Cloud Computing (16BT61201)

Unit I: Introduction to Virtualization & Technologies

NOTICE: Slides are extracted from "***Cloud Computing Virtualization Specialist Complete Certification Kit: Study Guide Book***" & *Other* ***Internet*** *resources.*

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- **Introduction to Virtualization:**
  - Definition & Objectives of Virtualization
  - History of Virtualization
  - Pros and Cons of Virtualization
- **Virtualization Technologies:**
  - Microsoft Hyper-V
  - Vmware
  - Xen
  - VirtualIron

Part – I

- **Introduction to Virtualization:**
  - Definition & Objectives of Virtualization
  - History of Virtualization
  - Pros and Cons of Virtualization

Objectives of Virtualization

Definition & Introduction:

Virtualization defined as the emulation of one of more workstations /servers within a single physical computer. In other words, Virtualization is the emulation of hardware within a software platform.

Virtualization allows the simulation of hardware via software. To make this possible, some type of virtualization software is required on a physical machine. Examples: Vmware, Virtual Box, Hypervisor, etc.

Full Virtualization is, allowing one physical computer to share its resources across a multitude of environments. This means that a single computer can essentially take the role of multiple computers.

Also, Virtualization is not limited to the simulation of entire machines. There are **many different types of virtualization, each for varying purposes** like Virtual Memory Simulation, Storage Memory Simulation, OS Simulation, Application Simulation, Network Simulation, etc.

Objectives of Virtualization

There are four main objectives to virtualization, demonstrating the value offered to organizations:

1. Increased use of hardware resources;
2. Reduced management and resource costs;
3. Improved business flexibility; and
4. Improved security and reduced downtime.

1. Increased use of Hardware resources:

With improvements in technology, typical server hardware resources are not being used to their full capacity. On average, only 5-15% of hardware resources are being utilized. One of the goals of virtualization is to resolve this problem. By allowing a physical server to run virtualization software, a server's resources are used much more efficiently. This can greatly reduce both management and operating costs.

For example, if an organization used 5 different servers for 5 different services, instead of having 5 physical servers, these servers could be run on a single physical server operating as virtual servers.

Objectives of Virtualization

2. Reduced Management and Resource Costs :

Due to the sheer number of physical servers/workstations in use today, most organizations have to deal with issues such as space, power and cooling. Not only is this bad for the environment but, due to the increase in power demands, the construction of more buildings etc is also very costly for businesses.

Using a virtualized infrastructure, businesses can save large amounts of money because they require far fewer physical machines.

3. Improved Business Flexibility:

Whenever a business needs to expand its number of workstations or servers, it is often a lengthy and costly process. An organization first has to make room for the physical location of the machines. The new machines then have to be ordered in, setup, etc. This is a time consuming process and wastes a business's resources both directly and indirectly.

Virtual machines can be easily setup. There are no additional hardware costs, no need for extra physical space and no need to wait around. Virtual machine management software also makes it easier for administrators to setup virtual machines and control access to particular resources, etc.

Objectives of Virtualization

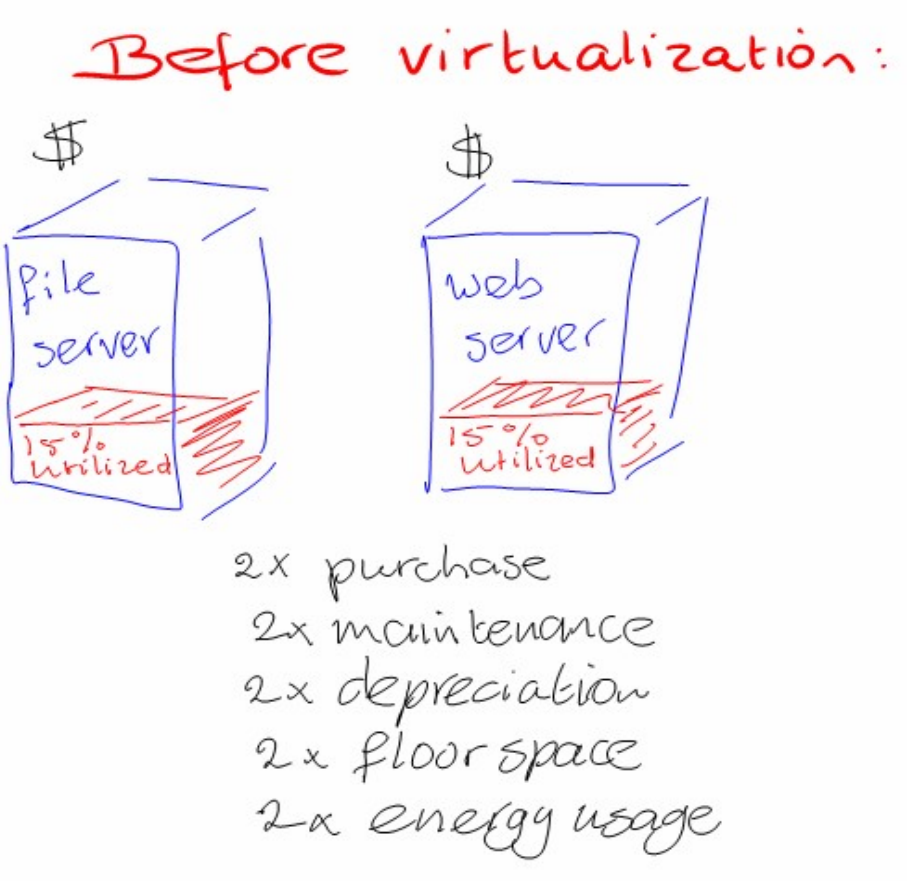
4. Improved Security and Reduced Downtime:

When a physical machine fails, usually all of its software content becomes inaccessible. All the content of that machine becomes unavailable and there is often some downtime to go along with this, until the problem is fixed. Virtual machines are separate entities from one another. Therefore if one of them fails or has a virus, they are completely isolated from all the other software on that physical machine, including other virtual machines. This greatly increases security, because problems can be contained.

Another great advantage of virtual machines is that they are not hardware dependent. What this means is that if a server fails due to a hardware fault, the virtual machines stored on that particular server can be migrated to another server. Functionality can then resume as though nothing has happened, even though the original server may no longer be working.

Objectives of Virtualization

Precisely, cost involved in the utilization of hardware resources **before** and **after** virtualization is as below:



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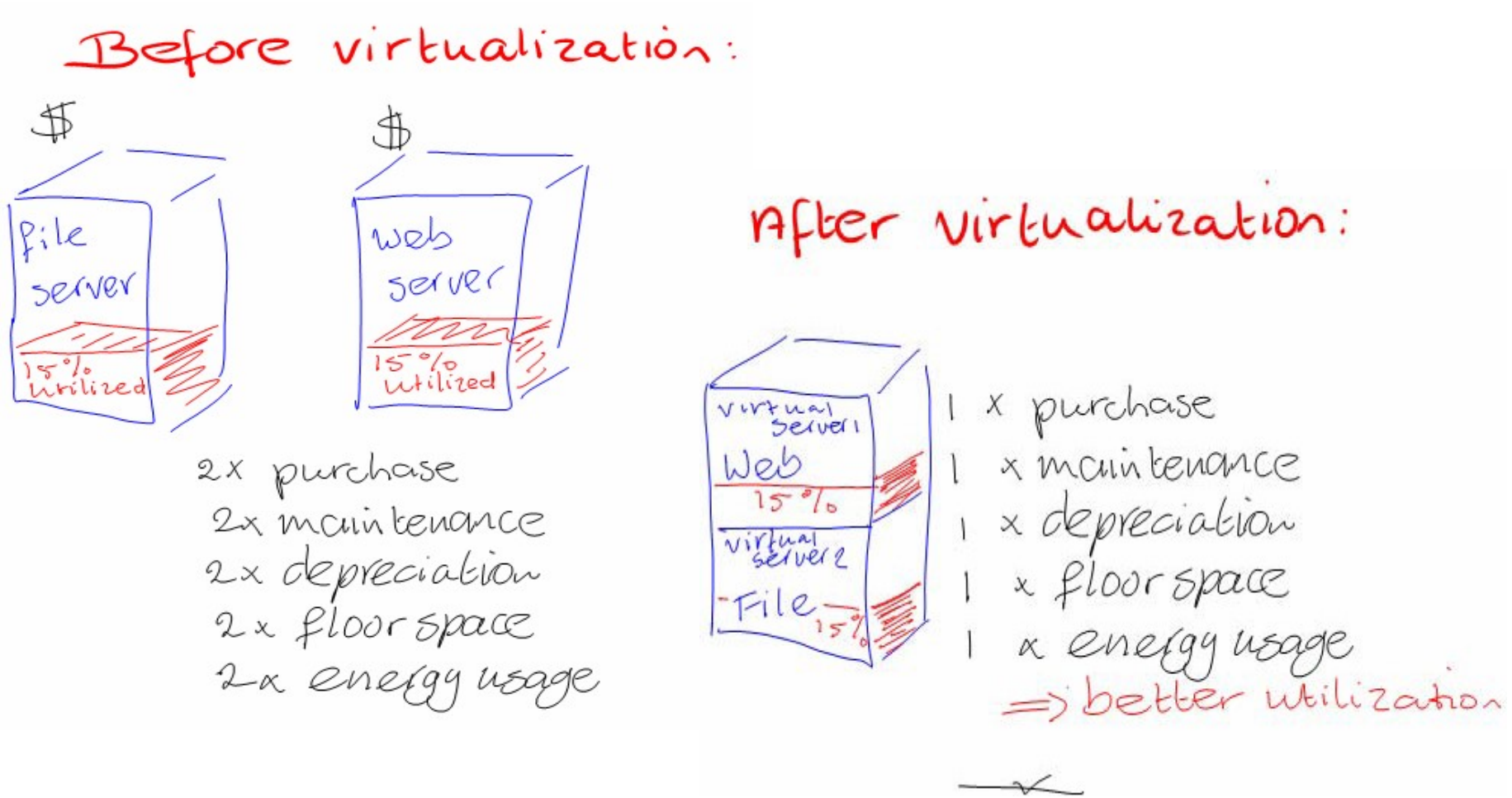


History of Virtualization

The concept of virtualization was first devised in the **1960s by IBM** to help split large mainframe machines into separate 'virtual machines'.

Before virtualization was introduced, a mainframe could only work on one process at a time, becoming a waste of resources. Virtualization was introduced to solve this problem. It worked by splitting up a mainframe machine's hardware resources into separate entities. Due to this fact, a single physical mainframe machine could now run multiple applications and processes at the same time.

This was done to maximize their available mainframe computers efficiency.

During the **1980**s, x86 became the dominant instruction set architecture in computer technology, and the client-server model was established to allow for distributed computing. The client-server model allowed administrators to connect together with many low cost workstations. Resources could then be distributed among these workstations using a few powerful servers. **This reduced the need for virtualization**!!

The massive use of Windows and Linux based operating systems during the 1990s further solidified the x86 architecture and client-server model.

History of Virtualization

The massive growth in the use of computer technology created new IT infrastructure demands as well as problems.

Some of these problems included:

- Low hardware infrastructure utilization;
- Rising physical infrastructure costs;
- Rising IT management costs;
- Insufficient disaster protection; and
- High maintenance and costly end-user desktops.

The promising solution to resolve the above-mentioned issues was hardware virtualization and thus, **in 1999**, VMware introduced their first virtualization application for x86 based systems. Modern day machines can now have their powerful hardware resources split up, just like mainframe machines did during the 1960s

Pros of Virtualization

Virtualized technology offers many benefits to organizations looking to migrate from a physical environment to a virtual setting. Some of the specific benefits to businesses are described below:

1. **Easier Manageability:** Through virtualization, administrators can monitor and manage entire groups of servers/workstations from a single physical machine.
2. **Elimination of Compatibility Issues:** In the past, running MAC OS, Linux or Windows on the same machine created many compatibility issues. These days, using virtual machines, many different operating systems and applications can run on a single physical machine, without affecting one another.
3. **Fault Isolation:** Any kind of error within a virtual machine will not affect any other virtual machine. Problems are automatically isolated, which can then be fixed or looked into by an administrator, while all other systems and services continue normal operation.
4. **Portability:** Virtual machine data is stored in files on a physical machine. This means that virtual machines can be transferred effortlessly from one physical machine to another, without any changes to functionality.

Pros of Virtualization

5. **Increased Security:** Administrators can separate information and applications on a single physical machine into different virtual machines. This prevents users from being able to access or view what they should not be able to. Also, if a virus gets on to a physical machine, it will usually affect the entire machine. Virtual machines are separate entities, therefore any viruses or problems will be isolated within that virtual machine. The physical machine and all other virtual machines will not be affected. Virtualization also makes it easier to revert back to a previous state. For example an entire virtual machine could be backed up manually at regular intervals or using the virtual machines built in checkpoint feature, it could be reverted to a previous fully working state.
6. **Efficient use of Resources:** Many virtual machines can run on a single physical machine, utilizing that physical machine's resources much more efficiently than if it was just running a single service or application. If a business previously used five physical servers, to provide five different services, they would now only require a single physical server. This one server would be much more efficiently used and its resources would not be wasted.

Pros of Virtualization

7. **Problem-Free Testing:** One or more virtual machines can be set up as test machines. These can then be used to test the stability of certain applications or programs, without affecting the functionality of day to day business operations.
8. **Rapid Deployment:** The Hard Drive of a virtual machine is often represented as a single file on a physical machine. This means that this Hard Drive can easily be duplicated or transferred to other physical machines. By using one virtual machine as a 'template' machine, its virtual Hard Drive file can be used to rapidly create new virtual machine clones. The advantage of this is that an administrator would only have to carry out an OS installation once.
9. **Reduced Costs:** Costs are reduced in the form of less physical hardware, less power and cooling requirements, less physical space and less staffing requirements. Once a business has moved to virtualized environment, they begin to reap the many rewards that this kind of solution provides. Less physical machines, means less physical space is required, therefore a business office and building costs are greatly reduced. Both heat and power outputs are also significantly reduced and again this helps to reduce the running costs for a business. Networking costs are also reduced because fewer switches, hubs and wiring closets are required. As you can see, one of the greatest reasons why a business would want to adopt virtualization is simply because of the large amounts of money that they could saved, both in the long- and short-term.

Pros of Virtualization

10. **The Ability to Separate Applications:** Services and applications that may conflict with one another can be installed and run on separate virtual machines. Because these services and applications are still running on the same physical machine, resources and processing power are not wasted.
11. **Easier Manageability and Improved Uptime:** Virtualization makes administering and managing an IT environment much easier. Less physical machines mean that administrators have less hardware faults or issues to deal with. This means that they can use their time on much more productive and beneficial tasks. Multiple virtual machines can also be configured and monitored from a single location. Again this makes things much easier for administrators, as they do not have to go from physical machine to machine when configuring updates or making changes.
12. **Easy Maintenance:** Backing up and restoring a virtualized environment is also much easier than a physical one. If there are problems on one physical machine, an administrator can easily copy over entire virtual machines to another physical machine. A business can then continue operating with a minimum of downtime.

Cons of Virtualization

1. **High cost of Implementation:** The cost for the average individual or business when virtualization is being considered will be quite low. For the providers of a virtualization environment, however, the implementation costs can be quite high. Hardware and software are required at some point and that means devices must either be developed, manufactured, or purchased for implementation.
2. **Invariable Limitations:** Not every application or server is going to work within an environment of virtualization. That means an individual or corporation may require a hybrid system to function properly. This still saves time and money in the long run, but since not every vendor supports virtualization and some may stop supporting it after initially starting it, there is always a level of uncertainty when fully implementing this type of system.
3. **Security Risks:** Information is our modern currency. If you have it, you can make money. If you don't have it, you'll be ignored. Because data is crucial to the success of a business, it is targeted frequently. The average cost of a data security breach in 2017, according to a report published by the Ponemon Institute, was $3.62 million. For perspective: the chances of being struck by lightning are about 1 in a million. The chances of experiencing a data breach while using virtualization? 1 in 4.

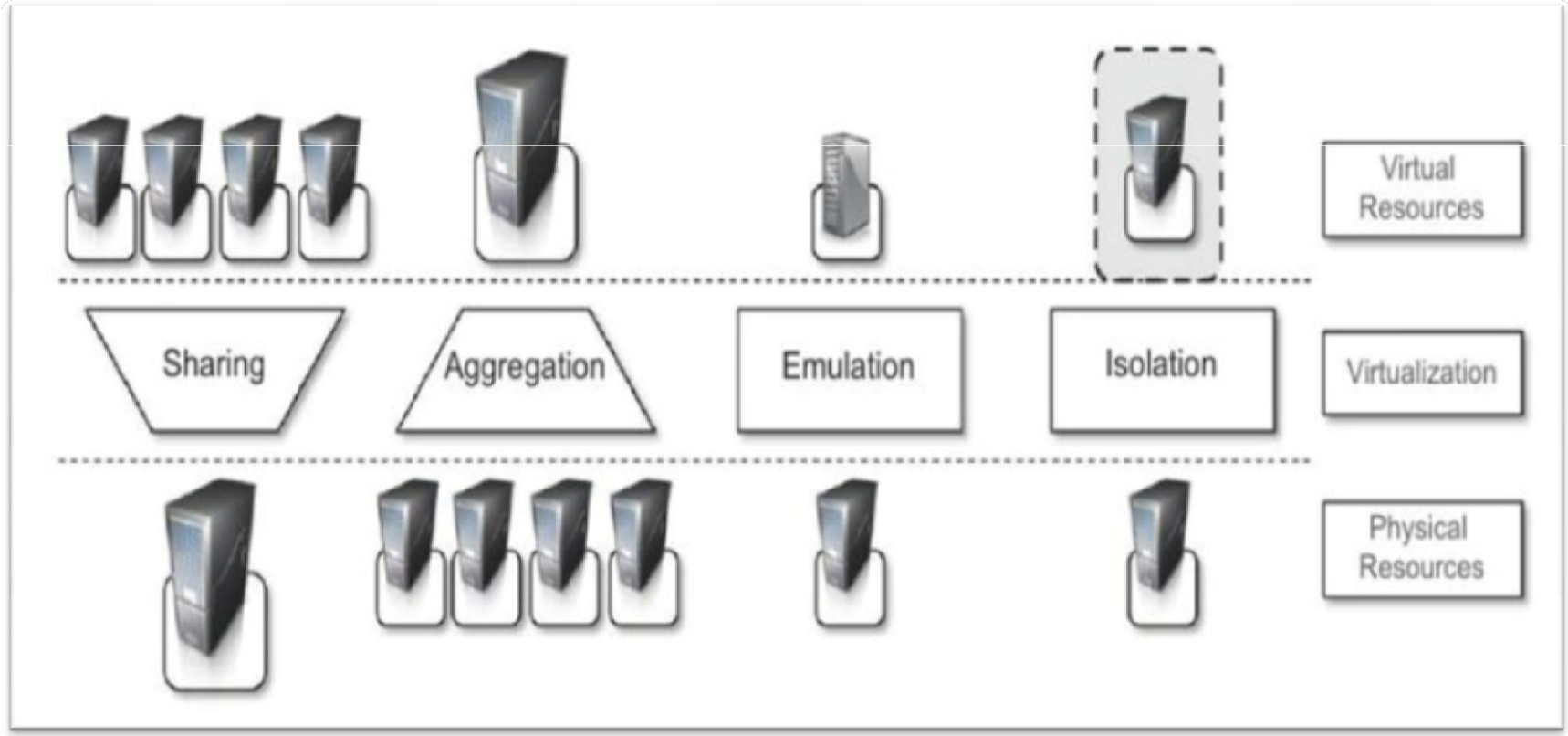
Cons of Virtualization

4. **Availability Risks:** The primary concern that many have with virtualization is what will happen to their work should their assets not be available. If an organization cannot connect to their data for an extended period of time, they will struggle to compete in their industry. And, since availability is controlled by third-party providers, the ability to stay connected in not in one's control with virtualization.
5. **Scalability Risks:** Although you can grow a business or opportunity quickly because of virtualization, you may not be able to become as large as you'd like. You may also be required to be larger than you want to be when first starting out. Because many entities share the same resources, growth creates lag within a virtualization network. One large presence can take resources away from several smaller businesses and there would be nothing anyone could do about it.
6. **Several links in a chain to work together Cohesively:** If you have local equipment, then you are in full control of what you can do. With virtualization, you lose that control because several links must work together to perform the same task. Let's using the example of saving a document file. With a local storage device, like a flash drive or HDD, you can save the file immediately and even create a backup. Using virtualization, your ISP connection would need to be valid. Your LAN or Wi-Fi would need to be working. Your online storage option would need to be available. If any of those are not working, then you're not saving that file.

Characteristics of Virtualization

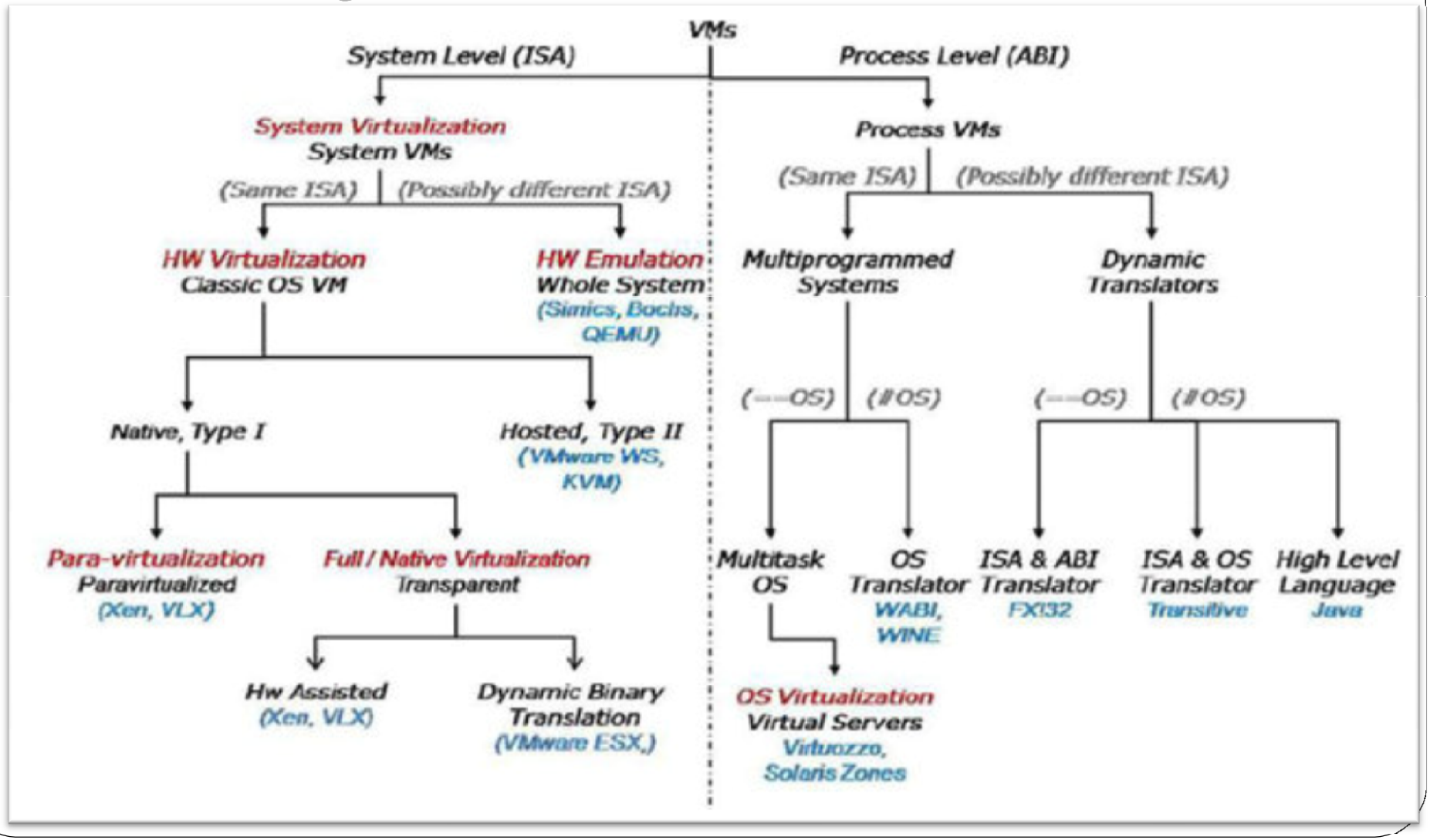
a. **Capacity to Enhance Security**: Virtualization shall be clearly discriminating the execution levels of host and guest environments. Accordingly, the effect and impact shall be restricted to the level of guest or host.

b. **Managed Execution Types**: "Sharing, Aggregation, Emulation, Isolation" ; These operations should be handled exclusively for effective functioning of virtualization.



Taxonomy of Virtualization

Virtualization is generally observed in: **Executing Environment** (System level & Process level), **Storage** and **Networks**.



Part – II

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Thank You

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