VIRTUAL DESIGN MASTER

Challenge 1: Design Document

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Contents

This design is incomplete but it represents the overall idea and design objectives that I put together. Thank you for your time and feedback.

Overview

Scenario / Summary

As the world continues to fall into disrepair and the zombies continue to grow in number we have been tasked to help with the eventual evacuation of humanity from earth. To do so we must coordinate our efforts to lay down the infrastructure required for such as feat. Using the space facilities already in place at Cape Canaveral Florida and the Moon colony we have been able to start preparing for our departure from earth and eventual resettlement in mars.

Thanks to the generosity of our anonymous billionaire contributor we are now tasked with providing the technology necessary to build and run another 3 space depots here on earth. A web based app has been developed that will manage and control the space depots. Since this application will control critical infrastructure as well as the potentially dangerous manufacturing and testing processes it must be highly available and resilient.

Another aspect of our mission is to collect as much historical data from earth as we can find and take it with us as we travel to our new home. To accommodate this need we will need to implement a storage system that will allow us to take at least a subset of reference and historical data with us.

Base to base communications will be provided with a dual redundant full mesh topology of site to site links. Links will be fiber 10gbe backbone connections. Each one tying into a set of carrier grade Cisco routers at each site. Backup communications will be provided by satellite data links and low-frequency packet radio as an emergency management network interface.

The web application is the top priority of this project but other needs have arisen. We must provide basic communications services such as telephones and radio to the bases and colony. Each base will undoubtedly be dealing with securing their perimeter from zombie invasion as well as potential outbreaks. Therefore we will need to implement CCTV, security and intrusion alert systems, as well as newly developed viral agent detection system that would allow the application to detect the presence of the zombie inducing virus and quarantine that section of the base. Wifi and cell sites throughout the properties are also being considered.

To support the planning efforts of our relocation we will also need large blocks of compute to crunch through the data and calculations needed for space travel and settlement as well as predictions. Any compute resources not in use will be dedicated to scientific computation when it is needed, however priority will always be given to all other applications.

To provide the ability to easily scale out the hardware will be assembled in Modular Datacenter Pods. This allows the datacenters to be built in a central location and then shipped to the new sites via boat, truck, military transport airplane, or space vehicle. The pods also give us a basic unit or building block with which to expand our infrastructure if it becomes necessary. This will be done by adding subsequent pods alongside the existing ones. This will help in terms of build times, modularity, as well as portability.

The ISS will act as a monitoring and management station due to proximity and isolation. However no datacenter will be built in the ISS.

Once we have safely made it to Mars and settled there we will relocate our datacenter pods to Mars for further expansion and research of the planet.

Scope

The scope of this project should cover the physical and virtual infrastructure required to support first the space depot application as well as other critical services that are needed. Application specific designs for these other critical services may fall out of the scope of this design and will likely be addressed by their respective teams. However some thought has been given to those services in terms of sizing and capacity planning.

Requirements

ID	Requirement
R01	Highly Available - All systems require some level of redundancy
R02	Solution must be able to scale with ease
R03	Support 4 Space depots, Moon Base, and possibly Mars colony
R04	Support Highly Scalable 3 Tier App
R05	Systems should survive catastrophic failure of all other space depots / bases.

Constraints

ID	Constraint
C01	Unnecessary Power Usage should be avoided
C02	All earth locations maybe subject to attack
C03	Communications with the Moon site may be unpredictable and unreliable

Assumptions

ID	Assumption
A01	This is a greenfield deployment
A02	Satellite's Orbiting Earth have not been affected and are in good working order
A03	The Global Positioning System (GPS) is fully functional
A04	The International Space Station (ISS) is intact, Manned, and fully operational
A05	There is a space vehicle ready for launch to deliver equipment, personnel, etc, to moon base.
A06	There is high speed fiber connectivity to all over future site locations.
A07	There will be IT personnel at each site
A08	Each site will have approximately 32,000 personnel (# of personnel at NASA's Cape Canaveral during normal shuttle operations)
A09	Workload overview (cpu, ram, etc..)
A10	Zombies could attack at any time and overrun any facility, possibly all of them at the same time

Risks

ID	Risk
Rs01	Laser PTP Technology is cutting edge
Rs02	The Florida site is a single point of failure for our space efforts until other sites become operational.
Rs03	If other sites are not operational within a year hurricanes could potentially impact operations at the Florida site.
Rs04	Modular datacenters could be destroyed during transport, causing further delays
Rs05	No utilization metrics available
Rs06	A failure in deployment could cost us our only active space depot
Rs07	Radiation Damage of Equipment & Data Corruption due to Radiation exposure in space

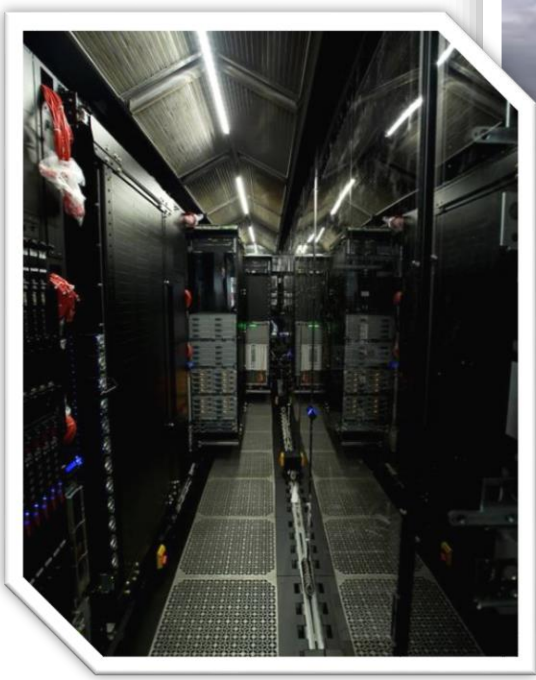
Sizing

Attribute	Specification
Number of CPUs (sockets) per host	2
Number of cores per CPU (Intel)	12
MHz per CPU core	2,700Mhz
Total CPU MHz per CPU	32,400Mhz
Total CPU MHz per host	64,800Mhz
Proposed maximum host CPU utilization	80%
Available CPU MHz per host	51,840Mhz

How many users are we supporting?	
# of VMS	
How many different classes of VMs?	
Resource Pools ?	
Storage Size?	
How many desktops?	
How many Devices?	
How many network devices (non-user)?	
IOPS?	
Bandwidth Requirements intersite? Intrasite?	
Storage	
Networking	
Compute	
Power	
Physical Space and Location Considerations	
Hardware List	
Naming Conventions	

Conceptual Solution

The main goal of this design is to provide a framework to build the computer infrastructure required to run the Space Depot Management App as well as any other applications that might be needed for day to day operations. Since scale is a large concern as we ramp up production of other space depots and bases. To address we can use a modular



approach to the design.

The base of this modular approach is a Datacenter Pod. The pod, like the one pictured below, is essentially a datacenter built around an ISO shipping container. Pods enable us to perform quick deployments, scale out in a modular fashion, mobility, and even help isolate problems to specific pods themselves (think fires). The pods come equipped with racks, Power distribution, UPS, Switched PDUs, fire suppression, access control, and A/C. Therefore providing the basic building blocks of any standard datacenter.

The next layer is Hardware. Hardware can be broken down into:

- Storage
- Networking
- Compute

These building blocks represent the hardware components that will be incorporated on top of the Pod base. Each category can be addressed in a modular approach on its own. For example we can add more storage by adding more drives to a subsystem or a whole other subsystem all together.

The virtualization layer will then allow us to apply a layer of abstraction over these resources and allow us to deploy our applications on top of this great hardware. In this case we will be using Vmware Vshpere 5.5.

The software and applications we want to run will be packaged into virtual machines and then deployed on top of the virtual infrastructure.

Orchestration and management software will then allow us to create automated processes to monitor, maintain, and even expand our infrastructure to make sure that our VMs and the apps that run inside of them always have the adequate resources they need.

The main site will be in Cape Canaveral Florida. Each subsequent site should be in the next quadrant of earth. Therefore once the next 3 sites are operational we should have a routable communications link with the space station, certain satellites, and the moon at all times (weather permitting).

Each site will deploy at least one datacenter pod. The datacenter will host the space depot control application and have enough resources to service all other local operation as well as act as a DR site for one other location. A datacenter pod will also be deployed on the moon and will act as a last resort DR location. All space depots will have an uplink to the moon datacenter and replicate data there. If all space depots on earth are destroyed the datacenter on the moon can continue to provide services for the mission to Mars.

Logical Structure

Currently there is one earth site (site E001) and the others will be built out soon. Since the Moon will be our foothold in the stars we must setup different communication links to be able to maintain reliable and constant contact with the colony base and their computer systems there. To do so the other 3 space depots will be spread out across the world so that as one base rotates out of range of the moon the next base can initiate a link and provide an alternate route for data and communications to continue.

SITES

Site ID	Location	Name/Location
E001	Earth	Cape Canaveral, FL
E002	Earth	Nasa Telescope Facility, Hawaii
E003	Earth	Europe/Africa Facility
E004	Earth	China Facility
M001	Moon	Moon Colony

Engineering Specifications

Vendors

- APC
- Cisco
- Netapp

- Vmware
- Microsoft
- Veeam
- Verto
- F5
- Riverbed

Software

- Vmware Vsphere 5.5
- Vmware vCenter
- Vmware vCenter Orchestrator
- Microsoft Windows Server 2012 R2 x64
- Microsoft SQL Server 2012
- Microsoft SQL Server 2014
- PowerShell
- Veeam
- Verto
- F5 virtual appliance for load balancing
- Riverbed Software appliance for Wan Optimization
- Cisco V1000 Switches & Routers

Physical Space

- Each data center is based around a Modular Pod that can be transported.
    - This can help to accelerate the construction of the other 3 sites. As the infrastructure could be built in Florida and then shipped off to the remote site prepopulated with all the configurations and data necessary.
    - Can also be useful for eventual space transport of datacenter to the Moon or Mars
    - The Pod comes equipped with 4x racks each with 42u of empty rack space.

Power & Cooling

- Power is being supplied by the former FPL Cape Canaveral Next Generation Clean Energy Center
- Dual Power circuits to each rack
- Onsite Diesel Generator Banks will be required (minimum 150KW output)
- In rack distribution will be 220v for efficiency
- Each rack will need to have a minimum of 30KW of power
- Redundant A/C Units
- Hot isle containment for efficiency
- APC Environmental Control and Monitoring Netbotz
- APC Vertical Switched PDU
- APC Redundant UPS Systems

Host Design

To keep with the modular nature of this design all hosts are sized equally. This also helps in that any blade can be swapped with any other blade in an emergency, as well as parts all being identical.

The system will implement a cable once strategy where all ports are populated and wired so as to reduce the need for manual human intervention. Most changes can be made by modifying the configuration in software and the committed.

Cisco UCS Blades are used in a 5108 chassis that can hold up to 8 blades and supports a total of 16 10Gb connections.

Attribute	Specification
Vendor	Cisco
Model	B200 M3
Number of CPU sockets	2
Number of Processors Installed	2
Number of CPU cores	24
Processor Model	Intel Xeon Processor E5-2697 v2 (12C, 2.7 GHz , 30M Cache, 130 W)
Processor speed	2.7Ghz
Memory	256GB Memory (16 x 16GB 1866MHz Memory)
Number of network adaptor ports	8
Network adaptor vendor(s)	Cisco
Network adaptor model(s)	Cisco UCS Virtual Interface Card 1280
Network adaptor speed	10Gbps
Installation destination	Stateless Cached
VMware ESXi server version	VMware ESXi 5.5 server latest Build

ESXi Hosts

The management cluster will be deployed using a standard install to the onboard SD card. Subsequent clusters will use auto deploy using stateless cached mode using the onboard SD card. This will make configuration changes and maintenance of the hosts much easier to handle.

Hardware

- Cisco UCS 5108 Blade Chassis
  - UCS 5108 blade chassis is complete with 4 hot swappable Platinum AC power supplies (redundant power), two UCS 2208XP Fabric Extenders (8 x 10 Gb FCoE ports each) for maximum chassis I/O through put capability, all mounting and cable accessories.
- Cisco UCS B200 M3 Blades
  - 2 x Intel® Xeon® Processor E5-2697 v2 (12C, 2.7 GHz , 30M Cache, 130 W)
  - 1 x UCS 1280 80Gb Virtual Interface Card
- Fabric Interconnects2 x 6296UP Fabric Interconnect
  - 6296UP Fabric Interconnect 1RU switch comes with 48 UP ports (UP / universal ports support - 1/10Gb Ethernet, FCoE, and Fibre Channel) upgradable to 96 ports, Layer 2 switching, redundant hot swappable power supplies, embedded UCS Manager v2.1, and all mounting and cable accessories.
- Dual Cisco Nexsus 7000 Core Switches

Time

Redundant NTP Servers will be deployed at each location. Network enabled GPS Receivers at each location will provide NTP servers with accurate time sync.

Network Infrastructure

Hardware

- Dual Cisco Nexus 7k for Datacenter Core
  - The 7k was chosen because of the ability to expand to handle expansion and scale (as required by R02) beyond something like a nexus 5k which has limited expansion.
- Cisco Carrier Grade for Edge Routing
- Cisco 3702e Wireless Access Point with Virtual Controller
- Purpose built Satellite Data link Units
- Purpose Built Point-to-Point Free Space Optics Laser Links
- Software Defined Packet Radio interface for management of devices in worst case scenario over Long Range RF frequencies

VLAN ID	Name	Description
110	OOB Management	Out of band management
120	Management	
130	vMotion	
140	FT Traffic	
150	IP Storage	NFS, iSCSI, ...
210	Network Traffic	All other unclassified traffic
220	Database Traffic	Traffic connecting to database VMs
230	Application Traffic	Traffic connecting to middle tier application VMs
310	WAN	(terrestrial)
320	Comm Links	(RF, Laser, etc…)

The Cisco Nexsus 1000v (n1kv) will be used as the virtual switch of choice. It was chosen for its granular control of traffic and QoS features.

Segmentation of traffic by type and QoS within

- Storage Traffic
- Fault Tolerance Logging
- vMotion
- Network Traffic
- Management

Cisco UCS is FCoE aware and lets us set priority levels for that type of traffic, which we cannot do through the n1kv.

Jumbo Frames and MTU

- Jumbo frames will be enabled on all ports being used for IP storage or high bandwidth traffic
- MTUs for the WAN Links, RF Links, Etc.. will have different MTU maximums and requirements . Since MTUs must be configured end to end for network to function optimally it should be taken into account when the application is written.

Cabling

All cabling should be labeled in accordance to the TIA-606-B standard.

Cable every port so that configuration can be done hands off and through software. Network configuration should be able to happen in most instances by changing the configuration of the switches and not by swapping cables. This will reduce time needed to implement changes as well as providing maximum available bandwidth when combined with port aggregation.

Storage

All data will be stored in dual Netapp Filers. The filler will be configured with FCoE. LUNS will be created to host the VMFS data stores for vsphere. Fillers will run ontap 8.0< in cluster mode. Storage APIs (vAAI) will be enabled and in use.

Storage Tiers

Tier	Drive Type
Gold	SAS SSD
Silver	High Speed SAS Spinning Disk 15k RPM
Bronze	SATA 7200

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vCenter

- 3x vCenter VMs in Linked Mode at each site
- vCenter VMs will be part of the management cluster
- Microsoft SQL Server 2012 with AlwaysOn for database HA
- Each site will have its own set of vCenter servers in a management cluster and linked in group

Management

Management of the infrastructure will use several products.

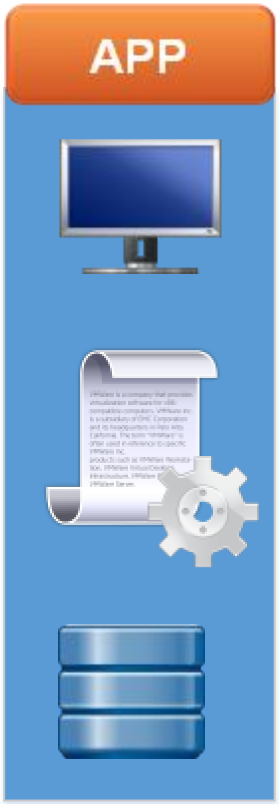
For Vmware we will use vCenter Standard combined with vCenter Orchestrator.
For some of the Microsoft stack System Center 2012 will provide management control.

Orchestration

Will be using a combination of Vmware vCO with custom developed PowerShell/PowerCLI scripts.

Application

The Space Depot Control Application is a mission critical application that must be protected at all costs as human lives depend on it. The application is a standard 3-tier application with a web-frontend, Business Logic, and database. Each tier will be composed of servers that will be clustered in order to provide availability and reliability of the application.



The web tier will be composed of Windows Server 2012 R2 Datacenter servers running IIS 8. The F5 Big-IP virtual appliance will provide application load balancing for the front end web tier.

The Business Logic will run the application server on Windows Server 2012 R2 Datacenter.

Finally the Database tier will run SQL Server 2014 Enterprise on Windows Server 2012 R2 Datacenter. High availability will be provided using AlwaysOn Availability Groups and Failover Clustering.

Using Orchestrator in combination with PowerShell we can easily scale out this model by provisioning more servers and having PowerShell configure all the pieces.

Application can be split up

- Local Functions (where local functions and computations are performed locally)
- Global Functions (Functions that must be run at the main site using

HA & DR

Site E001 will serve as the primary site for all global operations. Site E002 will serve as a DR recovery site for E001. Each subsequent site will use the closest geographical site as a DR site.

All data is also asynchronously replicated to the Moon Base when possible and offline backups are sent via rocket/shuttle.

Recovery Time Objective (RTO): 1 hour

Recovery Point Objective (RPO): 15 Min

Service Level Agreement (SLA): 99.9999% Uptime

Management

Management of systems will be performed at each corresponding site. There will be a balanced team of IT professionals and developers at each site. This will reduce the likely hood of losing all personnel of a particular skill set due to a site being compromised or destroyed.

Security

CCTV

Using IP based cameras all video data can be routed and stored efficiently without having to have additional infrastructure.

Alarm

Alarm system is IP based. Uses a combination of Sensor nodes (motion, seismic, etc..), Facial Recognition, and biological. Most systems run on embedded computers systems such as Raspberry Pi, Arduino, and Intel Galileo with Ethernet ports providing a link to the central system.

Outbreak Detection

Uses specially crafted sensors that can detect the “virus” and send alerts via network connection to trigger alarms, automated responses, and scripts.

Biometric ID

- Uses Fingerprints and Retinal Scan to ID user.
- Retinal scan can also alert if user may be potentially infected. This can fire off alerts, block certain levels of access, etc… especially useful in a case where an individual is exposed and is aware of the infection but is trying to undermine security out of self-preservation.

Access Control Systems

High security Areas are secured with a combination of Biometric, Keycard, & Pin access points. All three inputs are required. Access Control Systems integrate with Active Directory and provide reporting.

Satellite Imaging

Using satellite imaging to track zombie movements and weather patterns. The existing NSA and NOAA weather satellites fit the bill for this purpose.

Since Cape Canaveral is partially surrounded by water it helps reduce the attack footprint by which zombies could attack. Also by eliminating the bridges connecting to the mainland, attack vectors are also reduced.

Space

Space telescopes and Radio telescopes feed data back regarding possible debris, solar flare activity, and other space anomalies that could impact the success of our missions.

Deployment Plan

Phases

1. Florida Site
2. Moon Colony
3. 2nd Site
4. 3rd Site
5. 4th Site
6. Mars

Installation Guide

Physical

1) Build out Modular Container
2) Connect Utilities
3) Rack and Stack Computer Equipment
4) Cable and Label
5) Test Basic Functionality
    a) Power
    b) A/C
    c) PDUs
6) Setup PC for setup purposes
    a) Setup PC with all documentation and files for project
    b) Install all necessary management tools
    c) Prepare any necessary ISO, Executables, or additional files needed
7) Configure Networking
    a) Configure Basic Networking
    b) Configure Management Network
8) Configure Storage
9) Configure UCS, Fabric & Interconnects
10) Install and Configure Management Cluster
    a) Setup Main Esxi Hosts
    b) Setup Base Infrastructure
    c) Setup vCenter
    d)
11) Auto Deploy Hosts
    a) Host auto-deploy to Stateless w/ Caching
    b) Test Functionality
12) Install and Configure N1KV Virtual Switches
13) Install and Configure Management & Orchestration Tools
14)
15) Connect to Local Network Infrastructure
    a) Create links between Nexsus 7k to Core/Distributions layer of client/device network

16) Connect Environment to WAN Links, SAT Links, Terrestrial RF Data Links, and Laser Arrays
17)
18) Install Backup & Recovery Software
19) Perform Initial Backup
20) Test Backup
21) Implement DR Strategy & Replication
22) Test DR failover
23) Hand-off to Ops team
24) Postmortem Analysis

Standard Operating Procedures

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Other Considerations

Localization

Having different language options for the space depots in other continents and possibly a mixture of personnel at every base as well as the moon colony.

Change Management

Implementation of a change management / CMDB system will be crucial to making sure human error is reduced to a minimum.

Version Control

Version control is necessary not only to track changes but also to keep a distributed repository for all code and scripts in the unfortunate event that one of the space depots/bases are taken out.

Email

Email will undoubtedly be another application that will be required for day to day operations. Communication is key and email affords us the luxury of being able to communicate using text even in extreme circumstances where data bandwidth might be at a premium or unreliable.

Voice

In addition to email, voice communications will be the next step. Using a cisco call manager system we will be able to tie in all of the sites via VOIP.

RADIO COMMUNICATIONS

Radio Frequency (RF) Voice and Data Links play an integral part of this design as we will be dealing with off-world components that are only reachable via RF, Line of Sight Laser, or other non-conventional networking methods.

Can use Cisco iPICS to interface with existing radio platforms for communications with ISS and other emergency response infrastructure that might have survived.

Laser PTP Comm Link with Moon Base

Using freespace optics we can use laser point to point communications to establish data links with the moon base. Multigigabit links have already been tested.

http://opticalcomm.jpl.nasa.gov/PAGES/pubs.html#mgtsvr
http://trs-new.jpl.nasa.gov/dspace/bitstream/2014/17809/1/99-1257.pdf

CISCO NERV Truck & DIRT

When establishing a new site/base a cisco NERV truck could be used to establish satellite communications, setup temporary radio repeaters, provide network access, and other crucial components that could facilitate construction.

Log and Dump Collection

Network based Log and Core Dump collection should be implemented since the hosts are stateless and do not have local storage.