SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

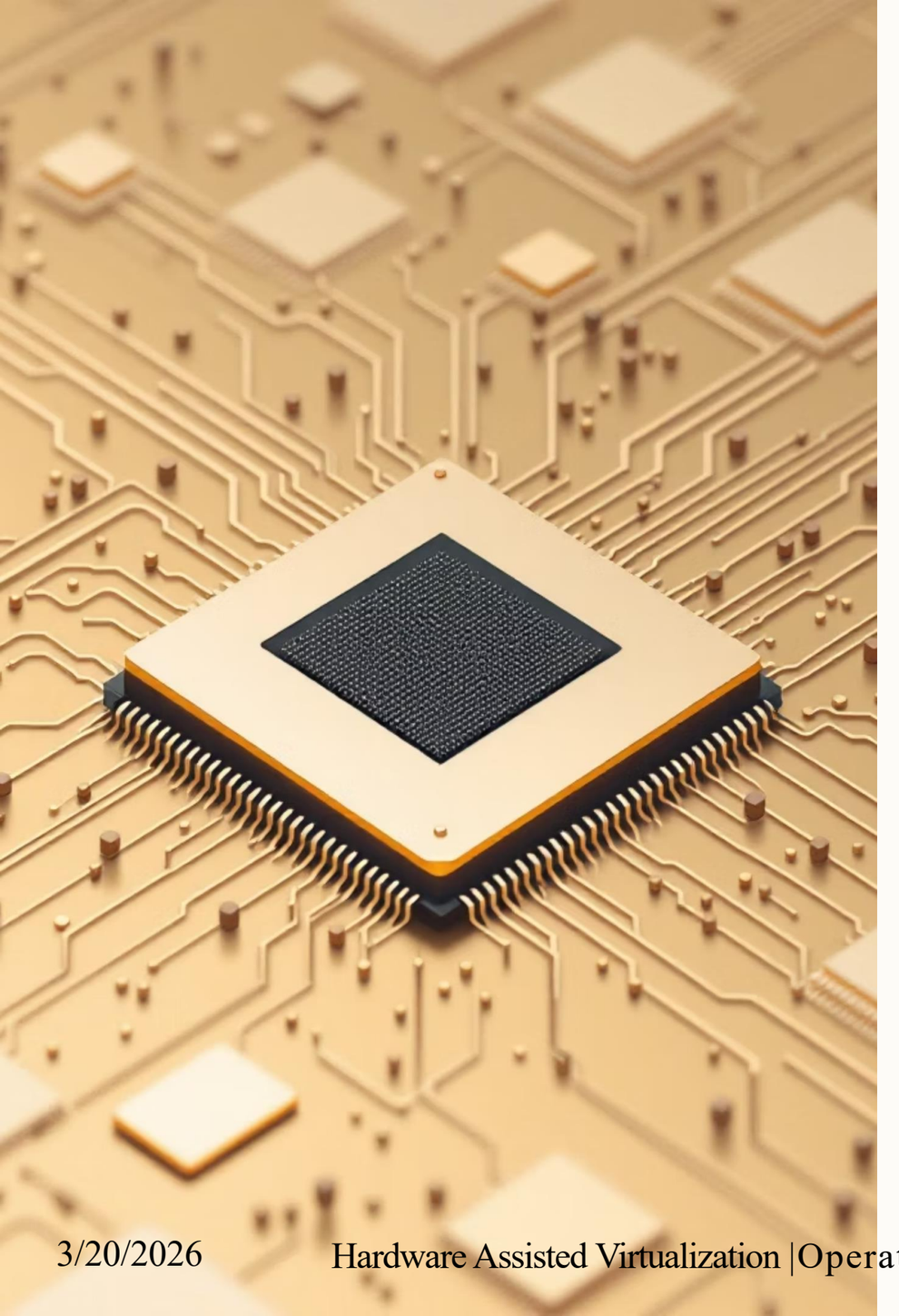
Department of Computer Science and Engineering

23CST206–OPERATING SYSTEMS AND VIRTUALIZATION

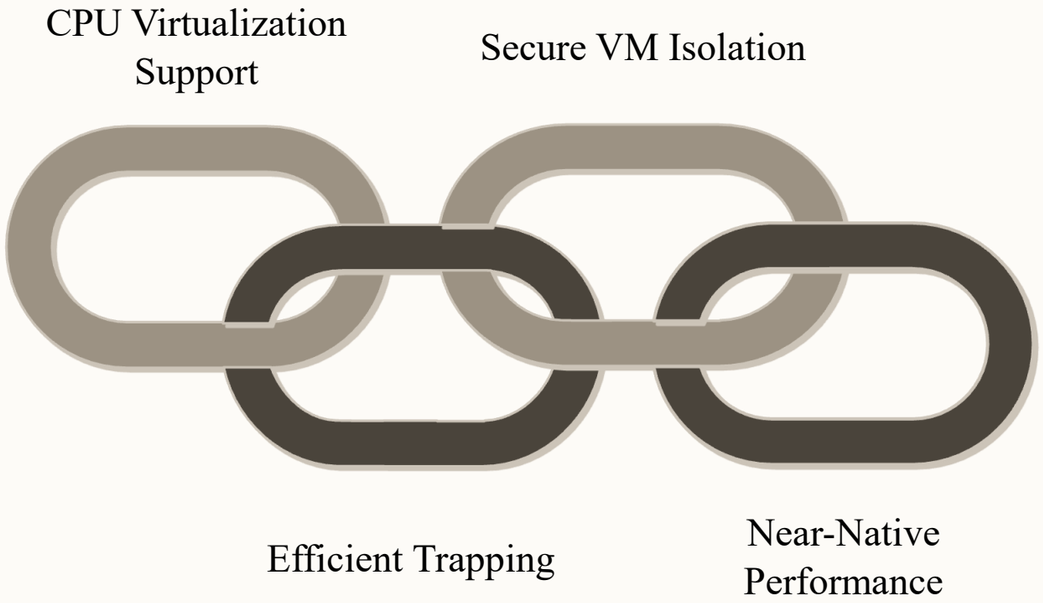
B.E- CSE /IV SEMESTER

UNIT – IV VIRTUALIZATION

Topic 4:Hardware Assisted Virtualization



Hardware-Assisted Virtualization



Hardware Assisted Virtualization

Power & Cooling Waste

Reducing energy consumption and costs.

Early x86 Limits

Overcoming legacy processor constraints.

Hardware Virtualization

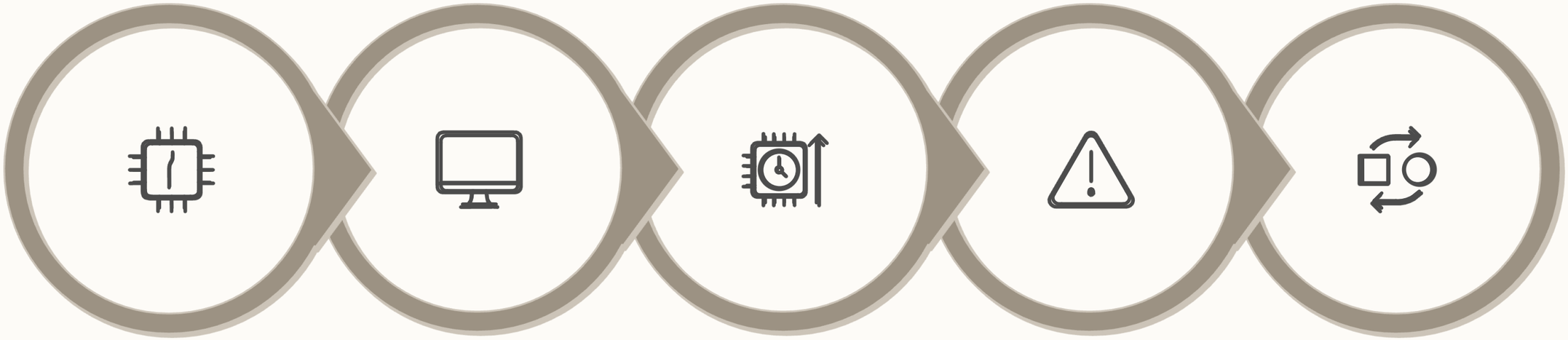
Server Underuse

Maximizing data center resource utilization.

Poor VM Performance

Addressing slow virtual machine execution.

How Hardware-Assisted Virtualization Works



Init VMX

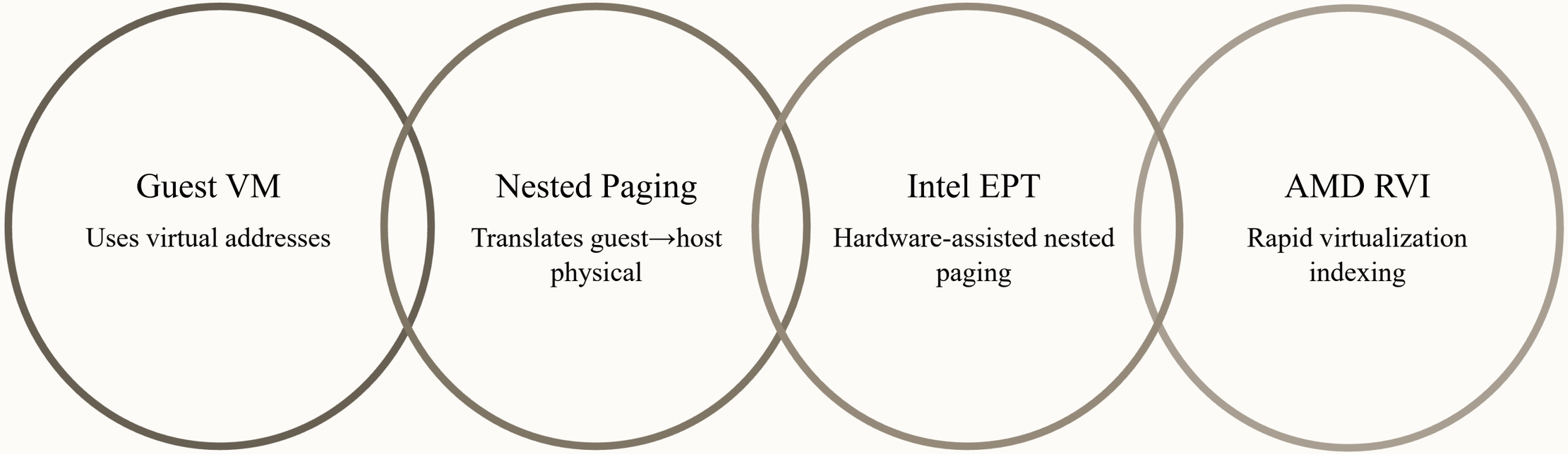
Guest Non-Root

Normal Exec

Privileged Trap

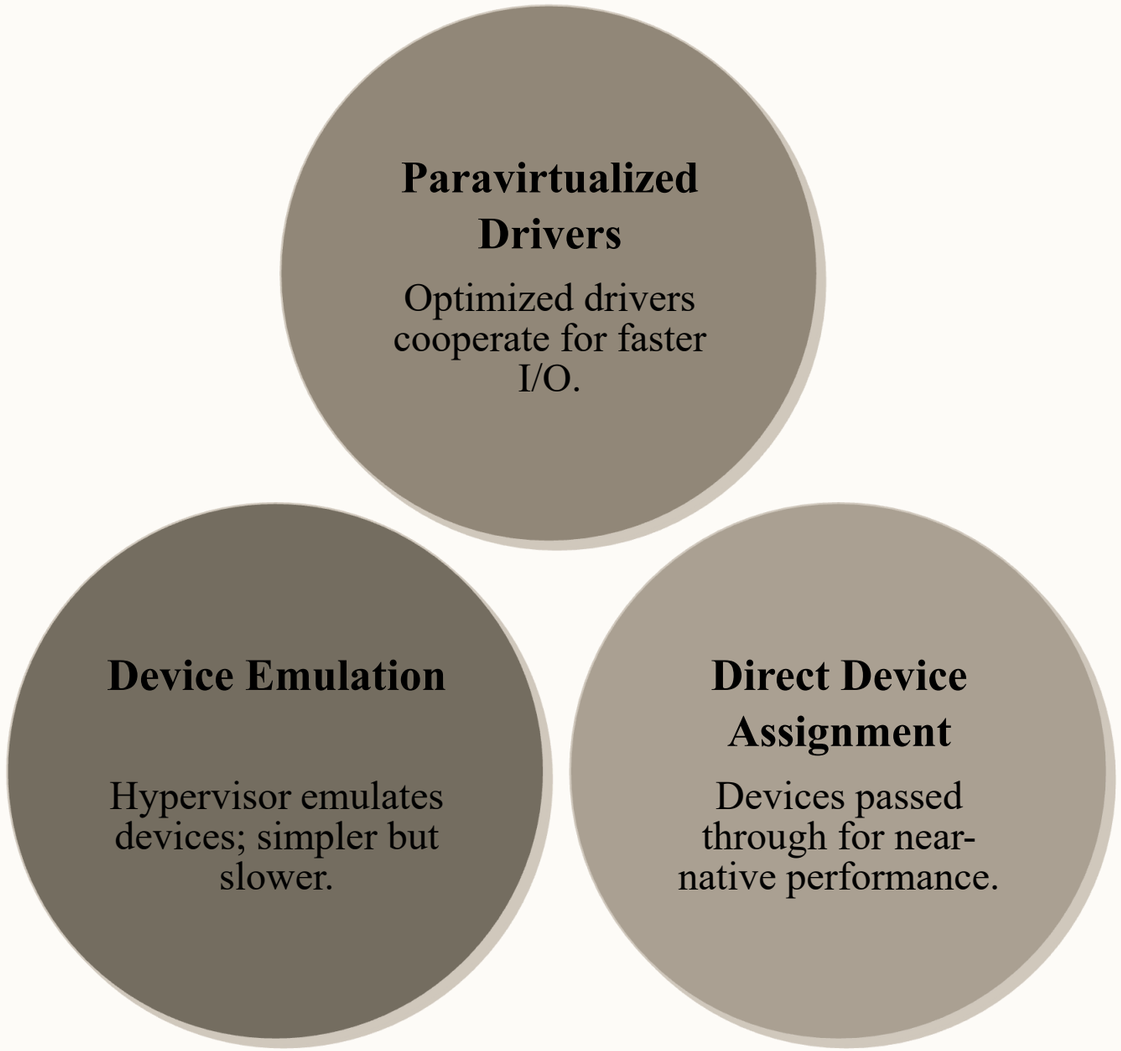
VM Exit

Memory Virtualization Support

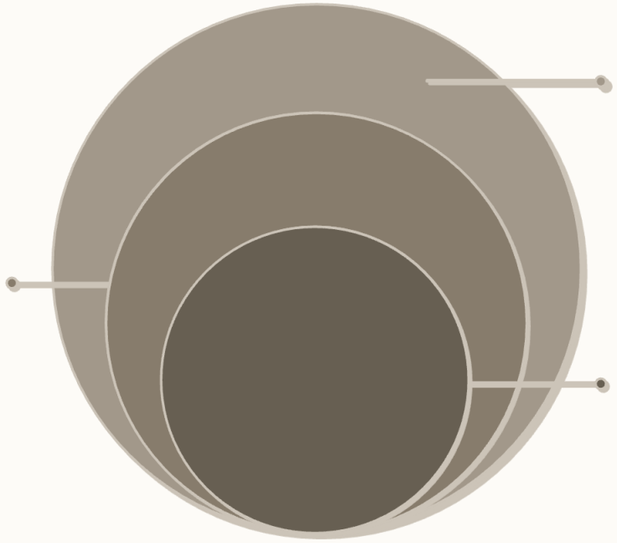


I/O Virtualization Methods

Hardware-assisted virtualization supports efficient I/O through three distinct approaches:



Hardware-Level Virtualization Architecture



Hypervisor & Host
Manages VMs and controls physical hardware

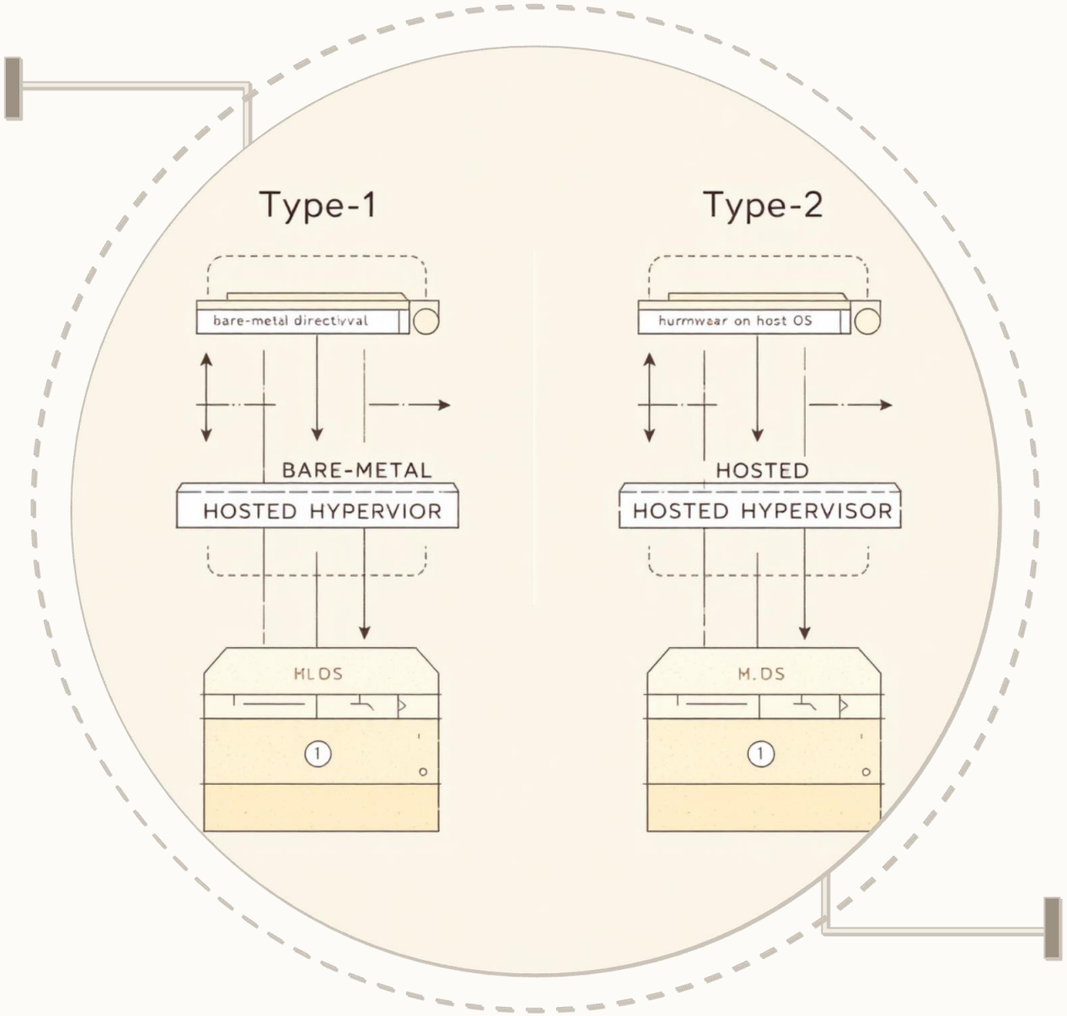
Virtual Machine
Emulated hardware environment

Guest OS
Operating system running inside VM

Types of Hypervisors Using Hardware-Assisted Virtualization

Type-1 Hypervisor

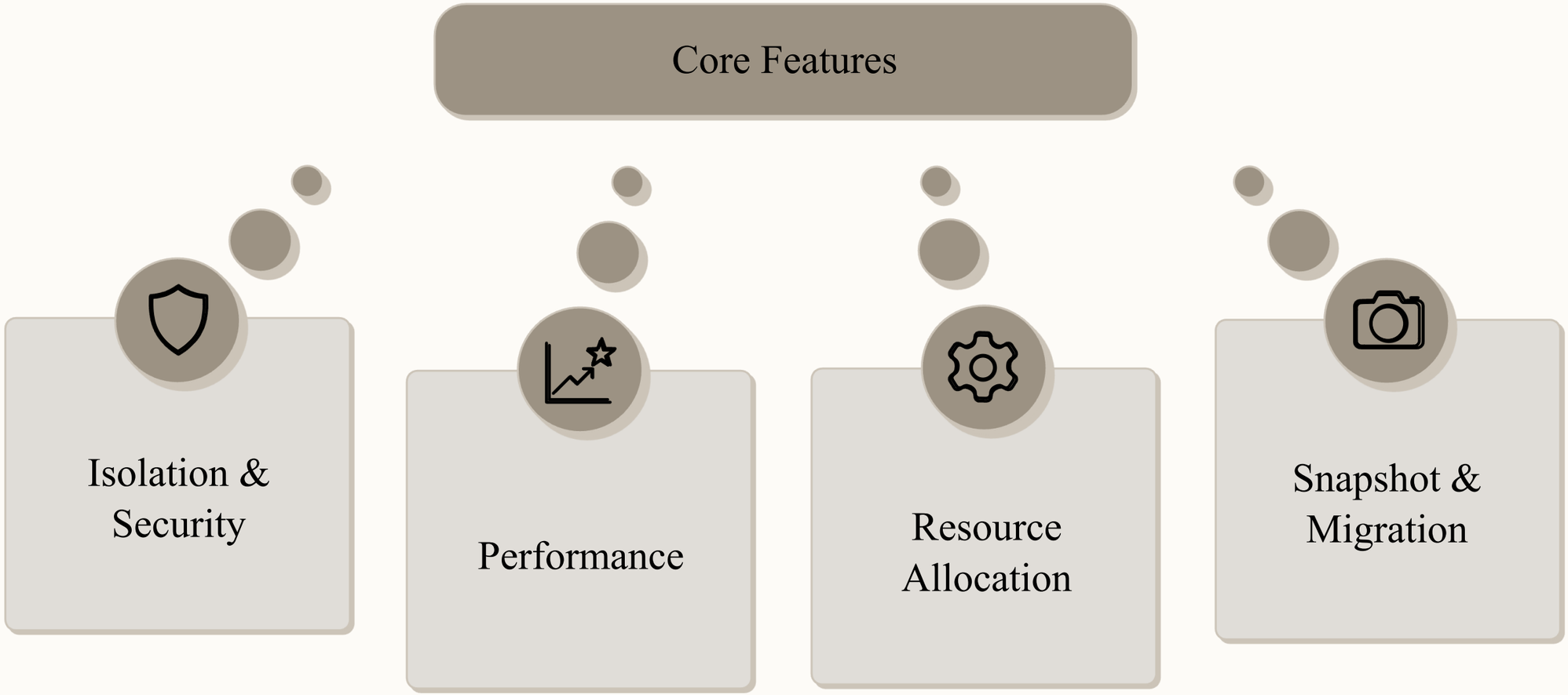
Bare-metal hypervisor runs directly on hardware for highest performance.



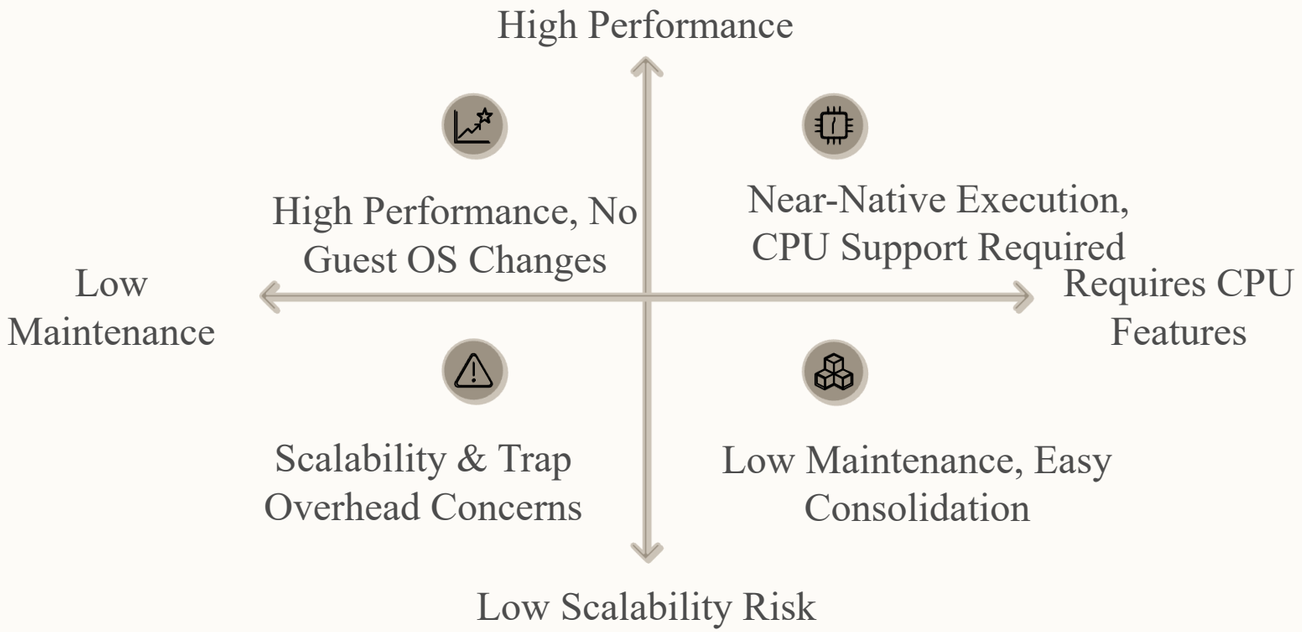
Type-2 Hypervisor

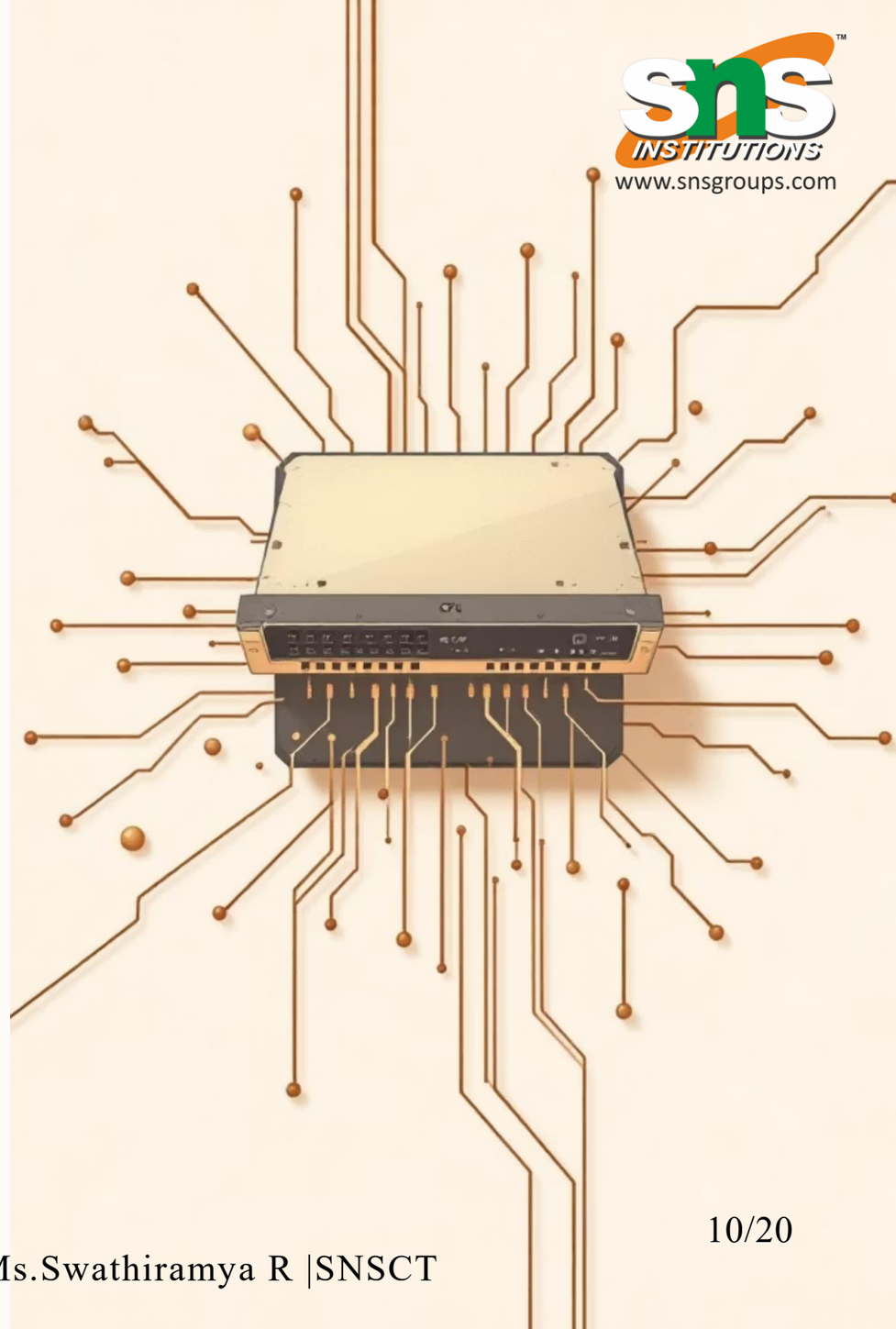
Hosted hypervisor runs on an OS with slightly lower performance.

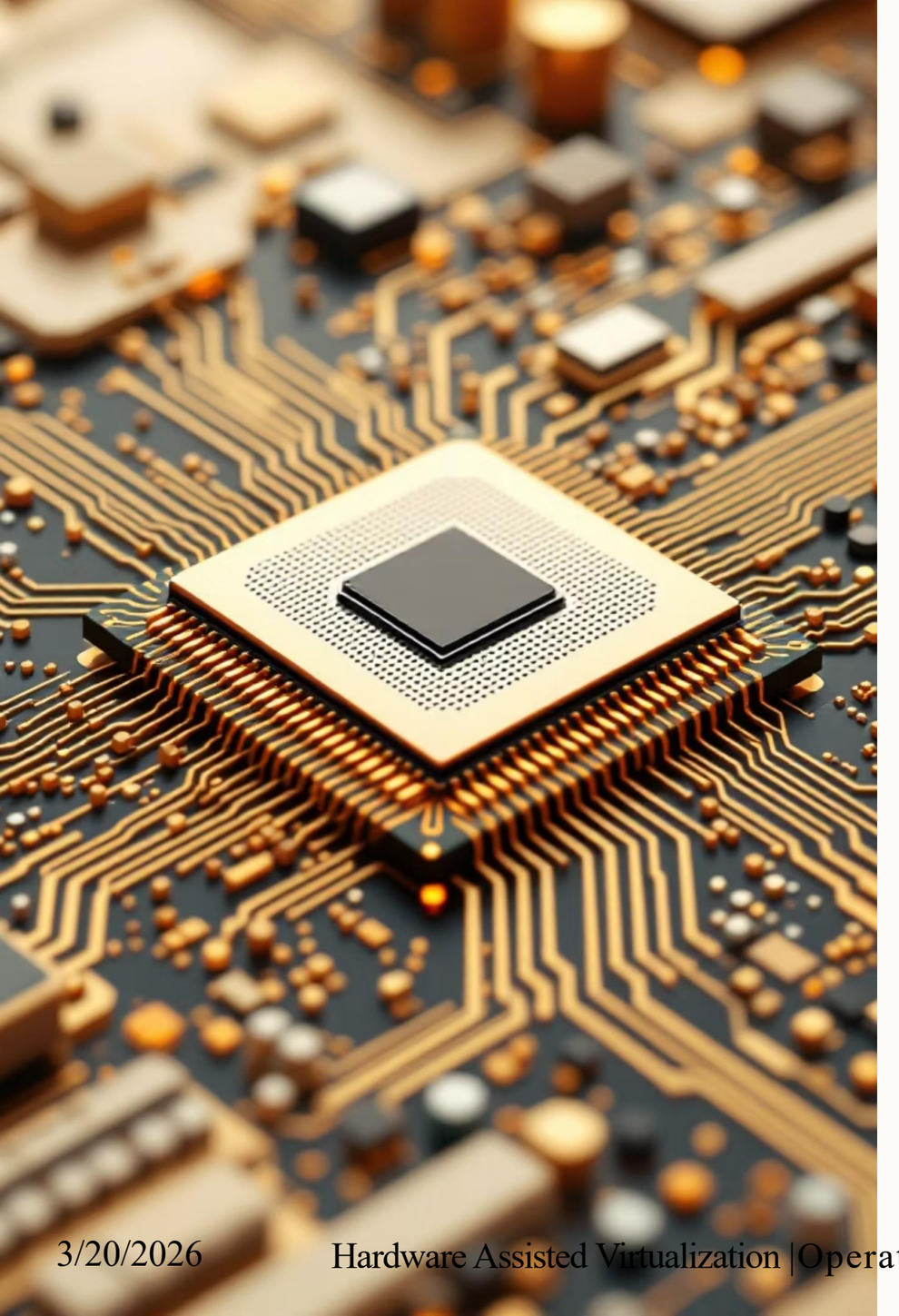
Key Features of Hardware-Based Virtualization



Advantages and Limitations

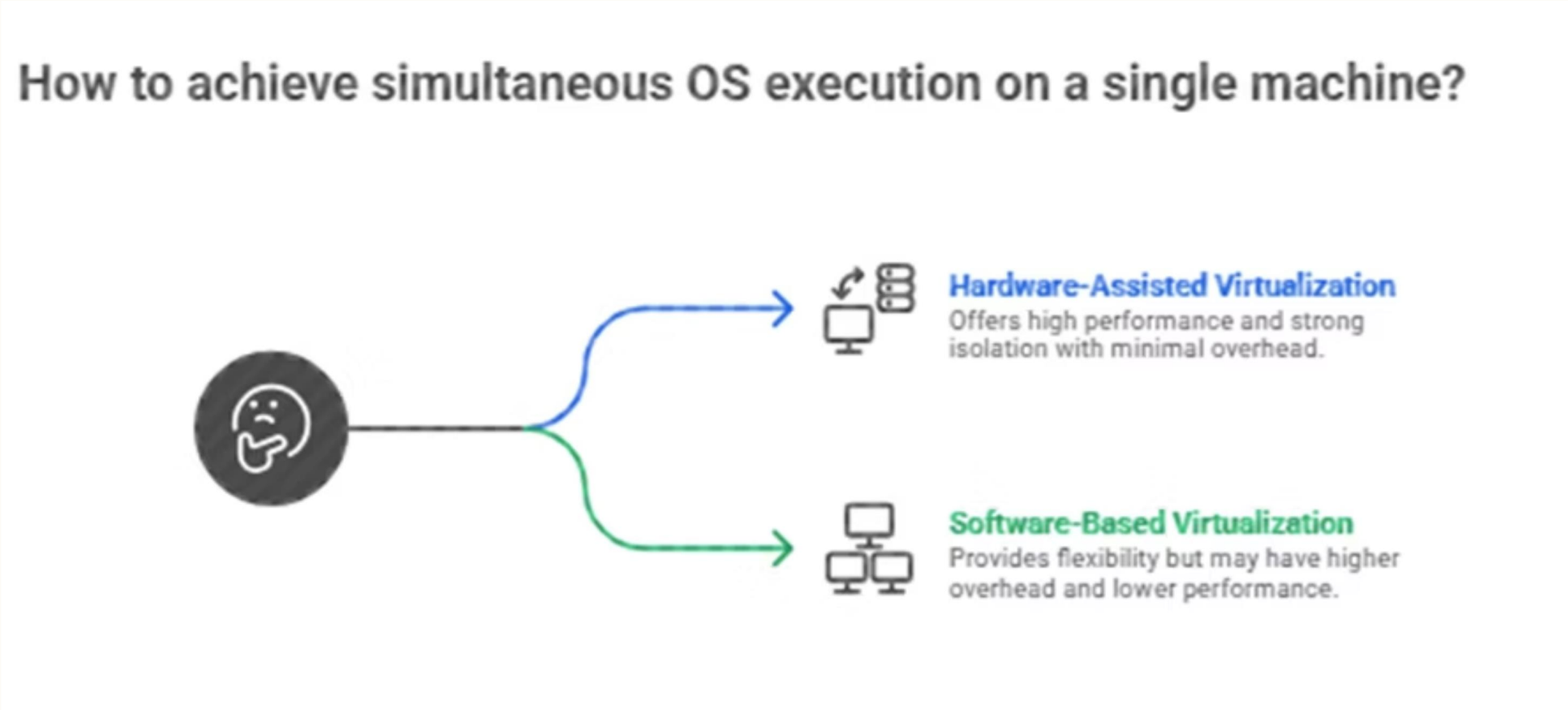






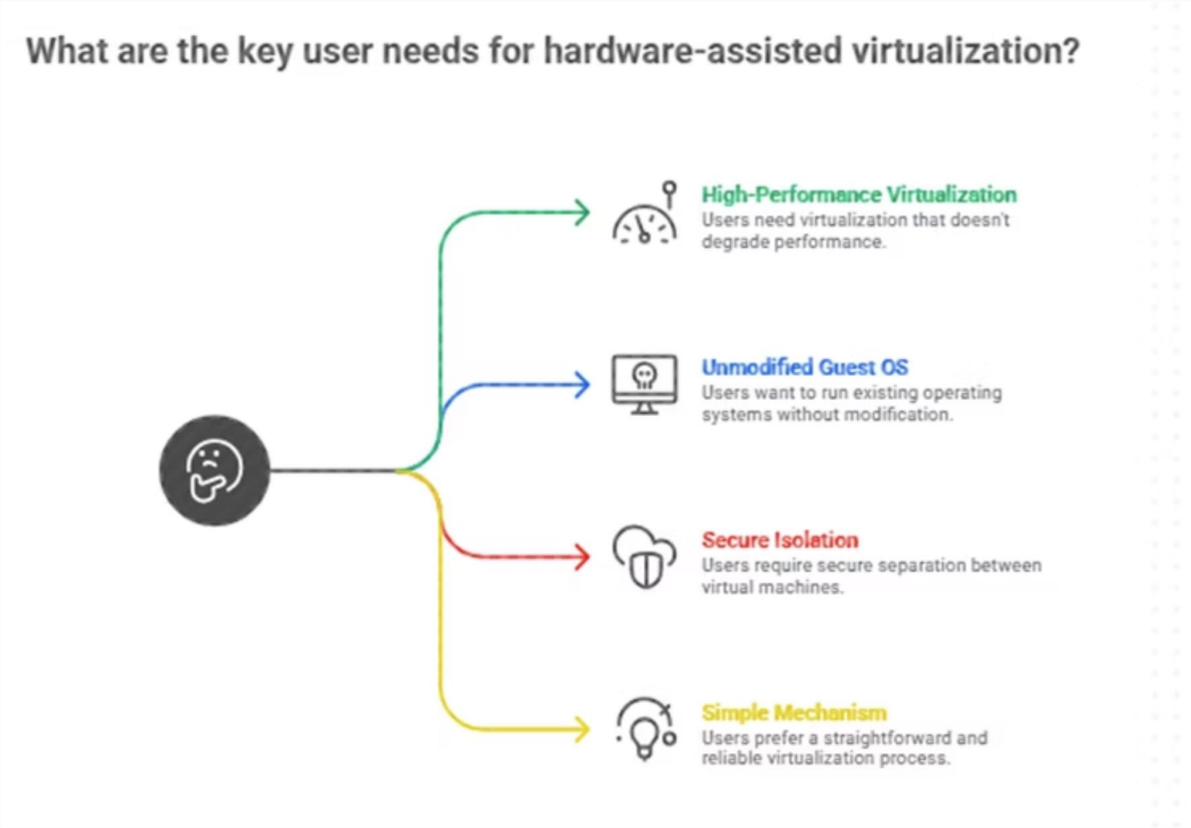
Design Thinking–Based Notes on Hardware-Assisted Virtualization

Problem statement



Design Thinking Explanation for Hardware-Assisted Virtualizatio

Empathize: Understand the Users and Their Problems



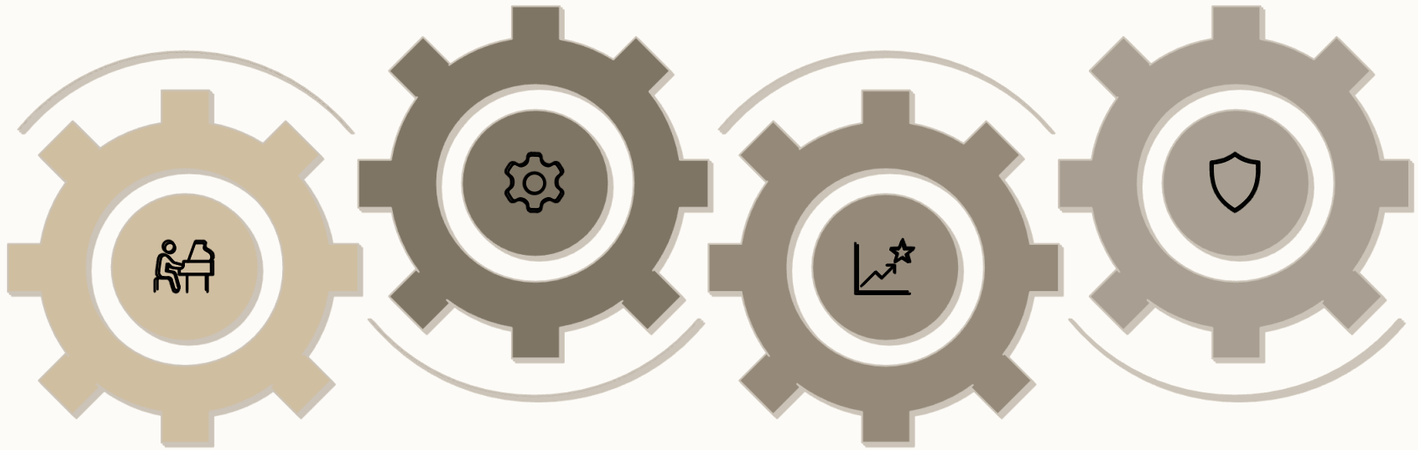
Define: Clearly State the Core Problem

Simplify Hypervisor

Streamline the virtualization layer for easier management.

Ensure Isolation

Guarantee separation between virtual instances for security.



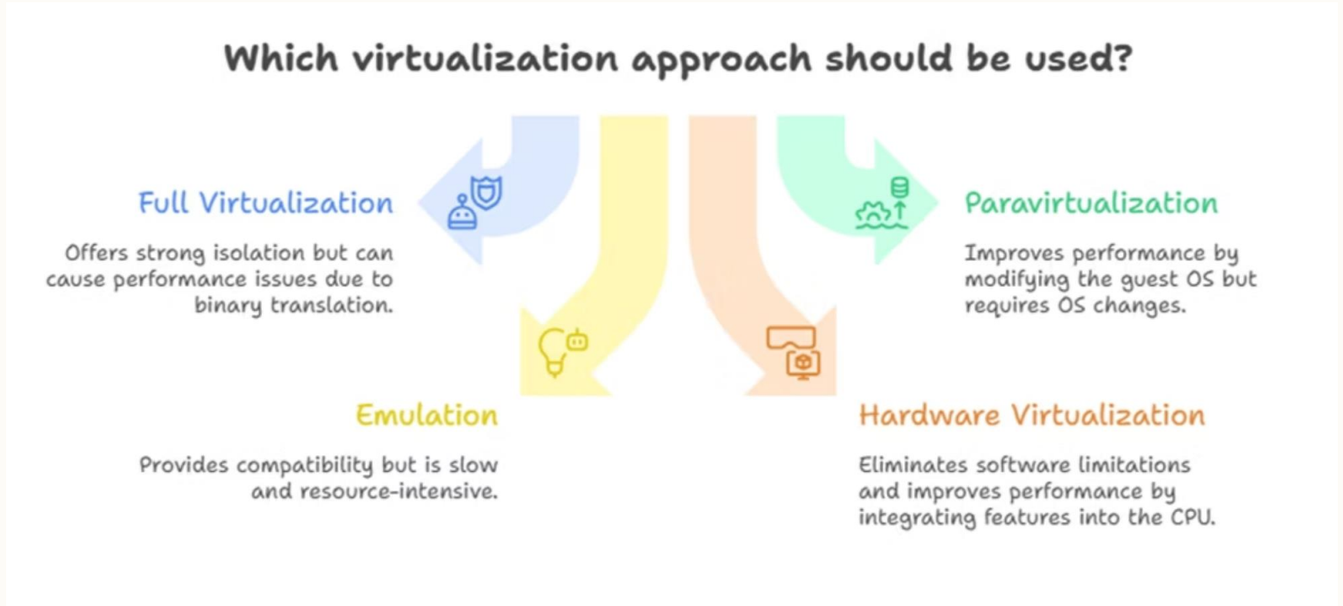
Reduce Overhead

Minimize resource consumption and operational costs for efficiency.

Improve Speed

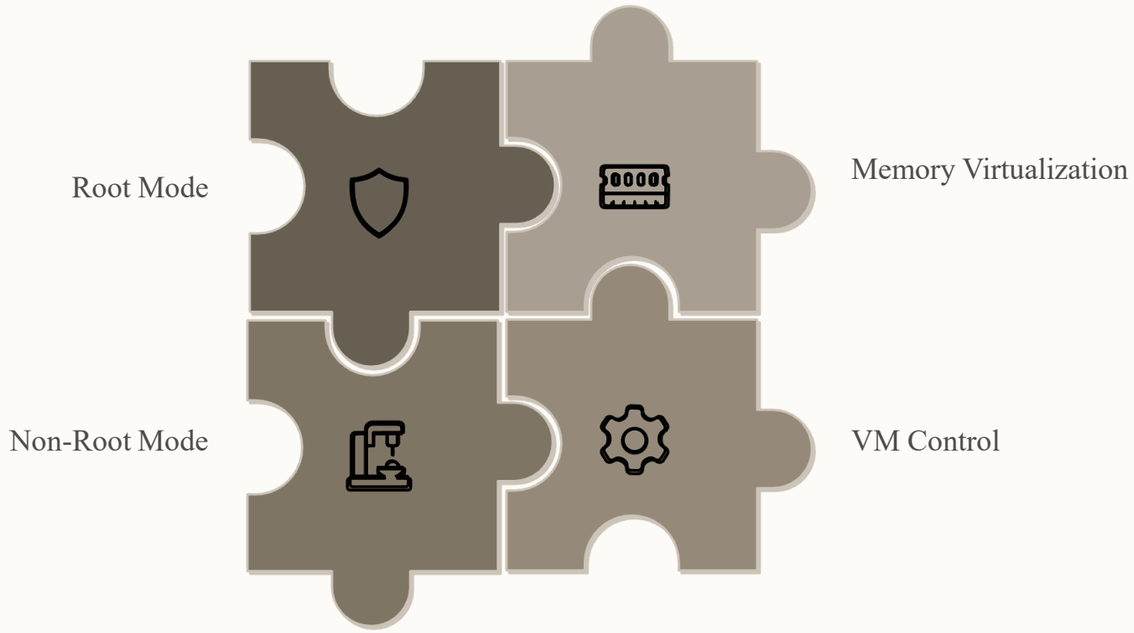
Enhance processing and response times for better performance.

Ideate: Generate Possible Solutions

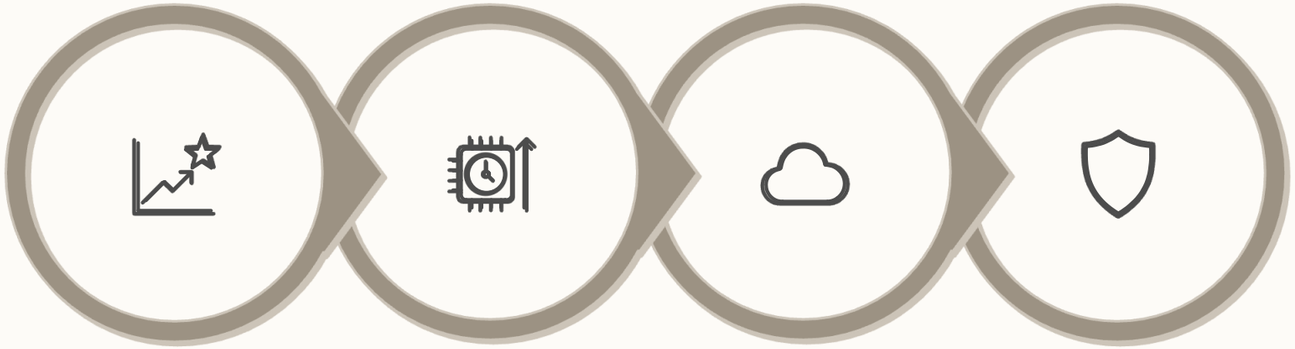


Prototype: Design the Solution

Hardware-Assisted Virtualization Architecture



Test: Evaluate and Validate the Solution



Near-Native Performance

Improved Scalability

Strong Isolation

Hardware Enforcement

Final Design Thinking Conclusion

Empathize

Understand administrator needs

Define

Isolate performance problem

Ideate

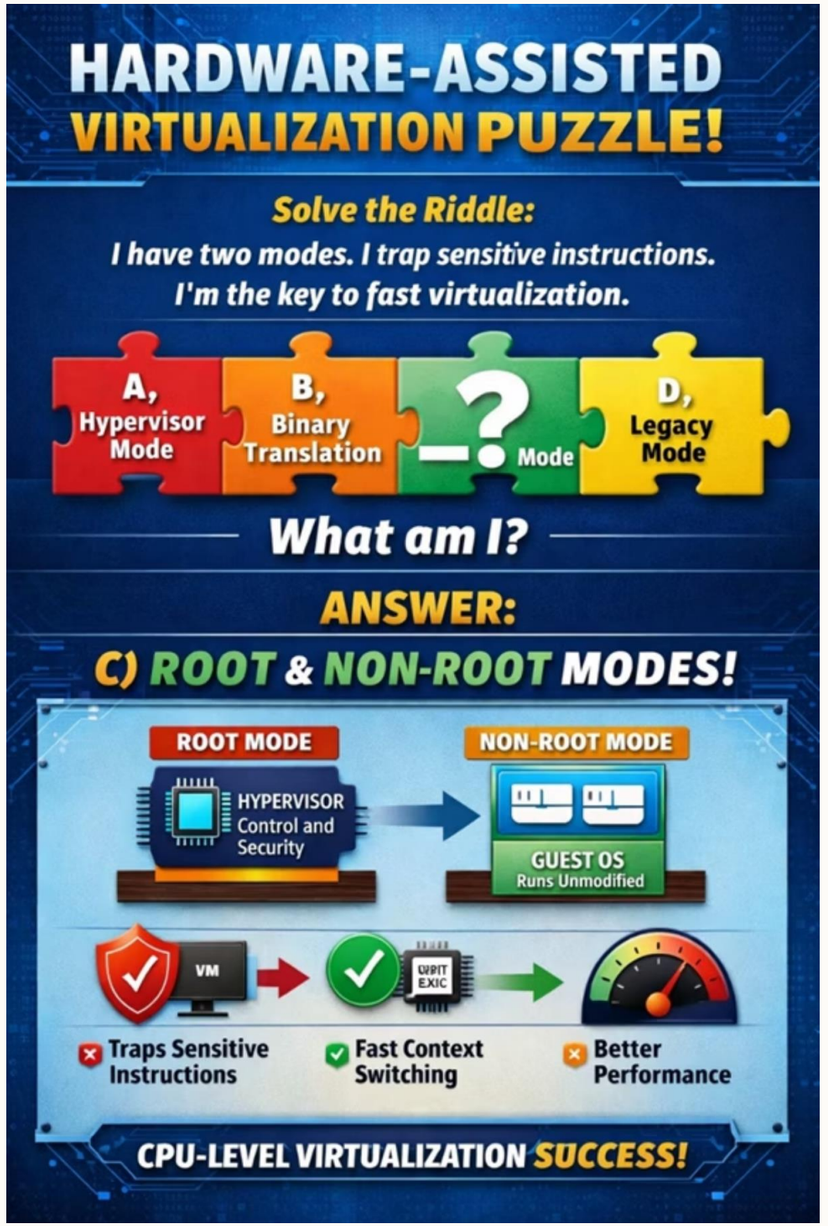
Shift to hardware solution

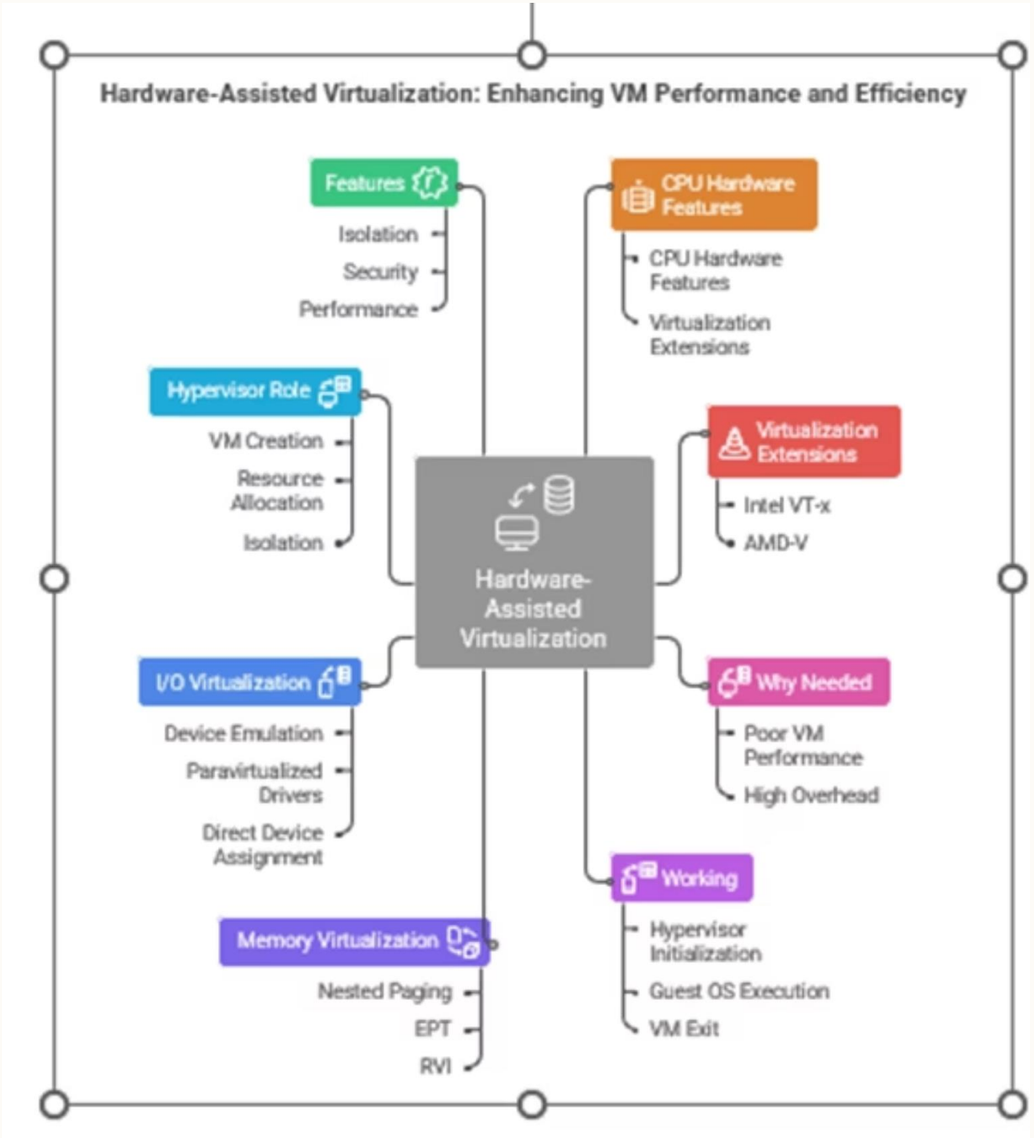
Prototype

Build CPU extensions

Test

Validate performance gains


HARDWARE-ASSISTED
VIRTUALIZATION PUZZLE!
Solve the Riddle:
I have two modes. I trap sensitive instructions.
I'm the key to fast virtualization.
A, Hypervisor Mode
B, Binary Translation
_? Mode
D, Legacy Mode
What am I?
ANSWER:
C) ROOT & NON-ROOT MODES!
ROOT MODE
NON-ROOT MODE
HYPERVISOR Control and Security
GUEST OS Runs Unmodified
VM
VMEXIT
Traps Sensitive Instructions
Fast Context Switching
Better Performance
CPU-LEVEL VIRTUALIZATION SUCCESS!


Hardware-Assisted Virtualization: Enhancing VM Performance and Efficiency
Features
Isolation
Security
Performance
CPU Hardware Features
CPU Hardware Features
Virtualization Extensions
Hypervisor Role
VM Creation
Resource Allocation
Isolation
Hardware-Assisted Virtualization
Virtualization Extensions
Intel VT-x
AMD-V
I/O Virtualization
Device Emulation
Paravirtualized Drivers
Direct Device Assignment
Why Needed
Poor VM Performance
High Overhead
Working
Hypervisor Initialization
Guest OS Execution
VM Exit
Memory Virtualization
Nested Paging
EPT
RVI