

DS 255 - System Virtualization

Assignment II - Evolution of Virtual Machines

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1. The motivations for using a virtual machine are as follows,
 - (a) To enable server consolidation which leads to reduced hardware and operating costs, improve availability and increase server utilization
 - (b) To facilitate the execution of multiple versions of privileged software nucleus at the same time in a single bare machine
 - (c) To provide high degree of isolation to each basic machine interface. This provides increased system reliability, security and privacy
 - (d) To enable interoperability of software programs that are tied to a specific ISA and OS interface across different systems

The evolution of Virtual Machine requirements and its impact in system design is detailed below,

2. Basic Machine Interface - It provides access to the execution of both privileged and non-privileged instructions on the bare machine. It is the collection of all software visible objects and instructions that are supported by the hardware and firmware of a system. Note that it can support only one privileged software nucleus directly on top of it.

Extended Machine Interface - The idea behind extended machine interface is to allow for a multiprogrammed environment for user programs with appropriate isolation between them to avoid interference. The functionalities offered by this interface include the execution of non-privileged hardware instructions and ability to make supervisory (system) calls for privileged functions.

This extended interface is achieved or realized through the notion of a process. The privileged software nucleus virtualizes the bare machine resources and provides an abstraction of it to each process.

3. The motivations for server sprawl syndrome are as follows,
 - (a) The need for running each application in isolation by organizations
 - (b) Unplanned acquisition of large no. of servers to cater to present and future growth
 - (c) Operating System heterogeneity - Example: mail server requiring Windows, database server requiring Linux, network management requiring AIX etc.
 - (d) Relying on coarse grained server driven isolation due to complexity associated with the integration of different applications
 - (e) Decreasing cost of hardware resources and increasing need for high availability and redundancy accelerated the syndrome

The after effects of this syndrome are as follows,

- (a) Large number of severely underutilized servers with true utilization in the range of 5-12% on average in many organizations
- (b) Increase in Total Cost of Ownership (TCO) (capital + operational expense) due to wastage of resources and large staff required for management
- (c) Applications were not able to scale effectively as per the demand due to 1:1 relationship with the hardware and operating system
- (d) Increased adoption of server virtualization manifested in data centers to combat this syndrome leading to innovations in virtualization technology

4. IaaS (Infrastructure as a Service)

- (a) The main abstractions/services provided in this layer are the following: Compute, Storage and Networking services. These are available to users as follows,
- (b) The Compute is abstracted as virtual machines for the users generally following different pricing models such as on-demand, prepaid etc.
- (c) The Storage is abstracted as storage pools or buckets which are accessible through APIs, web etc. These are composed of distributed storage systems like SAN in the backend
- (d) The Network is abstracted as virtual network on the cloud. The cloud providers generally offer load balancing, firewall and DNS services as part of Networking infrastructure
- (e) IaaS is the delivery of computing infrastructure as a service. It is provisioned and managed over the internet. It provides the highest level of flexibility and management control over the resources. It is the layer above physical hardware

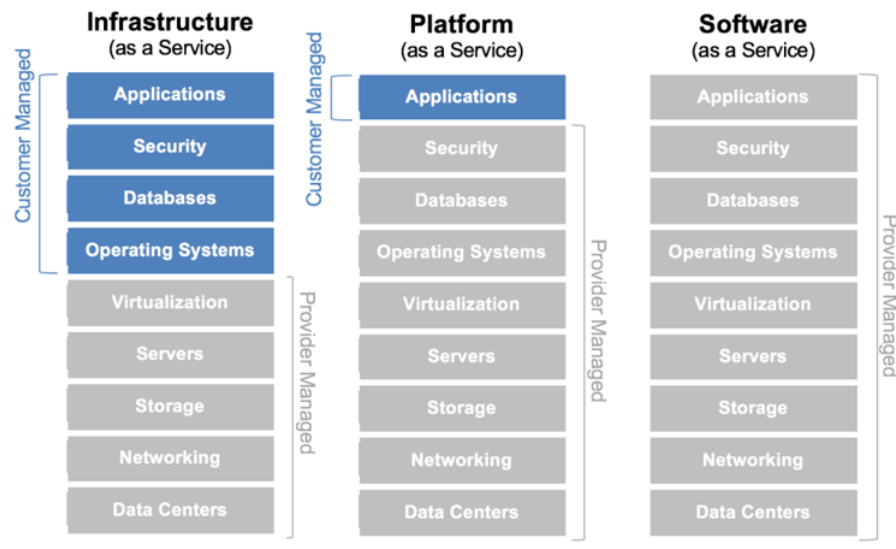
PaaS (Platform as a Service)

- (a) The main abstractions/services available in this layer are the following: execution runtime, development tools, middleware, database systems etc.
- (b) Note that these services are available in addition to the services from IaaS. Also, some authors/cloud providers consider IaaS and PaaS as a single entity as the accepted definitions for them vary widely
- (c) PaaS abstractions enable efficient application lifecycle management as activities such as capacity planning, patching, software maintenance are taken care by the platform
- (d) Examples of PaaS include Google App Engine, Amazon Beanstalk, Azure SQL etc.

SaaS (Software as a Service)

- (a) The main abstractions/services available in this layer are the following: Application software, application data. It is also known as Application service provider (ASP) model
- (b) SaaS offers multi-tenant architecture where the same platform hardware and software is shared among multiple users
- (c) SaaS enable accessibility to enterprise applications which can scale per demand, automatically perform software updates, etc.
- (d) Examples of SaaS include Salesforce, Microsoft PowerBI, Web mail service etc.

The following diagram illustrates the various layers and their abstractions,



References

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