



FUNDAMENTALS OF VIRTUALIZATION

PRASHANTH

CLOUD PLATFORM, SAP

INFORMAL SESSION

- Stop me
 - If you find it difficult to follow
 - If you need a break
- Prompt me to make use of the board even for the smallest thing

HOW MANY OF KNOW SOMETHING ABOUT

- How a program executes on your system?
- Hardware components in your computer?
- Operating Systems?
- Virtualization?
- Cloud computing?

QUICK INTRODUCTION



B.Tech. IT
SRM University
2011-15



M.Tech. CSE
IIT Bombay
2015-17



Developer
Cloud Platform, SAP
2017-Present

AGENDA

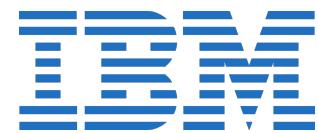
- Evolution
- Basics of operating systems & computer architecture
- Virtualization overview
- Types of virtualization
- Hardware (server) virtualization
- Benefits of virtualization
- How it effects cloud computing?



EVOLUTION OF VIRTUALIZATION



TIMELINE OF EVENTS



1960



2000



2001



2006



2010



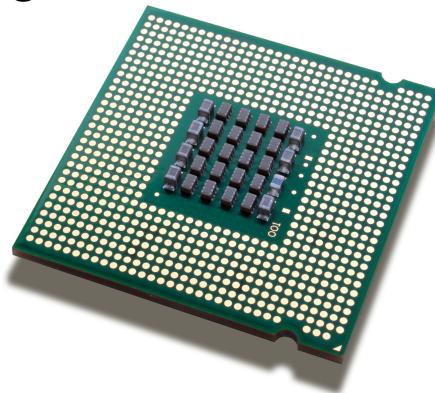


BRUSH UP THE BASICS

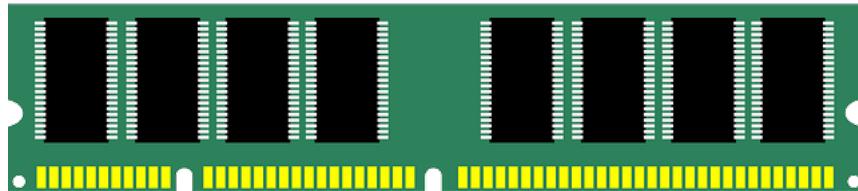
COMPUTER ARCHITECTURE & OPERATING SYSTEMS

COMPUTING RESOURCES

CPU



Memory (RAM)



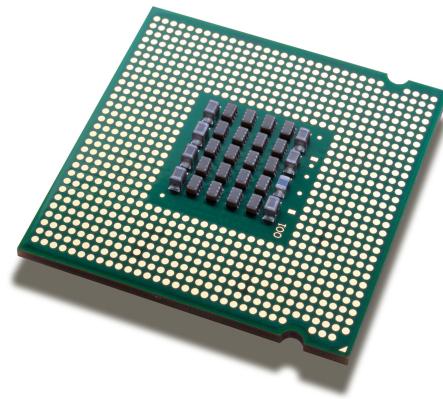
Network I/O



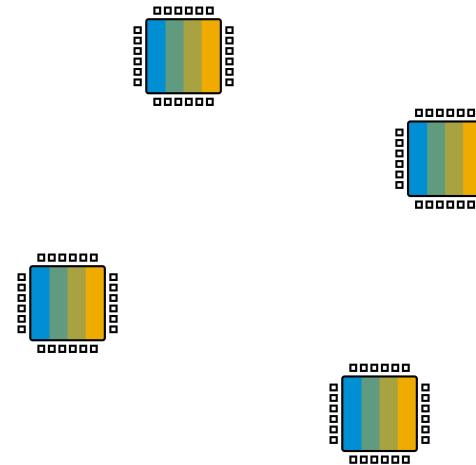
Disk I/O (Storage)



PROCESSOR VERSUS CORES

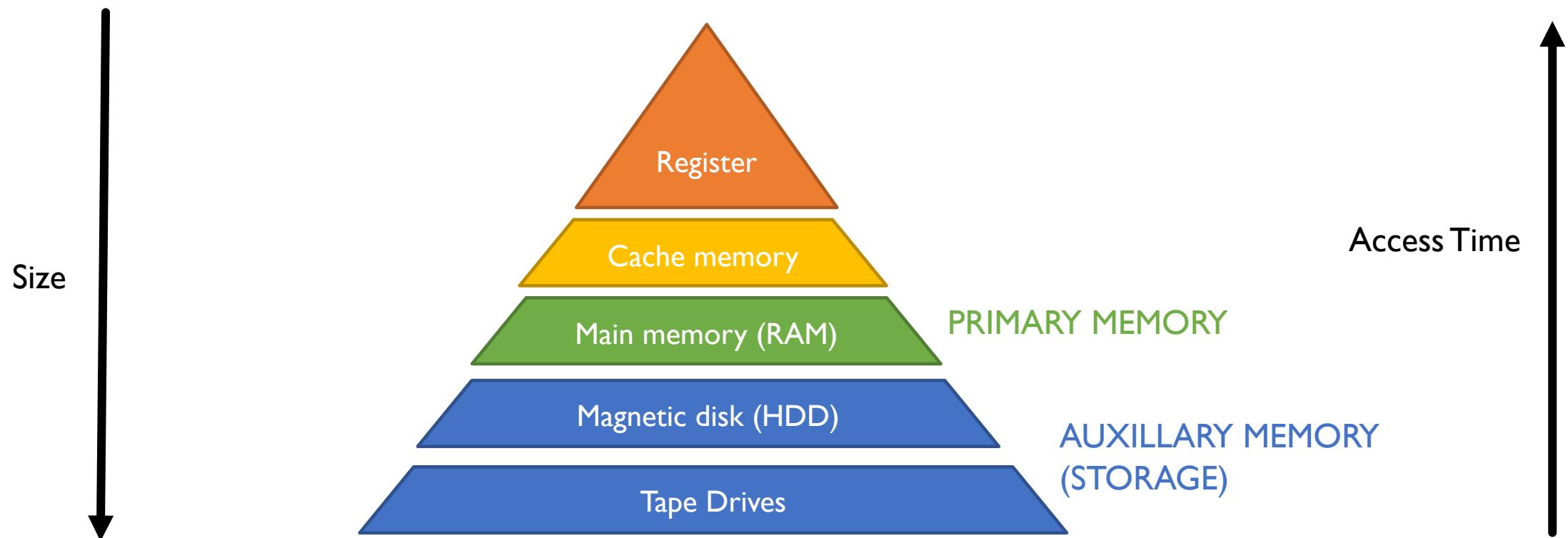


Processor chip (Intel / AMD)



CPU cores – Quad(4) core

COMPUTER MEMORY HIERARCHY



OPERATING SYSTEM (OS)

- A program that acts as an interface between the computer hardware and software/users
- Example: Windows, Ubuntu, OS X, Android etc.

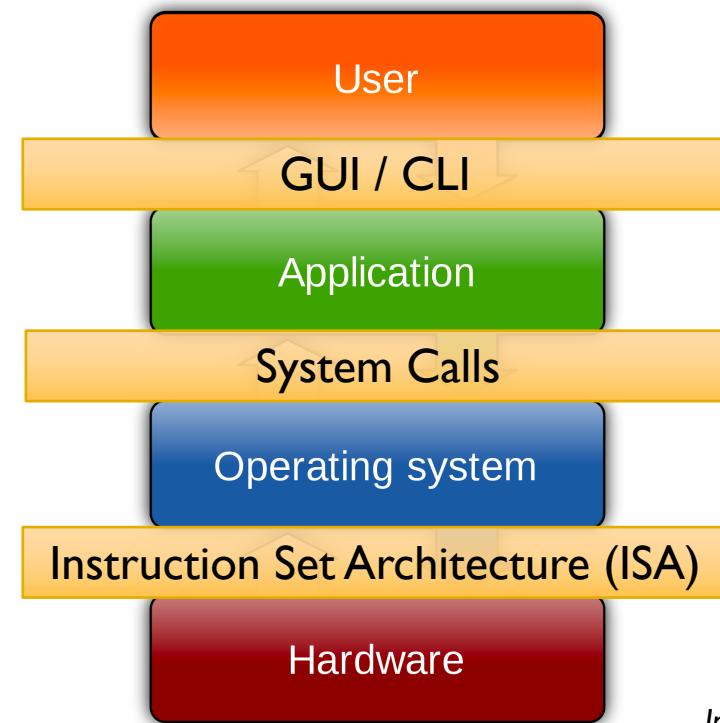
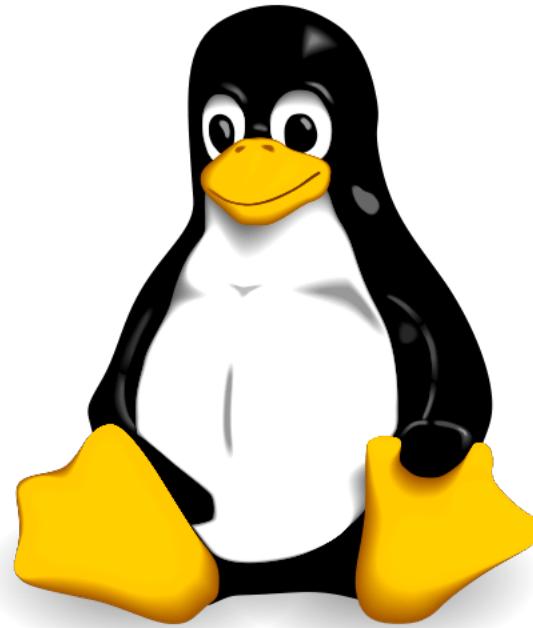


Image credits: Wikipedia[1]

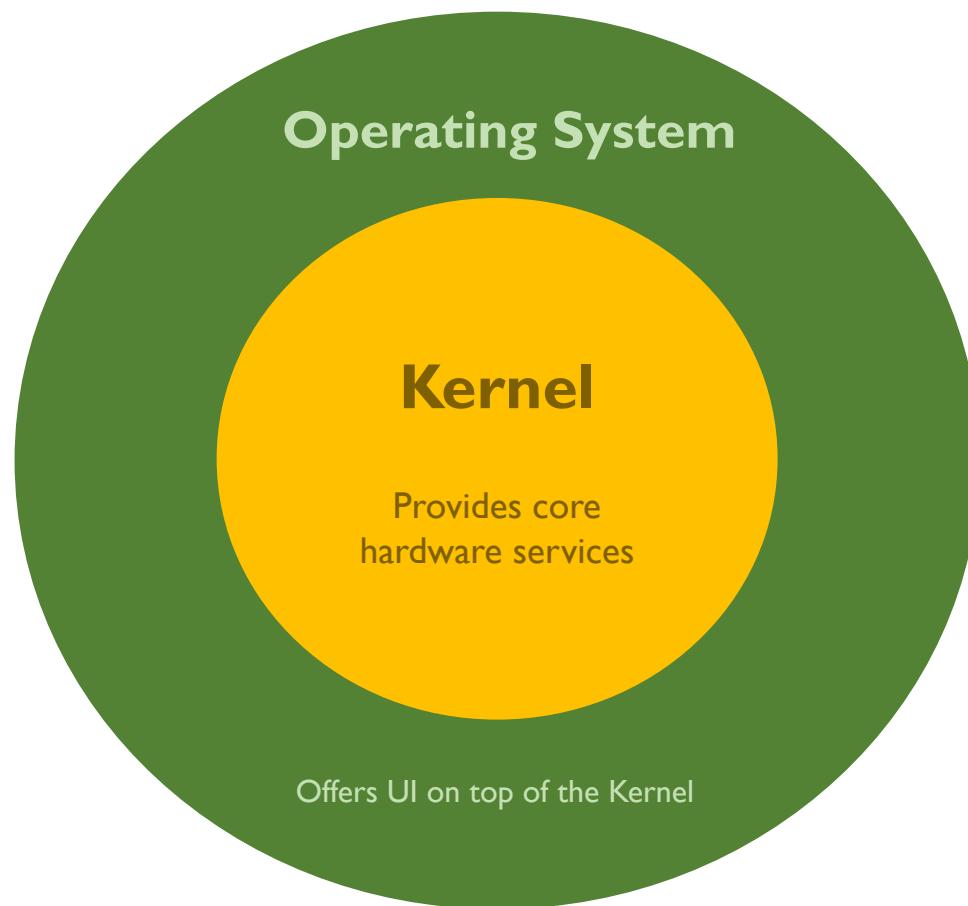


WHAT IS LINUX THEN?

The Linux mascot – Tux, a penguin

Image Credits: Larry Ewing and The GIMP, Attribution [2]

KERNEL V/S OS



However, both these terms are interchangeably used

LINUX V/S UNIX

UNIX

- In 1969, Group of AT&T employees at Bell Labs
- Multi-tasking and multi-user system
- Licensed (Paid)
- Example: OS X, Solaris, BSD etc.

LINUX

- UNIX like OS
- UI looks similar, internal is different
- Free open source software (FOSS)
- Example: Ubuntu, Fedora, RedHat

HOW MANY OF YOU USE LINUX/UNIX BASED SYSTEMS?

- FOSS
 - Linux
 - Add on S/W – Media players, image editors etc.
- Don't require an Antivirus
- As light or heavy as you want it to be
- Community
 - Support
 - Updates
- All top 100 supercomputers in the world run Linux
- **If you still don't, it's high time you do!**



VIRTUALIZATION



VIRTUALIZATION

- Virtualization hides the physical characteristics of computing resources from their users/apps
- **Abstraction of compute resources**
- These compute resources could be hardware/software resources

CPU AS A RESOURCE

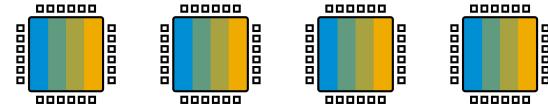
1 CPU core



1 CPU core



2 CPU cores



Server with 4 physical CPU cores

TIMESHARING OF RESOURCES

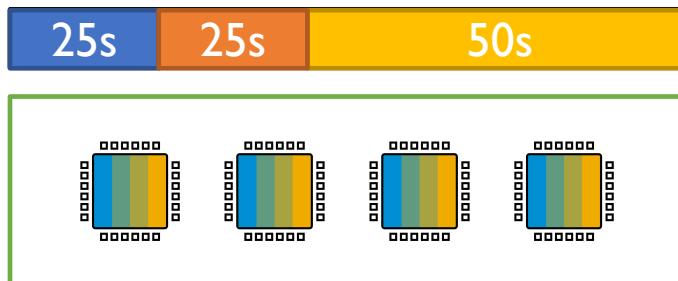
1 CPU core



1 CPU core



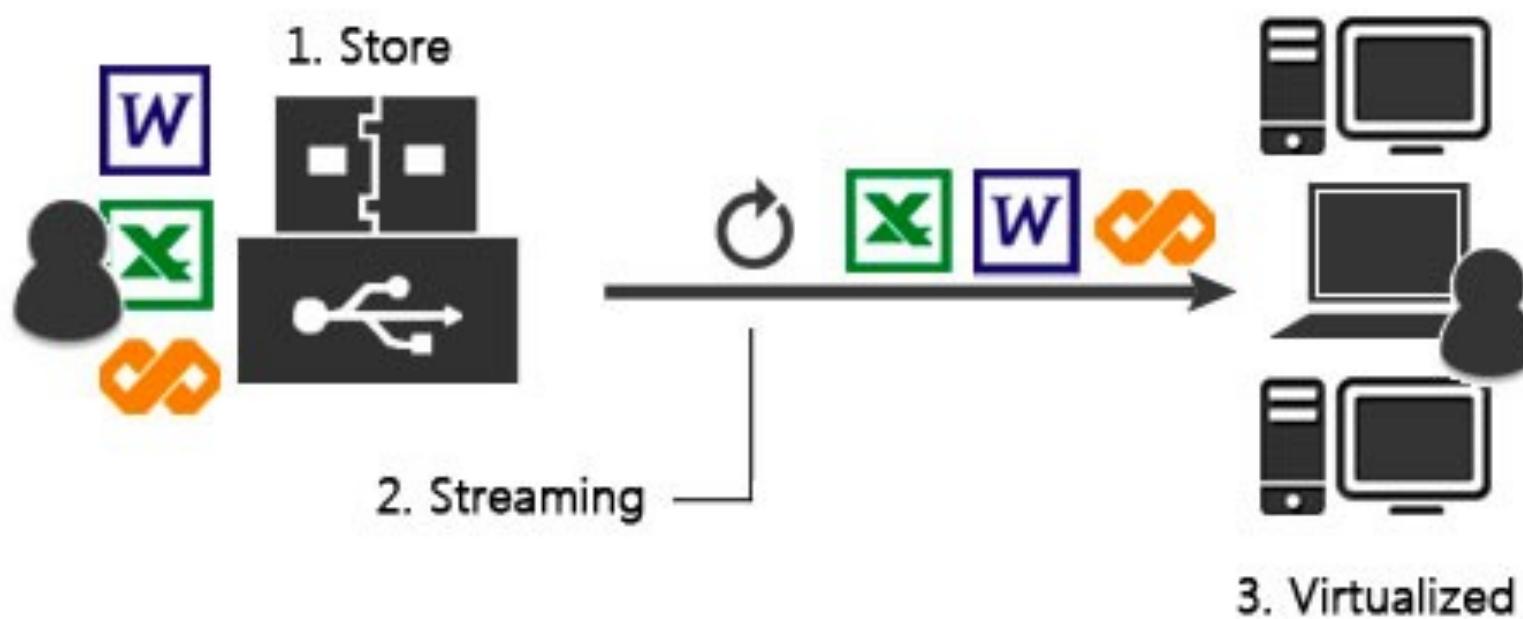
2 CPU cores



Server with 4 physical CPU cores

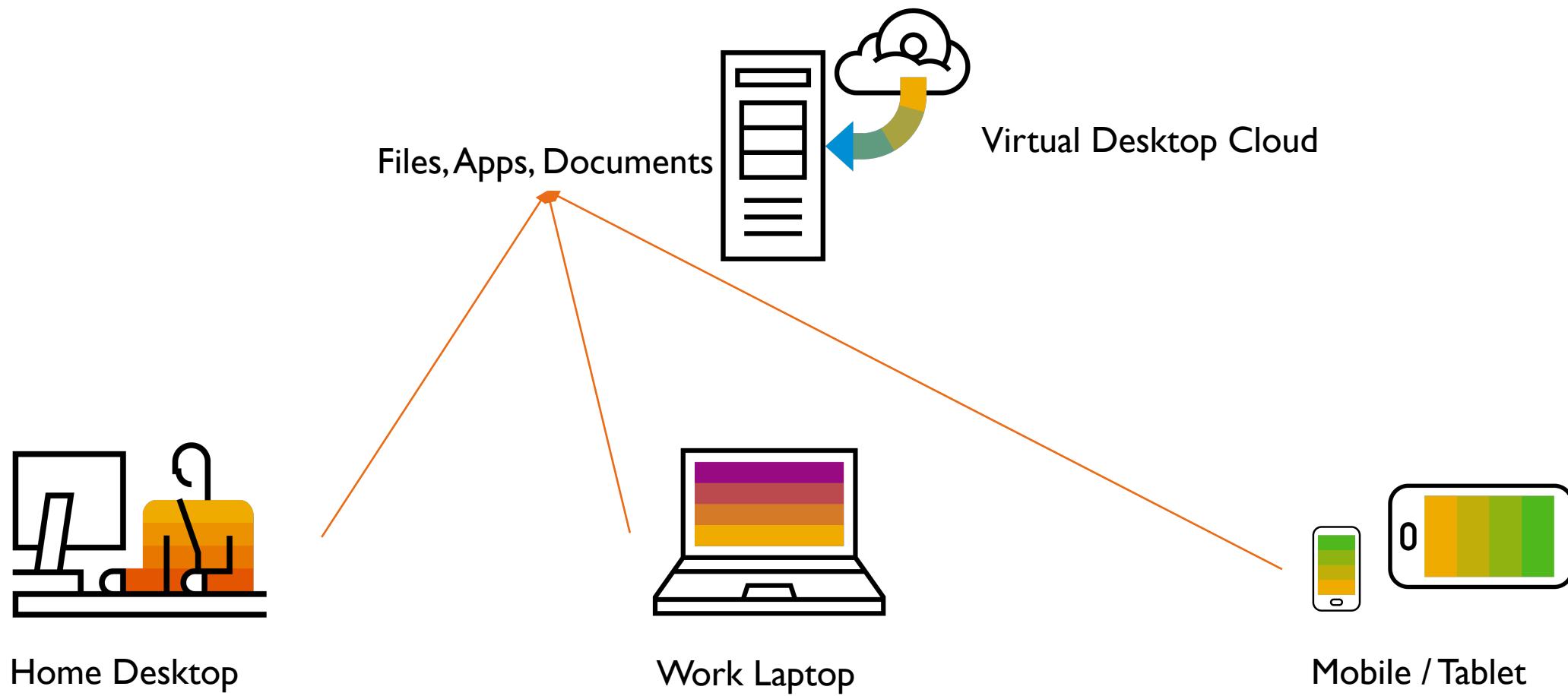
TYPES OF VIRTUALIZATION

APPLICATION VIRTUALIZATION

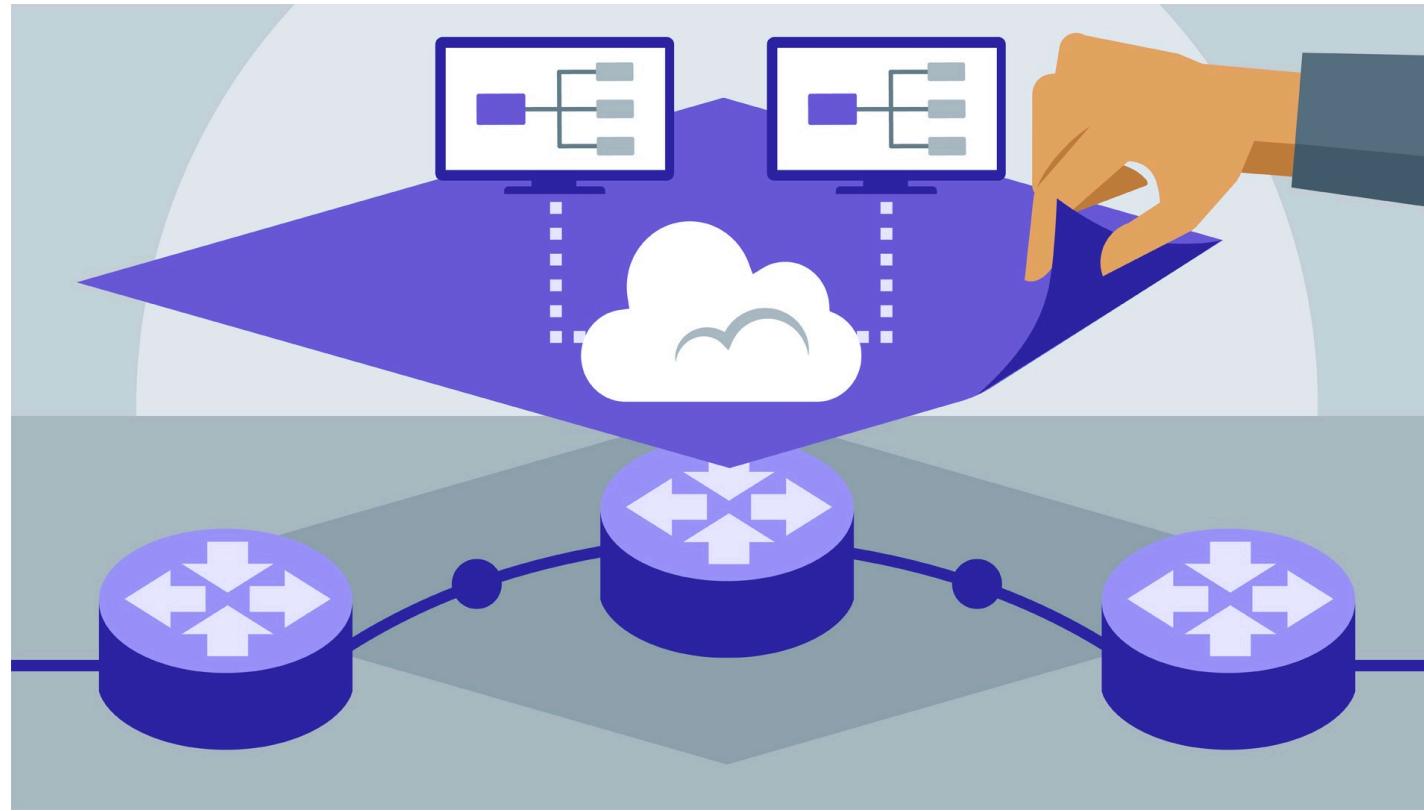


Credits: softonnet[3]

DESKTOP VIRTUALIZATION



NETWORK VIRTUALIZATION

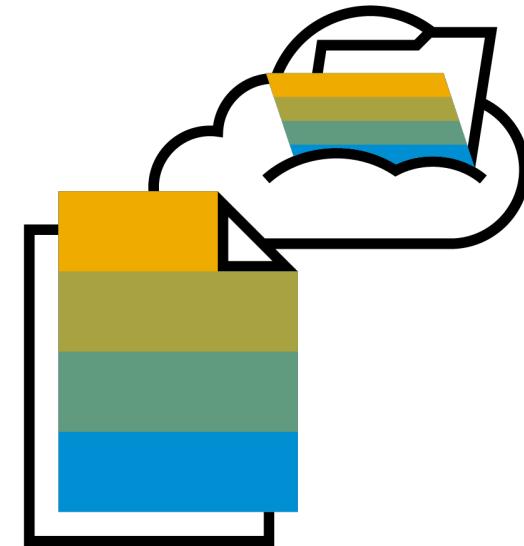


Credits: Lynda[4]

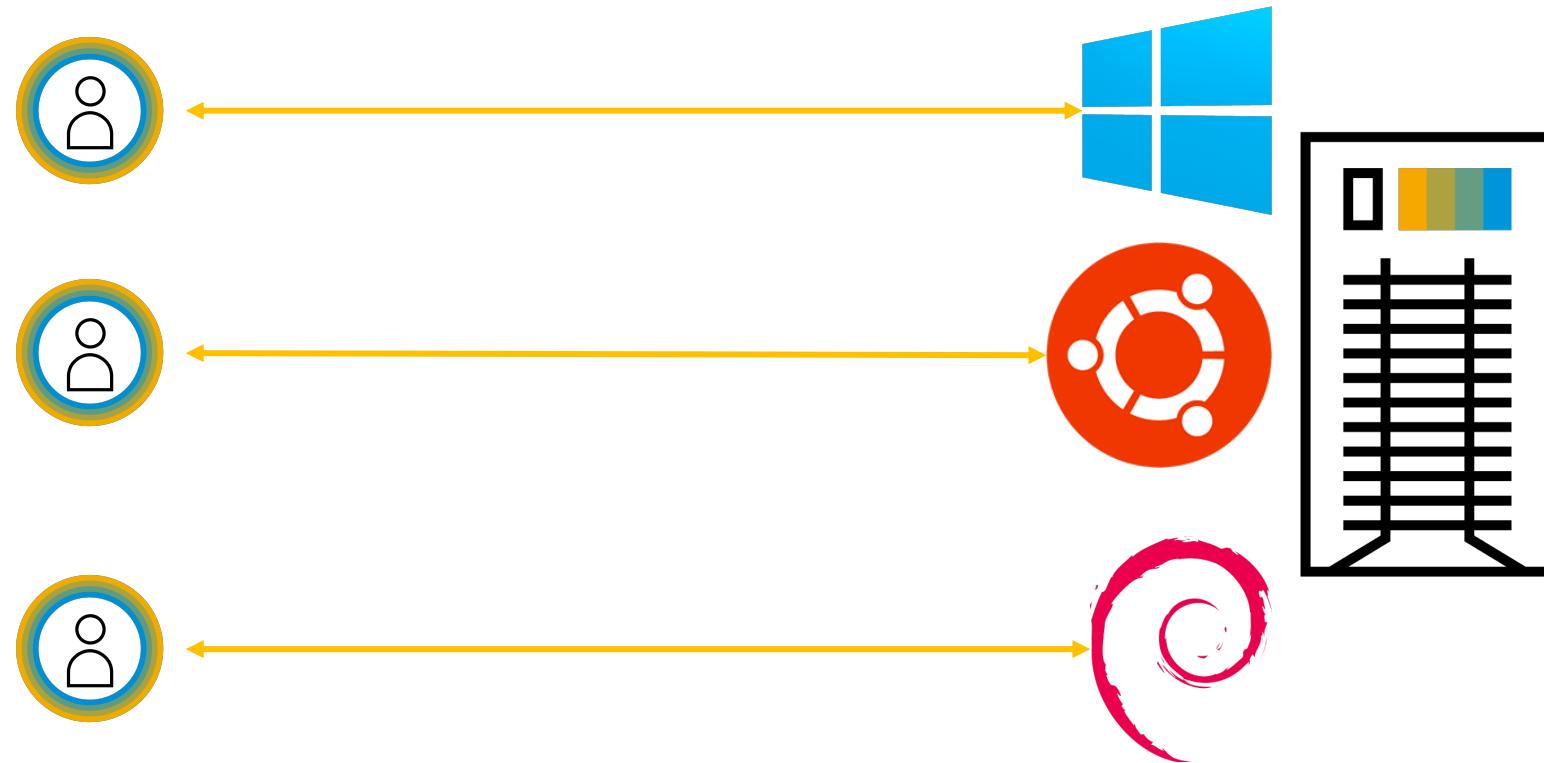
Fig: All network resources are virtualized and management using simpler UIs

STORAGE VIRTUALIZATION

- Store all your data at a single place
- Multiple smaller storage disks combined to look like a larger one
- Disaster recovery
 - Replication
 - Migration

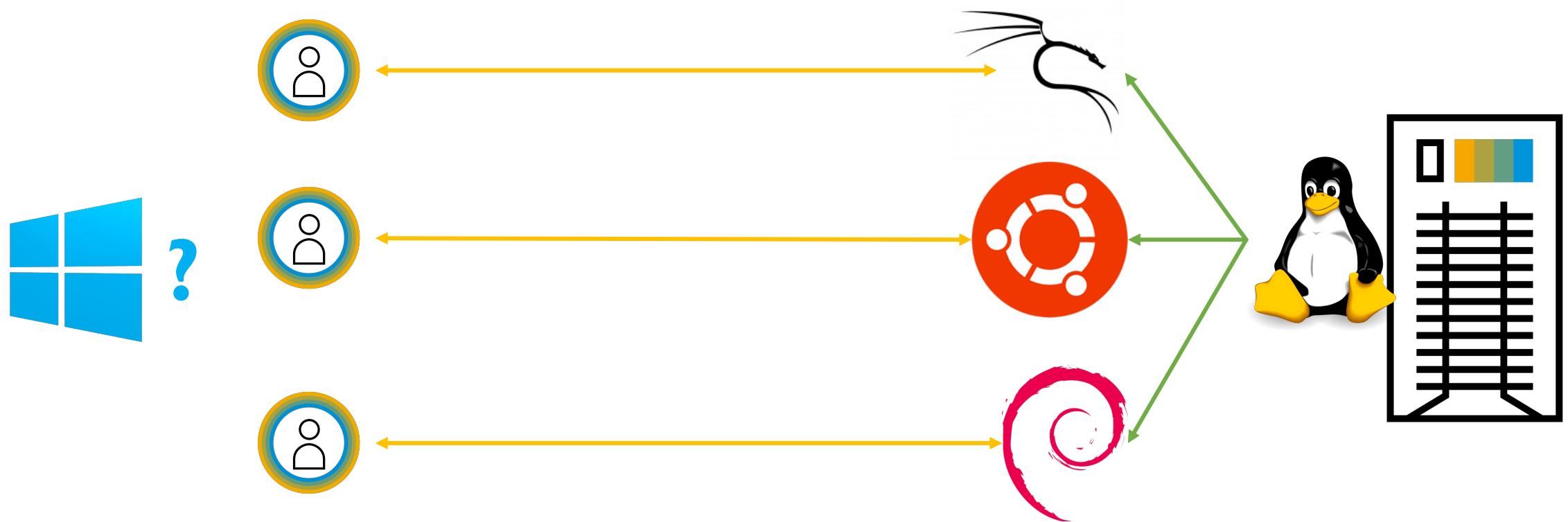


HARDWARE VIRTUALIZATION



Users can run different operating system on the same machine and system at the same time

OS LEVEL VIRTUALIZATION



OS (Kernel - Linux) has implicit support for virtualization of hardware resources

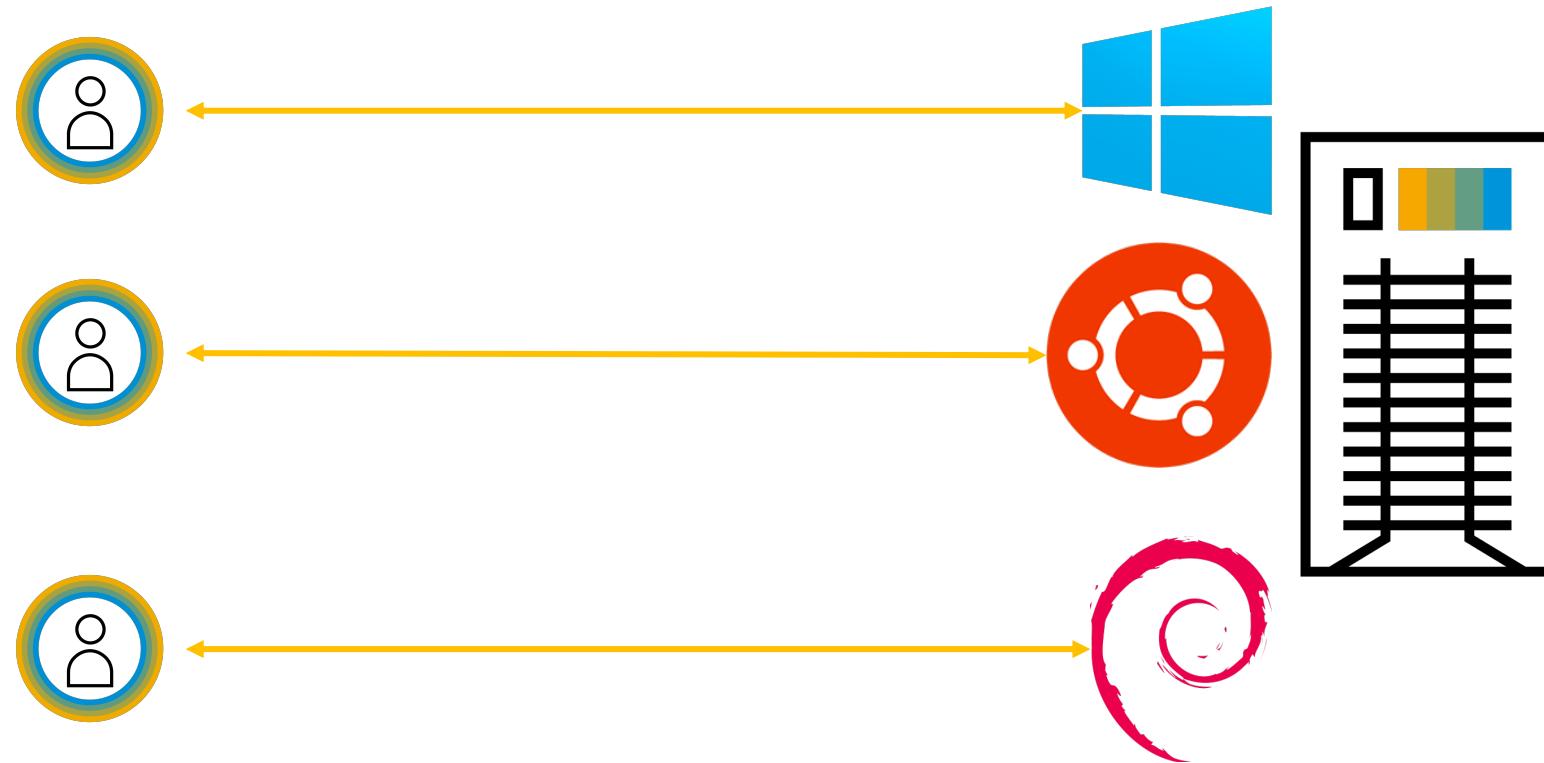


HARDWARE VIRTUALIZATION

SYSTEM LEVEL, SERVER, HYPERVISOR BASED



HARDWARE VIRTUALIZATION

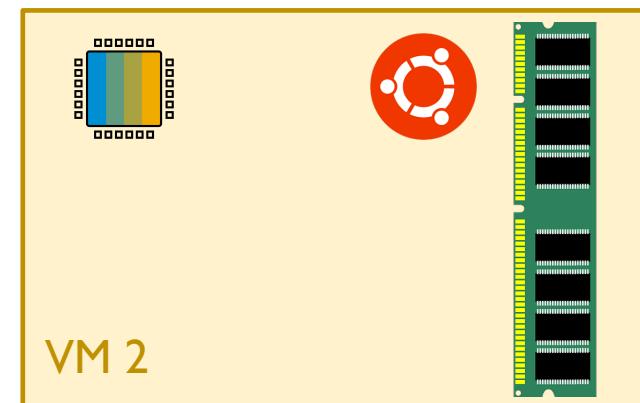
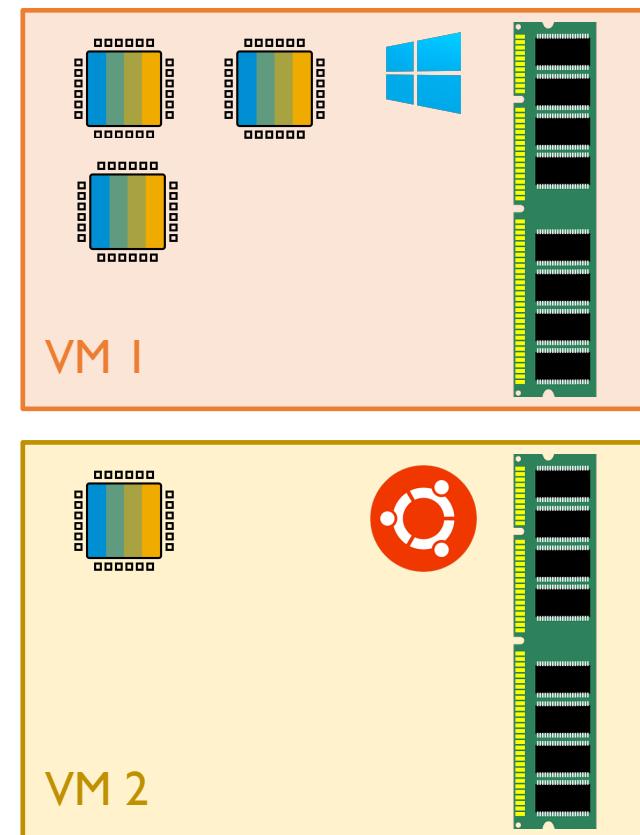
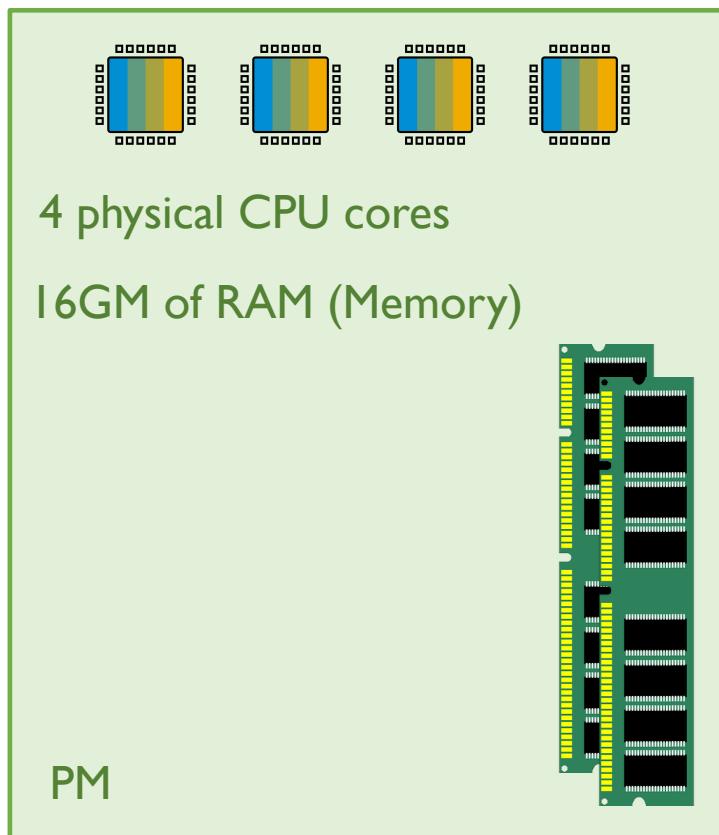


Users can run different operating system on the same machine and system at the same time

HYPERVISOR VIRTUAL MACHINE MONITOR (VMM)

Hypervisor is responsible for

- Emulation of H/W
- Translation of ISA to actual ISA



3 CPUs
8 GB RAM
Windows

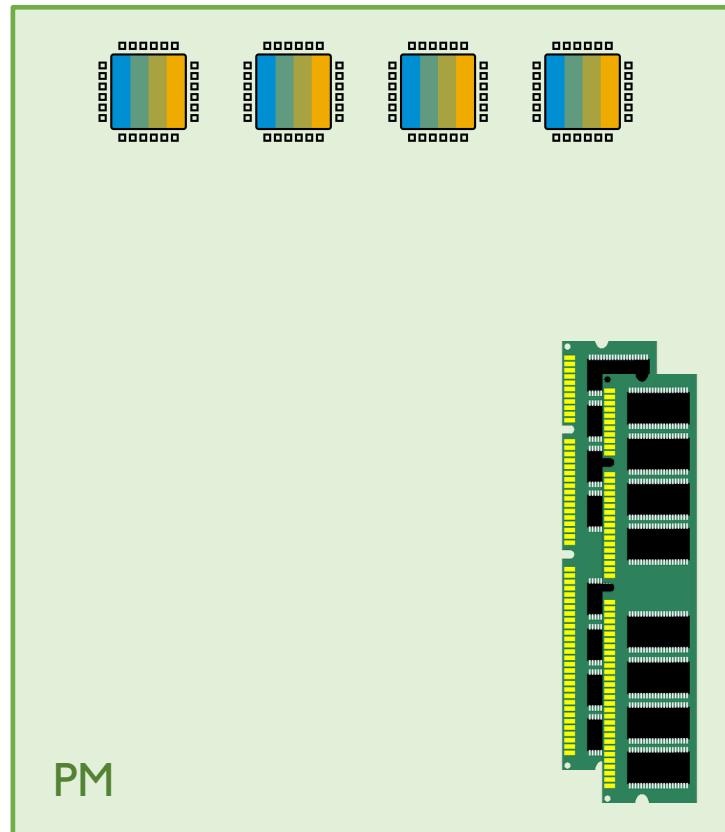


1 CPU
8 GB RAM
Ubuntu

User Requirements

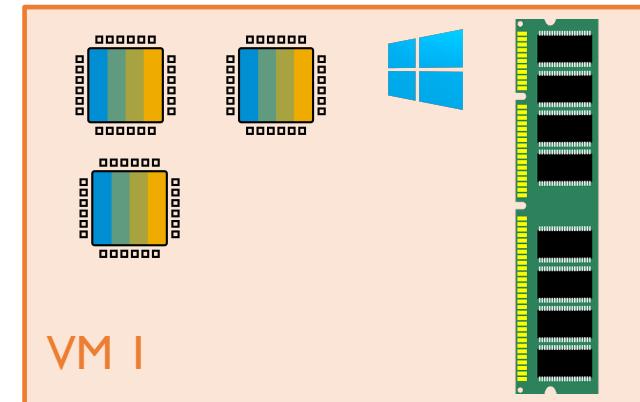
TYPES OF HYPERVISORS

BARE METAL HYPERVISORS (TYPE-I)

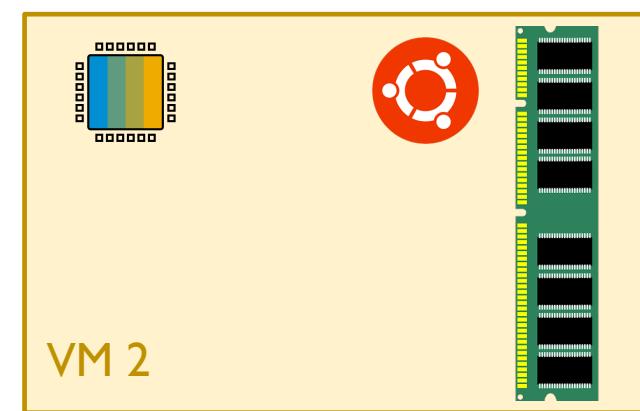


Physical Machine (PM)

Bare metal hypervisors



VM 1



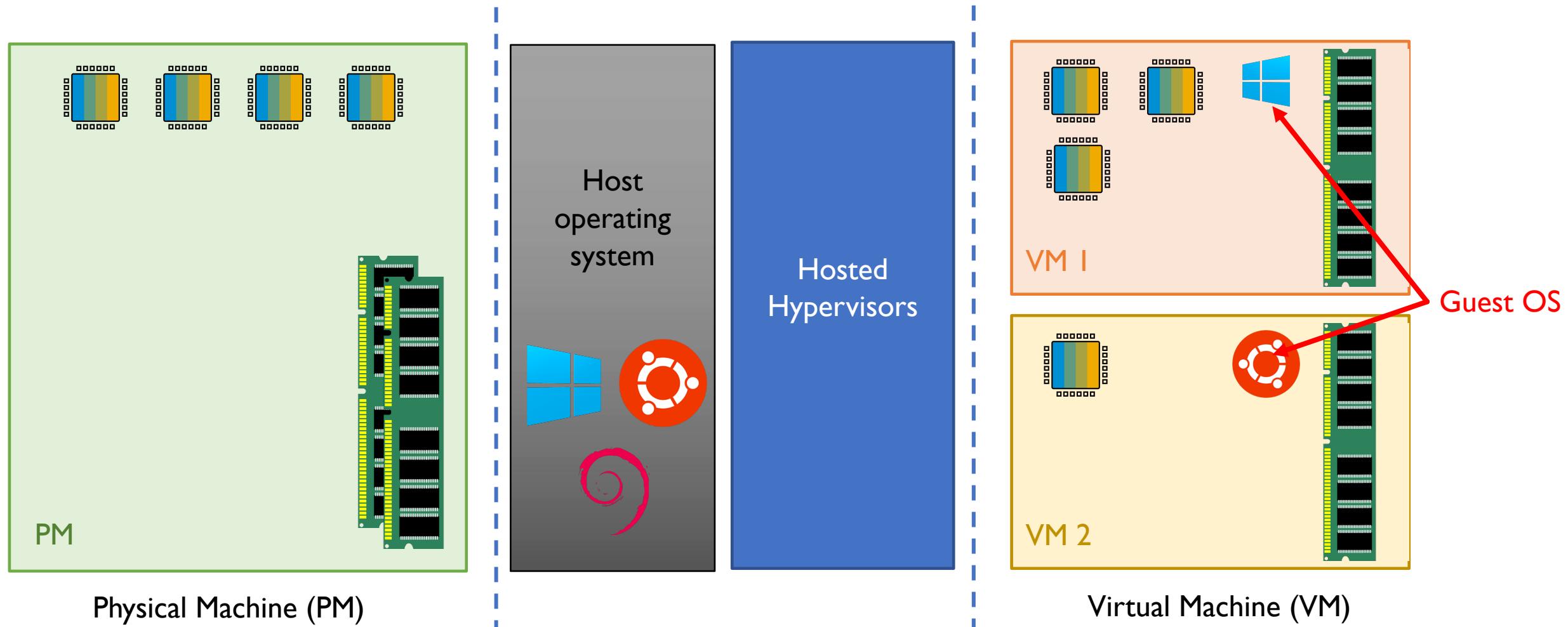
VM 2

Virtual Machine (VM)

BARE METAL HYPERVISORS (TYPE-I)

- Hypervisor sits directly on hardware
- Fewer software layers
- More/Direct control
- E.g. VMWare ESX

HOSTED HYPERVISORS (TYPE-2)



HOSTED HYPERVISORS (TYPE-2)

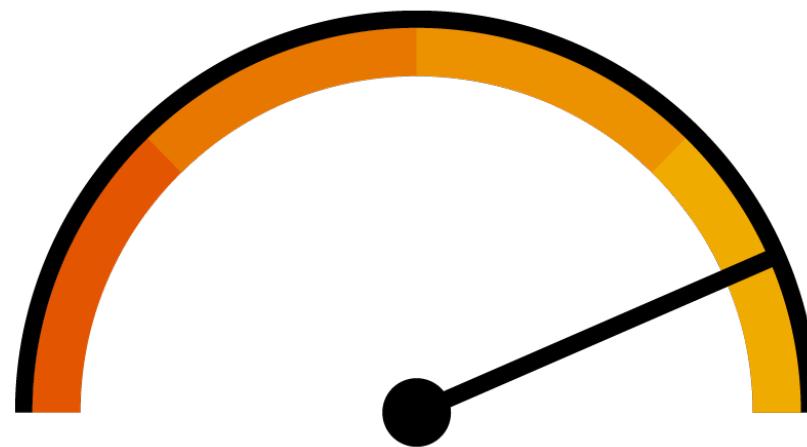
- Hypervisors are hosted on native OS
- Reuses host OS functionality for resource management (memory management, Disk IO etc)
- Further classified into
 - I. Para-virtualized VM
 - Guest OS aware of virtualization
 - E.g. Xen
 2. Full virtualized VM
 - Guest OS not aware of virtualization
 - E.g. Oracle VirtualBox, Microsoft Hyper-V, KVM etc



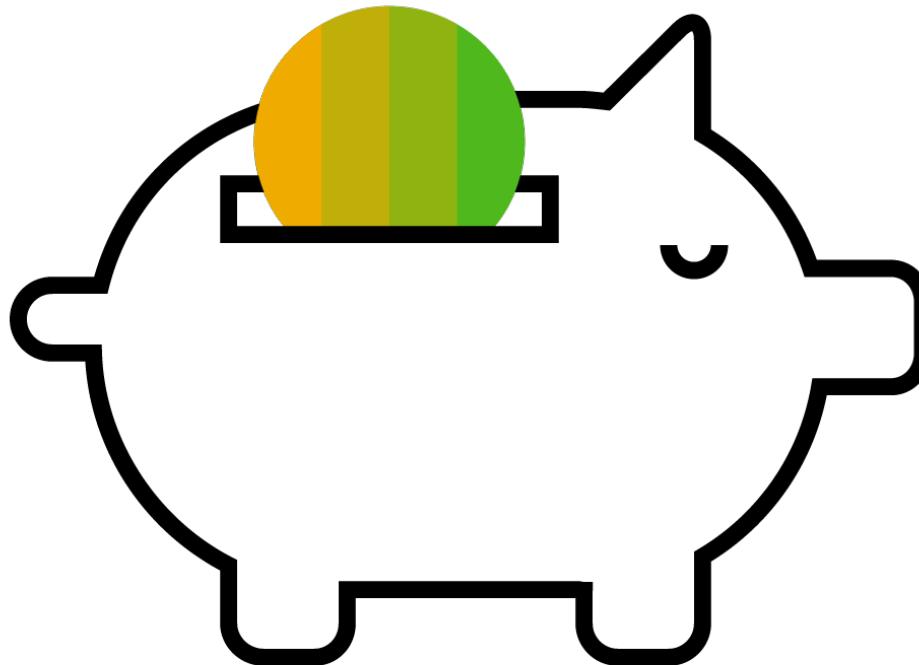
BENEFITS OF VIRTUALIZATION



EFFICIENT HARDWARE UTILIZATION



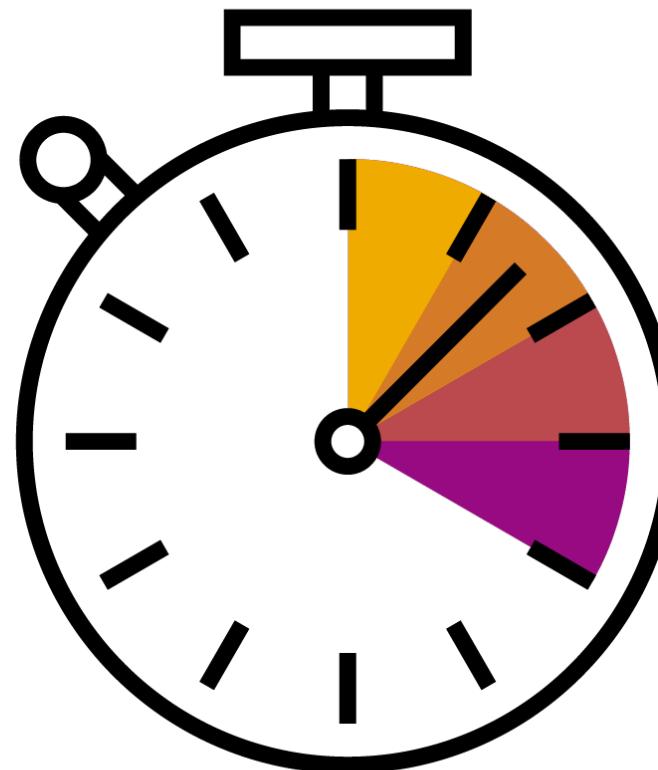
COST, SPACE & ENERGY EFFICIENT



BETTER SCALABILITY



FASTER DEPLOYMENTS



A photograph of a person from behind, holding a smartphone up to take a picture. The phone's screen shows a brightly lit stage or screen. The background is dark with numerous out-of-focus lights creating a bokeh effect.

SNAPSHOTTING



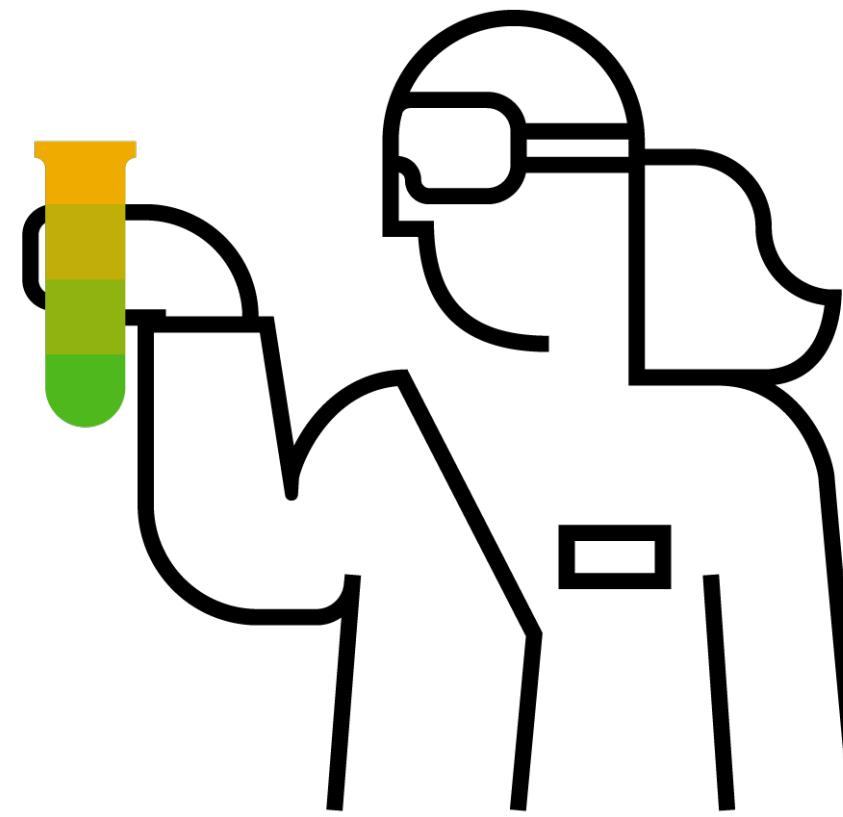
LIVE MIGRATION



DISASTER RECOVERY



EASIER TO TEST



VIRTUALIZATION TECHNIQUES

PROTECTION RINGS

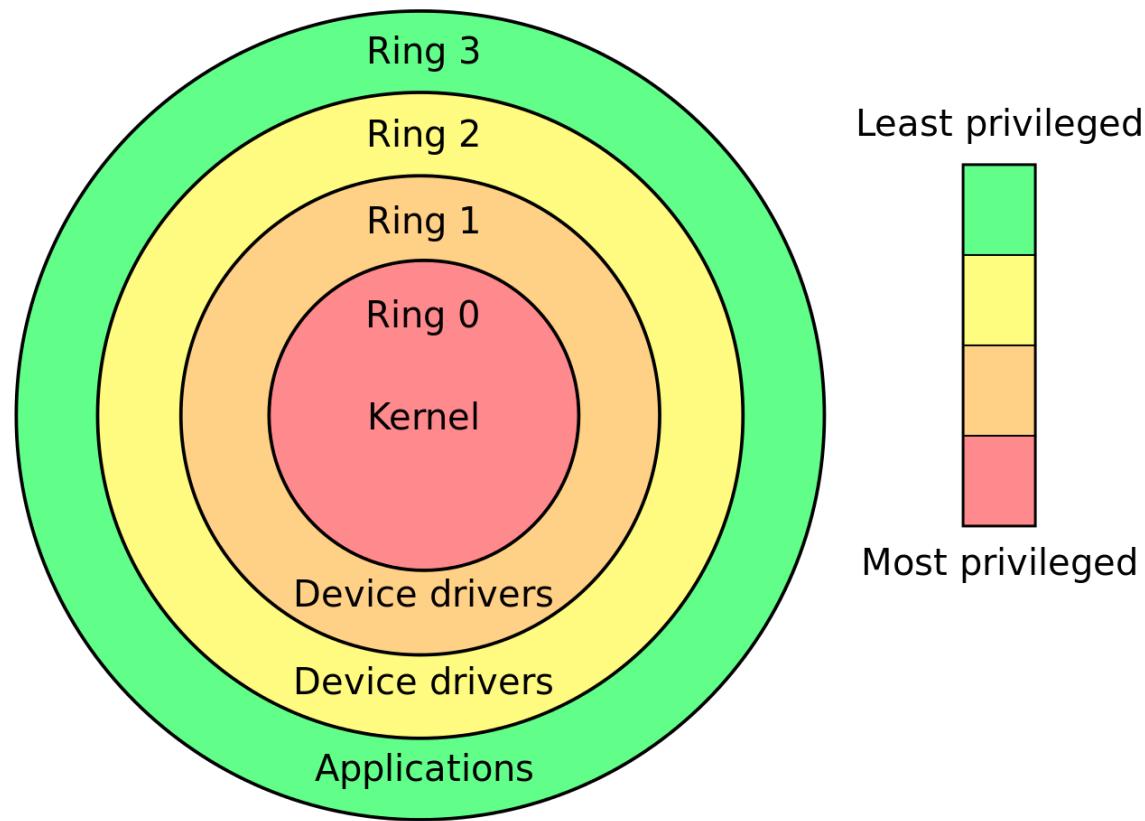


Image credits: Wikipedia[5]

SCAN & PATCH

- Start of every basic block of code – the VMM takes control
- Scans instructions in sequence and replaces privileged instructions (Ring 0) with a trap
- Trap executes VMs desired instruction on the host

PARAVIRTUALIZATION

- Replaces privileged instructions (Ring 0) with Hypervcalls
- New ISA exported by hypervisor to guest
- Guest OS is recompiled before running inside a hypervisor
- Avoids trap there by reducing overhead introduced by traps
- Hypervcalls - Calls from guest VM to the hypervisor - Similar to System Call

HARDWARE ASSISTED VIRTUALIZATION

- Hardware implicitly supports virtualization
- New operation ring (ring -1) created to support virtualization
- E.g. Intel VT_X, AMD-V



CLOUD COMPUTING



CLOUD COMPUTING

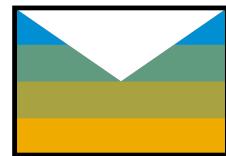
- Create a pool of resources/services that can be accessed over the internet
- Typically uses virtualization underneath

Virtualization solutions provided over the internet as a service

CONTACT INFO



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REFERENCES

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2. lewing@isc.tamu.edu Larry Ewing and The GIMP, Attribution,
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