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 – V HYPERVISOR

Topic 7:Clones, Templates & Snapshots

Clones, Templates & Snapshots

Understanding VM State Management in Modern Hypervisors

Snapshots **Clones** **Templates**

HOOK — A Story from the Lab

> *A developer spends 3 days configuring a perfect test server. She clicks 'delete' by mistake. Everything is gone. What could have saved her?*

Snapshot

She had taken a snapshot 2 hours earlier. Restore in 10 seconds.

Template

The base config was saved as a template. Rebuild in 5 minutes.

Clone

A full clone existed on another host. Zero data lost.

Clones, Templates & Snapshots in Hypervisors

Managing Virtual Machines Efficiently

1. Snapshots: VM State Saving

- ✔ Save Current State
- ✔ Revert Anytime

E.g. "Before risky install... Revertt if it fails!"

2. Clones: VM Duplication

Full Clone

✓ Complete Copy

Linked Clone

✓ Shares Storage

3. Templates: VM Blueprints

- ✔ Pre-Configured
- ✔ Read-Only

E.g. "Create 20 VMs Fast!"

Snapshot

✓ Restore VM State

Clone

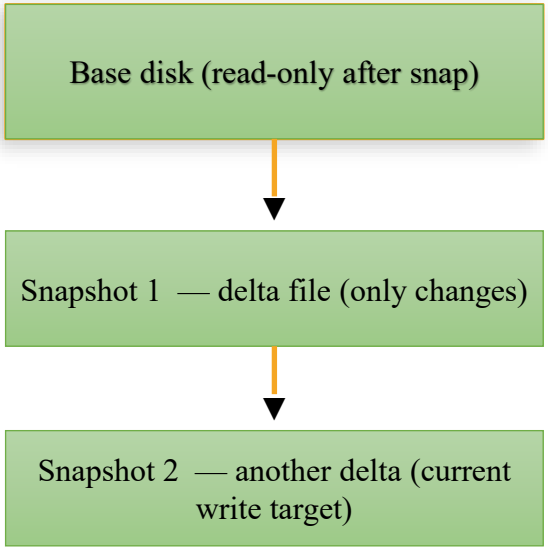
✓ Duplicate VM

Template

✓ Mass VM Deployment

SNAPSHOTS — How They Work

SNAPSHOT CHAIN ARCHITECTURE



KEY FACTS

Copy-on-Write (CoW)

Original blocks never modified. Only changes are written to the delta file, saving disk space.

Three components saved

Disk state, RAM contents (optional), and VM settings (NVRAM, CPU state).

Chain depth matters

Deep chains (10+ snapshots) degrade I/O performance. Flatten regularly.

Not a backup

Snapshots live on the same datastore. A disk failure destroys all snapshots too.

CLONES — Full vs Linked

Full Clones

– Independent Copies –

- Complete Copy of the Original VM
- Own Full Disk Space
- Performance: High

Example: *Duplicate Laptops*

Original Laptop *Fully Duplicated Laptop*

Linked Clones

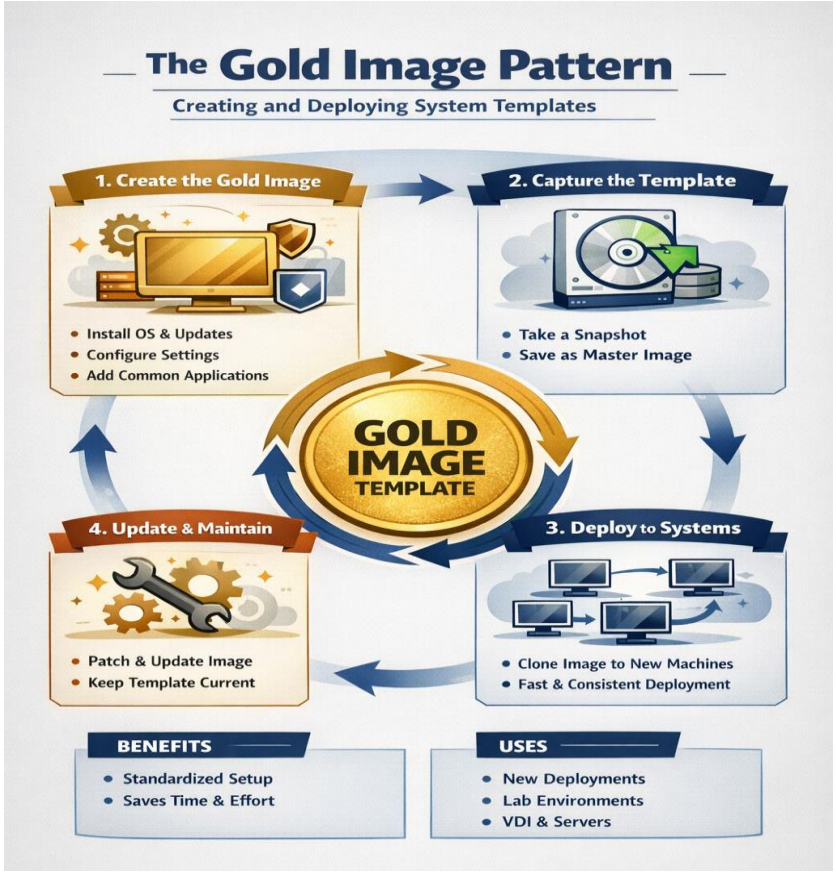
– Dependent Copies –

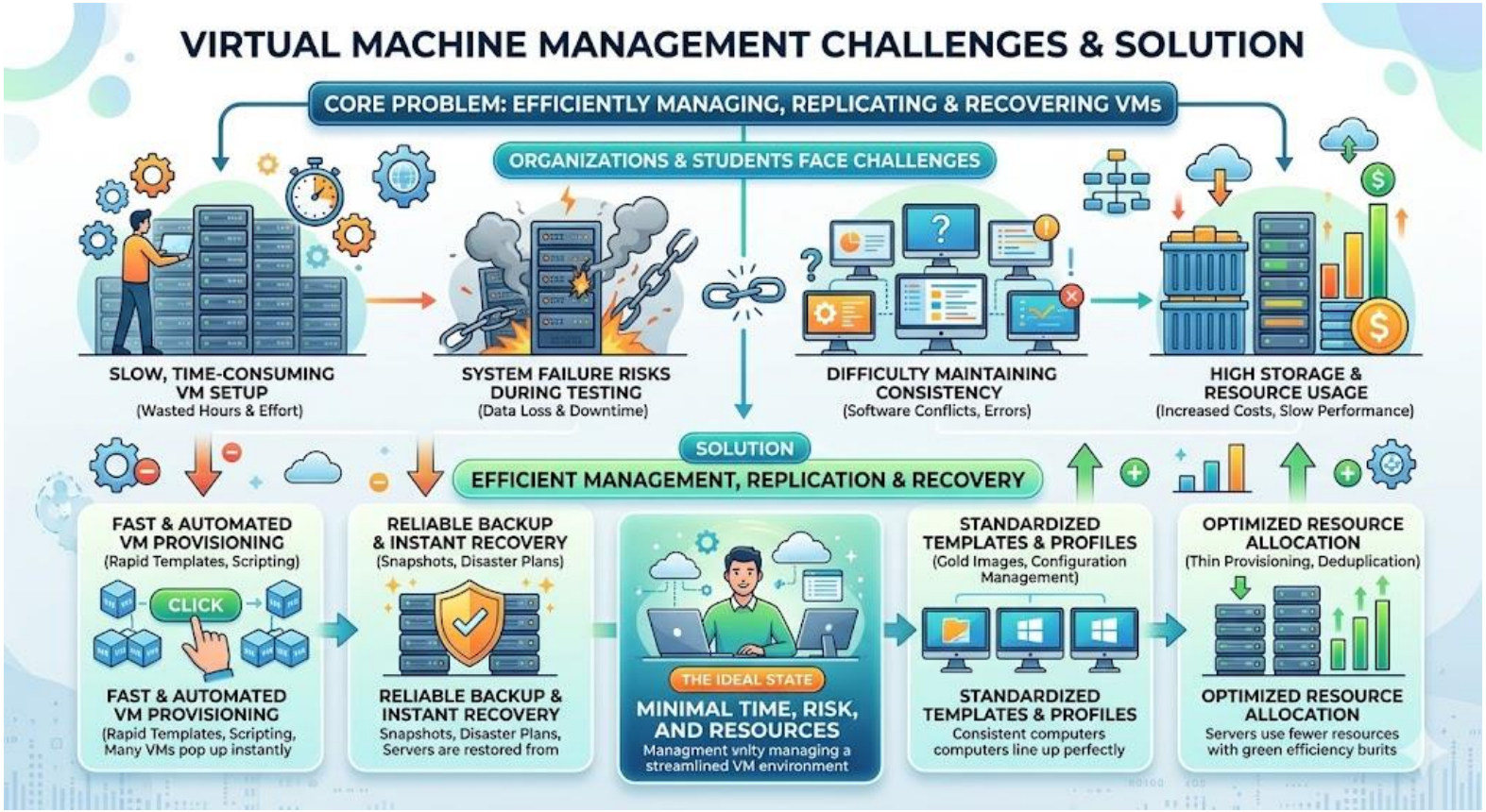
- Shares Base VM Disk
- Uses Less Storage
- Performance: Moderate

Example: *Guest House Setup*

Main House *Guest House*

FULL CLONE: *Complete, Independent Copy* **VS** **LINKED CLONE:** *Shared, Dependent Copy*


The Gold Image Pattern
Creating and Deploying System Templates
1. Create the Gold Image
Install OS & Updates
Configure Settings
Add Common Applications
2. Capture the Template
Take a Snapshot
Save as Master Image
GOLD IMAGE TEMPLATE
3. Deploy to Systems
Clone Image to New Machines
Fast & Consistent Deployment
4. Update & Maintain
Patch & Update Image
Keep Template Current
BENEFITS
Standardized Setup
Saves Time & Effort
USES
New Deployments
Lab Environments
VDI & Servers


VIRTUAL MACHINE MANAGEMENT CHALLENGES & SOLUTION
CORE PROBLEM: EFFICIENTLY MANAGING, REPLICATING & RECOVERING VMs
ORGANIZATIONS & STUDENTS FACE CHALLENGES
SLOW, TIME-CONSUMING VM SETUP
(Wasted Hours & Effort)
SYSTEM FAILURE RISKS DURING TESTING
(Data Loss & Downtime)
DIFFICULTY MAINTAINING CONSISTENCY
(Software Conflicts, Errors)
HIGH STORAGE & RESOURCE USAGE
(Increased Costs, Slow Performance)
SOLUTION
EFFICIENT MANAGEMENT, REPLICATION & RECOVERY
FAST & AUTOMATED VM PROVISIONING
(Rapid Templates, Scripting)
CLICK
FAST & AUTOMATED VM PROVISIONING
(Rapid Templates, Scripting, Many VMs pop up instantly
RELIABLE BACKUP & INSTANT RECOVERY
(Snapshots, Disaster Plans)
RELIABLE BACKUP & INSTANT RECOVERY
Snapshots, Disaster Plans, Servers are restored from
THE IDEAL STATE
MINIMAL TIME, RISK, AND RESOURCES
Managment vnity managing a streamlined VM environment
STANDARDIZED TEMPLATES & PROFILES
(Gold Images, Configuration Management)
STANDARDIZED TEMPLATES & PROFILES
Consistent computers computers line up perfectly
OPTIMIZED RESOURCE ALLOCATION
(Thin Provisioning, Deduplication)
OPTIMIZED RESOURCE ALLOCATION
Servers use fewer resources with green efficiency burits

Empathy: Understanding the Users

Students / Learners

- Quick VM setup for labs
- Safe testing environment
- Fear of system crashes

Developers / Testers

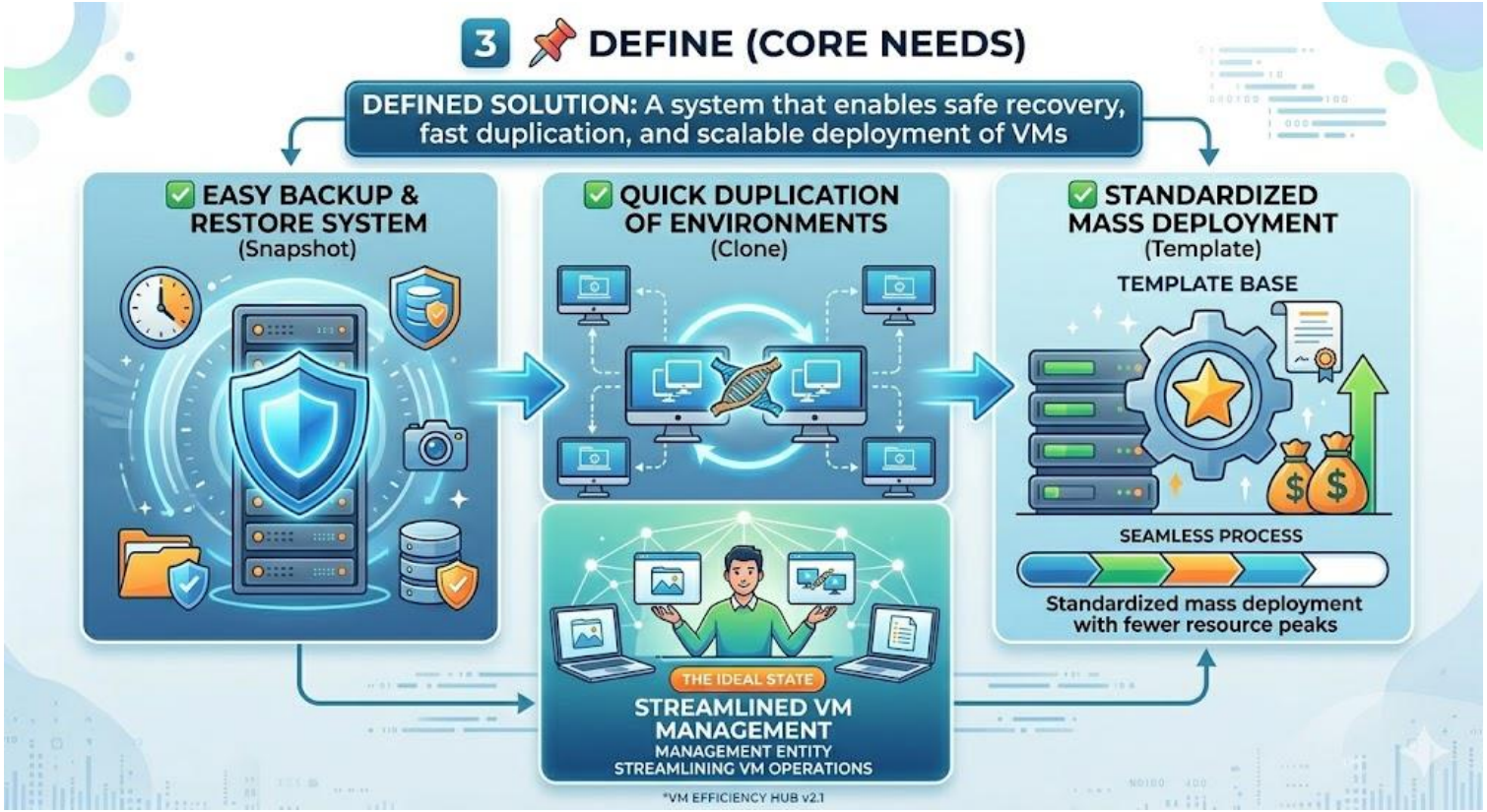
- Test new software often
- Need rollback options
- Multiple identical environments

IT Administrators

- Manage many systems
- Ensure consistency
- Reduce manual work

Pain Points:

- Time-Consuming Setup
- Risk of Data Loss
- Repetitive Configuration


3
DEFINE (CORE NEEDS)
DEFINED SOLUTION: A system that enables safe recovery, fast duplication, and scalable deployment of VMs
EASY BACKUP & RESTORE SYSTEM
(Snapshot)
QUICK DUPLICATION OF ENVIRONMENTS
(Clone)
STANDARDIZED MASS DEPLOYMENT
(Template)
TEMPLATE BASE
SEAMLESS PROCESS
Standardized mass deployment with fewer resource peaks
THE IDEAL STATE
STREAMLINED VM MANAGEMENT
MANAGEMENT ENTITY
STREAMLINING VM OPERATIONS
*VM EFFICIENCY HUB v2.1

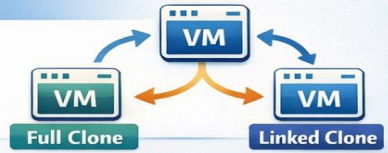
Ideate Generate Solutions

Idea 1: Snapshots

- Capture VM state instantly
- Allow rollback anytime

Idea 2: Clones

- Create multiple copies of a VM
- Full Clone ➡ Independent
- Linked Clone ➡ Storage Efficient

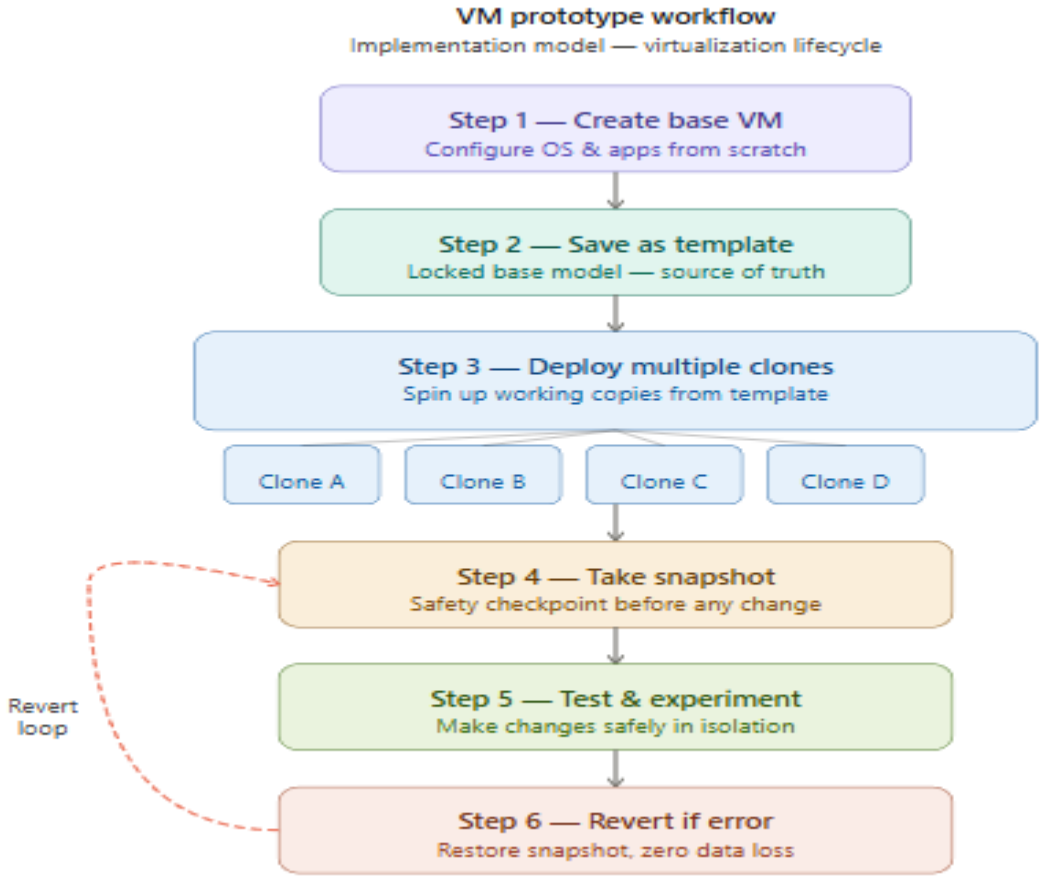


Idea 3: Templates

- Create a golden base VM
- Deploy multiple identical systems

Complete VM Lifecycle Management

Snapshots + Clones + Templates


VM prototype workflow
Implementation model — virtualization lifecycle
Step 1 — Create base VM
Configure OS & apps from scratch
Step 2 — Save as template
Locked base model — source of truth
Step 3 — Deploy multiple clones
Spin up working copies from template
Clone A
Clone B
Clone C
Clone D
Step 4 — Take snapshot
Safety checkpoint before any change
Step 5 — Test & experiment
Make changes safely in isolation
Step 6 — Revert if error
Restore snapshot, zero data loss
Revert loop


6 TEST (EVALUATION & FEEDBACK)
TESTING SCENARIOS
Faulty Software
Install faulty software → revert snapshot
Create 50 VMs → check deployment speed
Clone
New independent VM
Modify clone → verify independence
RESULTS
Time reduced significantly
faster
Easy recovery from failures
Consistent environments
Template
Optimized storage (linked clones)
VM
Deduplicated arrays
Shared base storage
IMPROVEMENTS
Manage snapshot limits
Max limit
Manage snapshot limits
Monitor storage usage
Monitor storage usage
FINAL INSIGHT
Snapshots, Clones, and Templates together form a smart VM management system that:
- Reduces risk
- Saves time
- Improves scalability
Maintain updated templates
Template
Maintain updated templates
09.1.2023
Software
*VM EFFICIENCY HUB v3.0 (Evaluation and Refinement Edition)

THINK–PAIR–SHARE — Scenario Challenge

SCENARIO:

You manage a university computer lab with 200 Windows workstations. Every semester a new software toolkit must be pre-installed. Students frequently break their machines. Budget for storage is limited.

? *Which combination of Snapshot, Clone, and Template would you use — and why?*

Option A	Option B	Option C
Build gold image → convert to template → deploy 200 linked clones → snapshot each after student login.	Take a snapshot of a configured machine → full-clone it 200 times → no template involved.	No snapshots — just templates. Students reset from template each day automatically via script.

CONCEPT CHECK — Quick Puzzle

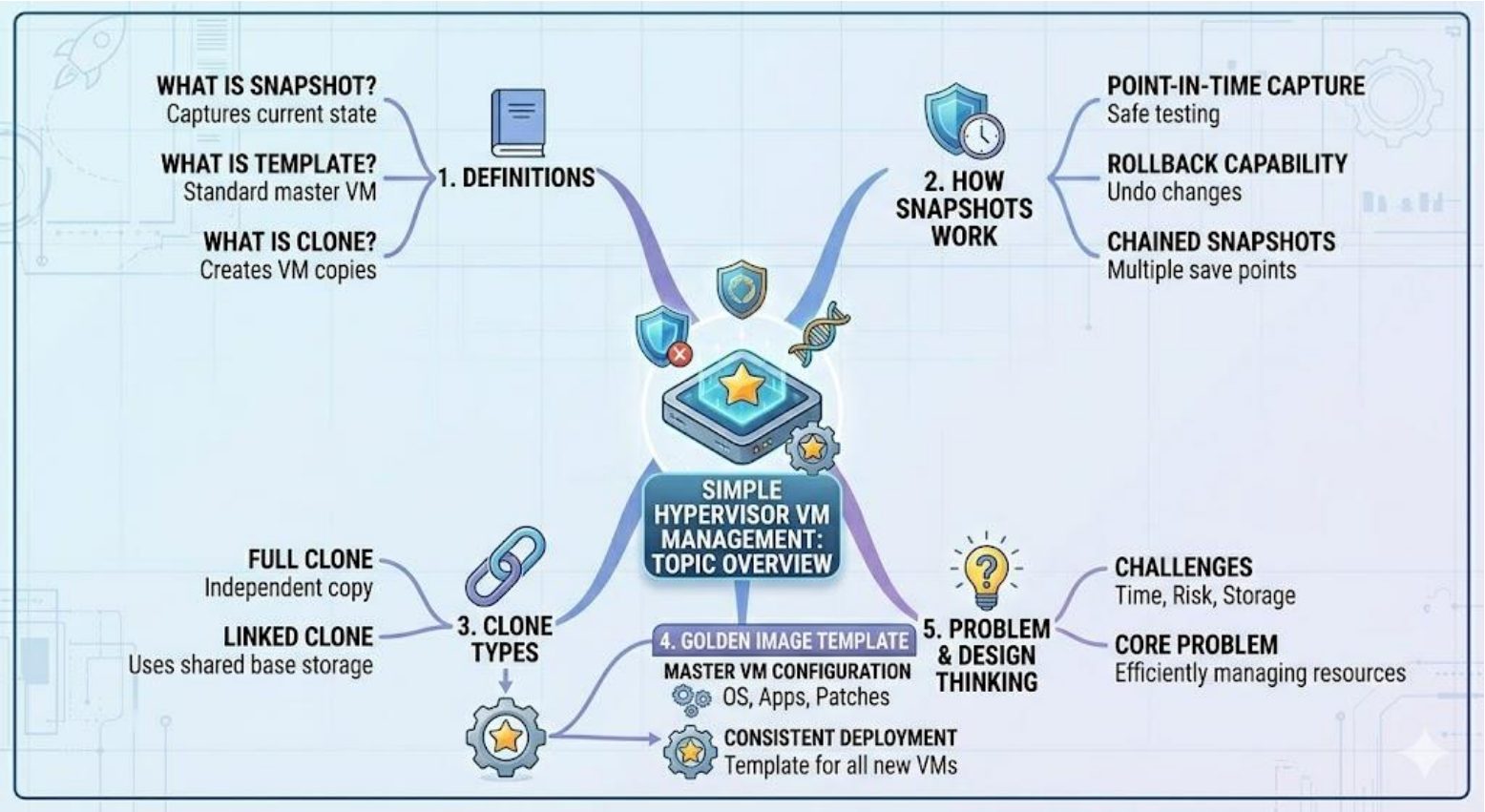
You have a production VM with 3 snapshots chained. You need a copy to share with a colleague on a USB drive. What is the CORRECT approach — and what will happen if you just copy the .vmdk file?

A. Copy just the latest .vmdk delta file — this contains the full current disk state.

B. Create a Full Clone first (which flattens all snapshots into one independent disk), then copy that.

C. Create a Linked Clone and copy it — it will bring its own base.

D. Convert to a Template and export it — templates bundle everything.


WHAT IS SNAPSHOT?
Captures current state
WHAT IS TEMPLATE?
Standard master VM
WHAT IS CLONE?
Creates VM copies
1. DEFINITIONS
2. HOW SNAPSHOTS WORK
POINT-IN-TIME CAPTURE
Safe testing
ROLLBACK CAPABILITY
Undo changes
CHAINED SNAPSHOTS
Multiple save points
SIMPLE HYPERVISOR VM MANAGEMENT: TOPIC OVERVIEW
FULL CLONE
Independent copy
LINKED CLONE
Uses shared base storage
3. CLONE TYPES
4. GOLDEN IMAGE TEMPLATE
MASTER VM CONFIGURATION
OS, Apps, Patches
CONSISTENT DEPLOYMENT
Template for all new VMs
5. PROBLEM & DESIGN THINKING
CHALLENGES
Time, Risk, Storage
CORE PROBLEM
Efficiently managing resources