

***NORTHROP GRUMMAN***

DEFINING THE FUTURE

# Cost Impacts of Server Virtualization

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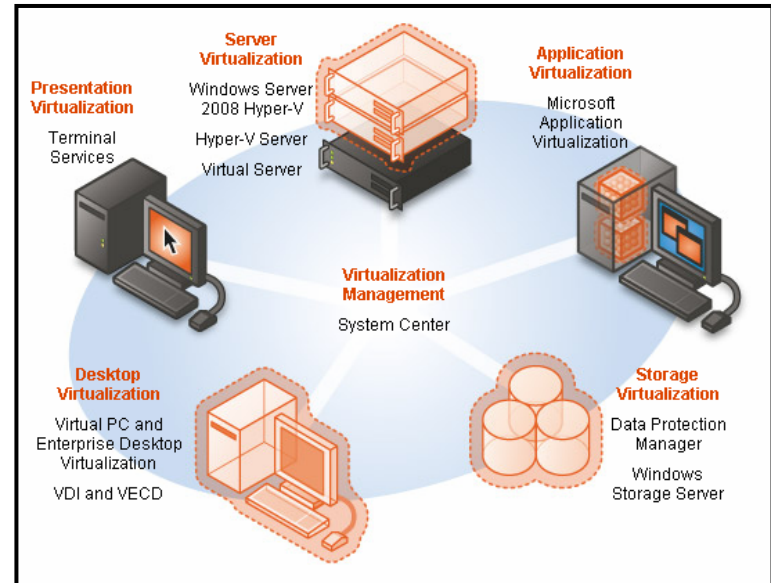
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# Purpose of Research

- **Investigate current virtualization efforts to better understand potential cost impacts**
- **When projecting total cost savings, the following factors should be considered :**
  - Purpose of program
  - Program size
  - Security and mission-critical application concerns
  - Availability of compatible COTS software
  - Virtualized server maintenance support
  - Program Complexity
- **Because many of these factors strongly impact business planning and activity, some large government agencies and companies might not experience as much of a decrease in cost**
- **This research considers server virtualization's impacts on costs in order to evaluate potential cost savings for future virtualization efforts**

# Definition

- **Virtualization is the ability of one computer or server to do the job of multiple computers or servers**
- **Server virtualization configures servers with sufficient processing capacity and additional network interfaces to function as multiple virtual servers on a single hardware platform**



- Virtualization is achieved through the transformation of hardware into software
- Through the use of commercial software packages, a “virtual machine” (VM) can be created to run its own operating system and applications similar to a physical computer or server
- Gartner predicts that virtualization will be the most important trend for servers through 2010

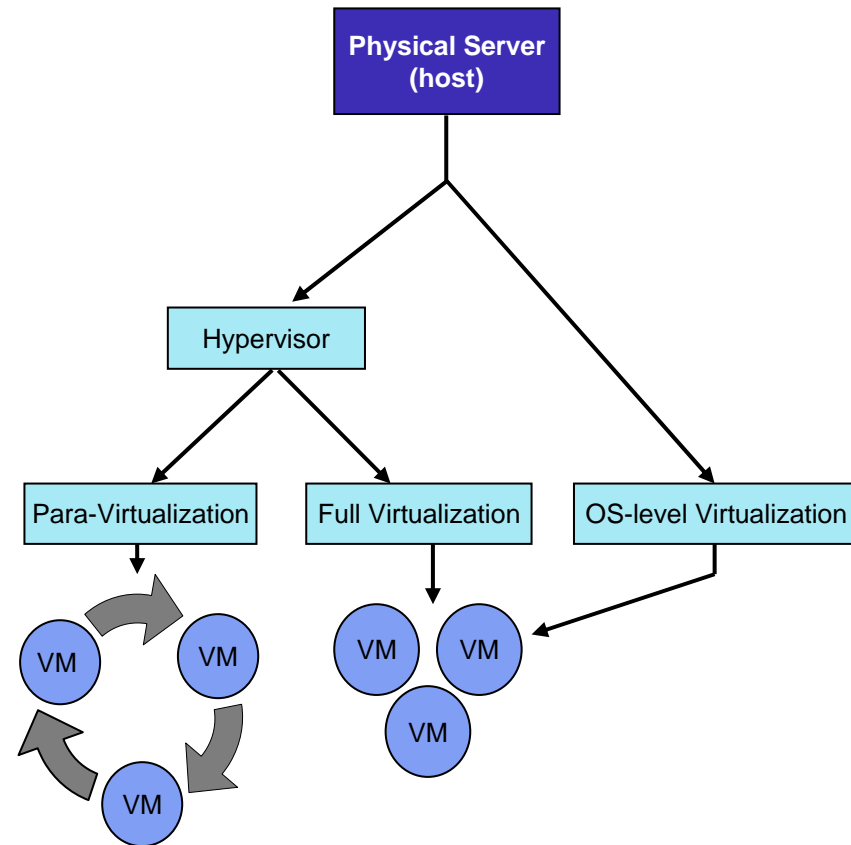
# Types of Server Virtualization

- **There are three primary types of server virtualization:**

- Full virtualization: Works through the use of a hypervisor to allow for the creation of VM's that can run on different operating systems while remaining unaware of the other virtual servers sharing a common host or physical server
- Para-virtualization: Works similarly to full virtualization, except that the hypervisor allows the virtual servers to be aware of one another
- Operating System (OS) level virtualization: Insists that all virtual servers run on the same operating system, but each server does remain independent from the others; virtualization capabilities are achieved by the physical machine's operating system

- **Each type possesses unique characteristics**

- Optimal configuration varies according to environment/infrastructure requirements
- No one configuration is universally better than another



# General Example

- **Server A is a 12 GHz server that consists of four (4) cores of three (3) GHz each**
  - To virtualize Server A, each core is partitioned into 4 “virtual servers” that are 750 MHz each
    - Total of 16 “virtual servers” at 750 MHz each
  - Many Applications / Processes use Server A partitions with some expected idle time
    - Some applications may not need to run at full power all the time
  - If there are 8 “virtual servers” in off-peak or idle mode, then the remaining 8 “virtual servers” have nearly 1.5 GHz ( $2 * 750 \text{ MHz}$ ) available to them

# Benefits of Virtualization

- **Quantifiable savings**

- Fewer physical servers: One physical server can host multiple virtual servers of varying operating systems requirements, allowing an organization to purchase less equipment to accomplish the same amount of work
- Decreased facility costs: Data centers will no longer require as many racks to store servers, leading to a reduction in needed floor space, energy consumption, and cooling costs
- Staffing & maintenance efforts: Data centers may no longer require as many employees to maintain the smaller hardware baseline, leading to a decline in staffing levels

- **Less quantifiable savings**

- Heightened disaster recovery: Virtualization allows for the creation of redundancy without the procurement of additional hardware
- Faster server deployment: A company can deploy new servers in a more expeditious, cost efficient way
- Fewer physical servers needed for testing: An independent system is typically needed for testing new applications; through the use of virtualization, programmers can create a virtual server on an existing machine at no risk to the current applications running on that server



# Limitations of Virtualization

- **While some commercial industries have seen an average 90% reduction in the number of physical servers, not all organizations can expect to see the same level of cost savings for several reasons:**
  - Security vulnerability: Because the technology of virtualization is still in development, only a portion of security concerns have been addressed
  - Licensing constraints: Vendors are still trying to determine how to set pricing when physical measures are no longer an accurate representation of quantity
    - Additional software constraints rise from the fact that packages like SAP and Oracle are poor candidates for virtualization
  - Lack of support from vendors: Many software vendors currently either offer no support or offer a limited level of support for software installed on virtual machines
  - Risk introduced when implementing a virtual environment on mission critical applications: Similar to security vulnerability, mission critical applications and programs that impose complex requirements may encounter problems with virtualization
  - Increase in needed storage capacity: Because virtualized servers are stored in storage, the creation of virtual machines typically requires more storage than the set up of a physical server would normally need
- **The nature of an organization's policies and work activities influence the susceptibility to these limitations**

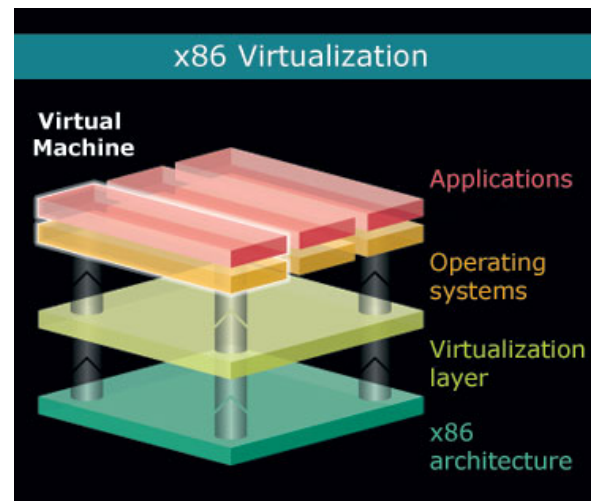


# Virtualization Efforts

- **Because server virtualization is a relatively recent trend, many organizations are just beginning to develop virtualized environments**
  - It is important to study and evaluate these current virtualization efforts in order to better anticipate cost impacts to future program virtualization efforts
- **Cost impacts resulting from virtualization can vary based on**
  - Inherent program differences, including
    - Program size
    - Program purpose
    - Necessary security
    - Hardware requirements
  - Point in life cycle
    - Some programs may currently be in the process of development, and can therefore be considered to have always existed in a virtualized environment
    - Older, more established programs may experience more difficulty transitioning to a virtualized platform due to necessary system modifications
- **The following slides consider a high-value IT government program, currently under development , that investigated and ultimately chose to take advantage of current virtualization technologies**

# Virtualization Example – Background

- **The architecture design for the high-value IT government program encompassed server virtualization early in the development process**
  - For purposes of this example, the program can be considered as always having been in a virtualized environment
- **Development of the program is occurring at the same time as other programs, both new and old (legacy)**
  - Other programs are also shifting toward virtualization
  - Virtualization of this program is further along than most other programs within the agency
- **This program, along with others in the government agency, will primarily use one specific type of server (x86) to create a cohesive environment**



# Virtualization Example – Strategy



- **The program will have 575 virtual servers across three security domains**
- **Most of the virtual servers will be accommodated by 197 virtualization-compatible Dell blades**
  - Each blade is expected to contain one to eight virtual machines, with most blades holding three or four virtual machines
  - The number of virtual machines per physical server is based on performance impact trends that have been observed in the past
- **Although most of the program will consist of virtualized servers, 341 “instances” will not be virtualized**
  - This limits the cost savings due to virtualization (though it does not mean that there will be 341 additional physical servers)
  - The majority of these instances represent the portion of the blade on which the hypervisor is installed to allow for virtualization, which is therefore not virtualized
    - In these cases, virtualized and non-virtualized “instances” can be found on the same blade
  - Some blades, on the other hand, will not be virtualized at all
    - Approximately 90 of these servers use Oracle based applications, which are specifically named as poor candidates for virtualization
    - Due to security concerns and server limitation, servers running Radiant Mercury High Assurance Guard (HAG), an application used for transferring documents between security domains, can not be virtualized at present
    - Other capabilities that will not be virtualized include data migration and media manager servers

# Virtualization Example – Program Impacts

- **The move to virtualization did introduce a level of complexity that slowed work down up-front, but employees have adapted to the new virtualized environment quickly**
  - With the exception of one individual who had prior experience with an older version of VMware, none of the program personnel had worked with or had received training on server virtualization
    - To ensure comprehension of the new technology, all personnel were sent to two main VMware training classes
    - On-the-job training was also intense, especially because personnel were required to handle programmatic issues while working 60 hours a week
  - It took approximately six months for employees to ramp up and begin working effectively with virtualized equipment, but the speed of this effort may not be typical
    - Due to schedule constraints, it was necessary for personnel to become familiar with virtualization at a much faster rate than might normally be expected
- **The majority of people working on the program's servers seem to approve of the effect virtualization has had on the program thus far, because it**
  - Provides the ability to create testing environments at a lower cost because virtual machines can now accomplish what full physical servers were required to do before
  - Offers more flexibility in support of transition efforts because additional servers do not need to be purchased to allow for dual-operations transitions
  - Increases mobility by delivering the ability to relocate virtual servers to different physical machines
    - Allows for better load balancing
    - Limits the down-time necessary in the event that maintenance must be performed on a particular physical machine

# Virtualization Example – Concerns and Setbacks

- **Thus far, the program has only experienced minor setbacks**
  - In one instance, a tool used for server maintenance was unable to see past the physical machine in order to see the virtual machines inside
    - With proper adjustments made to tools that administer these servers, the program's developers were able to correct this problem within 5 days
  - However, some issues are an intrinsic part of the program
    - As mentioned earlier, Oracle and HAG prohibit the implementation of virtualization, and other complex aspects of the program may also limit the ability to virtualize
  
- **The main concern for the program right now, and a significant concern for other programs that are currently shifting toward virtualization, is support for COTS software products**
  - Because some vendors are unwilling to guarantee support at present, it is a concern that if someone calls the vendor for assistance and must inform the support personnel that the problem exists in a virtual environment, the vendor will be unable to help and simply say "you're on your own"

# Virtualization Example – Analysis



- **As indicated by the example program's recent experiences, virtualization appears to be a positive architectural change**
  - This shift will most likely dominate hardware trends in the near future as more organizations move toward utilizing this new technology
  - Intelligence community programs that are in the process of virtualizing have already experienced some of the benefits of changing to the new environment, including the need for fewer physical servers and greater mobility and disaster recovery capabilities
  
- **Predicting the cost savings associated with this shift is difficult at present**
  - Because virtualization is a relatively new technology, few programs have currently completed a full transition to a virtualized environment
  - The example considered here describes a program developed in a virtualized environment from the beginning
    - This makes determining cost savings even more difficult because there are no "before" and "after" snapshots of the program
    - In order to calculate total cost savings, it is necessary to know what the costs were before virtualization
    - It is not possible to back into a comparison of the number of physical servers, because estimators cannot simply assume that each virtualized server would have required its own physical server in a non-virtualized environment
  - Once more IC programs have completed the transition to a virtualized environment, estimators will be better able to quantify the cost savings resulting from virtualization of government programs

# Analysis of Virtualization Cost Impacts

- **Research indicates that programs moving to a virtualized environment will see a decrease in hardware costs up-front because fewer physical servers will be needed**
- **On the other hand, most users will be likely to experience a slight net increase in administrative costs for a year or so while deploying and learning how virtualization changes management**
  - Savings may not appear until the virtualization effort is more mature and new management tools have been deployed
- **Despite this information, the impacts of virtualization on IC programs are not clearly understood at present**
  - Virtualization can bring about varying cost savings for different types of organizations
  - It is important to understand that while commercial industries can see significant cost savings associated with moving to a new virtualized platform, some companies and government agencies, due to the nature of their work, might not see the same substantial savings

# Things to Consider

- **Although it may not yet be possible to calculate the total cost savings attributed to virtualization for government programs, this research does indicate where cost savings could be expected**
  - Many aspects of a program must be considered in order to evaluate total cost savings, including
    - Change in number and cost of physical servers
    - Additional software that must be procured
    - New storage that must be purchased
    - Necessary training
    - Staffing level
    - Required facility modifications
- **The following slide contains example questions that should be considered when predicting cost impacts of virtualization**
  - These questions can be used in future research to determine what specific cost savings a program can anticipate



# Example Questions

- **What type of virtualization is being planned (Full, Para, OS-level)?**
  - Will multiple types of virtualization be implemented?
  - If a hypervisor will be used, which one will it be and how much will it cost?
  - Why is the program planning to virtualize?
  - What other efforts will this program look to as a guide for virtualization?
  - Are there any specific problems/complexities the program is anticipating (or has already experienced) as it moves toward virtualization?
  - Is a detailed COTS design available?
  
- **How many servers are currently being used?**
  - What types of servers are used?
  - How much does each of the current servers cost?
  - How many servers are currently used for backing up information?
  - How many of the current servers will remain after virtualization?
    - Why will these servers not be virtualized?
  
- **How many virtualized servers will be purchased to replace the current baseline?**
  - What types of servers will be procured and how much will they cost?
  - Will some of the new servers not be virtualized?
    - If so, how many?
    - What prohibits the virtualization of these servers?
  - How many virtual servers will be present on each physical server?
  - What certification and accreditation costs will be involved in the set up of the new virtualized hardware?
  
- **How much software development will be required for applications to function correctly on the new virtualized baseline?**

# Research Conclusions

- **Server virtualization is a promising method for creating cost savings, but limitations associated with virtualization can lead to setbacks for programs if the virtualization process for a specific program does not receive an in-depth evaluation**
  - Virtualization can only be a valuable cost savings driver if the right measures are taken and extensive research is conducted at the beginning of the process to ensure that the benefits of virtualization outweigh any additional associated costs
    - Research of indirect costs, such as service agreements and cost of new staff (or training of current personnel), should be conducted in order to ensure that the planned budget encompasses all costs associated with virtualization
    - Research on current virtualization problems similar organizations are encountering can help predict future issues
  - In order to avoid inefficiencies resulting from virtualization, organizations should create a detailed strategic plan on how to implement this new technology in the most effective way
- **Further research is needed to determine the overall impact of virtualization on IC programs and to develop estimating methodologies to predict the cost impacts of virtualization**



Blade Server

# Future Research

- **To ascertain what future costs may be incurred, the program discussed in this presentation should be followed until its implementation is complete**
  - The virtualized solution must be completed to gain full understanding of the potential costs
  - This will illustrate what programs that are virtualized from the beginning may experience
- **Additional programs, especially ones that are currently existing programs moving toward virtualization, should also be analyzed**
  - Because these programs will provide information before and after virtualization, analysts will be better able to accurately assess the direct impacts of virtualization and calculate the associated cost savings
- **The unique nature of each program means that virtualization will have different affects depending on the requirements and complexity of each program's mission**
- **With more research, it may be possible to establish overarching principles that can be used by cost estimators to determine a program's future savings due to virtualization**

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## Pictures Taken from:

- 1) <http://www.microsoft.com/virtualization/assets/images/products/landscape.jpg>
- 2) <http://www.python.org/files/success/rackspace/datacenter.jpg>
- 3) <http://i.dell.com/resize.aspx/blade-poweredge-m805-enclosure-right-314/295>
- 4) <http://www.desktop-virtualization.com/images/x86-hardware-virtualization.jpg>