WEEK 1 PAPER

Large-Scale Data Storage Systems – DATA-5400 | Spring 2020

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1. **When moving towards virtualization, a company will talk about 'Consolidating servers' and 'Containment'. What do you think these terms mean? How do they benefit the company?**

   In general, the word consolidation means integrating or merging several items into one. When we talk about servers, consolidation is the approach of merging multiple physical servers into one which is able to run many virtual machines (VM) instead. This procedure of reducing the total number of servers within an organization was developed in response to under-utilized servers, a phenomenon called "server sprawl". Thus, the company can achieve more efficient use of hardware and other resources through condensing servers which not only drives costs down but also gets rid of overfull data centers. The consolidation ratio is a measure that states the number of virtual servers that can run on a physical host, e.g. 5:1 means five VMs per physical host.

   Containment is the virtualization of server workloads. Instead of buying new hardware every defined period companies started to virtualize their physical servers.

   In implementing consolidation and containment solutions, the company benefits from reduced costs for buying software, maintaining software and hardware, electricity for power and cooling, cables and people amongst other benefits.

   Reference: Virtualization Essentials, Matthew Portnoy, John Wiley & Sons, Inc. , 2012

2. **If the same company installs a "Virtualization-first" policy, what does it mean? How will it benefit the company? What are advantages or disadvantages of this policy?**

   Centralized IT management, faster hardware resources and reduced overhead costs are some benefits of virtualization leading many companies to establish fully virtualized IT systems.
   "Virtualization-first" means that a company aims at trying to virtualize everything first unless there are technical issues or security reasons which demand a traditional server. The benefits of implementing a virtualization-first policy are the flexibility and cost savings. The latter applies to fewer hardware purchases and maintenance costs as well as less power and cooling which also impacts the environment. Creating snapshots of the VM also allows for straight forward failure control and disaster recovery which eliminates the rebuilding of a server from scratch or restoring from tape.

   One reason for not virtualizing is data sensitivity, if the data is too sensitive it might be better stored on a physical server. Another disadvantage of virtualization-first can be the build-up of too many VMs which can lead to "VM sprawl" which like "server sprawl" consumes resources and complicate management. The organization also has to make sure that the host server has the necessary processing power, RAM, storage and network capacity to sustain and run the installed VMs. To counteract, a company could establish restrictions and policies for VM creation whereby only certain users are allowed to instantiate new VMs.

   References:
   https://fcw.com/microsites/2013/snapshot-virtual-infrastruture/01-advance-virtualization-infrastructure.aspx
   https://www.atlantic.net/what-is-server-virtualization/

3. Describe a few risks of virtualization.

In order to secure the virtualization environment, stakeholders must identify potential virtualization risks and have countermeasures in place.
The Cloud Security Alliance lists in their report 11 potential risks for server virtualization, which I will list in the following: 1. VM sprawl, which can lead to an unmanageable state of machines. 2. Sensitive data within a VM could be easily compromised due if not managed properly. 3. Offline and dormant VMs can introduce security vulnerabilities due to limited security updates. 4. Unauthorized access to active VMs can introduce changes or malware in the virtual disks. 5. Lack of control over virtual networks limits security protection. 6. Virtual processes can impact physical resource capabilities. 7. The hypervisor is a risk factor for all virtual environments because it provides the single point of access to the virtual environment. Security of the hypervisor must be maintained throughout its life cycle. 8. The hypervisor must be protected against unauthorized access at all times. 9. Self-service portals can pose vulnerability to attacks. 10. Workloads of different trust levels located on the same server. 11. Risk due to cloud service provider APIs.

Generally, hosting multiple virtual servers on one piece of hardware increases the risk for single point of failure. A failure in the physical server running the hypervisor can make all applications running on VMs by the hypervisor unavailable. Thus, organizations should know about potential risks and failure points in their systems and implement strategies to counteract those.

References:
Cloud Security Alliance, Best Practices for Mitigating Risks in Virtualized Environments, 2015 (https://downloads.cloudsecurityalliance.org/whitepapers/Best_Practices_for%20_Mitigating_Risks_Virtual_Environments_April2015_4-1-15_GLM5.pdf)
arcserve, Trends in Server Virtualization, 2017 (https://s28241.pcdn.co/wp-content/uploads/2016/07/virtualization-ebook.pdf?m=1458566728)

4. Describe a few similarities and differences between Hypervisor Type 1 and Type 2. Which of the two types has a better performance?

A hypervisor or Virtual Machine Monitor (VMM) is the essential component in the virtualization stack which creates a virtual platform on the host computer capable of executing multiple guest operating systems.
Type 1 hypervisors reside directly on the physical server without an operating system beneath them and are thus called bare-metal hypervisors. A type 1 hypervisor acts like an operating system running on a server and capable of hosting multiple VMs. The direct contact with the hardware resources below allows for more efficiency as the software has direct access to the physical hardware. Type 1 hypervisors are also more secure than type 2 hypervisors because a damage in a single guest leaves the other guests unaffected. VMware ESX, Microsoft Hyper-V and Xen are examples for type 1 hypervisors.
In contrast, a type 2 hypervisor is an application that runs on top of a traditional operating system. Benefits of this system involve the large support of hardware, the easy installment and deployment. Through the extra layer between hypervisor and hardware the performance is not as efficient as for type 1 hypervisors. Also, the reliability of type 2 hypervisors is reduced because a failure in the underlying operating system will always affect all guests is supports. Examples for type 2 hypervisors are Oracle´s VirtualBox, Parallels for Mac and VMware Player.

References:
[1] https://docs.oracle.com/cd/E26996_01/E18549/html/VMUSG1011.html
[2] Virtualization Essentials, Matthew Portnoy, John Wiley & Sons, Inc. , 2012

5. Provide a brief description about VirtualBox. Include the history, purpose and benefits.

VirtualBox provides a cross-platform virtualization application that is able to run multiple operating systems at the same time, e.g. different versions of Windows or Linux on a Mac. The software was developed by Oracle Corporation and is a free and open-source hosted hypervisor for x86 virtualization. Originally Innotek GmbH created Virtual Box which in 2008 was acquired by Sun Microsystems and eventually in 2010 by Oracle.
Oracle VM VirtualBox is a type 2 hypervisor which can run on individual desktop machines as well as being deployed in datacenters and Cloud environments demonstrating its power. Next to its portability, VirtualBox allows for additional software to be installed in supported guest systems thereby improving their performance. Oracle VM VirtualBox also has good hardware support, like guest multiprocessing allowing 32 virtual CPUs for each VM, USB devices, full ACPI support, multiscreen resolution, built-in iSCSI support and PXE network boot as well as the ability to virtualize a vast array of virtual devices like virtual network cards and sound cards.
The software can also save snapshots of the state of the VM which permits reverting the VM back in time.
The VirtualBox Manager, is an intuitive software that allows for straight forward creation of new VMs as well as the management thereof.
In essence, Oracle´s VM VirtualBox is a good choice of a type 2 hypervisor for anyone looking for a free and easy-to-use software serving basic as well as advanced users.

References:
https://en.wikipedia.org/wiki/VirtualBox
https://www.virtualbox.org/manual/UserManual.html#virt-why-useful