The Use of Virtualisation Techniques for Ground Data Systems

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The existing approach for control centre data systems

- Fully dedicated hardware/installations serving individual applications for each mission
- Shared mission control user workstations in common areas (used for critical mission phases)
- Dedicated hardware for servers and routine clients, including platform migrations for long term missions

Advantages of the current approach

–Complete isolation of applications/systems, within missions and across missions

–Simple approach to hardware sizing (achieved on the basis of resource analysis of individual applications)

–Stable and reproducible ‘environment’ (no run-time competition across applications for hardware resources)

–Controlled procurement and deployment of ‘machines’ on the various networks, in particular on the operational network

–Clear management of pre-launch ‘configuration freeze’

–Simple billing policy (hardware resources entirely allocated to individual entities)

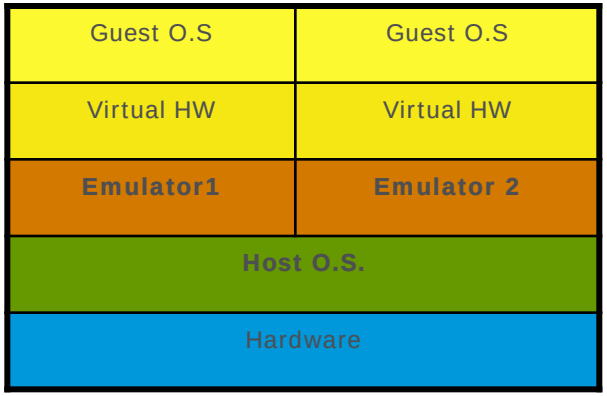
Disadvantages of the current approach

- Proliferation of baselines and hardware resources (due to the independent lifecycle of the operational applications)
- Underutilization of the available resources (because hardware resources are completely dedicated to individual applications)
- Chain effect of hardware ‘fast’ lifecycle, imposing the need of expensive applications migration during the operational lifetime
- Difficulty to manage the compatibility of applications with the underlying baselines (hardware, operating system, 3rd party products)
- Difficulty to manage common areas due to non homogeneous baselines of missions
- Difficulty to maintain reference/validation environments

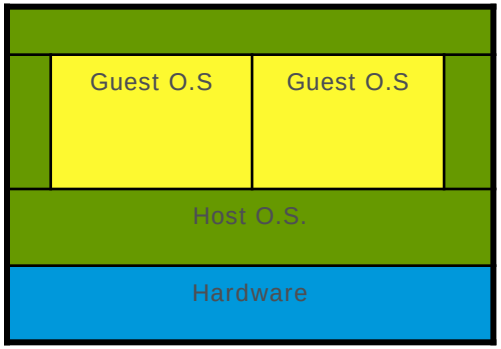
Virtualisation techniques

Virtualisation is a modern software technology which allows the partition of a physical machine into several 'virtual machines' (i.e. of software simulators of real machines)

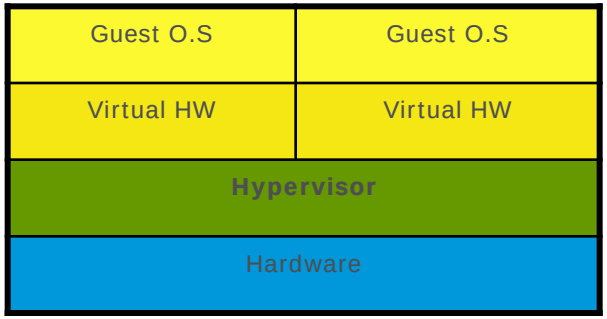
Emulation



OS-Level Virtualisation



Full/Native Virtualisation

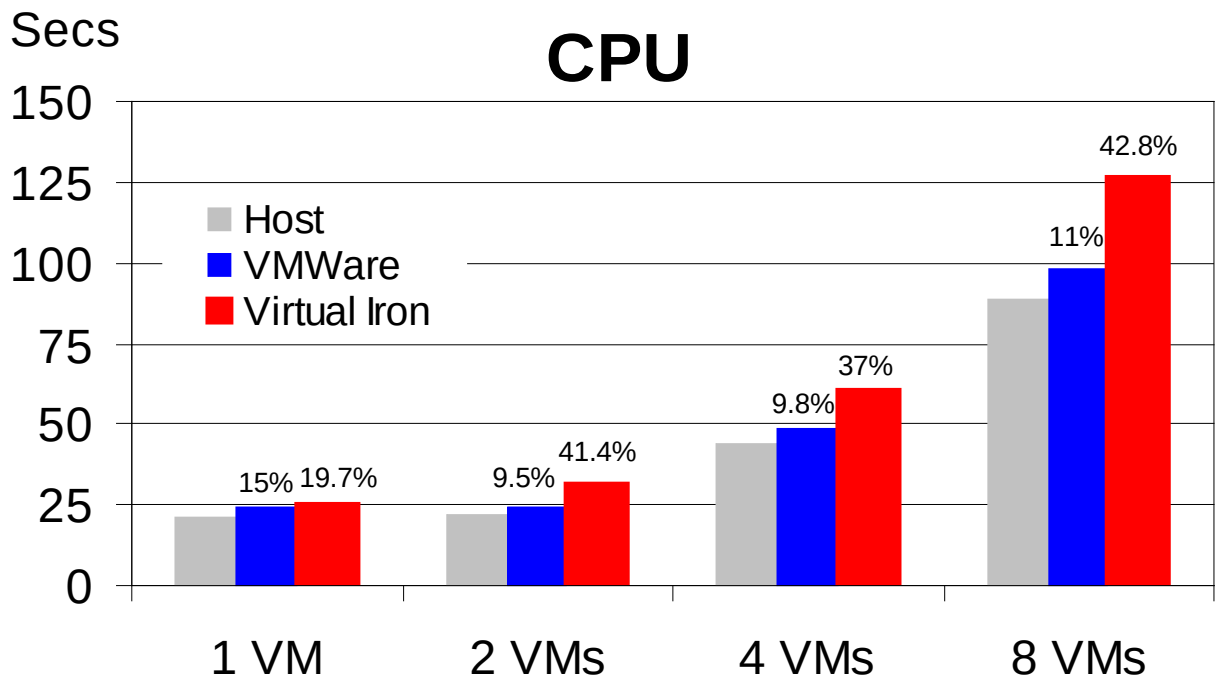


The potential of Virtualisation

- The application layer can be isolated from the underlying hardware
  - → The lifetime of application baselines can be extended
- Multiple heterogeneous applications can be installed/run on the same hardware (even if using different Operating Systems)
  - → The management of integration environment and operational common areas can be significantly simplified
- Completely independent applications can share the same hardware resources
  - → Less hardware can satisfy the user needs
- Resources can be dynamically allocated
  - → The increased flexibility allows a more efficient utilization of hardware
- Virtual machines can be created/deployed containing ‘turn-key’ systems
  - → The management of platforms and applications deployments can be significantly simplified.

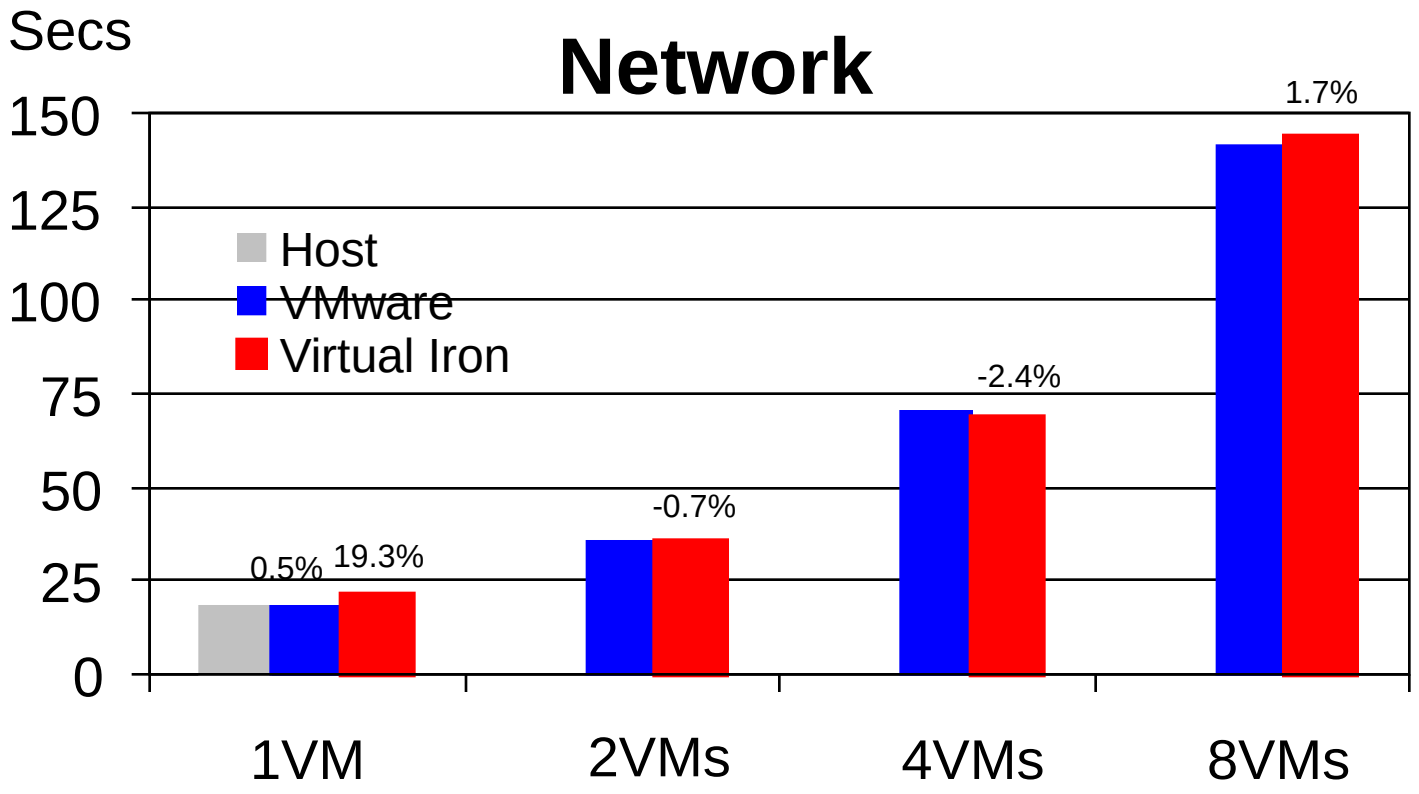
Evaluation: Performance penalty (CPU)

The computing performance penalty introduced by the virtualisation layer is small (10% for VMware)



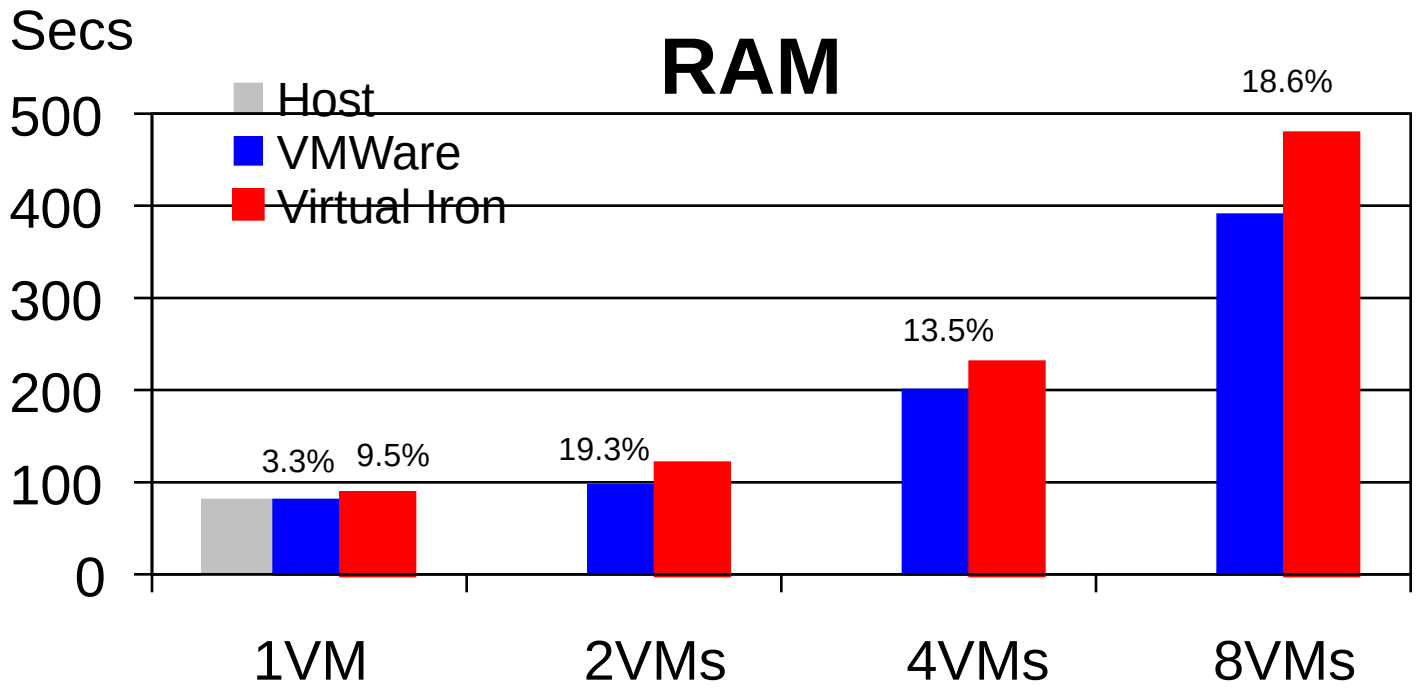
Evaluation: Performance penalty (Network)

Nearly no network access performance penalty is introduced by the use of virtualisation



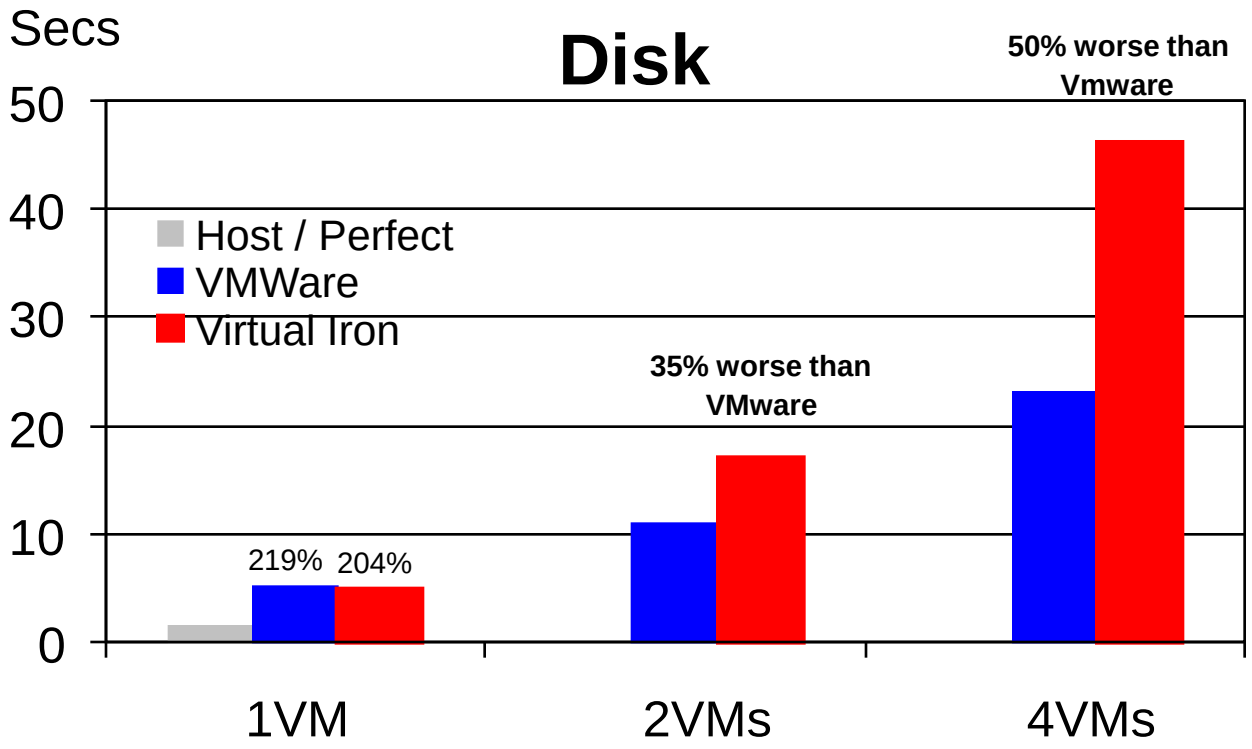
Evaluation: Performance penalty (RAM)

Access to RAM introduces a small penalty in VMware products



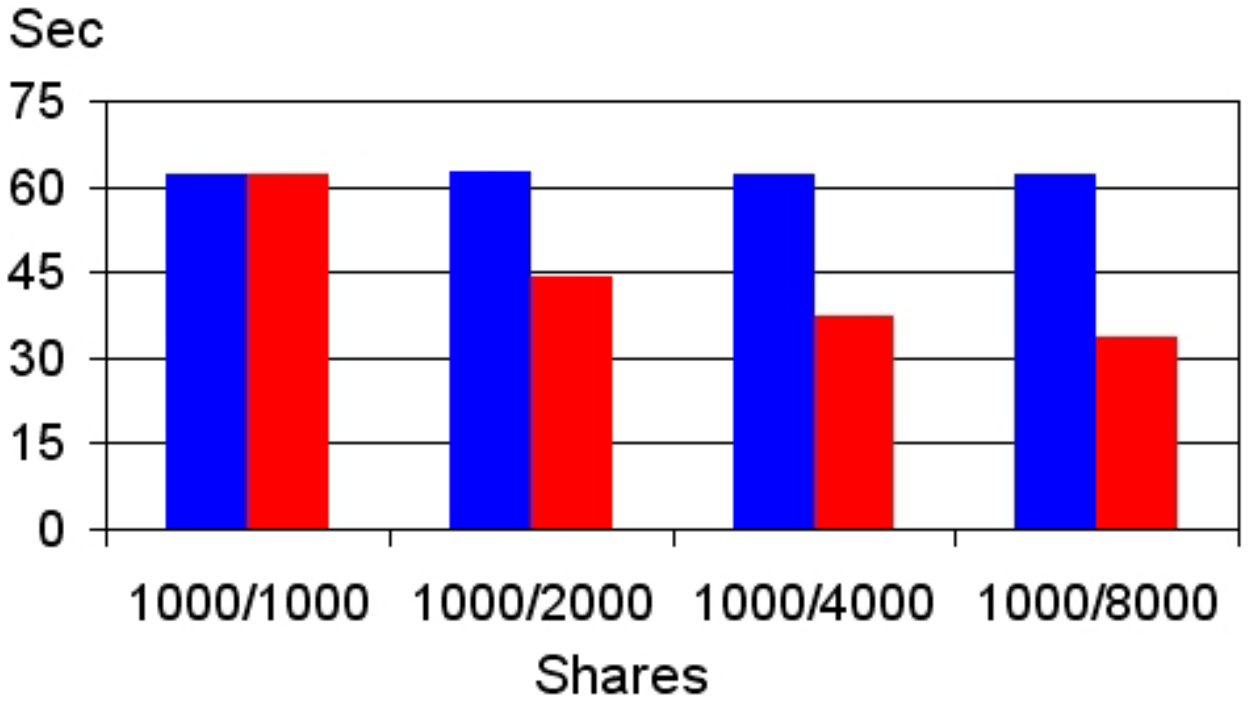
Evaluation: Performance penalty (Disk)

Disk access is the only area where the overhead was large. This could be solved using SANs (Storage Area Networks) or moving disk intensive applications out of the virtualised environment



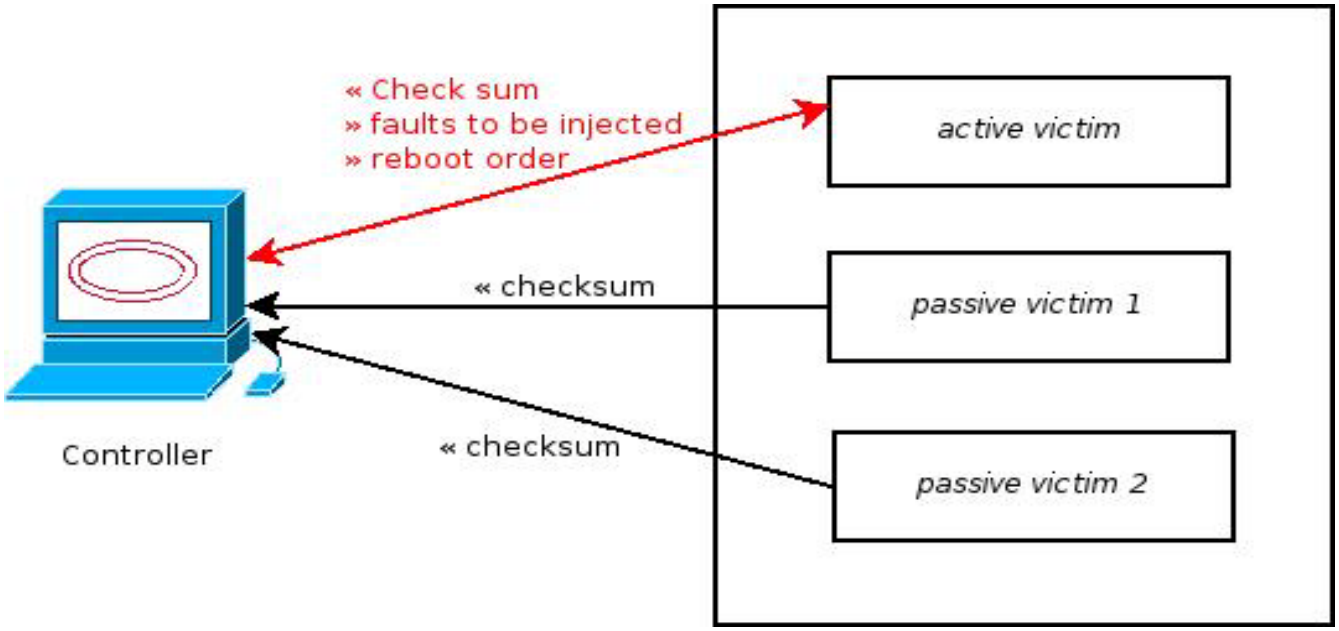
Evaluation: Performance isolation

Virtualisation can guarantee specific levels of performance (via allocation of priorities/shares) for a given virtual machine

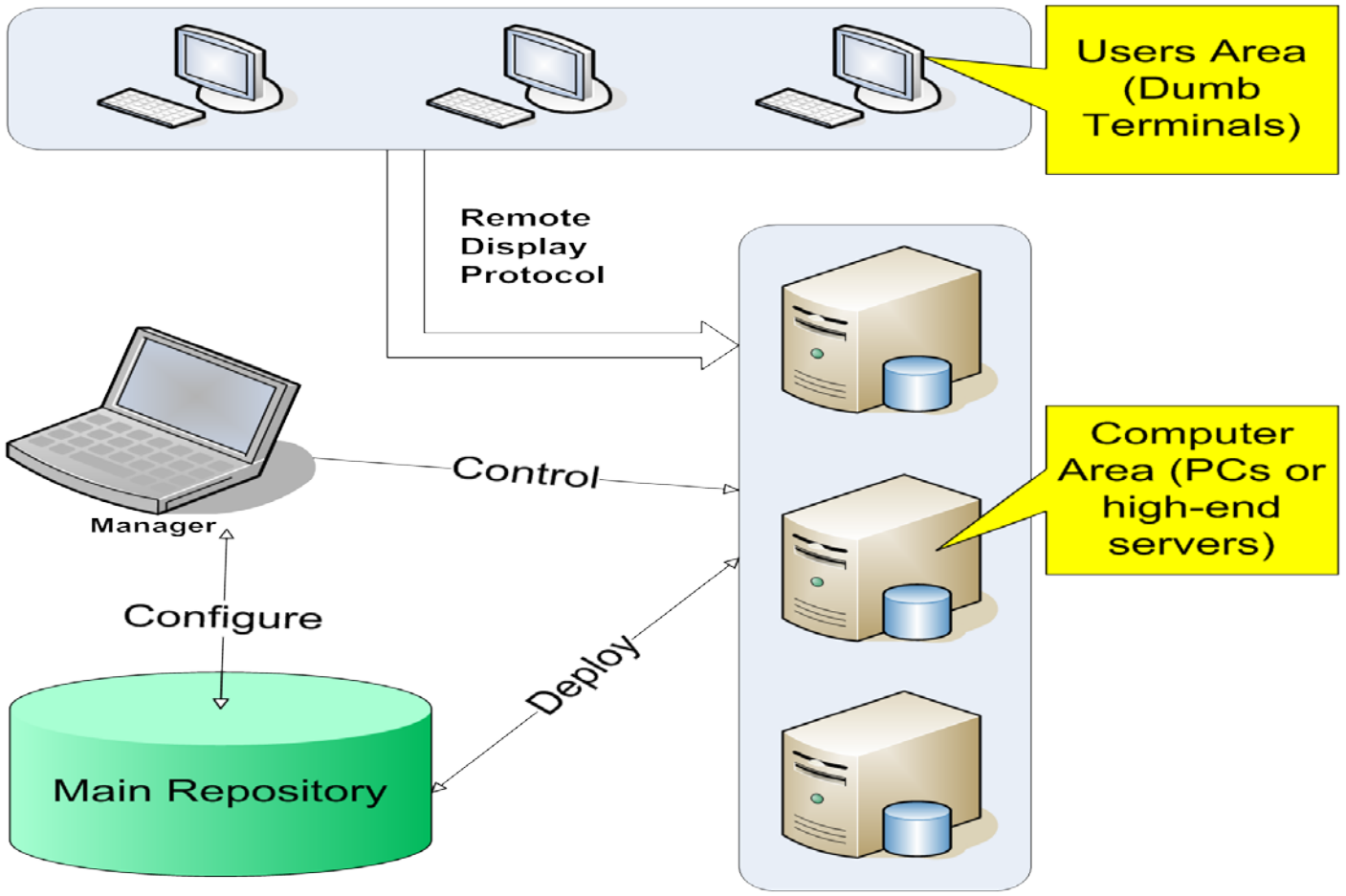


Evaluation: Fault isolation

Strong fault isolation: only 3 errors out of 59000 injected faults were propagated to the other virtual machines (0.005%)

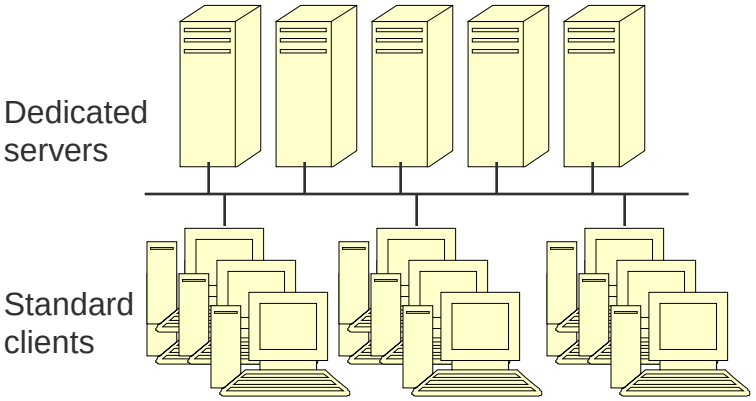


Overview of the proposed approach

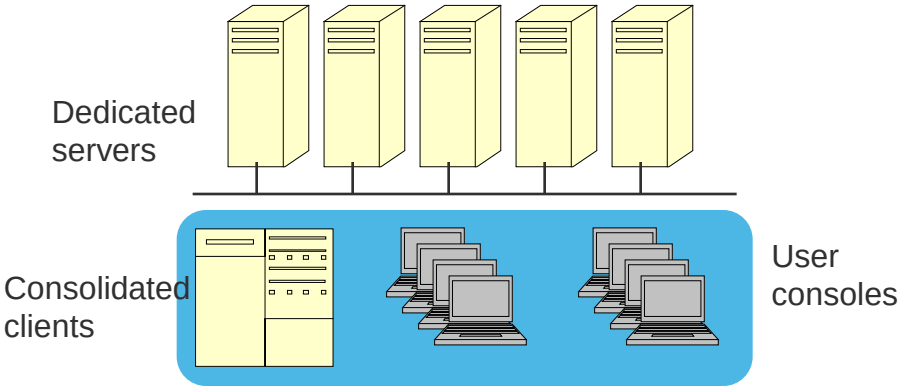


Control Systems consolidation approaches

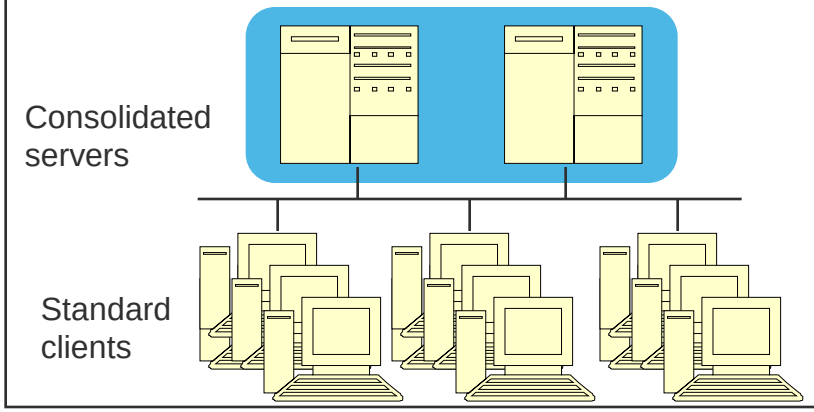
Scenario 1: Lowest consolidation:



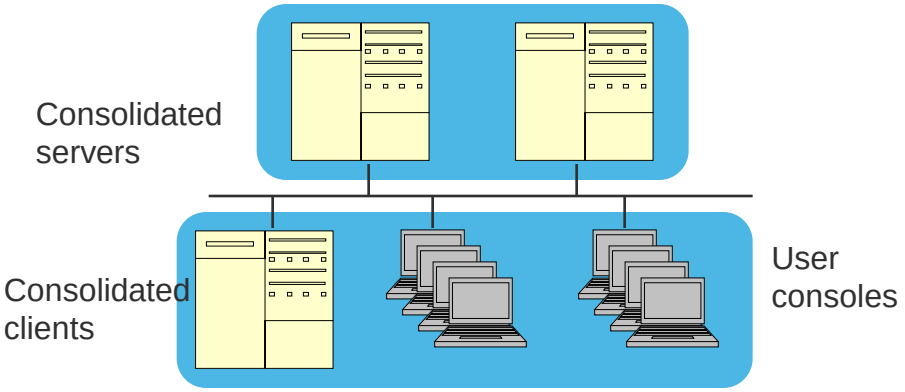
Scenario 2: Clients consolidation:



Scenario 3: Server consolidation:



Scenario 4: Full consolidation:



Areas currently being analysed

- Selection of hardware platforms to be used to support various levels of consolidation
- Platforms Management infrastructure (Backups, monitoring)
- Networking issues (e.g. management of addresses)
- Running costs (licenses, maintenance, management)
- Storage needs/approach/technology
- Certification and vendor support on virtual machines
- Remote display protocols/appliances
- Redundancy management
- Integration of the virtualised environment in current (development and operational) network

Roadmap towards a Virtualised Control Center

- Verification of applications compatibility with the Virtualised environment
  - Completed for the main control center applications, minimal changes required
- Consolidation of heterogeneous applications on common hardware platform
  - Ongoing for the integration/validation environments
- Redesign of operational areas to gain from consolidated/virtualised solutions
  - Pilot project recently started. All operational positions in common areas will be equipped with remote terminals accessing two blade servers
- Progressively expand the use of virtualised architectures to more and more applications

Lessons Learned (so far…)

- Very minimal changes required on the existing (PC compatible) control center applications to run in a virtualised environment
- Mission operators consider Virtualisation as a technology which may enable a cost reduction but also as an ‘increase of uncertainty’
- The baselines lifetime limiting factor when using Virtualisation is the Operating System support (typically ‘only’ 3 years after end of life)
- Legal issues to be carefully addressed in order to fully exploit the benefits of Virtualisation (e.g. exchange of VMs with off-site contractors)

Lessons Learned (so far…) (contd…)

- The deployment of an appropriate storage network is essential in order to enable an efficient management of Virtual Machines
- VMs deployment policies to be put in place upfront in order to avoid the ‘Virtual Machines Sprawl Problem”
- It is useful to ensure compatibility of low-end and high-end solutions for Virtualisation (e.g. the same Virtual Machine can run in VMware Server on a PC as well as in VMWare ESX on a high-end server)
- Users pretty much appreciate the capability to remotely access in the same way physical and virtual machines
- Strong commitment of the IT support team for the adoption of Virtualisation is essential for a successful deployment and maintenance of virtual environments

Conclusions

- Virtualisation technology and products (e.g. VMware) are mature, widely used and well supported
- The performance penalty is generally very limited (e.g. 10 percent CPU)
- The level of isolation between applications sharing hardware resources is sufficient
- No dependency on specific products is introduced at application level (the interface is still the standard Operating System)
- The amount of machines to support validation activities can (finally!) be sized according to the number of parallel users and not imposed by the number of different baselines

Conclusions (contd…)

- Virtualisation can be applied at various levels, ranging from standard PCs to high-end large servers
- The adoption of consolidated solutions based on Virtualisation requires significant investments in the area of IT infrastructure
- The risks associated to the use of Virtualisation can be managed by adopting a proper deployment approach
- Operational maturity of such a solution still needs to be gained.

It does require a cultural change in operational environments!

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THANK YOU FOR YOUR ATTENTION

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