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Using OpenVMS Technologies to Build an Agile Computing Base

From Experiment to Production without Interruption

Robert Gezelter, http://www.rlgsc.com

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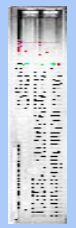
The goal – Seamless operation from Experiment through Production



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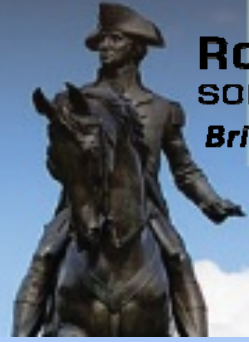
Do you use “cloud computing”?

- Scalability
- Configuration independence
- Maintainability
- Upgradeability
- Transparent failover

connect



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Maintainability

Scalability

Upgradeability

Configuration Independence

Transparent Failover

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"ility's" are results; not causes

- Specific engineering create results
- Most "cloud" presentations omit what creates the results
- Many "cloud" computing models are nothing more than "virtualized" versions of non-cloud platforms (e.g., Windows™, Linux)
- Virtualization does not solve problems (e.g., virtual machine migration)

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Is “cloud computing” new?

- The term is of recent origin
- Computing independent of being “in front of the machine” is by no means new
  - SaaS
  - ASP
  - Remote Access (1970’s)
  - Timesharing (Project MAC, circa 1963)

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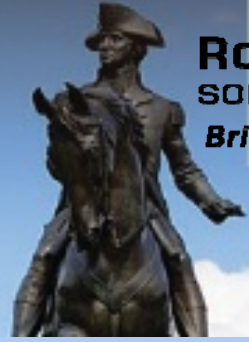
Six blind men and an elephant

- What you feel depends on where you are
- Perspectives are only a single point or slice

From Martha Adelaide Holton & Charles Madison Curry (1914), *Holton-Curry readers*, Rand McNally & Co. (Chicago), p. 108



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Often, what appears different is merely a question of perspective

- Not unlike the elephant
- Circles, ellipses, parabolas, hyperbolas, and other curves are all “conics”
- “conics” are all slices of a cone
- Analyses are all related
- Understand general case, all of the special cases are solved

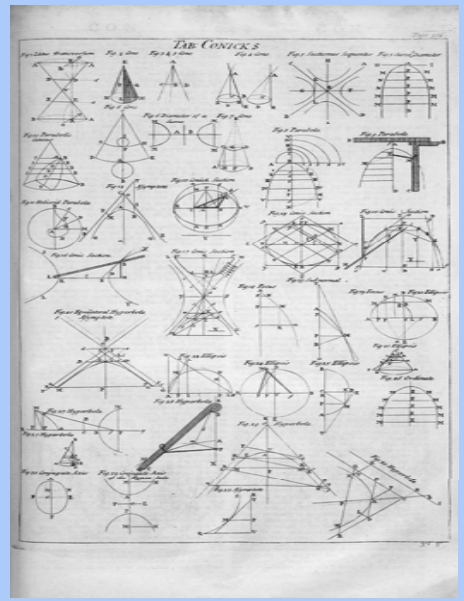

Table of Conics, *Cyclopaedia* (1728), volume 1, pp 304

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Difference between clairvoyance and reality

- Controlled and uncontrolled changes are fundamentally different
- Example: Processor upgrade
  - Known in advance
  - At “Time and Place chosen”
  - Can always be aborted

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Difference between clairvoyance and reality (cont'd)

- Example – Uncontrolled
  - "Time and task not of my choosing" (?) – Chester Nimitz, Admiral, USN, Spring 1942
  - No advance warning
  - No reschedule
  - No inherent fallback
  - Cases in point: World Trade Center, 9/11; Blade-out in a jet turbine; Spring 2004 HPTF NE US power outage

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The difference – In short

The difference can be summarized as that between a ordinary switch and a circuit breaker

- Switches work when thrown
- Circuit breakers work either when:
  - Manually
  - Automatically (when an overload occurs)
- Circuit breakers are more embracive than switches

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Back to computing: An example – Virtual machine migration vs. OpenVMS Clusters

- Comparing apples to oranges
- Virtual machine migration is a “switch”
- OpenVMS cluster failover is a “circuit breaker”
- Virtual migration is useful ***WITHIN*** the context of an OpenVMS cluster; it is not a substitute

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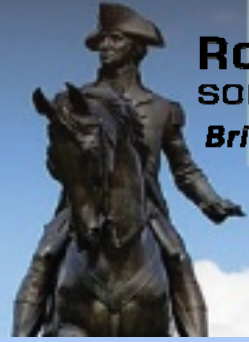
Combining existing fundamental facilities in new ways

- OpenVMS clusters
  - Shared locking domain
    - Shared system volumes
  - Logical names
  - Rolling reboot
  - Volume Shadowing for OpenVMS (aka HBVS)



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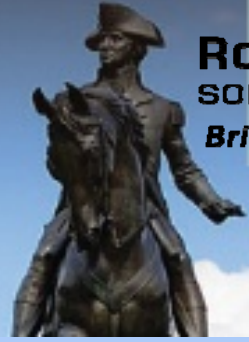
Combining existing fundamental facilities in new ways (continued)

- HP Virtual Machines (and other virtualization products from Stromasys and Migration Specialties)



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Each of these technologies is independent

- These technologies are independent
- In concert, they create an extremely malleable environment
- This flexibility allows us to transition the hosting and capacity of a cluster in any way we choose

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The fourth dimension: Time

- Hindsight is always 20/20 (if not better)
- Foresight, somewhat less so
- Capacity projects are fallible; both high/low

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Employ technology to remove shortfalls

- OpenVMS clusters address capacity up/down
- Volume Shadowing for OpenVMS allows us to change storage platforms
- Virtual machines allow:
  - Fractional provisioning
  - +(fractional second) Ready Reserve capacity
- Dynamic Volume expansion allows expansion of file volumes
- Logical names hide hardware dependencies

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Not new technologies: Change Perspective

- "short sightedness" is a common hazard
- Manuals often reinforce with "on point" examples
- The general case is often under explained and thus under appreciated

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Technologies from a high perspective

- "Not seeing the forest for the trees"
- A more global perspective aids comprehension

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Then look at point cases as one point in a long-term continuum

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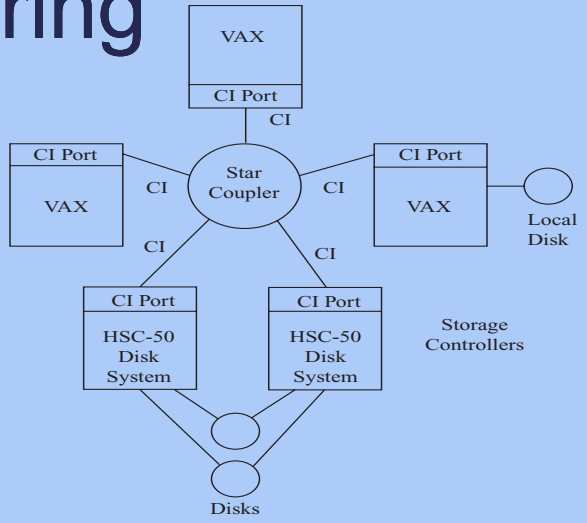
In this vein, revisit OpenVMS clustering

- Classic VAX cluster (Kronenberg, Levy, Strecker, 1986)
- Certainly valid
- Not the entire concept
- Does not illustrate the potential of the "OpenVMS cluster gestalt"



From Kronenberg, Levy, & Strecker, (1986)
VAXcluster: A closely-coupled distributed system
ACM Transactions on Computer Systems 4(2)

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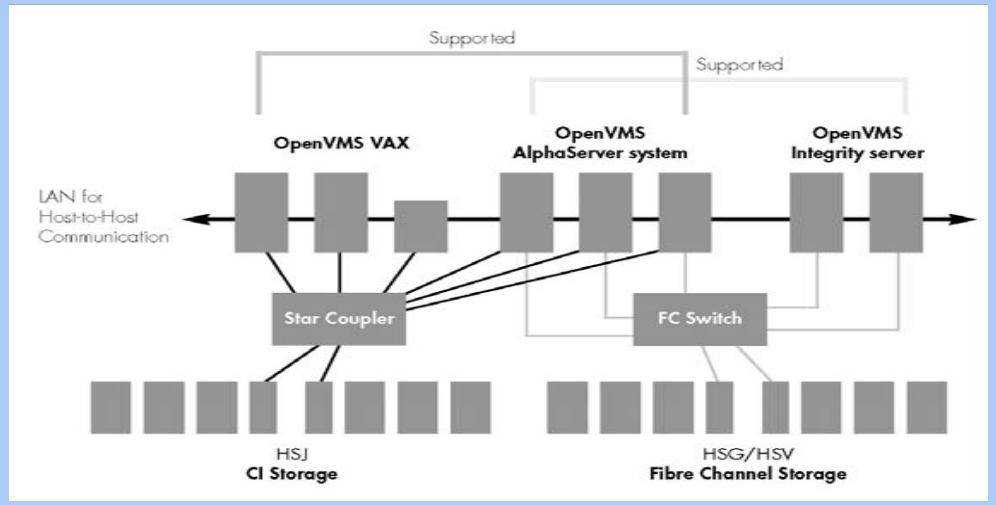
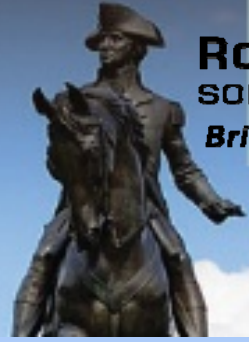
Current OpenVMS Clusters

- Even today's examples are far too restrictive
- Cluster nodes remain hardware tied
- This is an unneeded and incorrect belief





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Both classic and present are snapshots

- Both are individual moments in time
- Over time
  - a cluster node may be small, large, or non-existant
  - Over time, nodes matter
  - Nodes are independent of their hardware

Monday	Fractional VM
Tuesday	BL 860
Wednesday	<none>
Thursday	Fractional VM
…	<none>
Monday + n	Superdome

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An OpenVMS cluster node is *NOT* a :

- CPU, blade, box, or virtual partition
- System disk (or root thereof)

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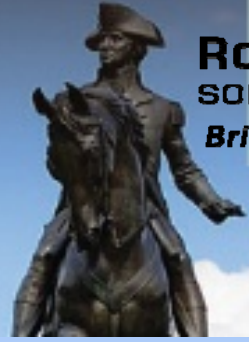
If a node is not a machine, what is it?

A member belonging to an OpenVMS cluster is identified by its Cluster ID (**SCSSYSTEMID**) and Cluster Node name (**SCSNAME**). At any given point in time, a member can exist on at most one “processor” with communications to the OpenVMS cluster. The current host processor may be real or virtual.



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An active OpenVMS cluster member has a:

- Host processor(s)
- A system volume or shadow set
- A specific system root on the system volume (**SYS$SPECIFIC**)
- Files specific to that root
- Files specific to that node (note the difference with the preceding)

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Types of nodes in an OpenVMS cluster

- Core nodes (voting)
- Satellite nodes (non-voting)

Both types of nodes may be individually virtualized at various times.

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New logical name needed: **SYS$NODE_SPECIFIC**

- New root on system volumes: **[NODE_SPECIFIC]** [Gezelter, 2009]
- Each member has a directory below this root (e.g., **[NODE_SPECIFIC.ALPHA]**
- Add logical name definition early in startup process by entering definition file in user side of **STARTUP** database (**STARTUP$STARTUP_LAYERED**)
- Inserted in **SYS$**... search lists behind **SYS$SPECIFIC** and before **SYS$COMMON**

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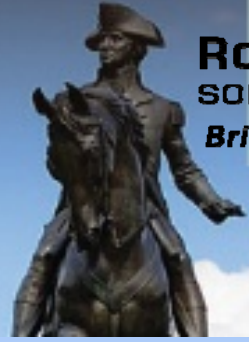
New logical name needed: **SYS$SITE_SPECIFIC**

- Logical names specific to local site [Gezelter, 2004]
- May have separate directory tree, e.g. **[SITE.<location>]**
- Add logical name definition early in startup process by entering definition file in user side of **STARTUP** database (**STARTUP$STARTUP_LAYERED**)
- Inserted in **LNM$FILE_DEV** ahead of **SYS$COMMON** and behind **SYS$NODE_SPECIFIC**



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Each OpenVMS cluster node has several alternative boot roots

- Base node definition information (**SCSNAME**, **SCSSYSTEMID**, DECnet node address, etc.) in **SYS$NODE_SPECIFIC**
- Individual boot roots hold system parameter file
- Writeable logs
- Possibly page file (could be in **SYS$NODE_SPECIFIC** or elsewhere)
- Possibly dump file (could be in **SYS$NODE_SPECIFIC** or elsewhere)

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Why separate node specific and boot roots?

- Production version
- Test version
- Previous production version
- Experimental version
- Different hardware scenarios (e.g., blade, virtual, rx2660, AlphaServer DS10)

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Separate roots – Example

Cluster member **GREEN** has:

- node specific files in **[NODE_SPECIFIC.GREEN]**
- Port Production BL860c boot root of **SYS1**
- Starboard Production BL860c boot root of **SYS11**
- Emergency rx2660 boot root of **SYS21**
- Test BL860c boot root of **SYS31**
- Experimental boot root of **SYS41**
- etc …

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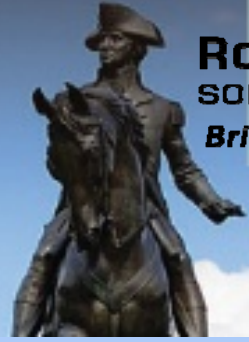
Specific boot roots invoke Node-specific files

- **STARTUP** series command files (e.g., **LAT$SYSTARTUP.COM**)
- **AUTOGEN** files
- Test within “Experimental Boot root”, promote to “Production” roots or Node-specific directories
- Similarly, promote from Node-specific to **SYS$COMMON** as appropriate



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About system volumes

- Characterizing OpenVMS as a “single system image” cluster understates the case
- “single system images” (e.g., shared system disk) is a possibility; but it is only one of many
- “a copy of the system that may be used by zero or more nodes at any point in time” may be a more appropriate description
- At least one (preferably more) per architecture per cluster at any moment in time

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System volumes are similar to boot roots

Per architecture:

- Port/Starboard Production (or more depending on load) copies
- Test copies for upgrading
- Previous copies for fallback
- Experimental copies as needed
- Master copy

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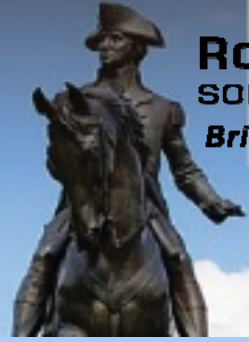
Treat system volumes same as applications

- Clone masters for “Production” copies
- For “Upgrades” or “Installations”
  - Clone master creating test system volume
  - Perform update/installation
  - Following test; promote Test to master
  - Create one/more new Production clones
  - Phase in use of new Production clones; phase out previous set of Production clones



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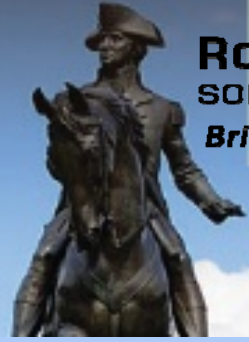
Steady state:

	Port			Starboard		
Alpha	(SYS0)	SYS5	SYS9	(SYS0)	SYS5	SYS9
	SYS1	SYS6	SYS10	SYS1	SYS6	SYS10
	SYS2	SYS7	SYS11	SYS2	SYS7	SYS11
	SYS3	SYS8	SYS12	SYS3	SYS8	SYS12
Itanium	(SYS0)	SYS105	SYS109	(SYS0)	SYS105	SYS109
	SYS101	SYS106	SYS110	SYS101	SYS106	SYS110
	SYS102	SYS107	SYS111	SYS102	SYS107	SYS111
	SYS103	SYS108	SYS112	SYS103	SYS108	SYS112

Active System Root
Inactive System Root

From *Evolving OpenVMS Environments* (Gezelter, 2009) presented at the 2009 HP Technology Forum, Las Vegas, NV (June 17,2009)



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About cluster members:

OpenVMS clusters are often incorrectly described as being a "***n***-node cluster". A better phrasing would be "normally a ***n***-node cluster".

Why?

- Sporadically operating test nodes
- Scheduled expansion (daily) nodes (e.g., "Wildfile')
- Pre-configured expansion nodes (often non-voting)

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Surge capacity ("call up the reserves"):

- Pre-defined satellite "worker" nodes
- May be physical (e.g., blade, test system, quality assurance systems, training systems)

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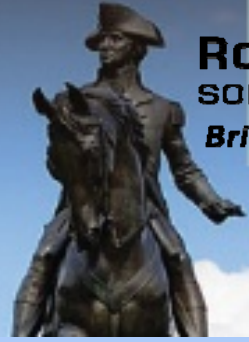
"Oh &^%**&$#; get 10,000 (or more) VUPS online now!!!!!

- Remember those pre-configured reserve production roots?
- Consider:
  - Virtualizing test/quality/assurance/training systems
  - Creating a nominally, high priority reserve production cluster member instance in a different VM on the same physical host hardware.
  - 90+% return of capacity in under one second; reduced impact on normal users (test, QA, students)



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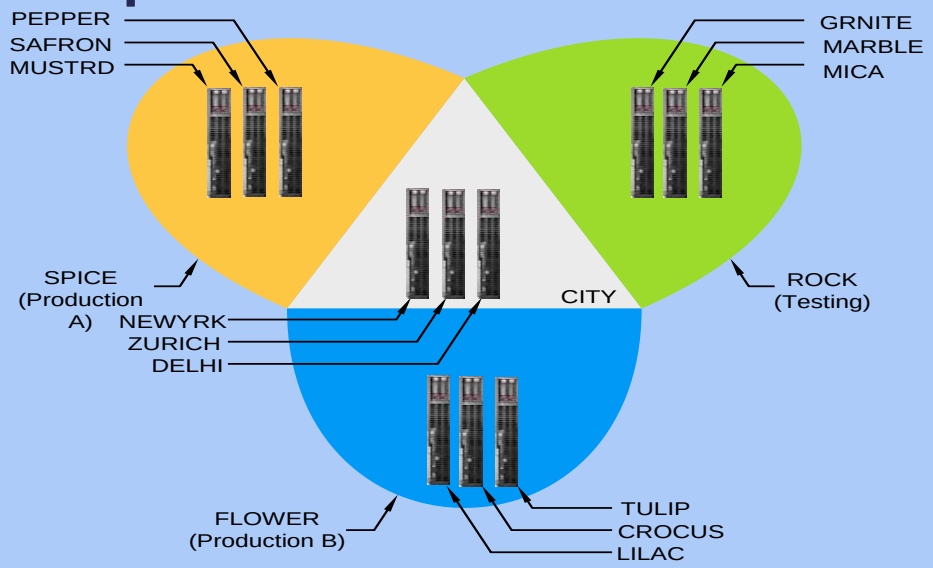
Hardware assets become a "pool":

- Assets are fungible
- Reallocate as needed
- Virtual slices can be quickly pre-empted



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This is not theoretical

- This is all completely legal OpenVMS
- Nothing has been done which has not been supported
- Fall forward; not fall back
- Shortened downtime
- Agility ≡ pre-provisioned and prepared
- This is an “OpenVMS” private cloud with all of the attributes of a virtually hosted servers on other platforms

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Back to the original problem – Prototype to Production without Interruption

- There are multiple variables, each of which can prevent success
- Look at successful episodes, is there a common thread?

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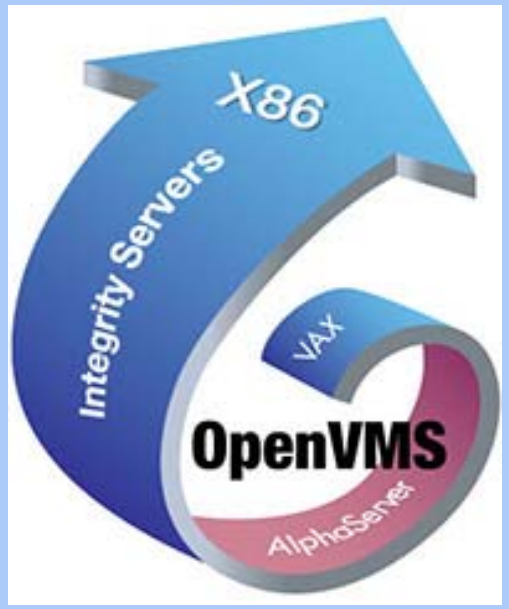
How does OpenVMS do it?

- Since 1976, OpenVMS has run on
  - VAX
  - Alpha
  - HP Integrity™
- Some users and engineering have done this without disruption
- What is the “secret sauce”?



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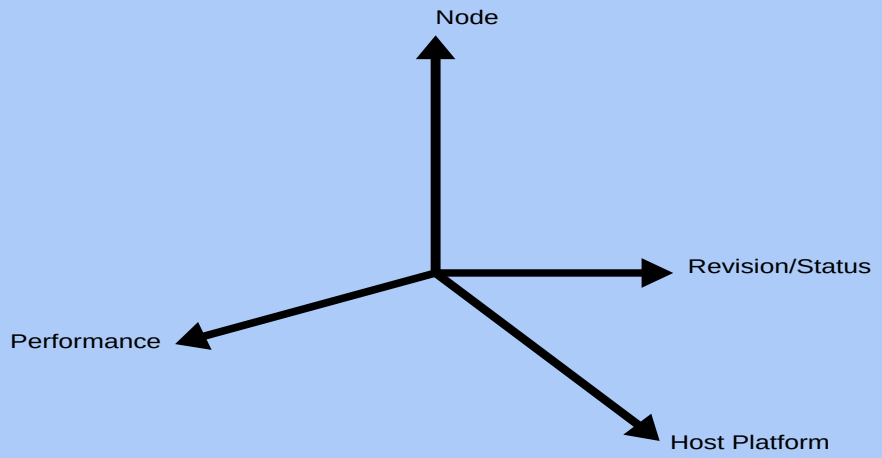
Difference issues are independent, not linked

- Each one is independent



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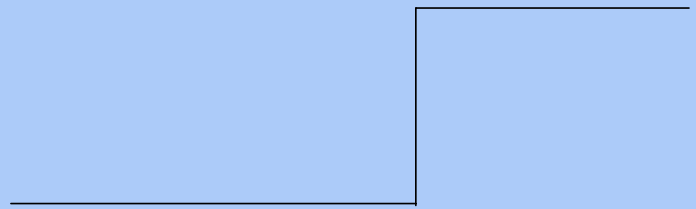
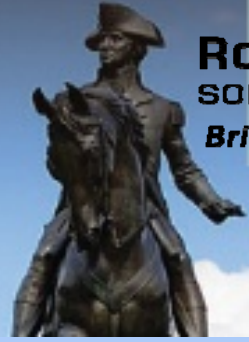
What is the challenge?

- Quantum transitions
- High risk
- No control
- Difficult to retreat





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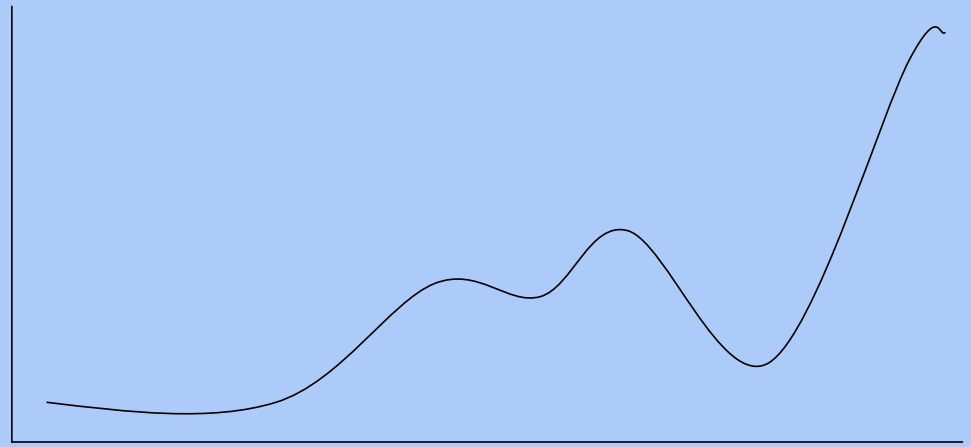
A better approach – Incrementalism or Gradualism

- Calibrated changes
- Do change as can be accommodated
- Amount at risk is calibrated by business and technical considerations



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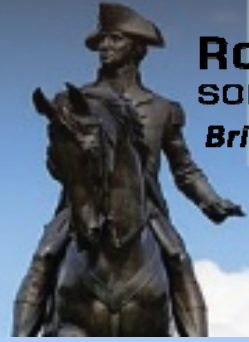
Continuity is the goal

- The OpenVMS trademark – rolling upgrade
  - Switch architectures
  - Switch system disks
- The constant is the “cluster member”, not the disk, CPU, or architecture



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Toward the future is often a teleological trap

- The future is inherently unclear and unknowable
- Evolution is in the current, not the future. Effort will not be expended for something that is not an immediate advantage
- Change is constant
- Positioning for change is the foundation of agility

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Dealing with load

- Pre-configured worker members
- Instant availability surge capacity as already active members on slices of virtual processors
- Difference between activity surge and flash spike
- Flash spike created by
  - Member hardware failure or crash
  - Flash spike in demand
- Long term phenomena are different

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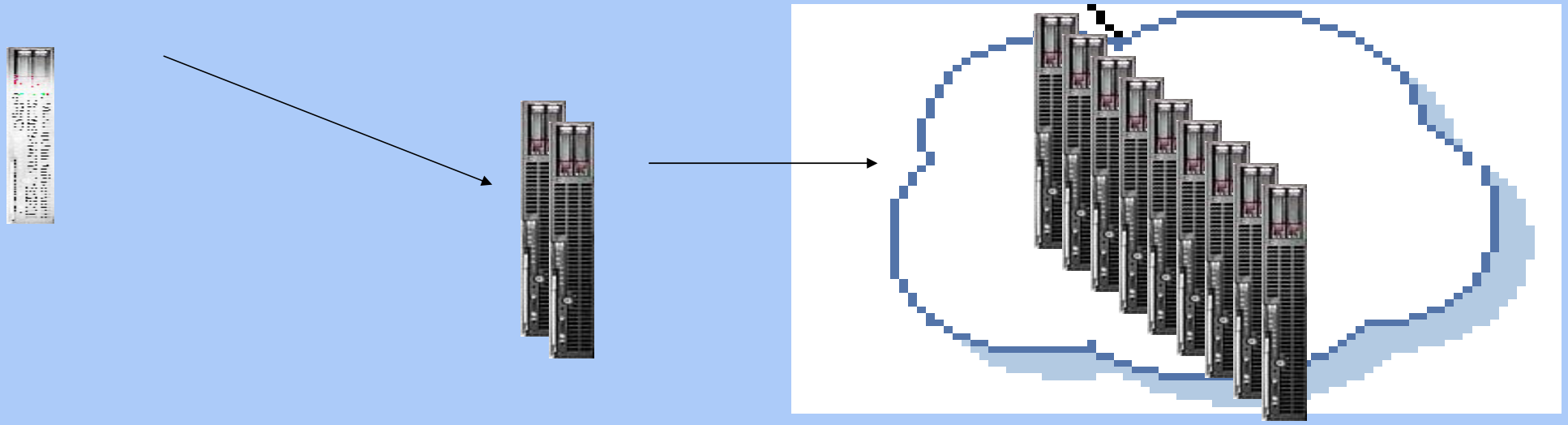
Back to our goal: Experiment through Production without interruption



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Each step in the lifecycle is not significant

- Each increment is nothing more than a change in
  - Capacity
  - Host
  - Architecture
  - Version or revision
- "rolling reboot" is the core:
  - Add new member to cluster
  - Remove/reboot old member

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Initial configuration

- "Soloist OpenVMS Cluster" [Gezelter, 2009]
- Configuration
  - Single node OpenVMS cluster
  - Single member shadow sets (system disk, data disk)
  - Fractional CPU hosting
    - HPVM
    - Stromasys Charon
    - Migration Specialties Avanti
- De minimis capital costs for prototype applications

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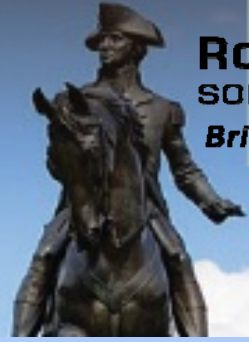
Capacity increases over time

- Increase virtual slide
- When appropriate, add real hardware
  - Boot in second member
  - Member may be spare free-standing; or it may be a blade
  - Up to a certain point, it can be increasing slices of a virtual processor
  - Business decision, the technical architecture is agnostic on the details of the provisioning



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Disk storage

- All volumes members of shadow sets
- For ordinary disks
  - Use 1-member shadow sets
  - Transition to different hardware or array by temporarily creating 2-member shadow sets
- For all shadow sets
  - Dynamic volume expansion enabled
- See “Migrating OpenVMS Storage Without Interruption” [Gezelter, 2007] HPTech Forum 2007

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Operational considerations

- Volumes that are shadow sets can be migrated without interrupting normal operations
- User indistinguishable
  - File resident virtual disks
  - Real disks
  - MSA
  - EVA
  - Reconfiguration thereof (RAID)

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The key underlying principle

- Changes in all cases are user indistinguishable.
- If no user perception of change, change did not happen

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Where to start?

- Start process where appropriate
- If “budget challenged” the “on-ramp” (entry point) is
  - Fractional virtual CPU slice (VAX, Alpha, Integrity)
  - One/two single member host based shadow sets (may be containers a.k.a. file based “virtual disks”
- Anywhere in between, this is a business decision

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Summary

- "Highly agile" is the result of preparation
- Many "cloud" offerings have substantial undisclosed and undocumented approaches, e.g., "Trust us"
- Infinite capacity is physically impossible
- Calling on reserves quickly without user disruption is the long term key

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Questions

Slides and other materials:

http://www.rlgsc.com/openvms-bootcamp/2014/agile-openvms.html

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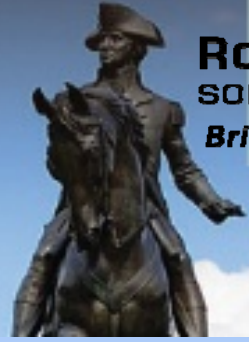

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