# Introduction to Virtualization

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# How do Cloud Services Work?

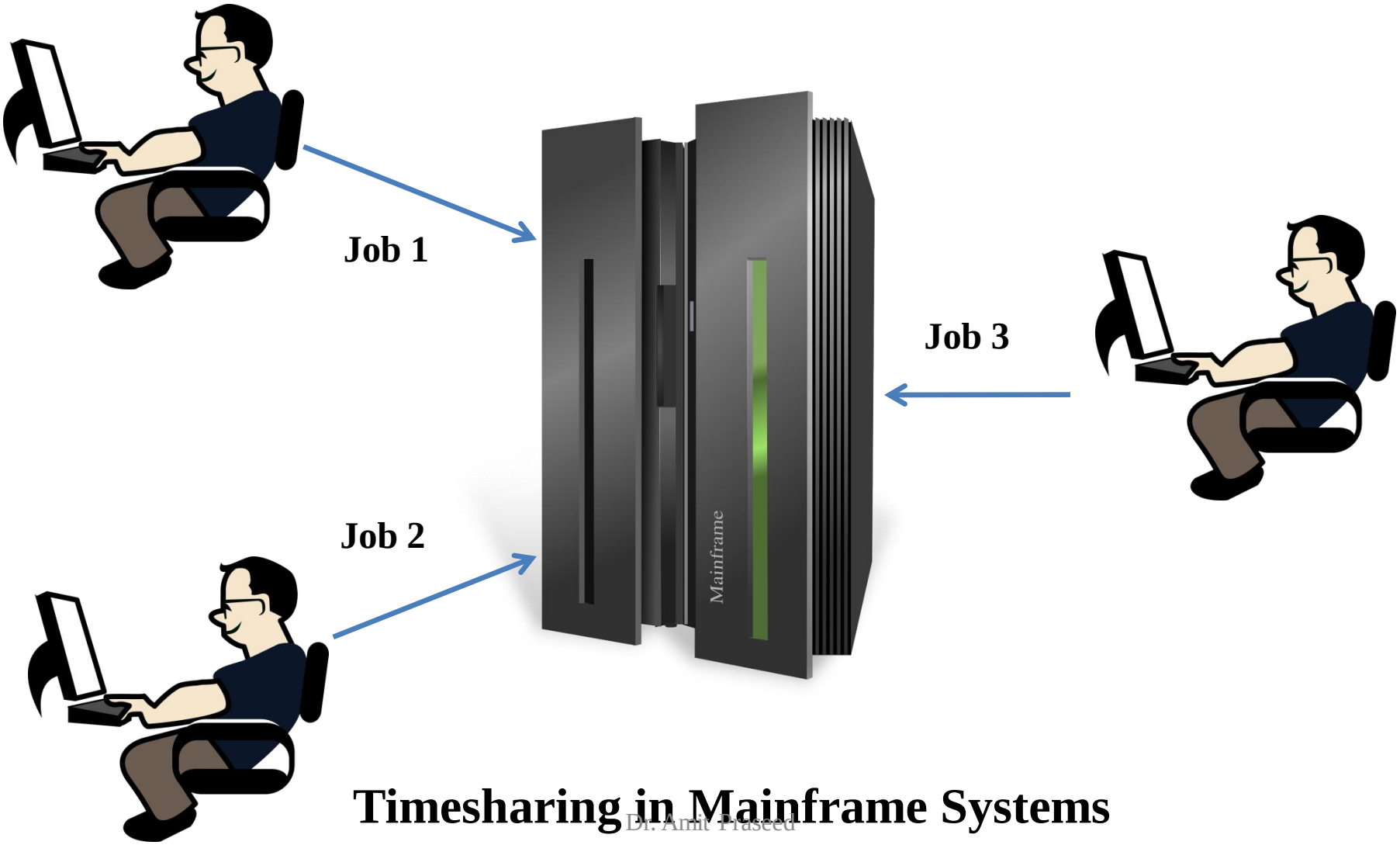
- Assume a cloud service provider has a datacentre with 4 CPUs and 8 GB RAM
  - Alice wants a system with 1 CPU and 2 GB RAM
  - Bob wants a system with 2 CPUs and 2 GB RAM
  - Carol wants a system with 1 CPU and 4 GB RAM
- In a traditional IT setup, this would be impossible!
- Solution: Create **virtual machines** with the required specifications and provide to the customers
- This uses a disruptive technology known as **virtualization**

- Put in simple terms, virtualization means

  *creating an illusion of something which is not actually present*

- Virtualization is used very commonly nowadays
  - **Virtual memory** gives us the illusion of a significantly larger memory than we physically have
  - **Virtual Reality** games allow users to perceive a world that doesn't physically exist

# A Brief History of Virtualization

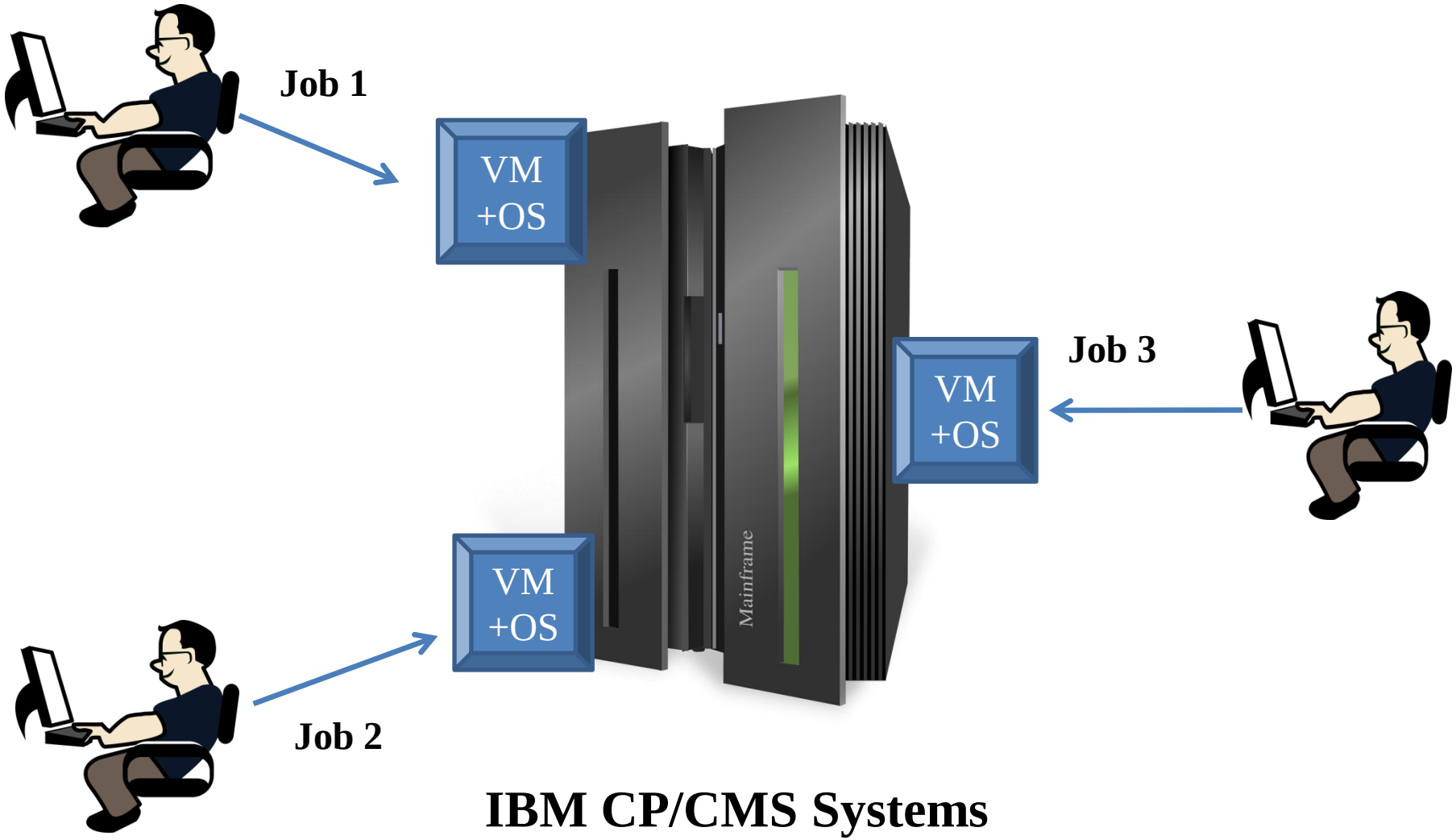



**Timesharing in Mainframe Systems**

# A Brief History of Virtualization

- **Timesharing in Mainframes**
  - Support multiple users through terminals
  - When users block for I/O, system executes jobs from other users
  - System still executes only one job at a time
  - Creates an illusion of multiple jobs being processed at the same time
  - Later, a time quantum was introduced to increase server utilization

# A Brief History of Virtualization

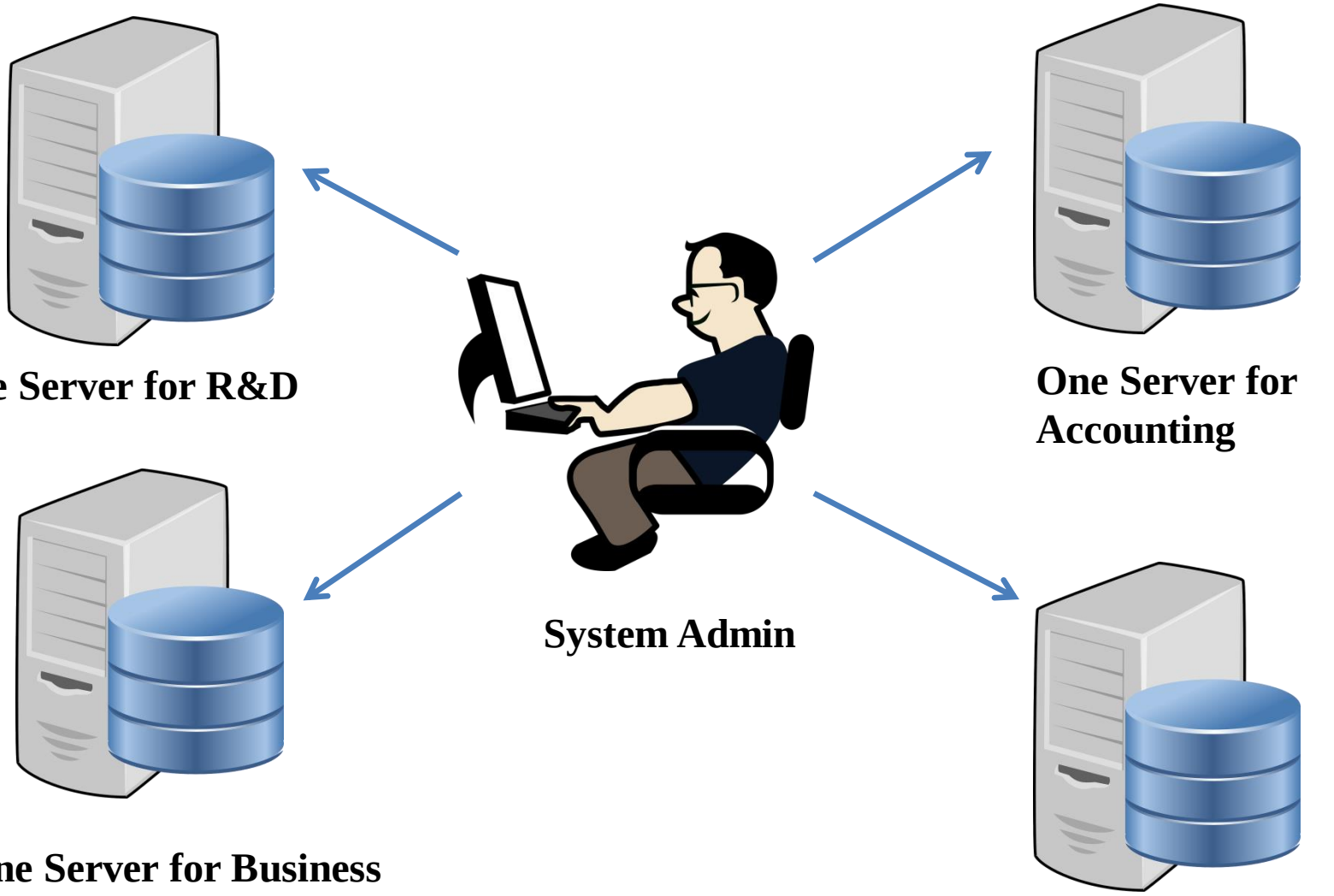



**IBM CP/CMS Systems**

# A Brief History of Virtualization

- **IBM CP/CMS Systems**
  - First virtualized operating system
  - Every user gets a separate “virtual machine” for operating
  - Every user interacts with their own version of OS
  - No concept of time sharing – multiple tasks can be run simultaneously
  - No conflicts between users, so more reliable
  - The rise of personal computers led to a small decline in the importance of virtualization for a period of time

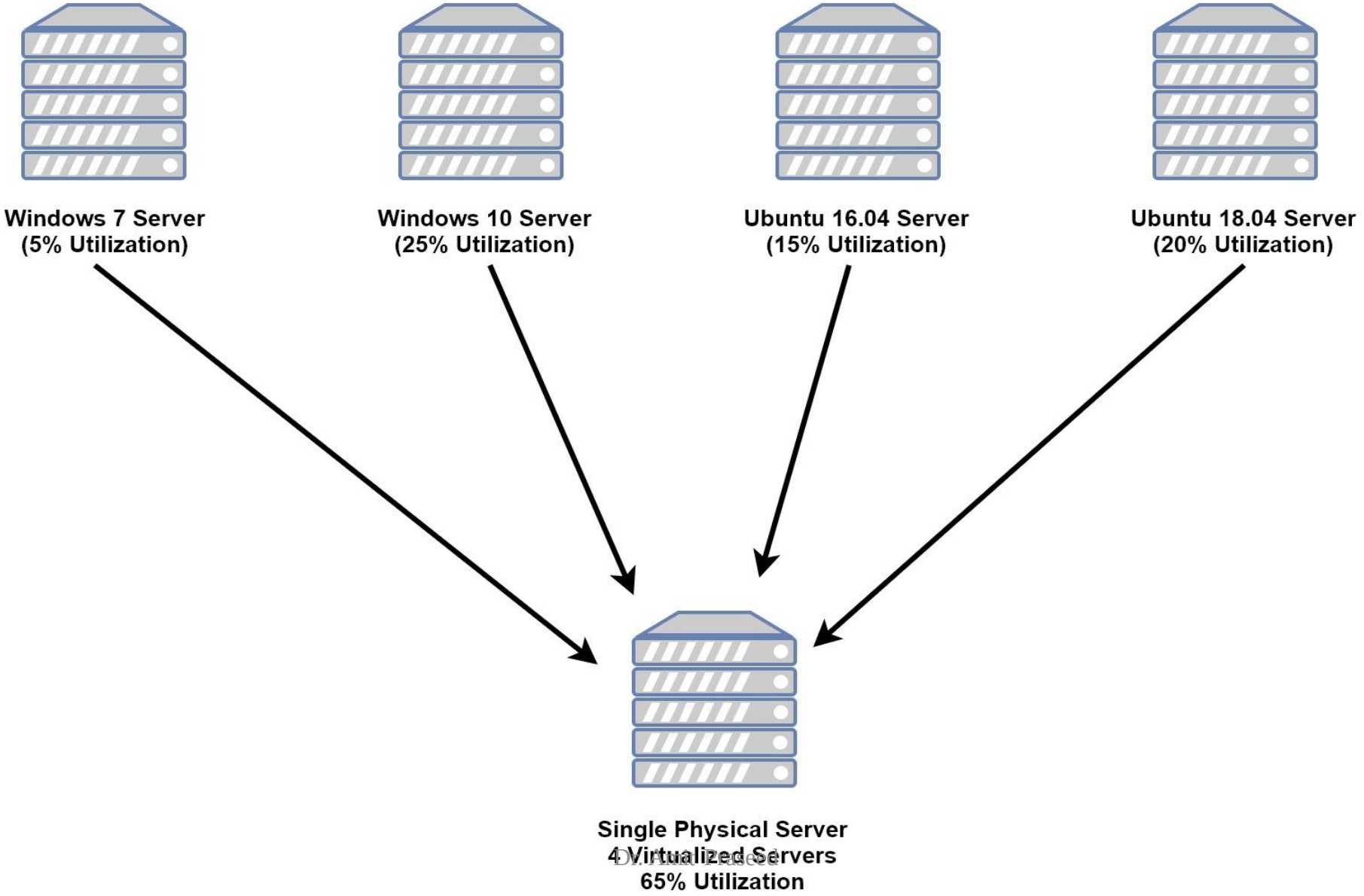
# Need for Virtualization in Data Centres



# Need for Virtualization in Data Centres

- System administrators allocated one machine per application
  - Increased stability – what if one application interfered with the other?
  - Increased security – hiding “sensitive” data
- Issues
  - Increased capital cost
  - Low server utilization

# Virtualization



# Virtualization

- Process of creating a function of a resource simulated or emulated in software identical to that of the corresponding physical resource
- **Two key points**:
  - It is a software simulation of a physical resource
  - Users must be able to use the virtualized resource exactly as they would use a physical resource

# What can be virtualized?

- Desktop
- Application
- Server
- Storage
- Network

# Levels of Virtualization

| |
|---|
| **Application Level**<br>**(Microsoft .NET, Java Virtual Machine – JVM)** |
| **Library Support Level**<br>**(WINE, MingW)** |
| **Operating Systems Level**<br>**(Docker, LXC)** |
| **Hardware Abstraction Level**<br>**(Xen, IBM CP/CMS)** |
| **Instruction Set Architecture (ISA) Level** |

# Merits of Different Types of Virtualization

| Level of Implementation | Higher Performance | Application Flexibility | Implementation Complexity | Application Isolation |
|---|---|---|---|---|
| ISA | X | XXXX | XXX | XXX |
| Hardware-level virtualization | XXXX | XXX | XXXX | XXX |
| OS-level virtualization | XXXX | XX | XXX | XX |
| Runtime library support | XXX | XX | XX | XX |
| User application level | XX | XX | XXXX | XXXX |