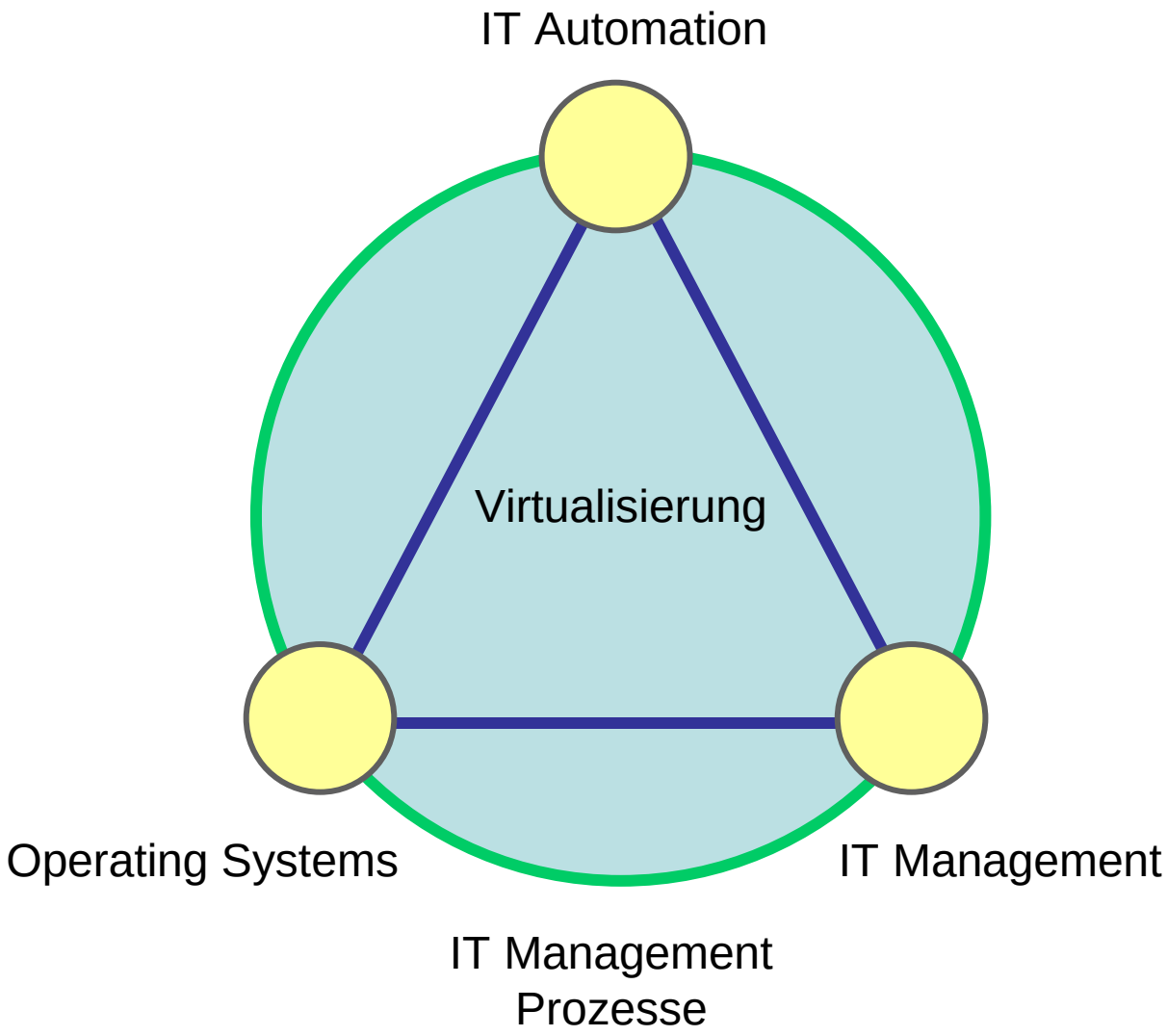
Virtualized IT Infrastructures and Their Management

Dr. Sven Graupner
Hewlett-Packard Laboratories
Palo Alto, USA


IT Automation
Virtualisierung
Operating Systems
IT Management
IT Management
Prozesse

Why is Virtualization such a Topic?

- Because it is being sold to customers with good arguments:
  - Average 10-30% system utilization on Windows and Unix production systems
    - address “Server Sprawl”, IT consolidation, denser environment
  - Improved Production Agility
  - Test and Development Host Optimization
  - Reduction in variation and complexity
    - Servers
    - Desktops
  - Reduce data center TCO
    - Hardware, Electricity, Environmental
  - Disaster Recover / Improved MTTR
    - Restore an image to a target virtual host

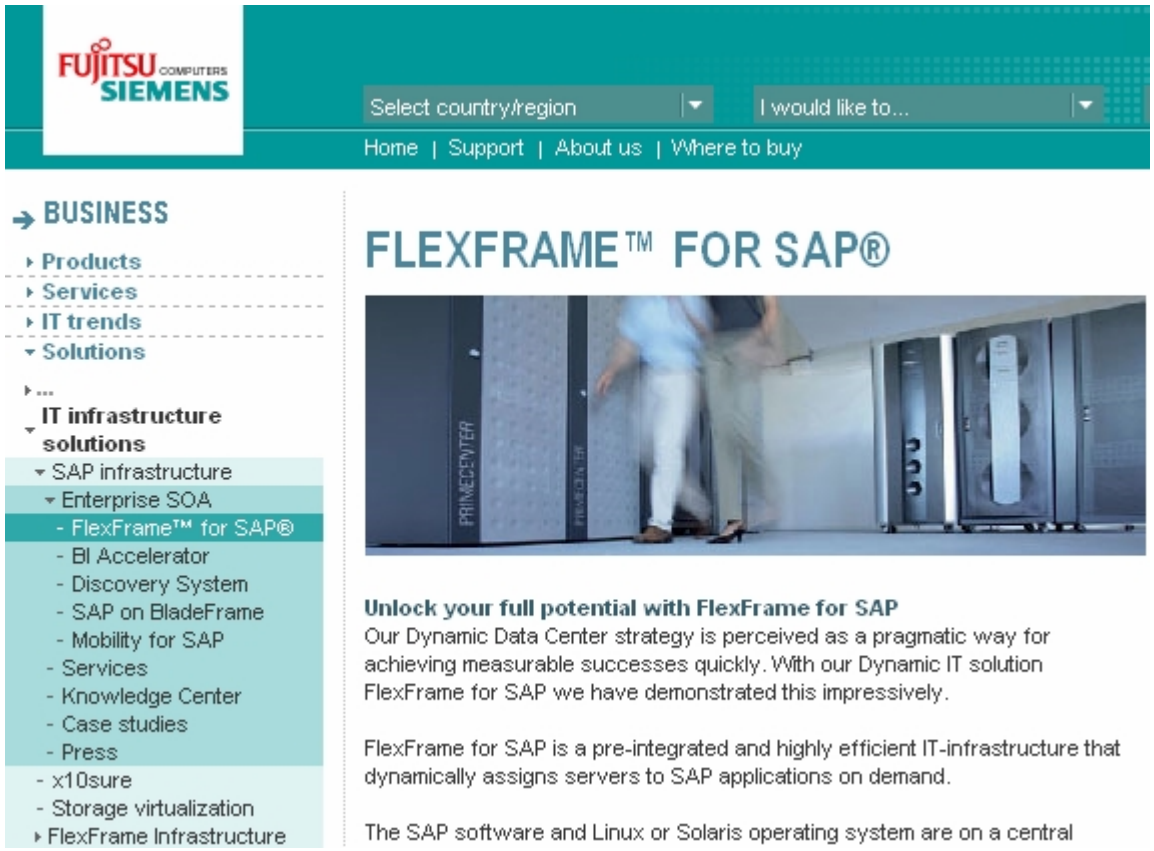
vmware

Virtualization is Everywhere

- HP c-class Blades with Virtual Connect (VC)

- run VMWare/VMotion on VC, both management systems are unaware of one another

Integrated Solutions using Virtualization



Managing Virtualization in IT

“Virtualization is such an old concept,
why is there a problem?”

“What is the problem?”

“If there is a problem,
how can it be addressed?”

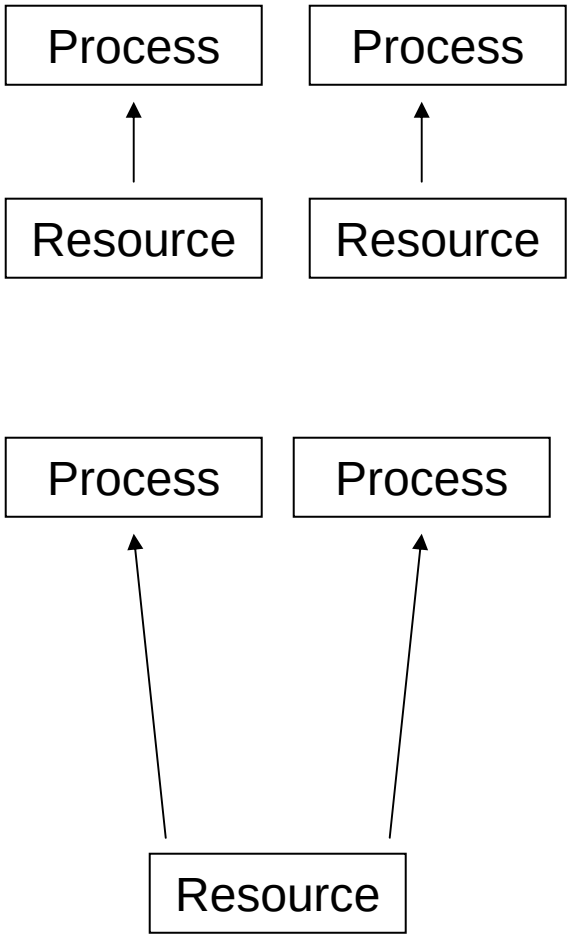
Virtualization

- Operating system view
  - Resource abstraction for processes
- IT infrastructure view
  - Virtualization describes the separation of a resource or request for a service from the underlying physical delivery of that service (vmware).
  - Pooling and sharing of resources in a data center, including servers, storage and networking (hp).
- IT services view
  - Abstraction of IT services from systems
- Business services view
  - Abstraction of business functions from IT services

Virtualization

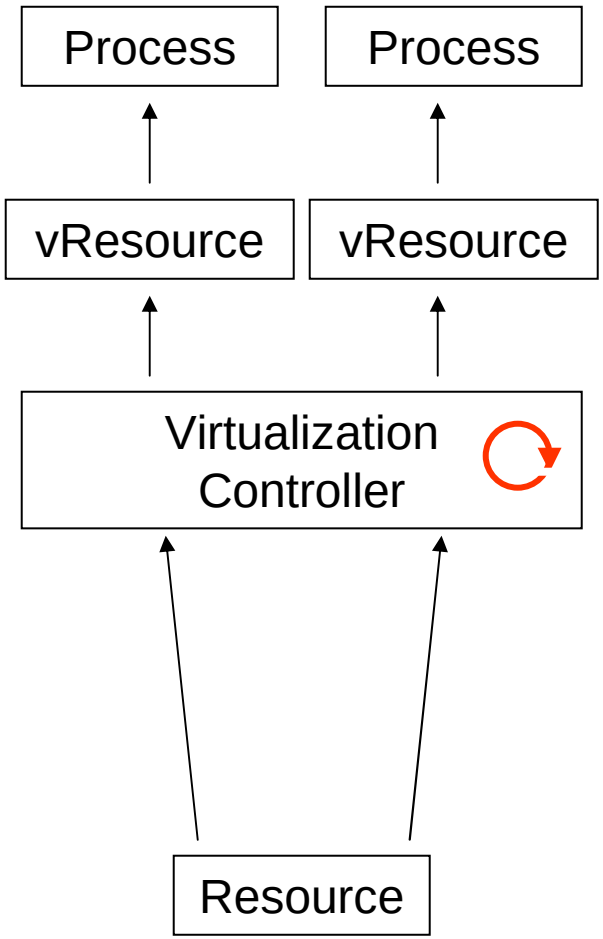
- Operating system view
  - Resource abstraction for processes
- IT infrastructure view
  - Virtualization describes the separation of a resource or request for a service from the underlying physical delivery of that service (vmware).
  - Pooling and sharing of resources in a data center, including servers, storage and networking (hp).
- IT services view
  - Abstraction and separation of IT services from systems
- Business services view
  - Abstraction and separation of business functions from IT services

Processes and Resources



- Single process with exclusive resource
  - underutilizing resources
  - process throughput low (others wait)
- Parallel processes with parallel resources
  - requires multiplication of resources
  - often not economical due to multiplied resource cost
- Parallel processes sharing a resource
  - often a good compromise
  - coordination required between processes -> complexity
- Automating and hiding coordination from processes

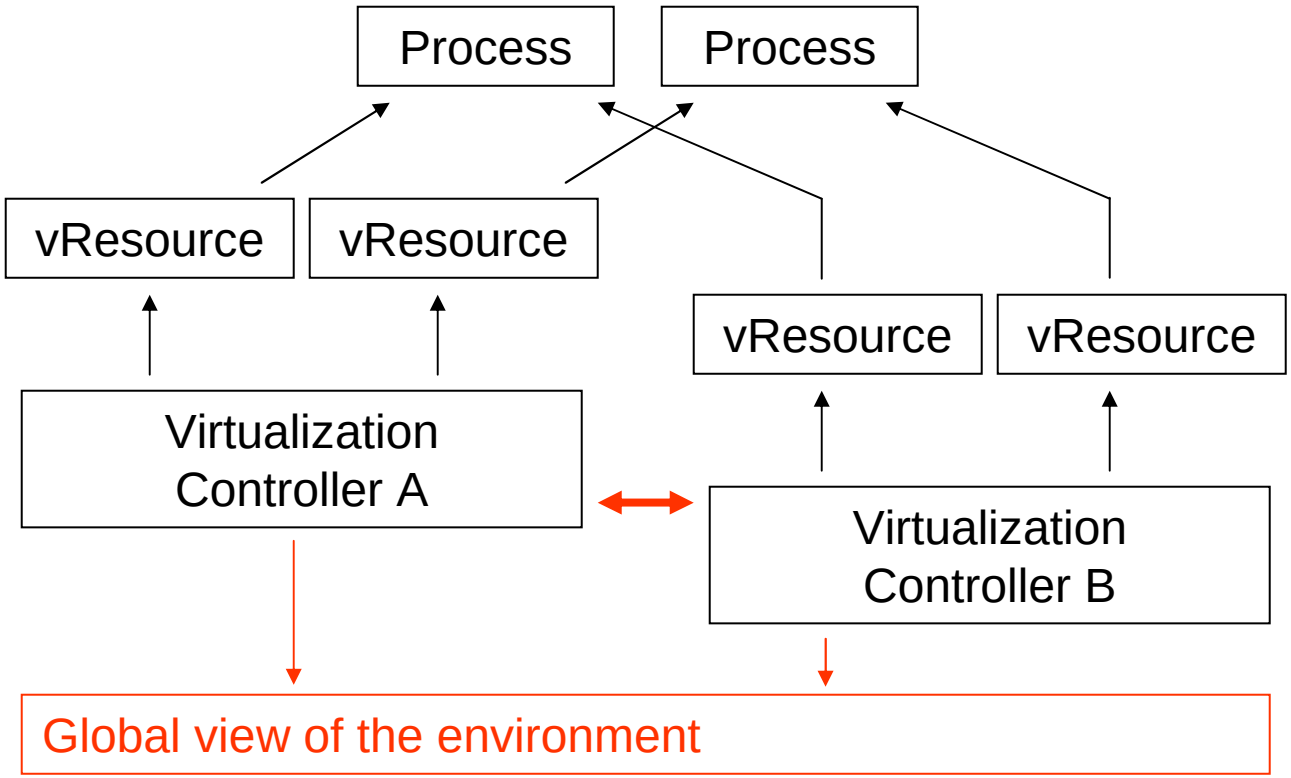
Virtualization



- Parallel processes with parallel virtual resources
- Virtualization Controller arranges the:
  - multiplication / creation of virtual resources
  - assignment to processes
  - mapping to the underlying physical resource or resources, often by multiplexing
- Ideally, the virtualization controller operates automatically and transparently for processes and resources

Virtualization

- Processes need more than one resource, which may be virtualized as well
- Virtualization Controllers must coordinate based on a global view of the environment



Virtualization in Computers

- Virtualization is fully managed by Software (Operating System) in a coordinated way
  - Memory
  - Processors
  - Disks
  - Peripheral devices

Virtualization in IT

- People create and manage virtualized resources
  - Machines
  - Storage
  - Networks
- People also manage physical IT resources
- People are aware of physical and virtual resources, their mgmt systems are not

The Bright Side of IT Virtualization

- Simplified, denser and more streamlined physical IT environment
- Better resource utilization, chance of higher ROI if managed well
- Enhanced capabilities, e.g. easier migration
- Easier provisioning of resources, e.g. for test&dev purposes

The Dark Side of IT Virtualization

- Lack of management practices, skills and systems
- Build-up of virtualization silos and stacks
  - caused by explosion of virtualization capabilities by vendors
- Intransparency
- Intertwined dependencies, unpredictability
  - unpredictable performance due to unknown sharing policies; isolation harder; ripple effects of failures; root cause analysis harder;
- Virtual resource sprawl
  - VMs, disks, networks – easy to create, not identified and registered as inventory, often lost + forgotten
- Physical world may look nice, but the virtual messy

Core Problems in Virtualization Management

- Virtualization Controllers are unaware of one another
- No single, coherent view exists that spans physical and virtual worlds, e.g. needed to assign monitoring data
- Context of virtual or physical resources not captured
- Unclear status of virtual resources wrt existence, identification and ownership (“unassigned”, CI in CMDB)
- Often not seen as managed entities; hence management processes are not applied, e.g. change, release, config
- Lifecycle of virtual resources often undefined, must include design stages, creation, assignment, inactivity, destruction

Core Solutions to Problems
Virtualization Management

- Connect and integrate Virtualization Controllers
- Establish a single, coherent view that spans physical and virtual worlds (Information Model)
- Define context of virtual or physical resources (Topology)
- Recognize status of virtual resources as existent (even if not active), with clear identification and ownership
- Recognize virtual resources as managed entities and apply management processes
- Define lifecycle for virtual resources including design stages, creation, assignment, inactivity, destruction

Problems will not be Solved Anytime Soon

- Subject to enhancements in IT Management practices, standards and systems

- Subject to research in IT Management (e.g., what can be learned from Operating Systems?)

Synergies between OS Concepts + Data Center Infrastructure Management

- Structural
  - Layers -- application, OS, hardware
  - Components – application, OS, hardware
  - Interfaces -- OS, HAL, drivers, component interfaces
- Functional
  - user, process, persistent data management, all based on basic
  - resource management (scheduling, sharing, isolation)
  - resource abstraction + creation (OS creates resources by properly configuring hardware components)
- Organizational
  - scope of the information maintained by the management system
  - policy (for automated decision making)

Enhancements in IT Management for Virtualization

- Standards:

  DMTF VMAN Initiative, Nov'07

  http://www.dmtf.org/initiatives/vman_initiative/

  DMTF Open Standard for System Virtualization Management Initiative

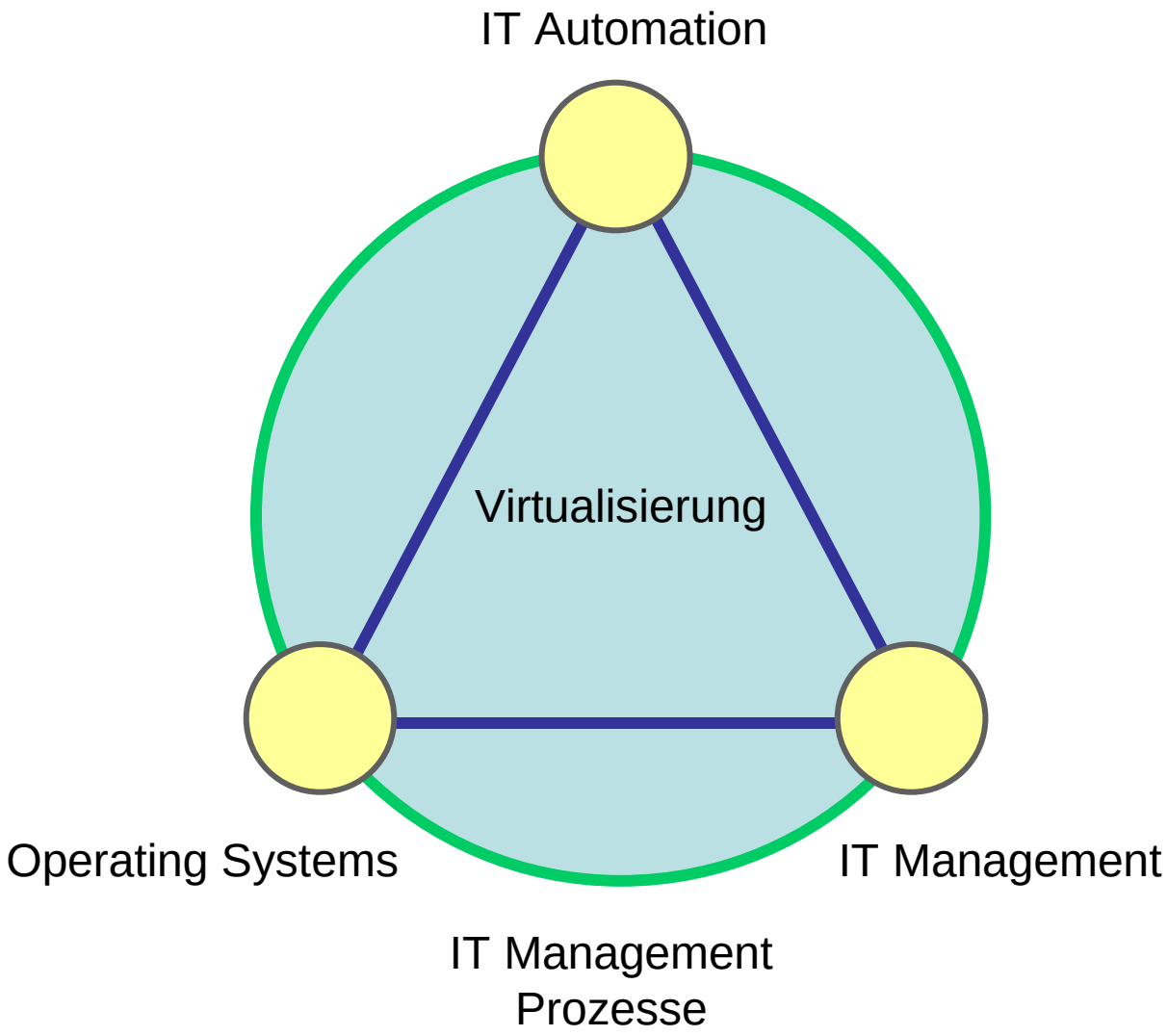
  http://www.dmtf.org/newsroom/pr/view?item_key=70d5d3ba78d39488626f838397a3d1e9812e5d40

- Practices:

  ITIL + Virtualization, a number of publications, topic of workshops and conferences, e.g. SVM'08, MANWEEK'08

- Systems:

  support emerging, e.g. HP uCMDB discovers and recognizes lifecycle of VM's


IT Automation
Virtualisierung
Operating Systems
IT Management
IT Management
Prozesse

Virtualization + IT Management

Beyond introducing virtualization as a technology, the impact on management practices is often underestimated, such as the impact on:

- Change Management
- Configuration Management
- Release Management
- Incident Management
- Problem Management
- Service Level Management
- Availability Management
- Capacity Management
- Continuity Management
- Financial Management
- Security Management

Virtualization + Change Management

- Can IT manage risks associated with changes to services?
- 80% of availability problems can be tied to human error.
- The ability to deploy a change to a 100 hosts may automate the ability to crash 100 hosts unless careful.
- Risks associated with changes must be managed.
- How will Change Management process handle requests for virtual hosts?
- Is there anything special that must be taken into consideration?
- How can one answer the prime question – “What changed?”
- How can failed changes be rolled back?

Virtualization + Release Management

- Can IT reliably deploy new and changed services into production without negatively impacting the business?
- How will the deployment of virtualization technology be managed?
- Project management, stakeholders, testing, rollout
- How can virtualization enable test and development environments to mirror production?
- How will the deployment of virtual hosts be managed?
- Can images be retained and governed by change management?
- Far faster to build, or rebuild, from an image than manually.

Virtualization + Incident Management

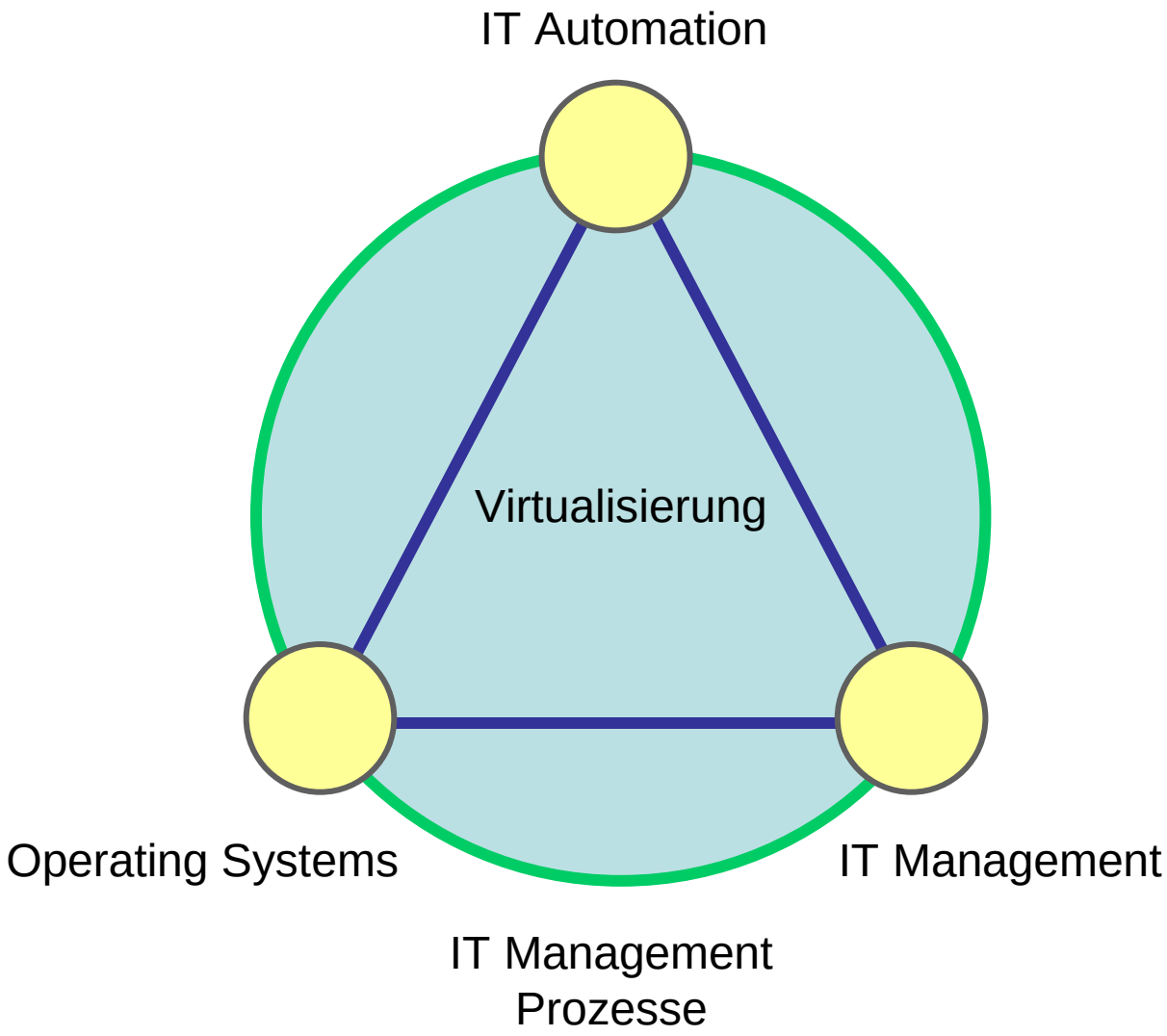
- Can IT assist users in the speedy recovery of services or service requests?
- Does the Service Desk know about proposed changes and the schedule? (Don't surprise them on Monday morning!)
- Do any scripts need to change when the Service Desk takes a call involving a virtual host? Are there any new questions or branches?
- What training does the Service Desk need?
- What monitoring is needed?
- Do alerts and alarms route through Incident Management?
- How can virtualization reduce MTTR and the Incident lifecycle?
- Occur, Detect, Diagnose, Repair, Recover, Restore Service.

Virtualization + Problem Management

- Are root causes established to address trends and/or prevent incidents from occurring?
- How might virtualization affect root cause analysis?
- What data can be collected from virtual hosts to aid in problem analysis?
- What should problem managers be looking for in terms of proactive problem management?

Virtualization + Capacity Management

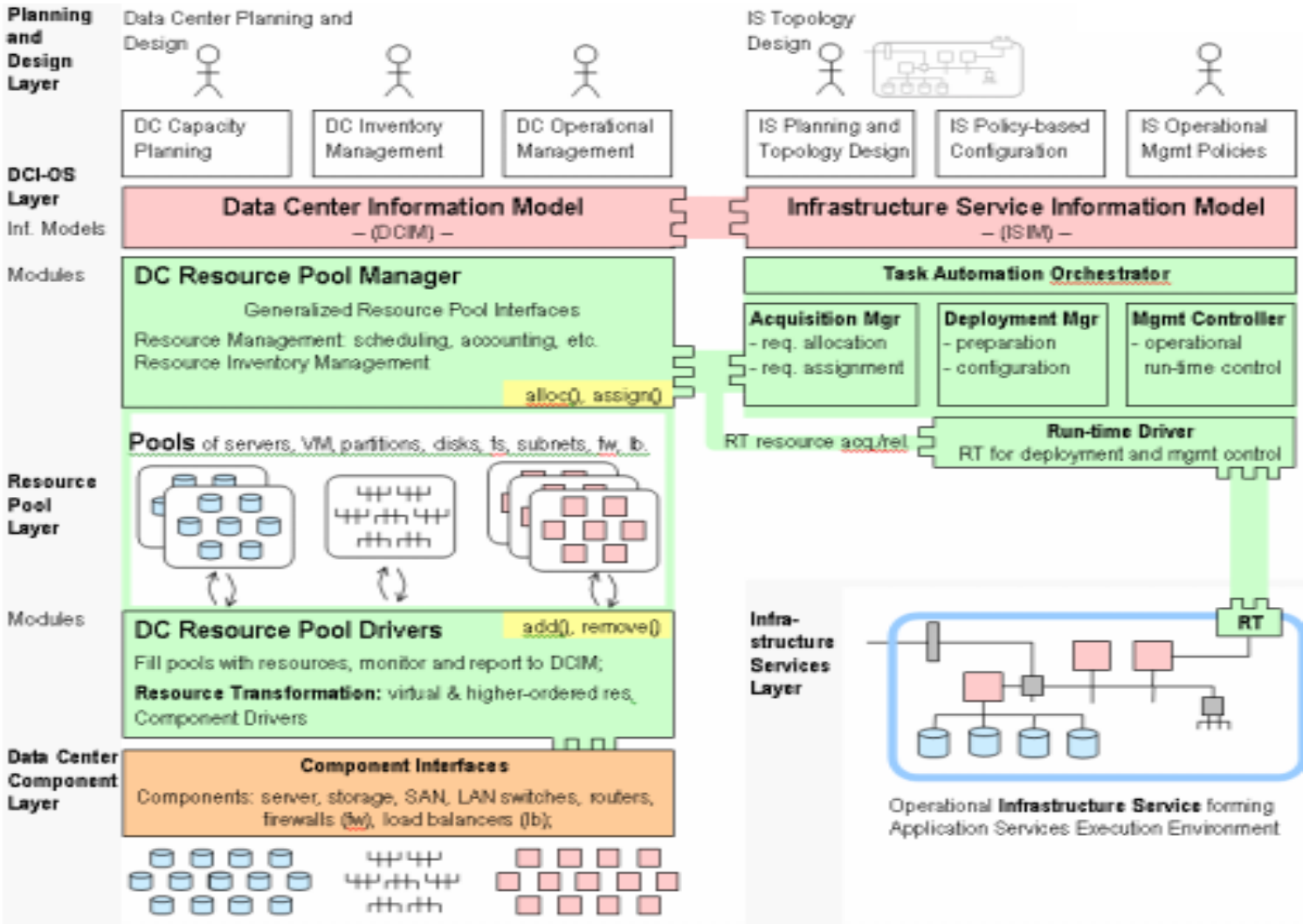
- Can IT provision services with adequate capacity to meet the needs of the business both now and in the foreseeable future?
- One of virtualization's greatest benefits is in improving capacity utilization
- First, understand business capacity requirements
- Regular meetings and review of business planning documents
- What are the IT service capacity requirements needed to meet this?
- What component resource capacity is needed?
- What are target thresholds?
- How can virtualization enable better utilization of capacity?
- How can demand be managed to perhaps reduce capacity escalations?
- Proper SLAs that include Capacity and performance requirements are very beneficial!


IT Automation
Virtualisierung
Operating Systems
IT Management
IT Management
Prozesse

Research Related to IT Management for Virtualization

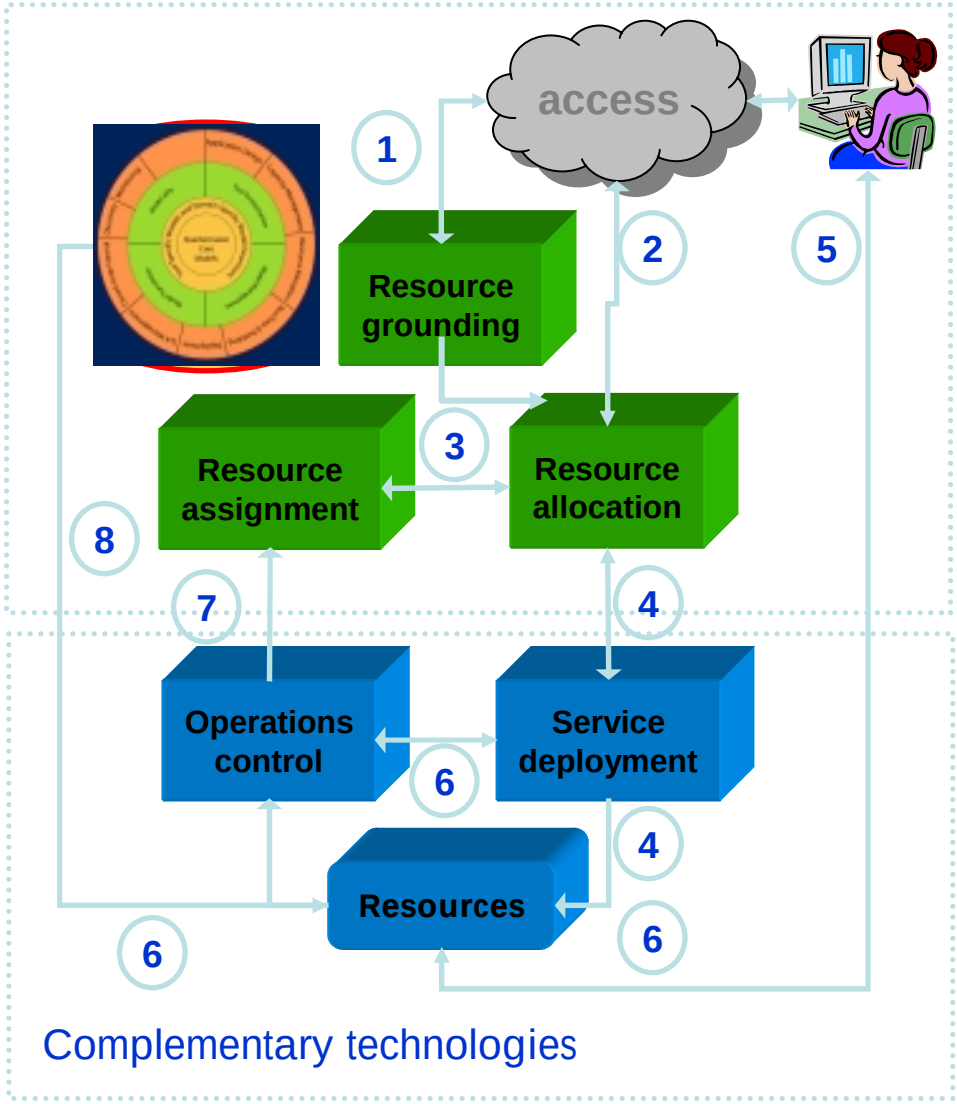
- Understanding aggregated workloads
- Automating virtualization decisions
- Tuning virtualization parameters
- Automating virtualization management
- “Data Center Operating System”

Architecture of a Data Center Infrastructure Operating System

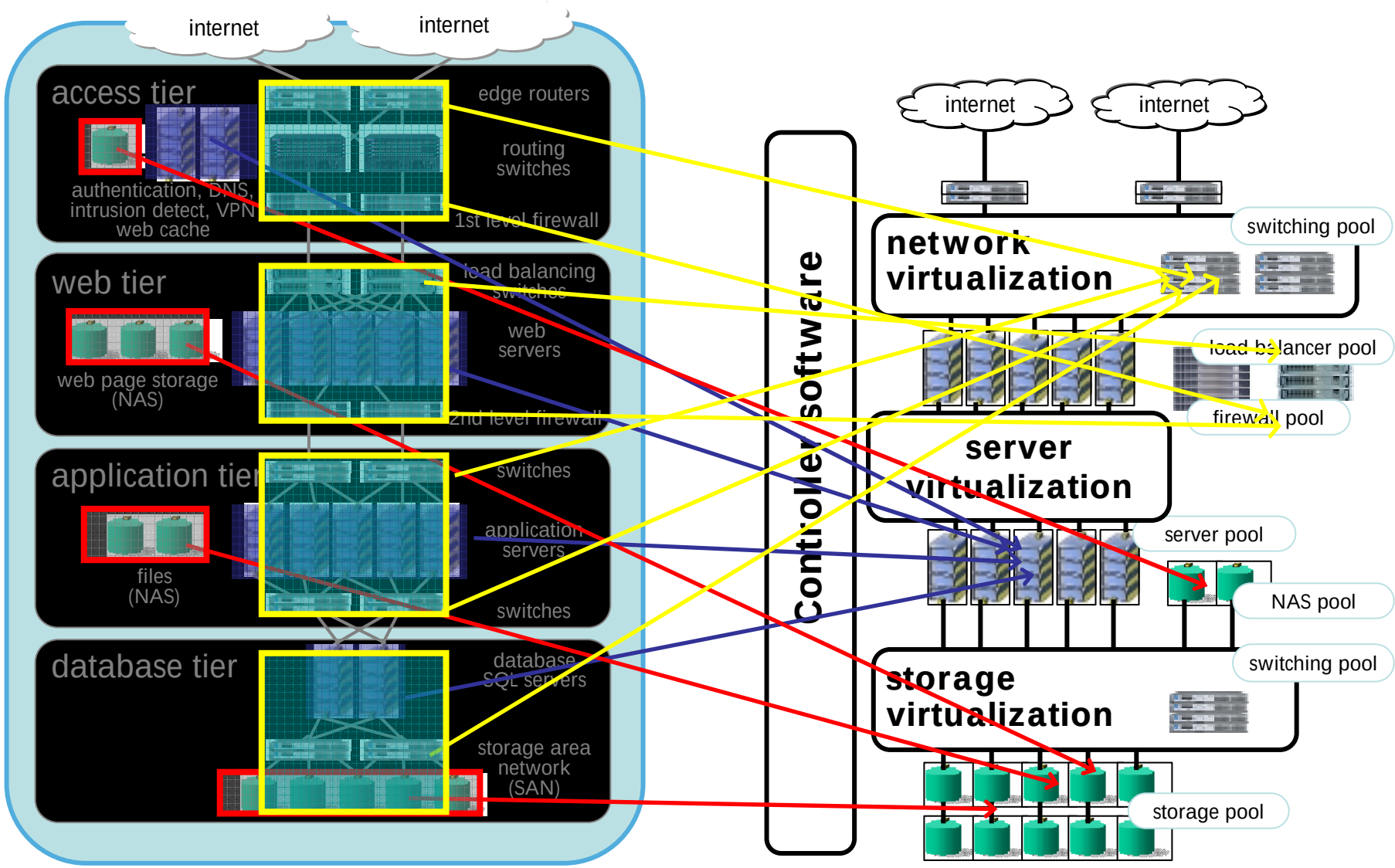


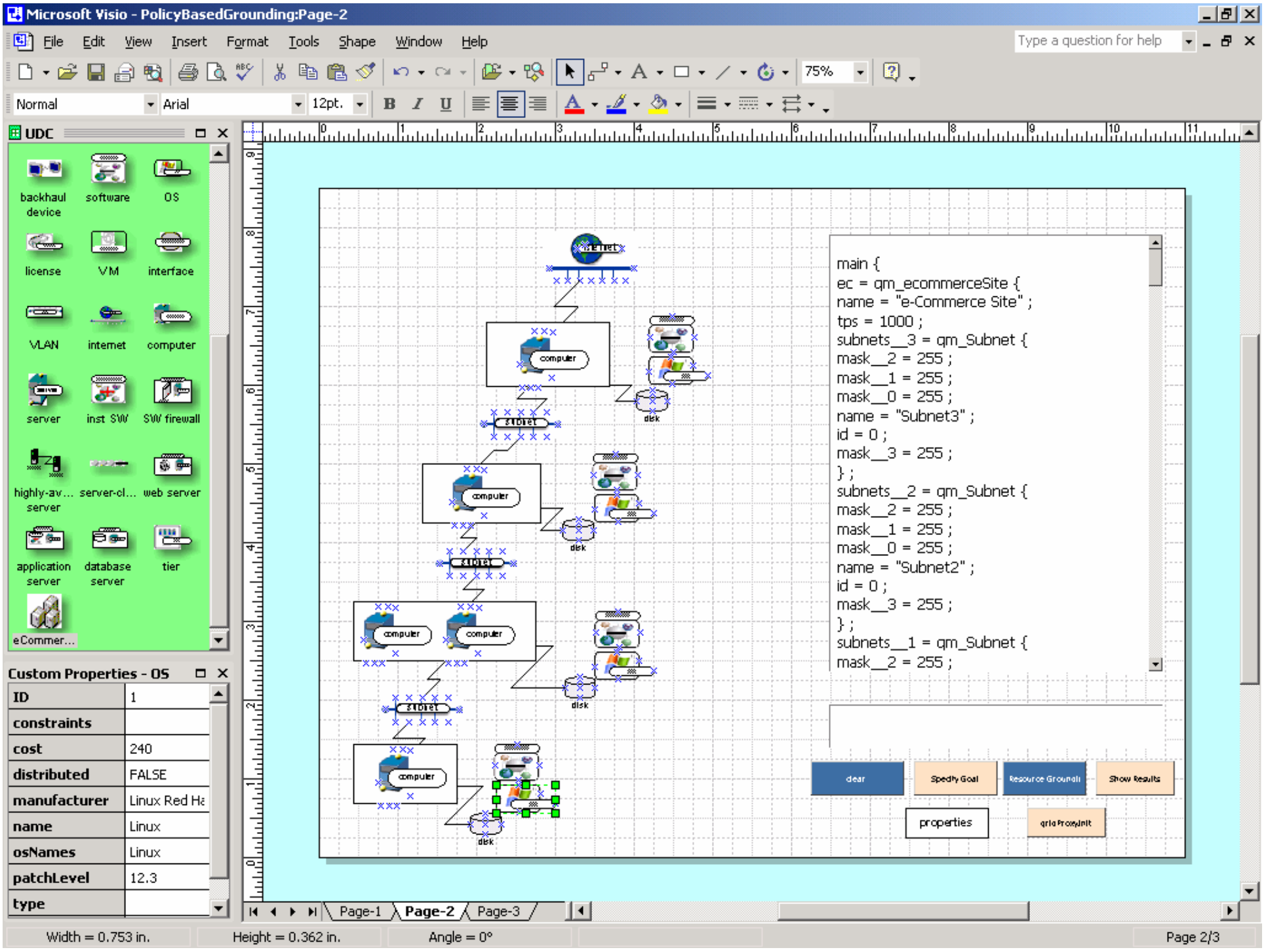
“Data Center Operating System”

1. User uses a resource composition service to design a custom environment (or selects a pre-configured template).
2. User schedules deployment of application.
3. Resources needed for the deployment are assigned.
4. Service is deployed, and
5. Resources are made available to user.
6. On-line monitoring is used to adjust resources as necessary.
7. Resource availability & utilization is used to improve future decisions.
8. The type/inventory repository tracks any changes in resources.

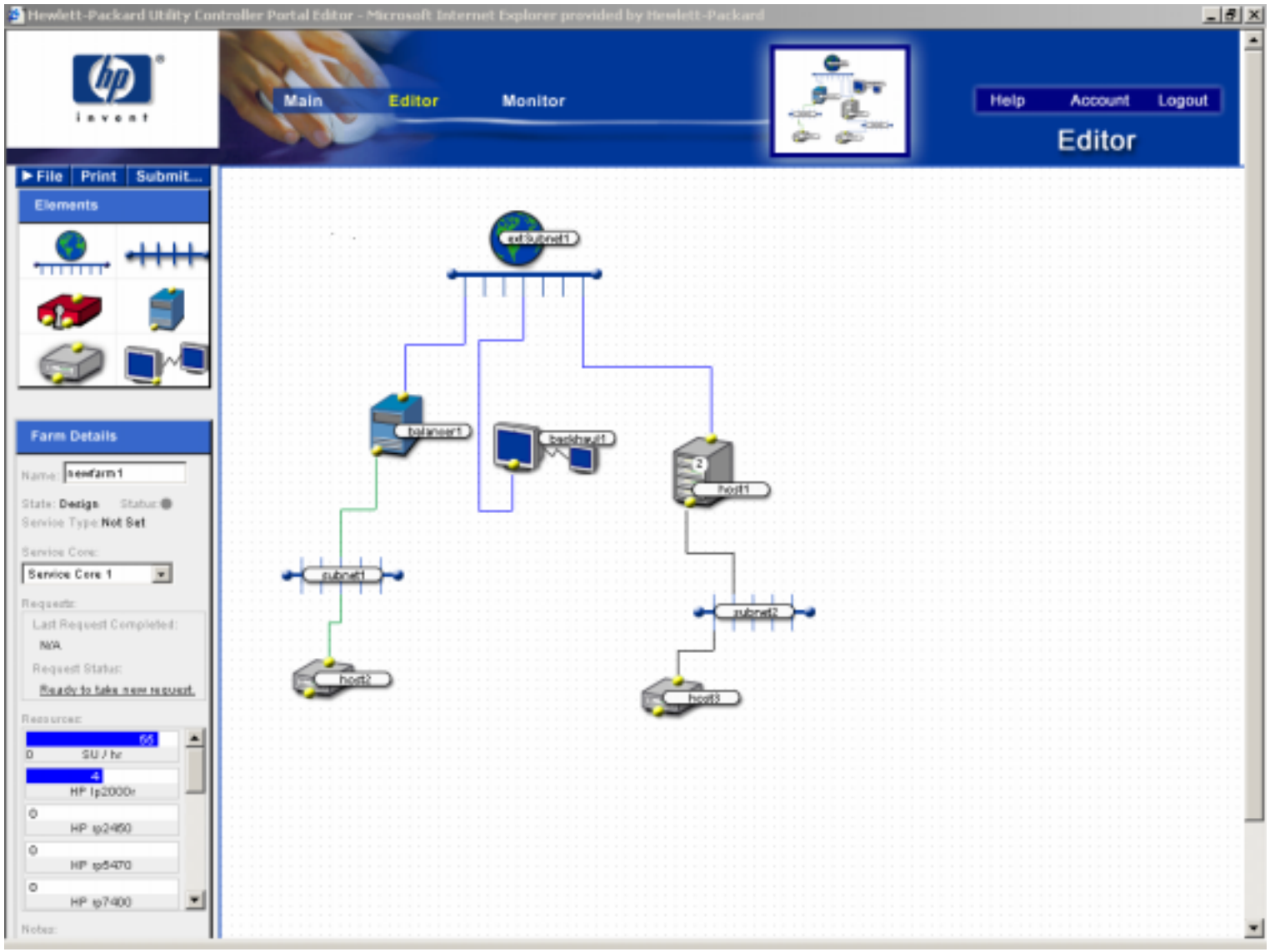


Mapping a Logical Application Configuration into Virtualized IT Infrastructure

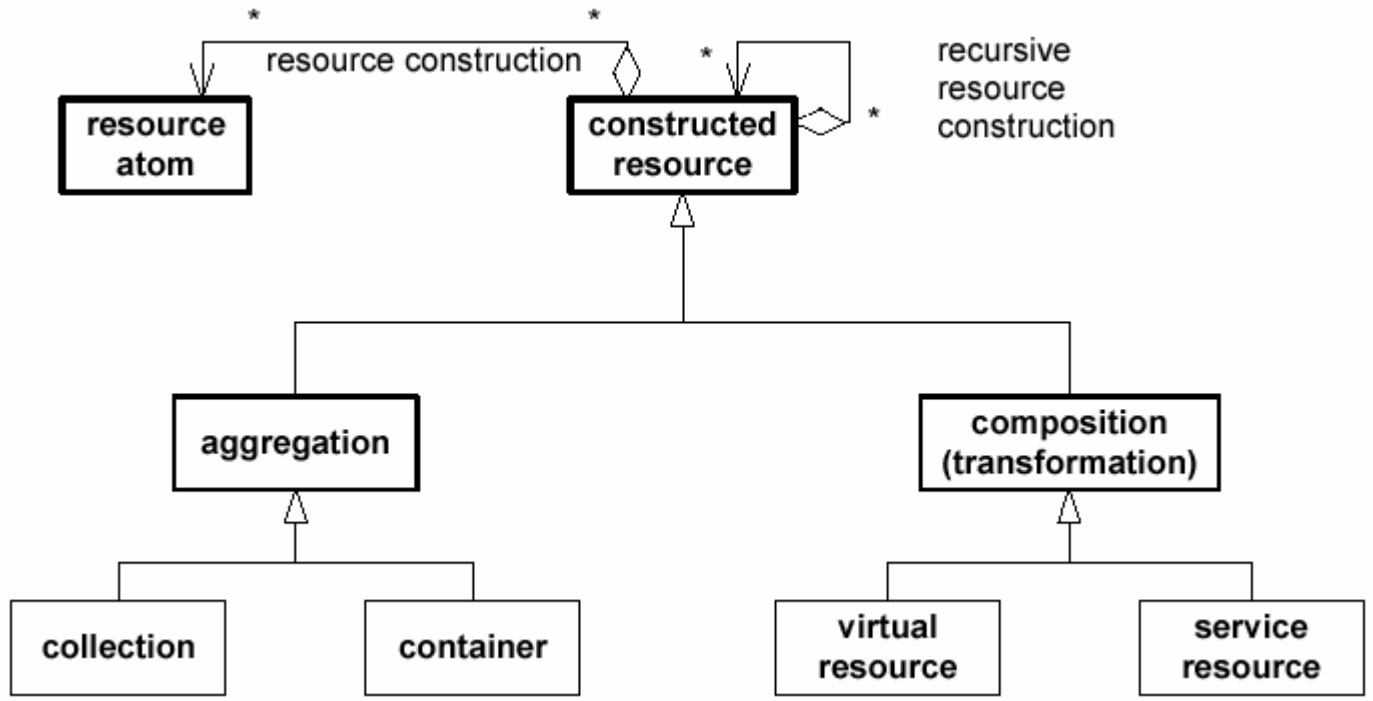



Microsoft Visio - PolicyBasedGrounding:Page-2
File Edit View Insert Format Tools Shape Window Help
Type a question for help
75%
Normal
Arial
12pt.
UDC
backhaul device
software
OS
license
VM
interface
VLAN
internet
computer
server
inst SW
SW firewall
highly-av... server
server-cl...
web server
application server
database server
tier
eCommer...
Custom Properties - OS
ID 1
constraints
cost 240
distributed FALSE
manufacturer Linux Red Ha
name Linux
osNames Linux
patchLevel 12.3
type
internet
computer
disk
subnet
main {
ec = qm_ecommerceSite {
name = "e-Commerce Site" ;
tps = 1000 ;
subnets__3 = qm_Subnet {
mask__2 = 255 ;
mask__1 = 255 ;
mask__0 = 255 ;
name = "Subnet3" ;
id = 0 ;
mask__3 = 255 ;
} ;
subnets__2 = qm_Subnet {
mask__2 = 255 ;
mask__1 = 255 ;
mask__0 = 255 ;
name = "Subnet2" ;
id = 0 ;
mask__3 = 255 ;
} ;
subnets__1 = qm_Subnet {
mask__2 = 255 ;
clear
Specify Goal
Resource Grounding
Show Results
properties
qria ProxyInit
Page-1
Page-2
Page-3
Width = 0.753 in.
Height = 0.362 in.
Angle = 0°
Page 2/3

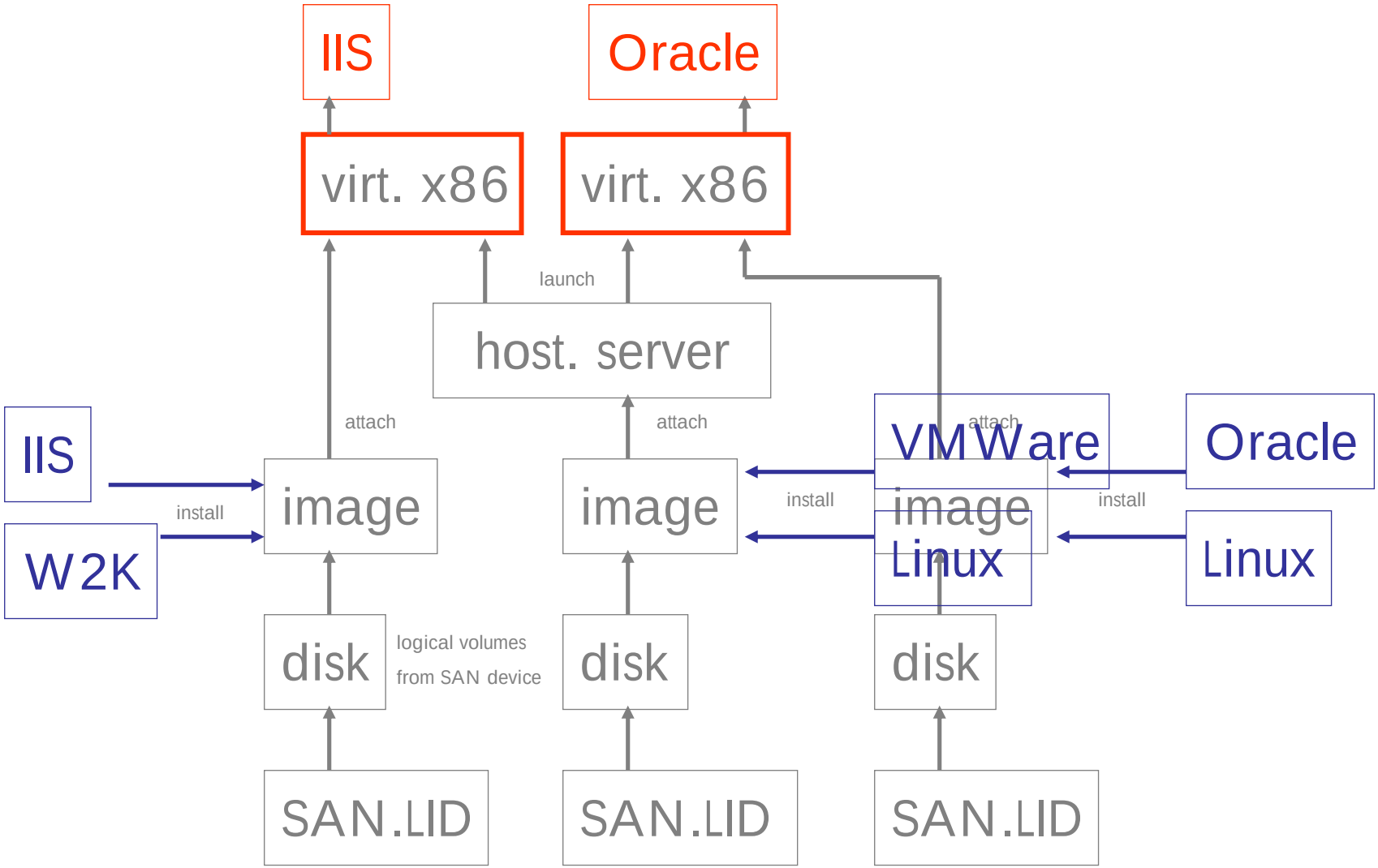
Resource Topology Editor



Resource Constructions



Resource Construction Example



Requirements for the Information Model

- Information model must capture resource creation relationships
  - at present
  - in the past (to reconstruct history)
  - in future (plan future resource needs)

- Operating systems and IT management systems mainly capture the present state, but little past and future states

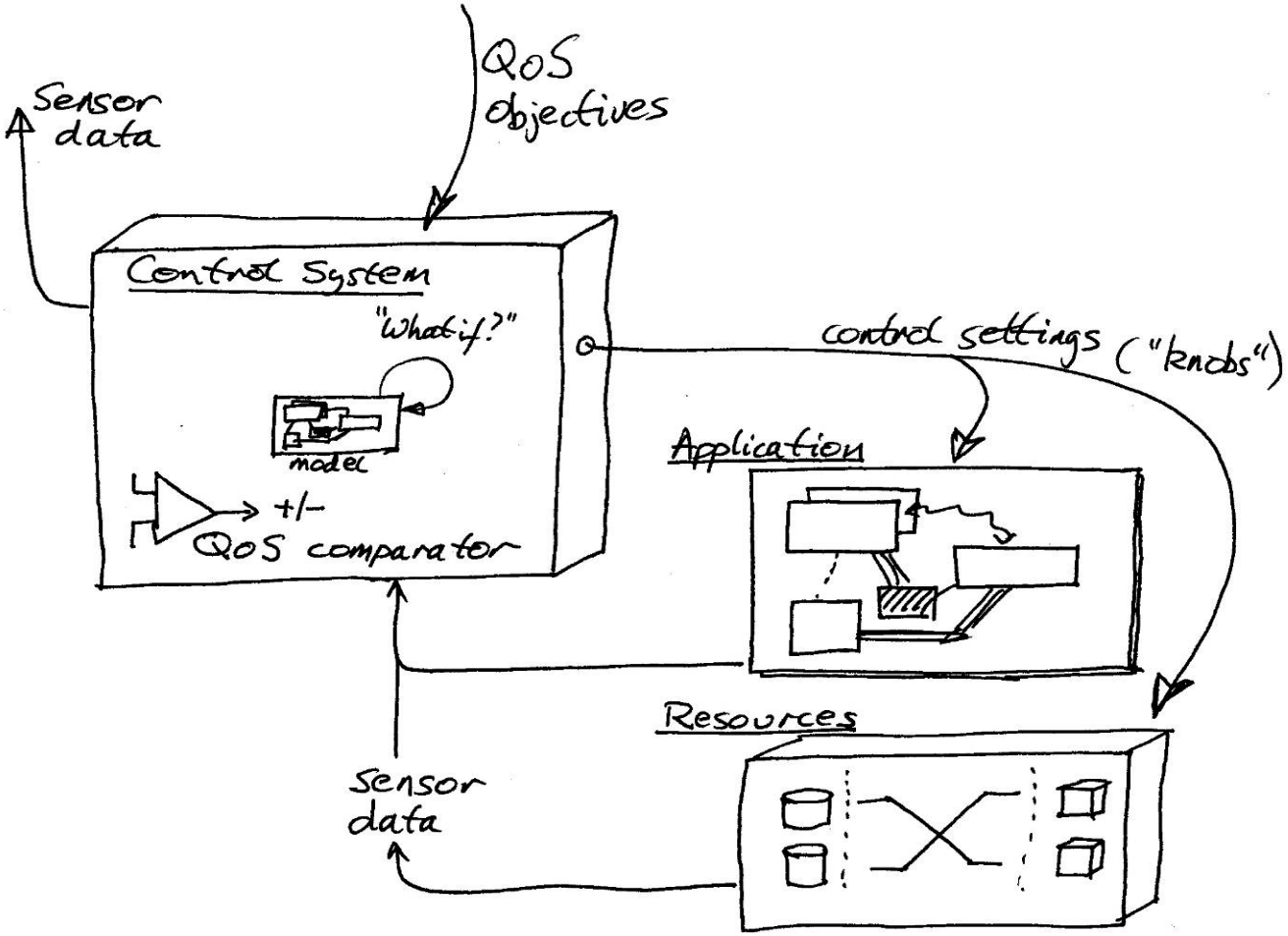
- The environment is often assumed to be static. Virtualization breaks this assumption.

Automation

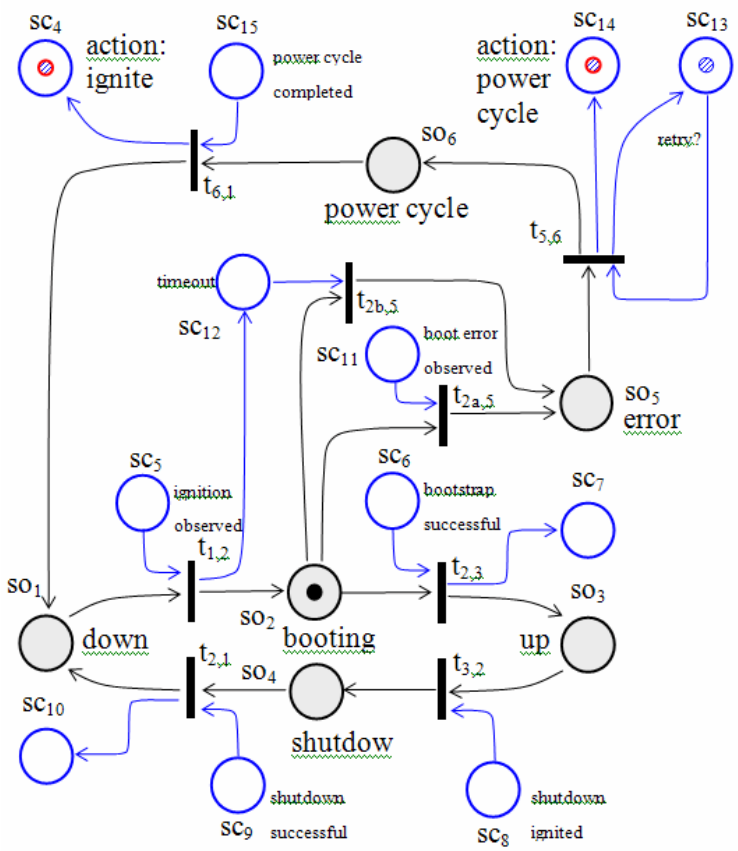
- Purpose of an OS is automating the management of a machine environment.
- Automation in IT often relies on scripts and workflows.

- What are appropriate abstractions and interfaces for automation?

Controller


QoS
objectives
Sensor
data
Control System
"What if?"
model
+/-
QoS comparator
control settings ("knobs")
Application
Resources
sensor
data

Automation Controller for Operational IT Management



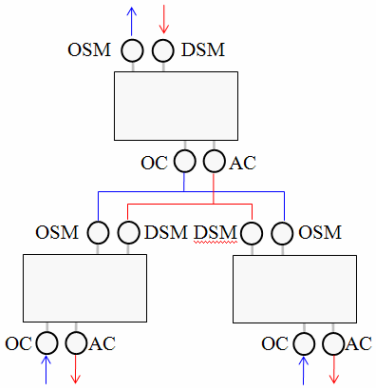
Based on Desired State / Observed State paradigm

PTN as implementation principle

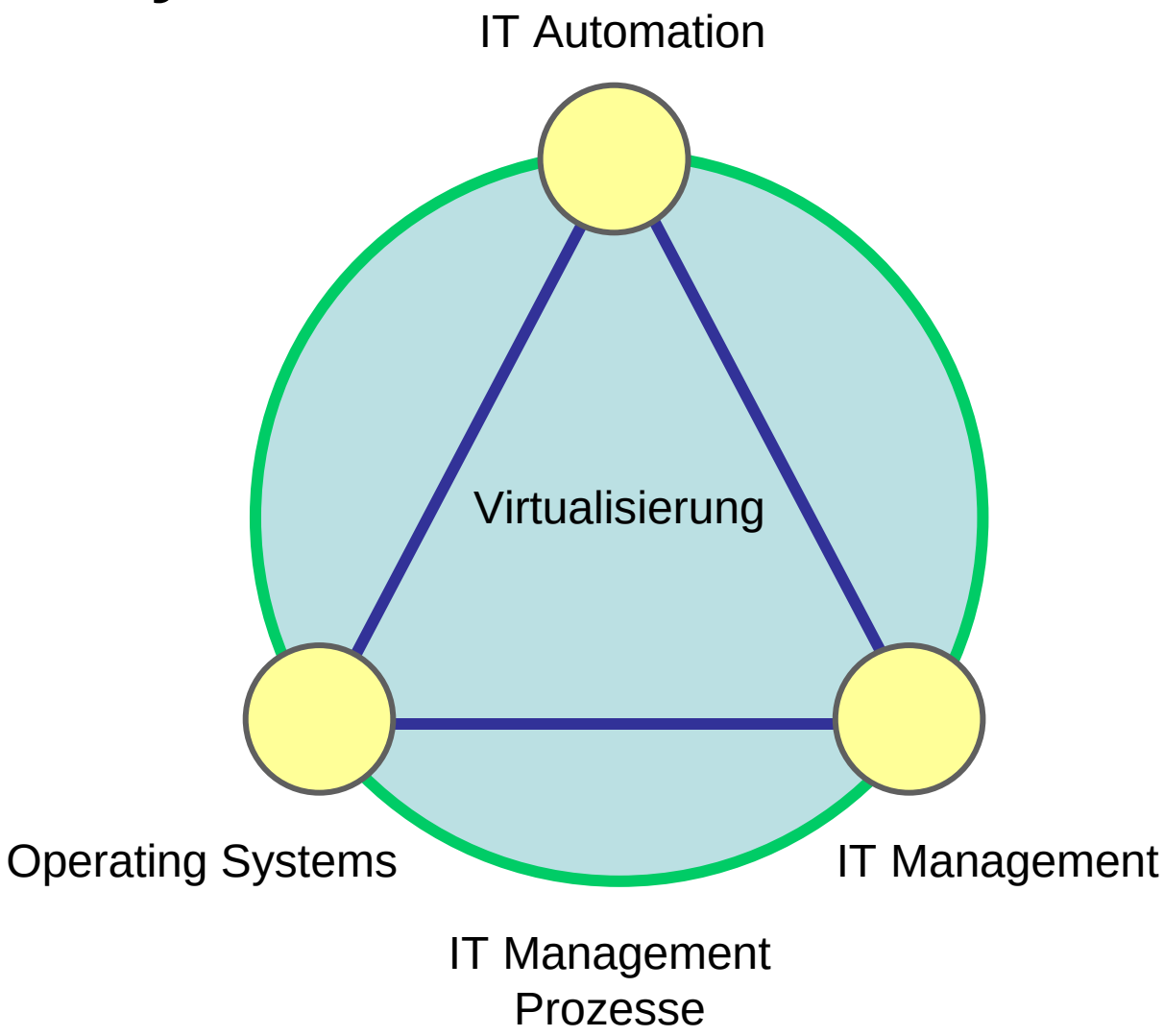
POC "Adaptive Database" with three automation use cases:

1. Basic provisioning of Oracle 10g on HP blades.
2. Storage auto-correction (attach SAN disk when Oracle detects disk shortage).
3. Response-time guard (make additional blades available to Oracle when load and response time increased).

Controller Composition:



Summary


IT Automation
Virtualisierung
Operating Systems
IT Management
IT Management
Prozesse

Summary

- Although the physical world may look clean, the virtual world can be messy.
- The virtual world must be subject to management as is the physical world, which has not widely been recognized in management practices and systems.
- Virtual entities must be identified and managed like physical entities. Context in which they are brought together must be captured (past, present, future).
- Integration and automation of virtualization management is key to lower management cost and complexity.
- Patterns from operating systems can be applied.