - 1 Proxy Server per Rack
      - Pinned via DRS rule
  - Storage Configuration
    - Veeam Master will hold Backups on 5TB VMDK
- Solidfire Replication

Solidfire provides built-in array-based real-time replication for Disaster Recovery purposes. Given that the manufacturing facility does not have off-site DR capabilities, the LUNs will be replicated between

racks 1 and 2. Since this replication is also real-time, low latency 10Gbe connectivity should provide plenty of bandwidth to sustain the replication model without significant loss to performance.

From a fault domain perspective, in the case of an entire rack failure, the LUN can be turned into a writeable entity, and the VMs can be registered on the remove hosts and started up. Once the issue is resolved, the data can be resynchronized back to the previous storage device. The Veeam backups will be replicated to each of the three racks to provide as close to a 3-2-1 backup scheme as possible. The Solidfire system can be paired with up to 4 different systems and replicated to.



Appendix A – Bill of Materials

Equipment	Quantity
Cisco 5596UP	2
Cisco 2232TM	4
Solidfire SF6010	15
Cisco C240 M3	6
Racks	3
PDUs	6