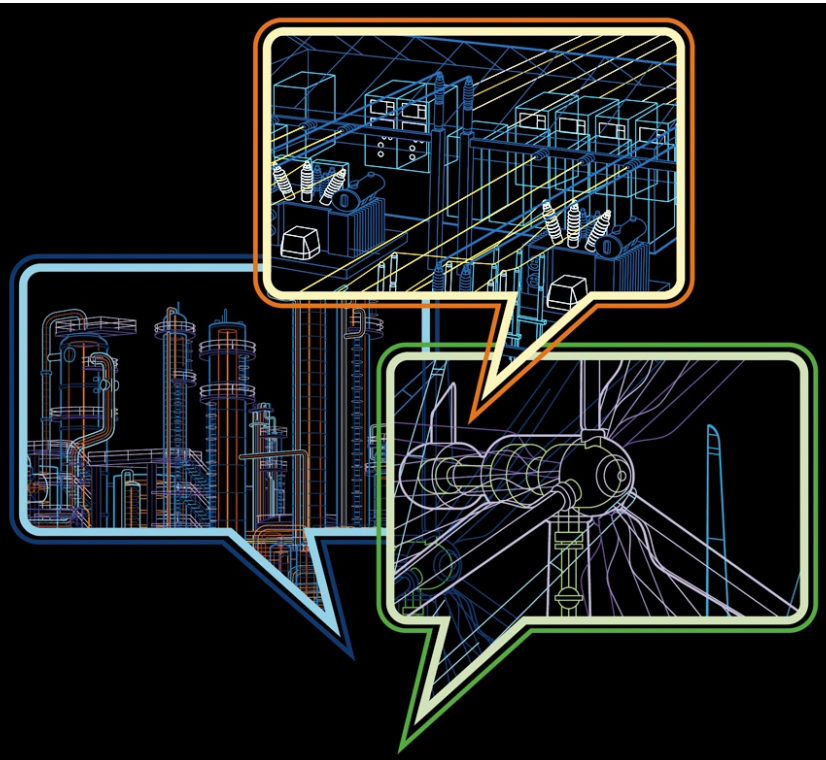


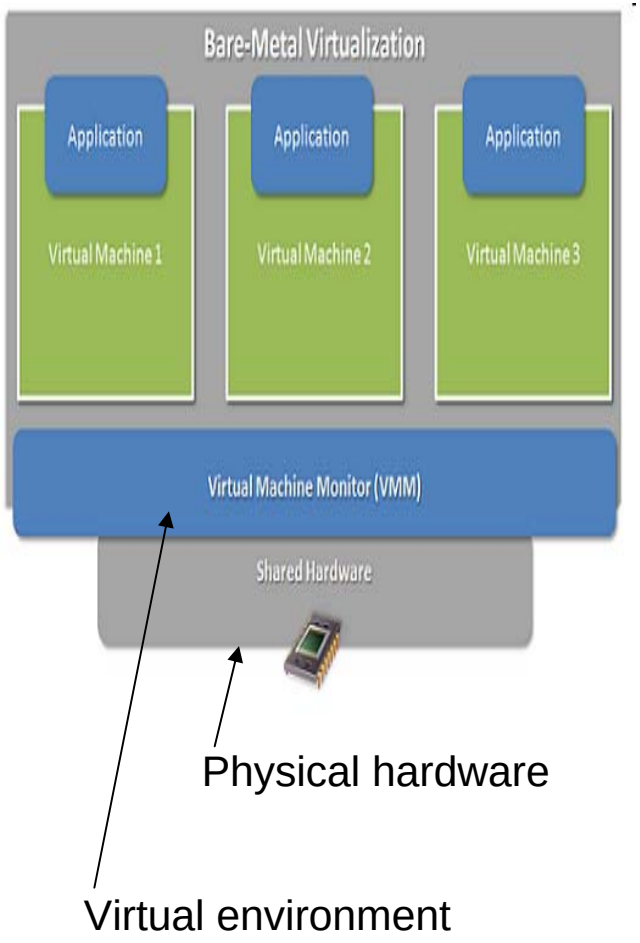
Dave Belliveau ABB September 2012

System Architecture & Virtualization with System 800xA

Agenda

- What is Virtualization?
- Benefits of Virtualization
- Virtualization update
- Virtualization technologies for future use
- Server layer optimization
- System size, Multiple systems
- Performance optimization

What is a Virtual Machine?

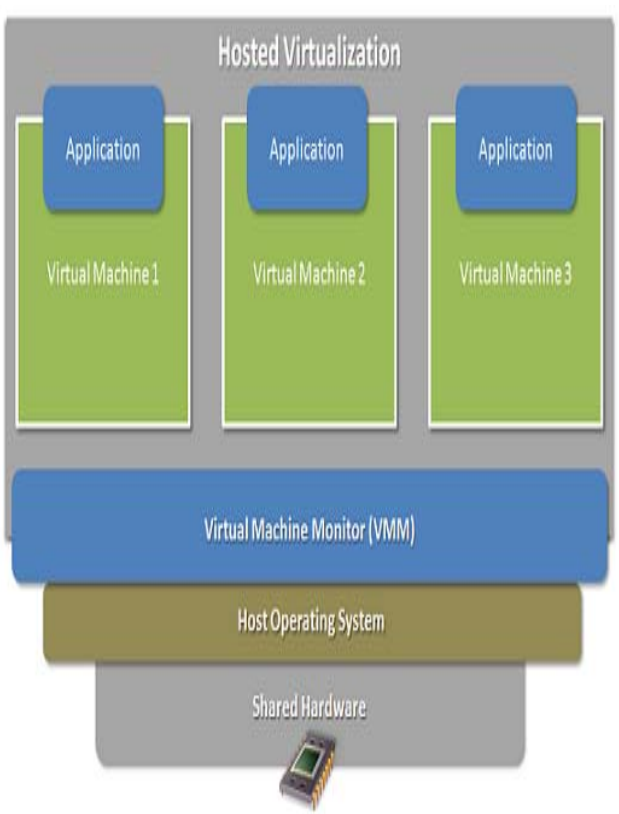


- A virtual machine (VM) (software) emulates a physical computer
- One or several VMs run on a regular computer
- Virtual hardware of each VM can differ, e.g. 2 NICs, amount of RAM, etc.
- Run different operating systems on the same physical computer - old as well as newer ones

The First Virtual Machine 1967

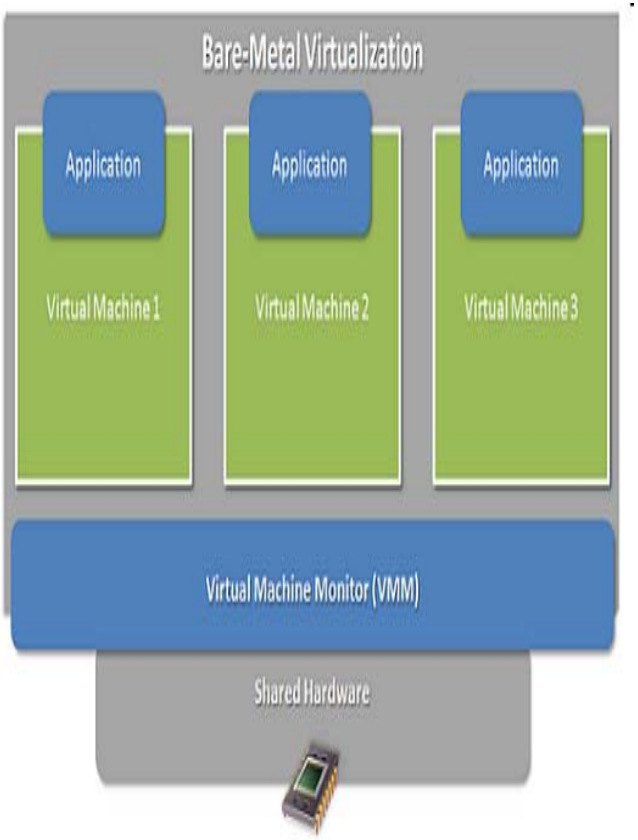
- Virtualization was first implemented more than 30 years ago by IBM as a way to logically partition mainframe computers into separate virtual machines. These partitions allowed mainframes to “multitask”: run multiple applications and processes at the same time. Since mainframes were expensive resources at the time, they were designed for partitioning as a way to fully leverage the investment.

Virtualization technologies



- Hosted virtualization
  - VMware Workstation
    - Virtual machines are run using software with option for hardware assistance
    - Runs on top of a standard operating system
    - Not for production purposes

Virtualization technologies



- Hardware virtualization
  - vSphere ESX
    - Dedicated operating system kernel for running virtual machines
    - Thin layer between hardware and virtual machines
    - High level of performance
    - For production purposes

System 800xA
Virtualization

Customers specify it

Customers harmonize with IT

Training environments

Lower cost of ownership

Backup validation

Lower power and cooling costs

Server footprint reduction

Virtualization is the future

Spare parts reduction

Flexibility

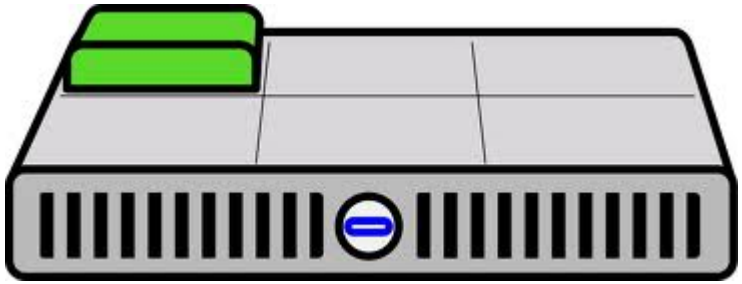
Lifecycle benefits

Performance benefits

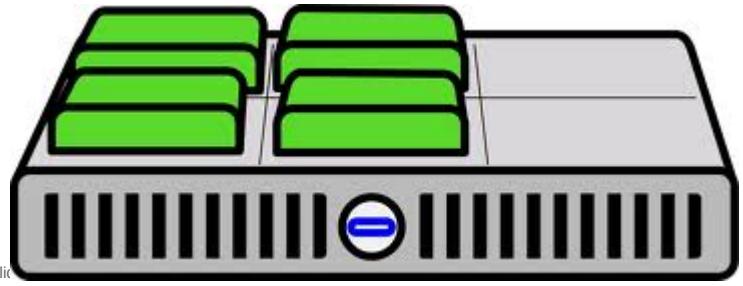
Project upgrade benefits

Improved availability

Benefits of Virtualization



- Ability to maintain a current Operating System of the DCS or QCS platform beyond the life of the hardware,--extends the life of the DCS or QCS due to obsolete hardware.
- Distributed engineering and remote support is easier and less costly because the VM looks the same regardless of the hardware
- Reduction in total physical hardware server machines



Benefits of Virtualization

- Reduction in total power consumption and cooling load
- Ability to restart an OS within a Virtual Server without a hard restart
- Ability to install applications on their own OS inside the virtual environment, eliminating possible conflicts inside an OS for hardware resources or common drivers
- Increased ability for redundancy of data and applications through virtual server redundancy

Benefits of Virtualization

- Better lines of responsibility between IT department and Process Control Engineers
- Ability to run server applications in demonstration or test mode on a standard PC like a laptop
- In the case of a virtualized 800xA (DCS or QCS) system, reduces downtime and risk associated with applications when doing an upgrade of the OS or server hardware.

Virtualization – Things to Consider

- More expensive Server hardware with multiple network cards
- More Operating system costs (VM and M$ Licenses)
- Increased IT skills may be required to support another layer of software
- Loss of traditional serial ports

Enter the world of VMware virtualization

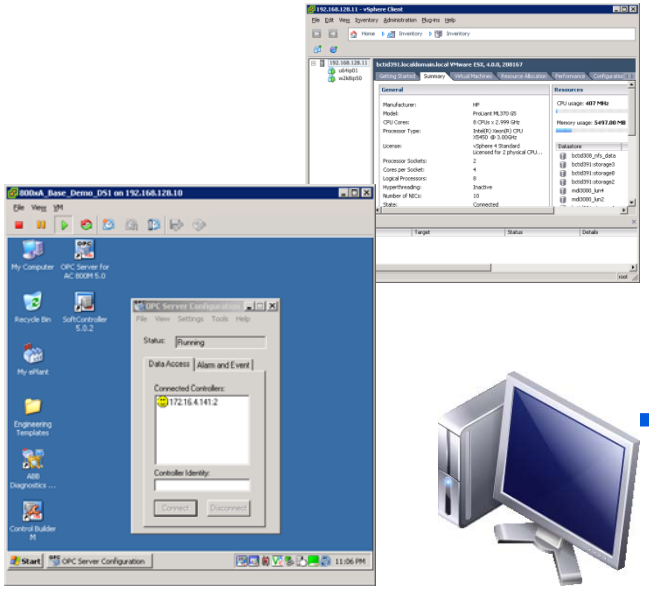
- Customers are now taking advantage of System 800xA running on virtualized VMware vSphere ESX
  - VMware ESX is a bare metal high performing environment used and trusted by major financial, business, and military organizations
  - Market leader in virtualization
  - Used in 70%-90% of the worlds virtualized computer systems
  - Extends virtualization with advanced functionality such as high availability and fault tolerance
  - Has additional tools such as vConverter allowing physical computers to be converted into virtual machines

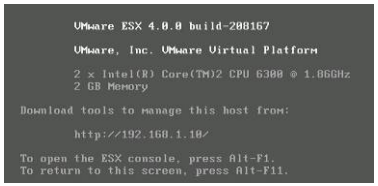
What do we need for virtualization?
VMware vSphere ESX

- VMware vSphere is the commonly used enterprise virtualization technology
- VMware vSphere ESX virtualization server for running virtual machines. Does not need vCenter
- VMware vSphere ESX has a proprietary VMware kernel for running virtual machines
- vCenter adds common control, High Availability, vMotion, Storage vMotion, Fault Tolerance
- vCenter runs on a Windows computer

How do we interact with the system?
Servers and clients

- ESX Server does not have a graphical interface
- ESX Server does have a Console Operating System based on Linux.
- vSphere client software running on Windows is used for interaction with the ESX Server





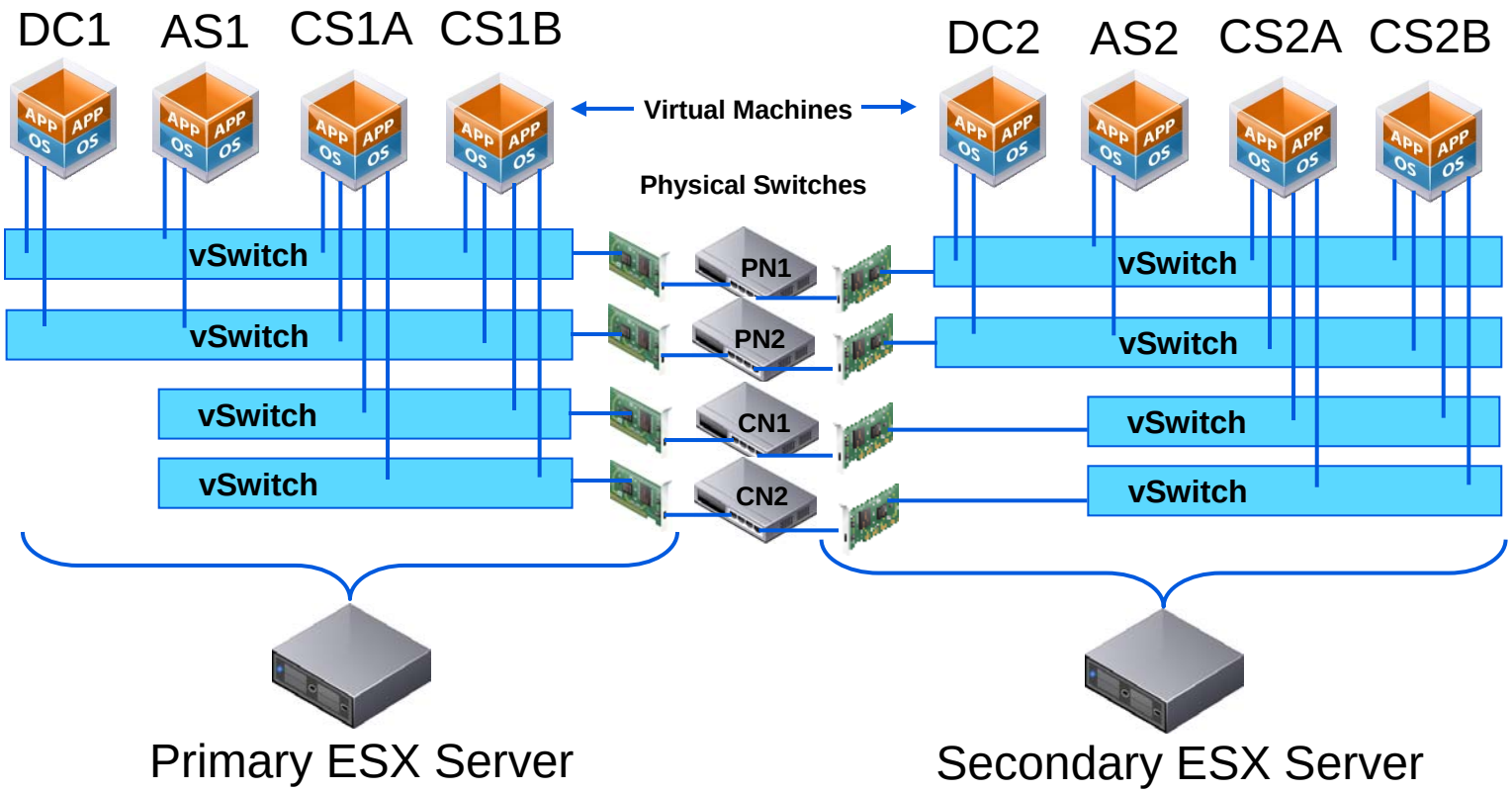
- 800xA System
  Domain controllers
  Aspect Servers
  Connectivity Servers

Primary ESX Server

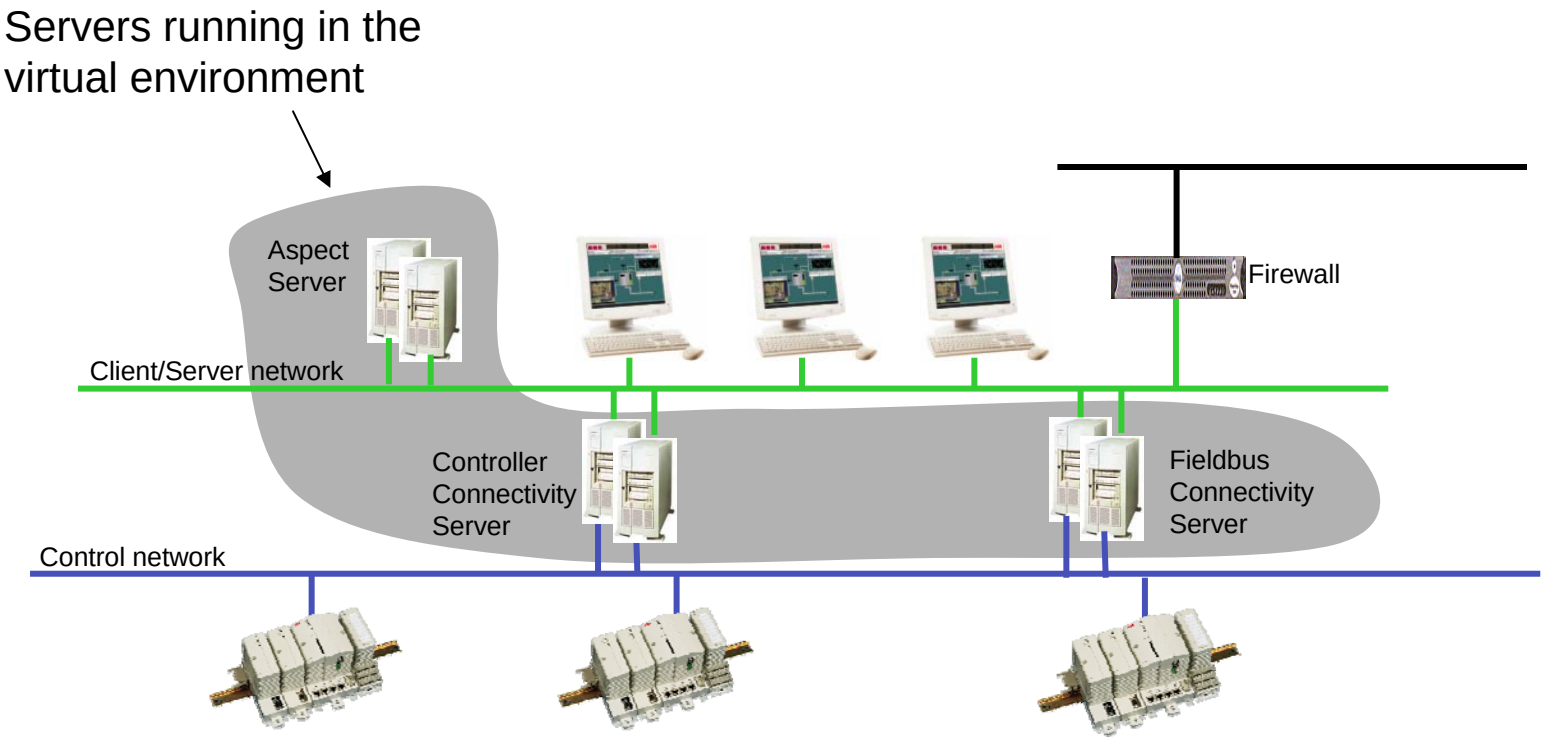
Secondary ESX Server

Where are the 800xA Servers?
System 800xA running as virtual machines.

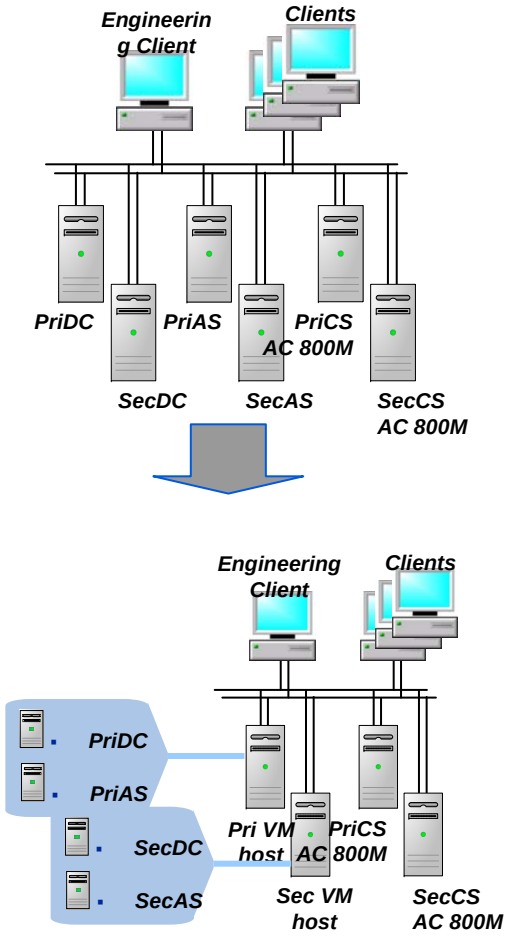
- Primary and Secondary 800xA nodes are running on respective ESX Servers
- Virtual switches connect the 800xA nodes to the physical network via ESX Ethernet adapters



Server node virtualization in System 800xA

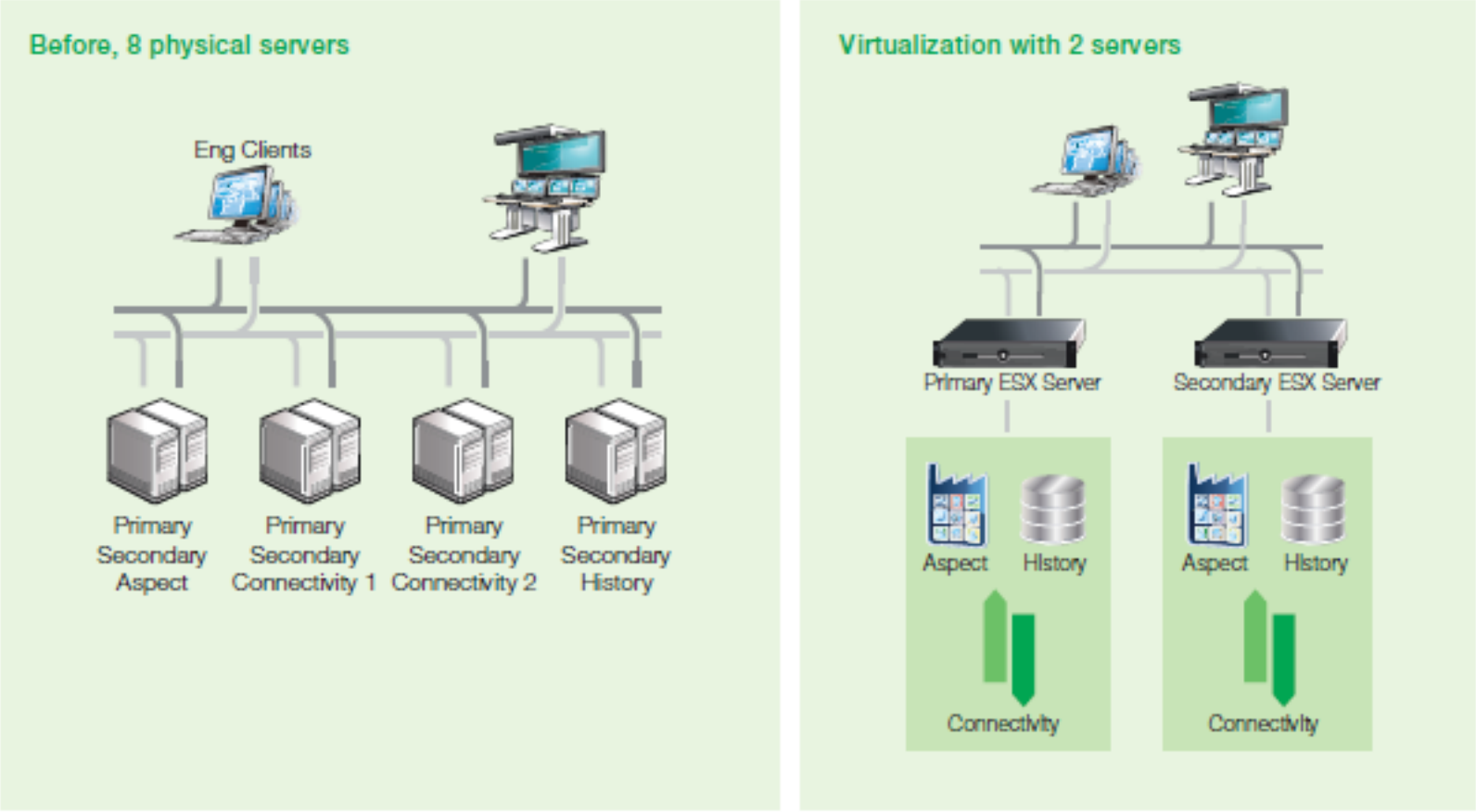


Virtual environment for DC and AS
Commonly requested use case



- Low risk footprint reduction (6 servers -> 4 servers)
  - Essentially a subset of the supported configuration
  - Hardware arrangement according to rules, but less powerful server required
- => mixed configuration virtualization / traditional possible

Example of System 800xA Virtual Environment



The most obvious benefit of System 800xA virtualization is the hardware optimization gained from server consolidation.

800xA Server Node Virtualization
Current status

- Initially released in June 2009 (800xA 5.0)
  - Approved; >100, Projects won; >75
- Full core function support in 800xA 5.1
  - Tag count 40 000 (60 000)
- Current Version
  - ESX 5.0
  - Almost all system server functions covered

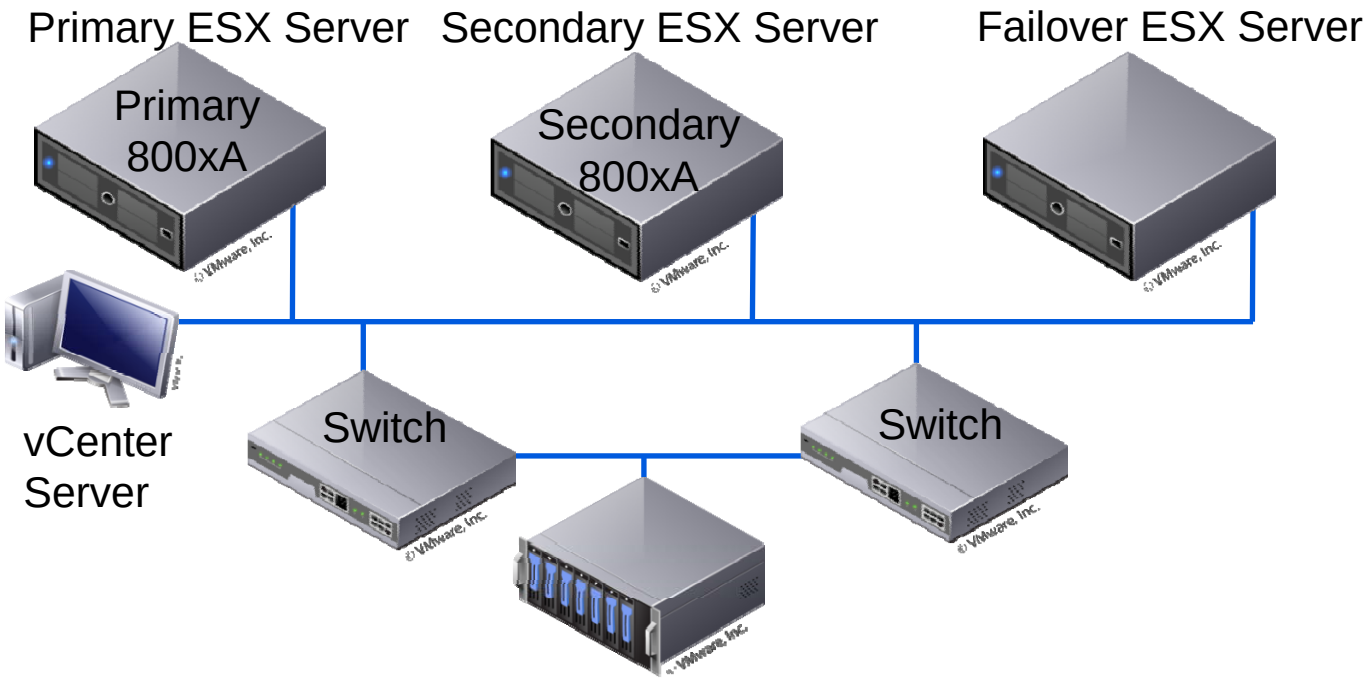
Security

- Security benefits of virtualization
  - CDROM, USB and Floppy Disk support can be removed from the virtual machines, eliminating one entry point of viruses
- The same rules apply for a virtual system, e.g.
  - Apply security updates
  - Configure virus scanner
  - Secure the system with firewall/application gateway
  - Secure access to the hardware

Improved Maintainability
SAN storage

- Virtual machine storage in separate, redundant, disk cluster
- The server box does not keep any data, or hold any installation
- Virtual machines can be moved between servers
  - Benefit from VMware High Availability
  - Makes use of VMware vMotion features
- Beneficial in maintenance (security updates, 800xA software updates, hardware failures, etc.)
  - In maintenance, not a replacement for 800xA redundancy!
- Available for 800xA

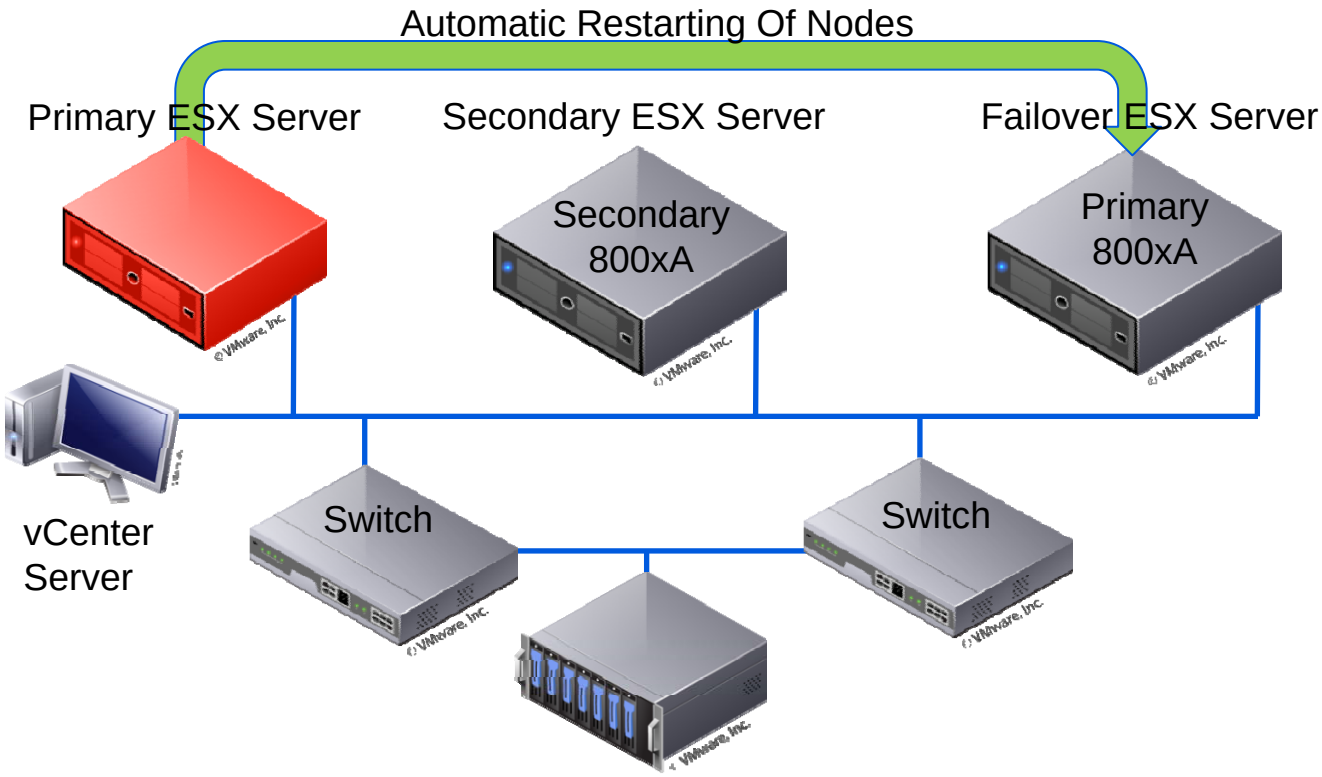
Improved Maintainability
SAN storage



Improved MTTR
SAN storage

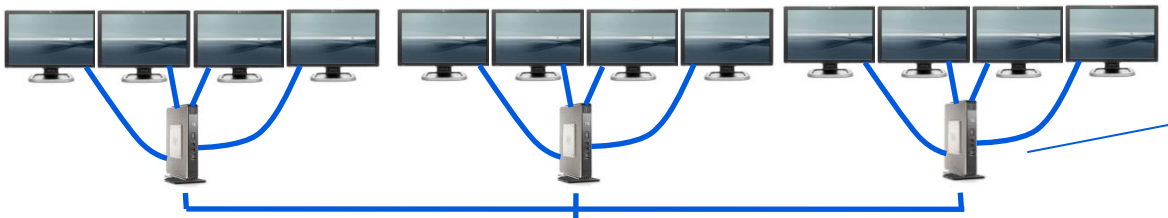
- At server failure the Virtual Machines are moved to another server and resume operation
- Single mode operation only for a few minutes – MTTR improved
- Makes use of the VMware High Availability feature
  - Restarting virtual machines on another ESX server in case of hardware failure
  - Will not replace 800xA redundancy schemes – not real time from a DCS perspective
- Available for 800xA

Improved MTTR
SAN storage



Virtualization technologies for future use?
800xA Client virtualization

- Reduced maintenance
  - Much easier to replace a thin client than a workstation
- Simplified hardware
  - No fans, no hard drives, no noise
- Higher stability
  - Less driver issues
- More secure
  - Ability to remove all USB access, no DVD slot, …
- In our test labs now

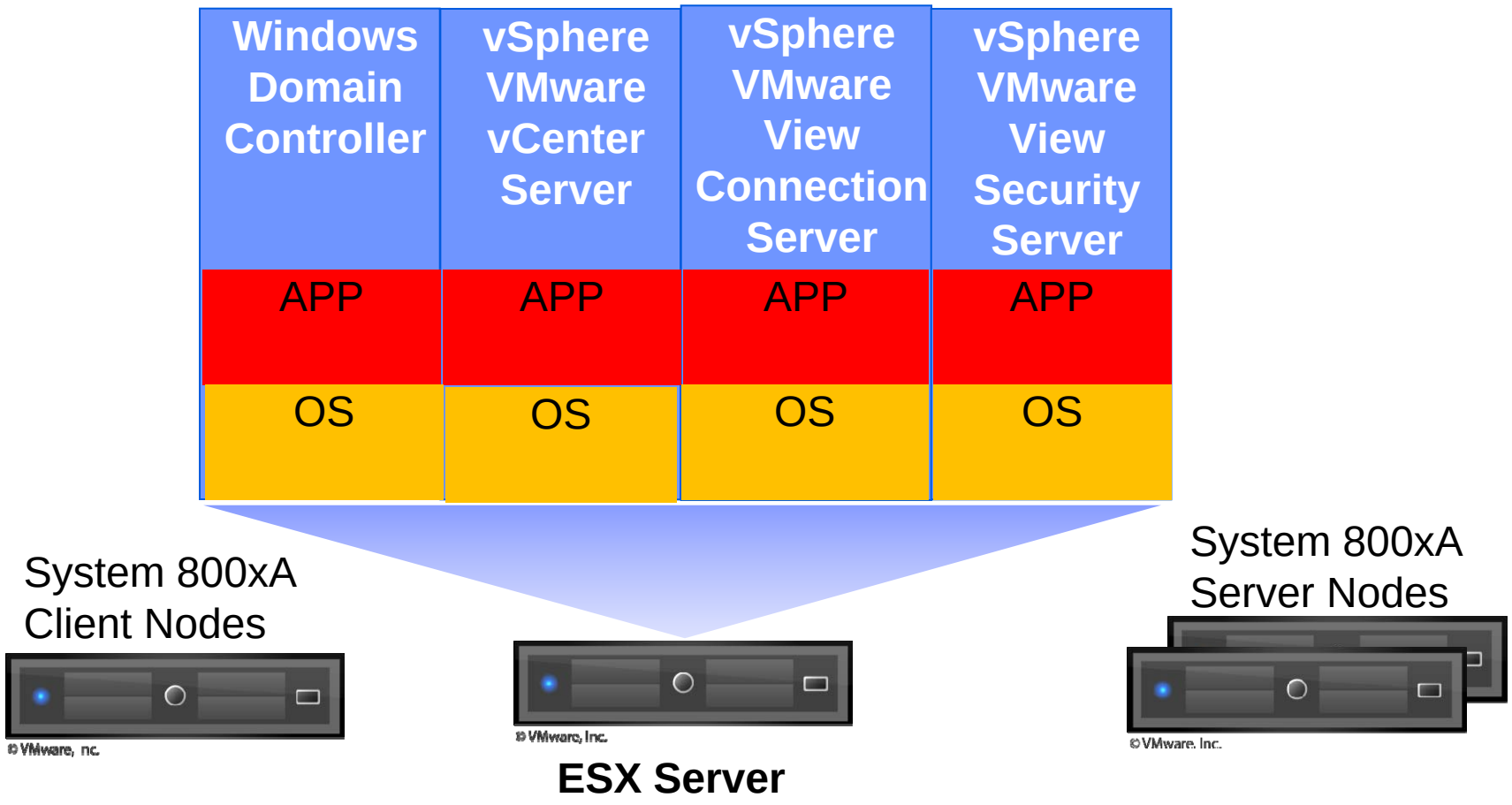


HP g7725
thin client

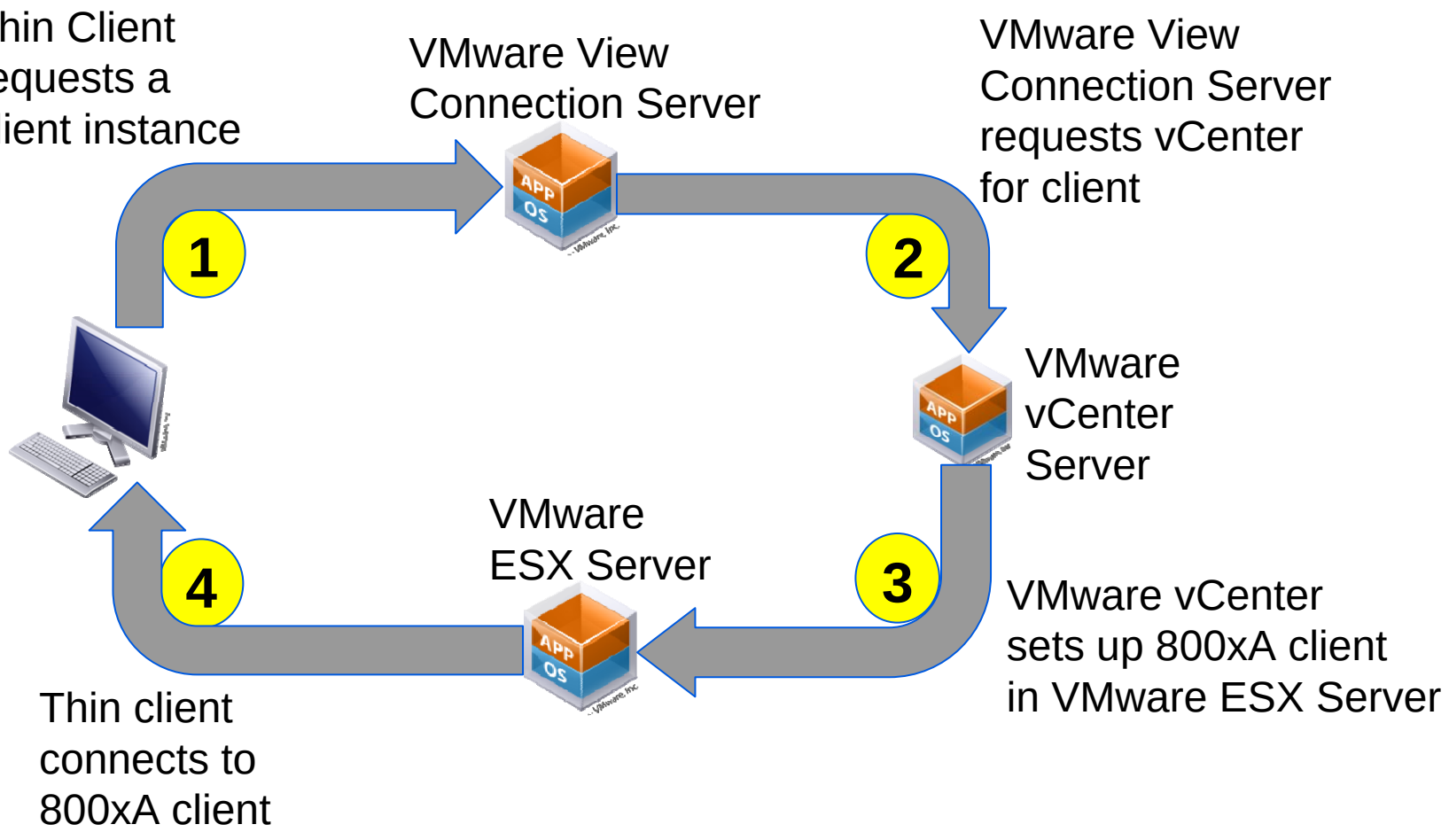
- Vmware View connection server
- Vmware vCenter
- 800xA Client VMs

- Host server
- Vmware vSphere ESX
- Vmware View

Virtualization technologies for future use?
800xA Client virtualization

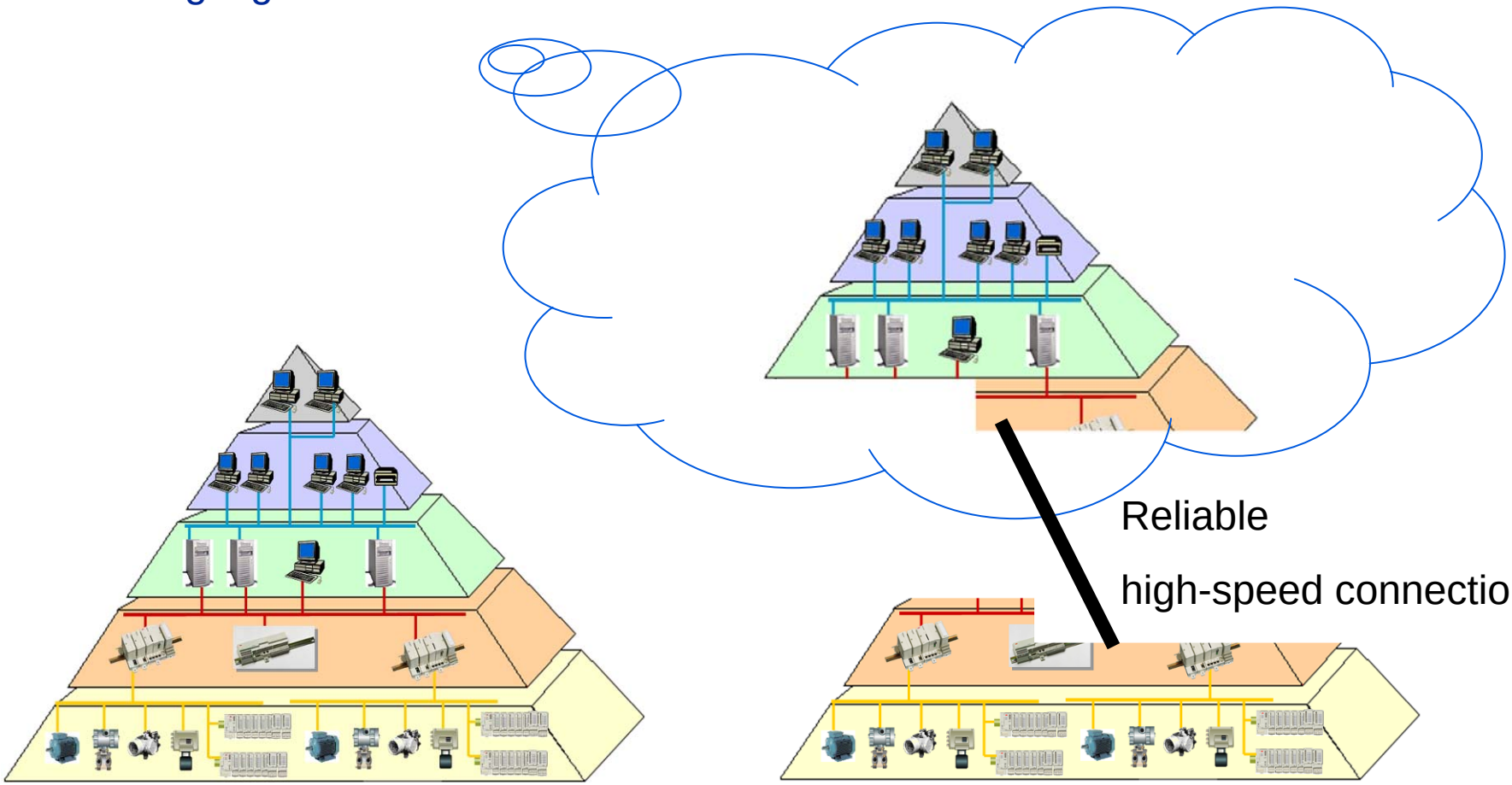


Virtualization technologies for future use?
VMware View - overview



Virtualization technologies for future use?
Cloud Computing

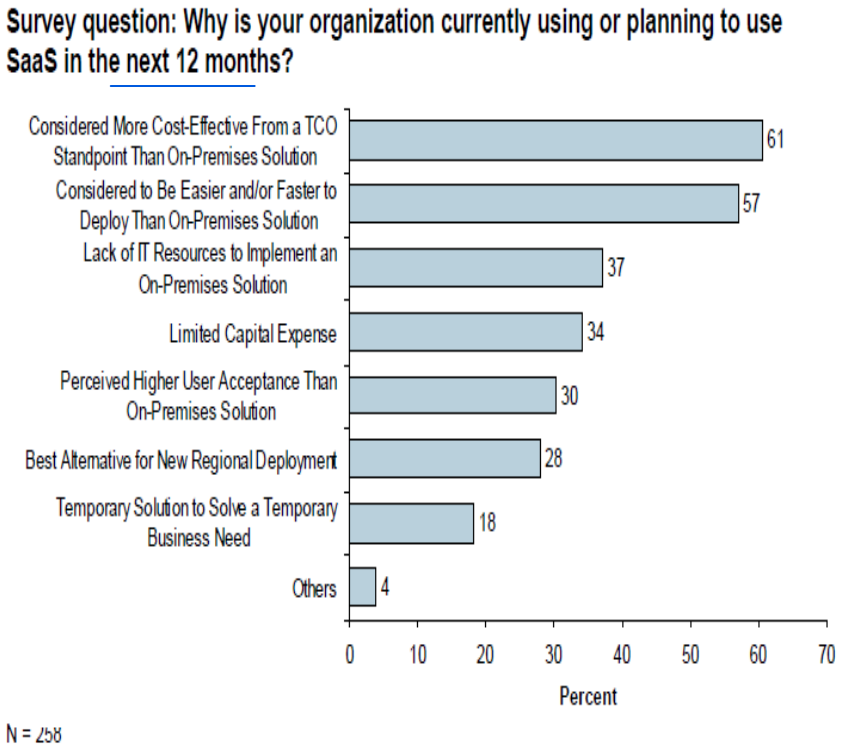
- Moving higher automation levels into the cloud



„classical“ automation pyramid

Safe + reliable core production

Virtualization technologies for future use?
Cloud Computing

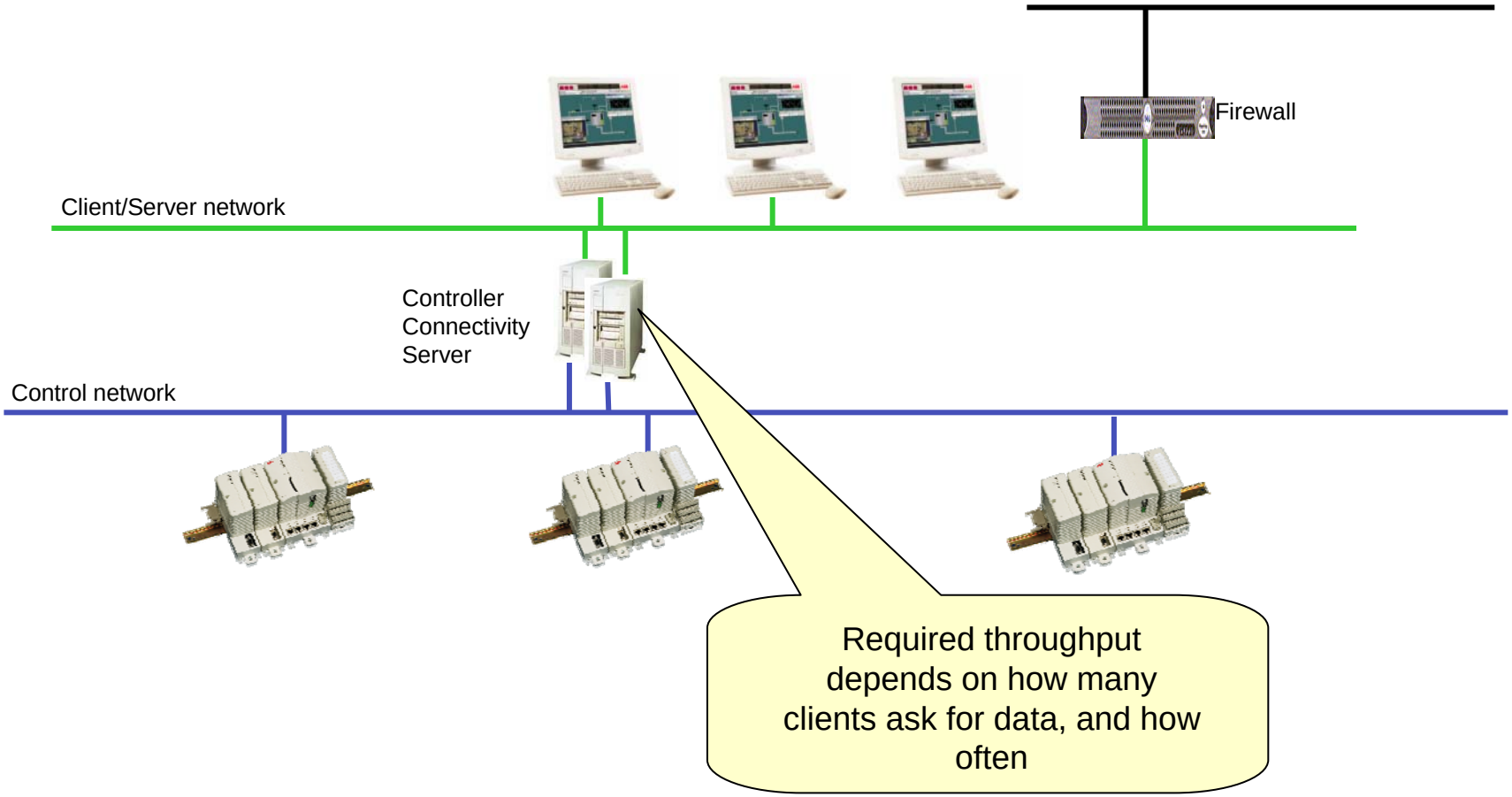


10

Gartner

- Benefits
  - Efficient resource usage allows cheap high quality services
  - Access from anywhere connected to the network
    - Connecting multiple plants in the same company
    - Connecting companies along the supply chain
  - Pay as you go without massive initial cost
  - Scalable to fit current demand
  - No need to engineer for peak performance
- **Software as a Service

Server layer optimization
Connectivity server throughput



Server layer optimization
Connectivity server throughput

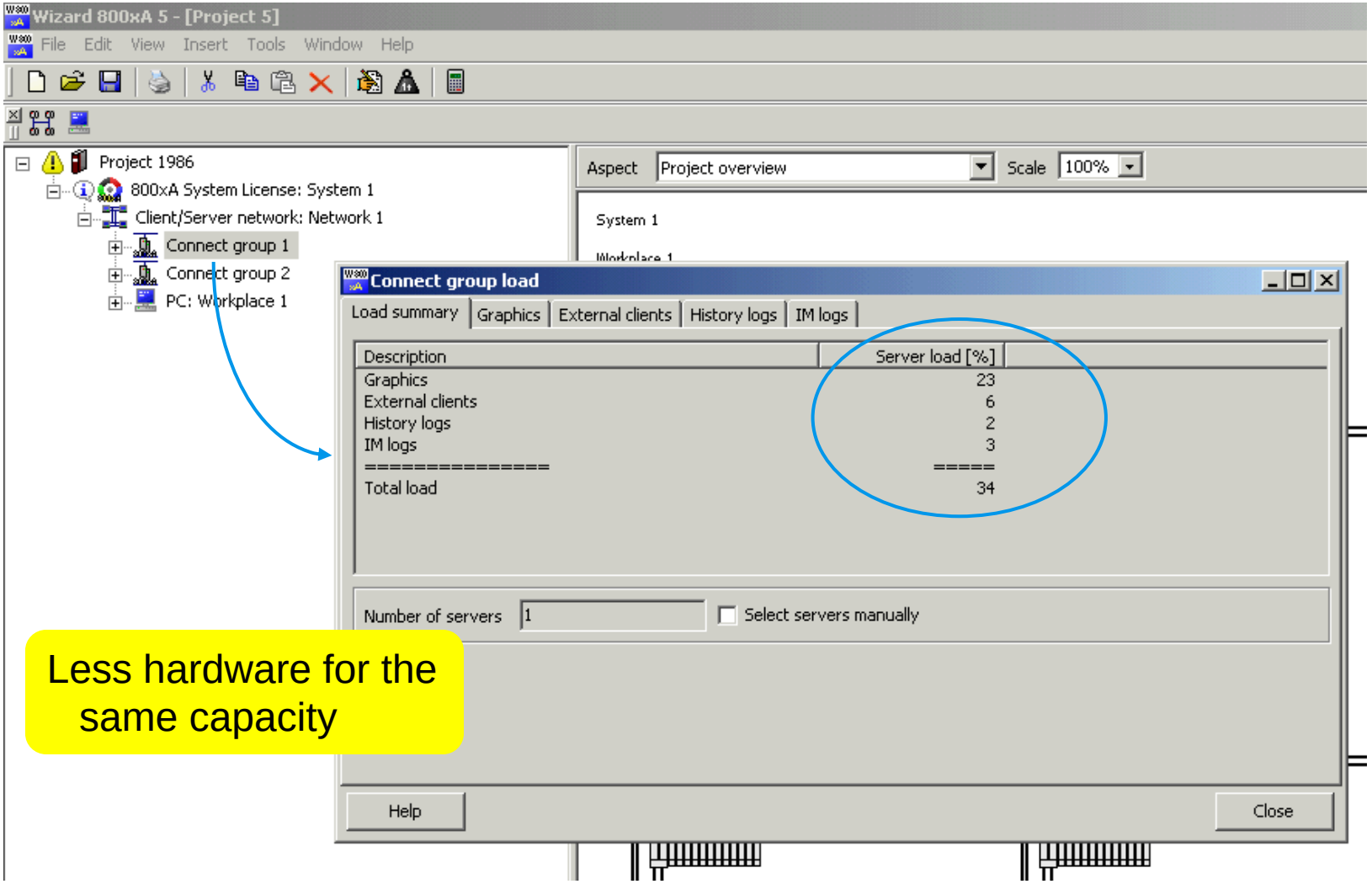
- Calculation Model for connectivity servers
  - Default (old) rule – 12 controllers per connectivity server
  - Optimized rule to optimize CS usage
    - Determined by # Clients, # Logs, and external subscription volume
  - Calculation rules using the 800xA Wizard
    - Throughput now at a level where controller connectivity server count is no longer an issue
    - One CS is good to feed 30 clients with 2 screens each
    - Most plants, except the very large ones, will do with a single pair

Server layer optimization
Connectivity server throughput

Parameter	Default rule	Optimized rule
Controllers per connectivity server	12	**24 -> 48**
Active OPC DA subscriptions	20,000	**50000 -> 100,000**
Field devices	1,000	1,000
Primary History logs per connectivity server	10,000	20,000
OPC items from External subscription (OPC Client Connection)	2,000	20,000

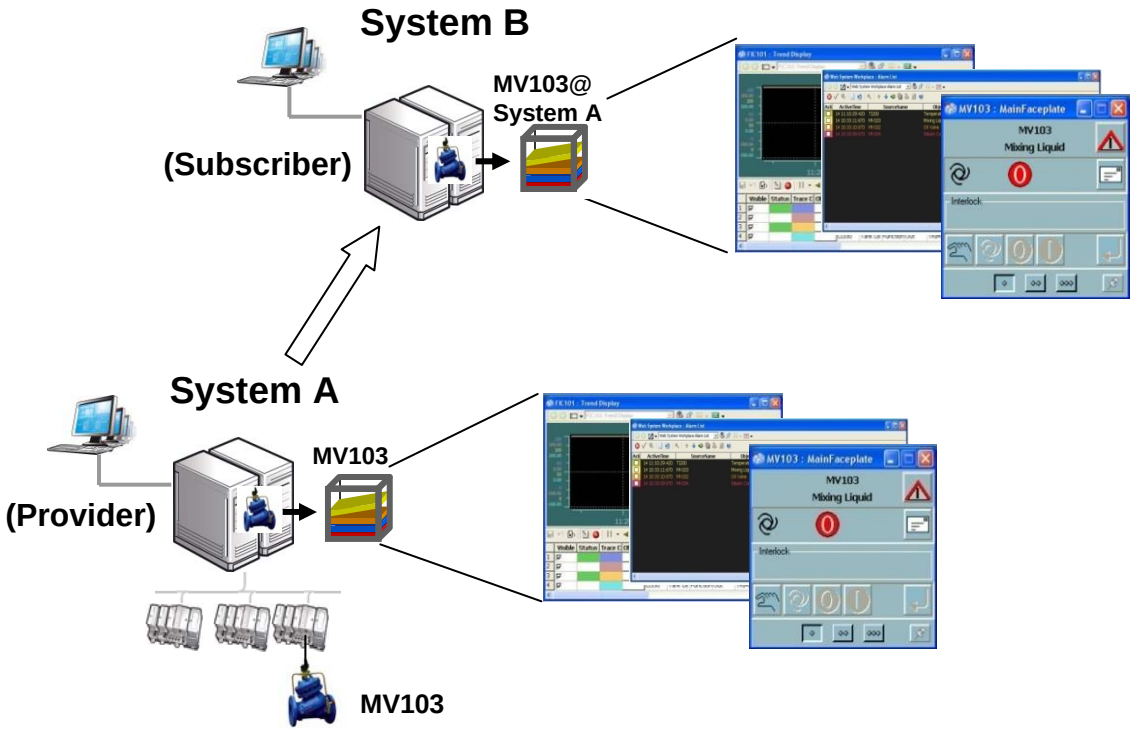
- Max figures per connectivity server

Server layer optimization
Connectivity server throughput – Wizard support



Less hardware for the same capacity

Multiple systems
Multisystem integration



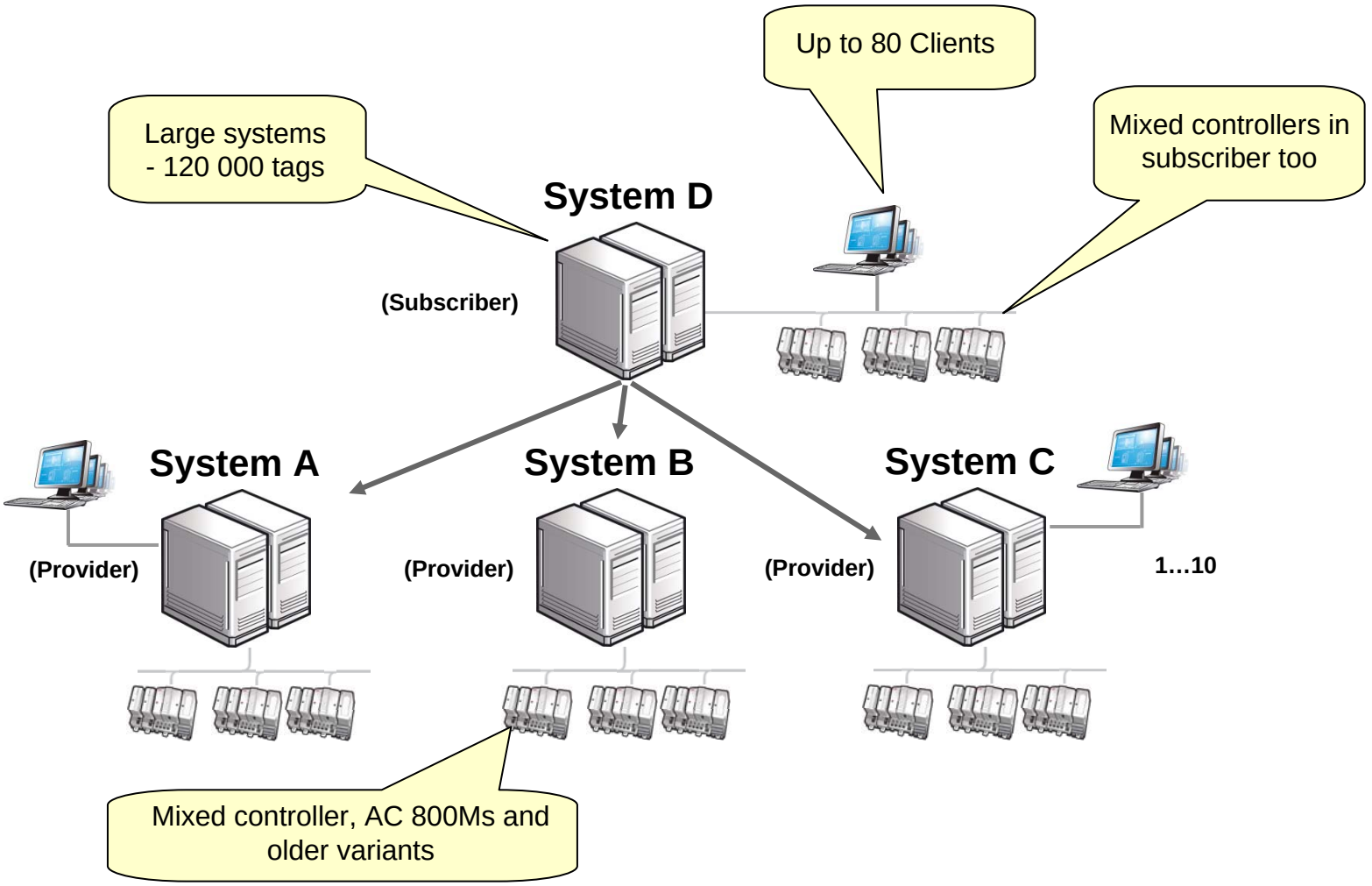
- Proxy objects are created in the Subscriber when uploading objects from the Provider

Multisystem integration

- Multisystem Integration makes it possible to connect to one or more 800xA systems and operate them from one single place, as if they where one system

Larger systems control more with the same operators

Larger systems
Improvements in 800xA 5.1



Performance optimization
Server disk arrangement

- Optimize system performance by allowing exclusive hard drive for certain system functions
  - Aspect Directory in an Aspect Server
  - History storage in a Connectivity Server
  - …
- Configured via the System Configuration Console
  - For upgraded projects, or when change is required
  - System installer supports disk selection for new installations
- Improves engineering performance as well as runtime

Agenda

- What is Virtualization?
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- Virtualization technologies for future use
- Server layer optimization
- System size, Multiple systems
- Performance optimization

Summary

- Virtualization offers excellent cost-of-ownership advantages
- Small to large size configurations in virtual environment supported by System 800xA. All server types supported.
- ESX and ESXi supported
- From a security standpoint a system running on virtual machines does not differ from a conventional one
- Vmware vMotion used for migrating (moving) virtual machines. Improves maintainability, but does not replace 800xA server redundancy

Summary, cont’d

- Server layer optimization
  - Cut footprint by calculating required throughput
  - Improvements in controller connectivity
- System size, Multiple systems
  - Larger systems and more clients
  - Larger systems, and still independent life cycles if desired
- Performance optimization
  - Multiple disks

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