# Obligatory rubric

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# Tape and the SNIA shared-storage model

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This revision:

- 2002-06-12: last content update
- 2003-04-13: last graphics update

# Scope

- Open Systems
  - Mainframe tape function and usage are qualitatively different
- Backup/archive/HSM motivate architectural choices
  - The only significant open system usage of tape
- Backup architecture examples
  - Goal: Explain use of storage networking for backup/restore
  - Non-goal: explain all backup application features/functions

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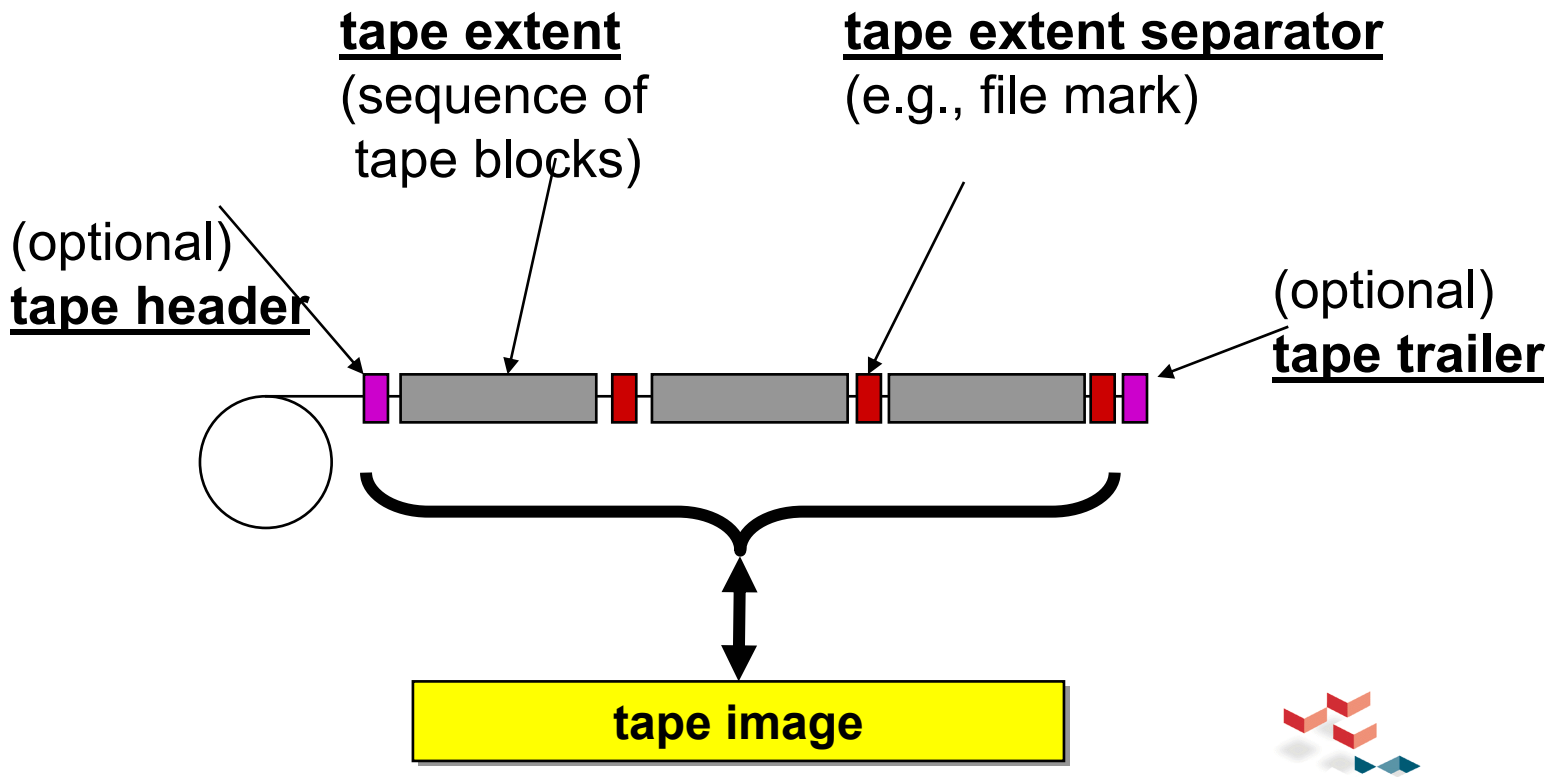
# Tape layout: *logical* tape structure (representative)







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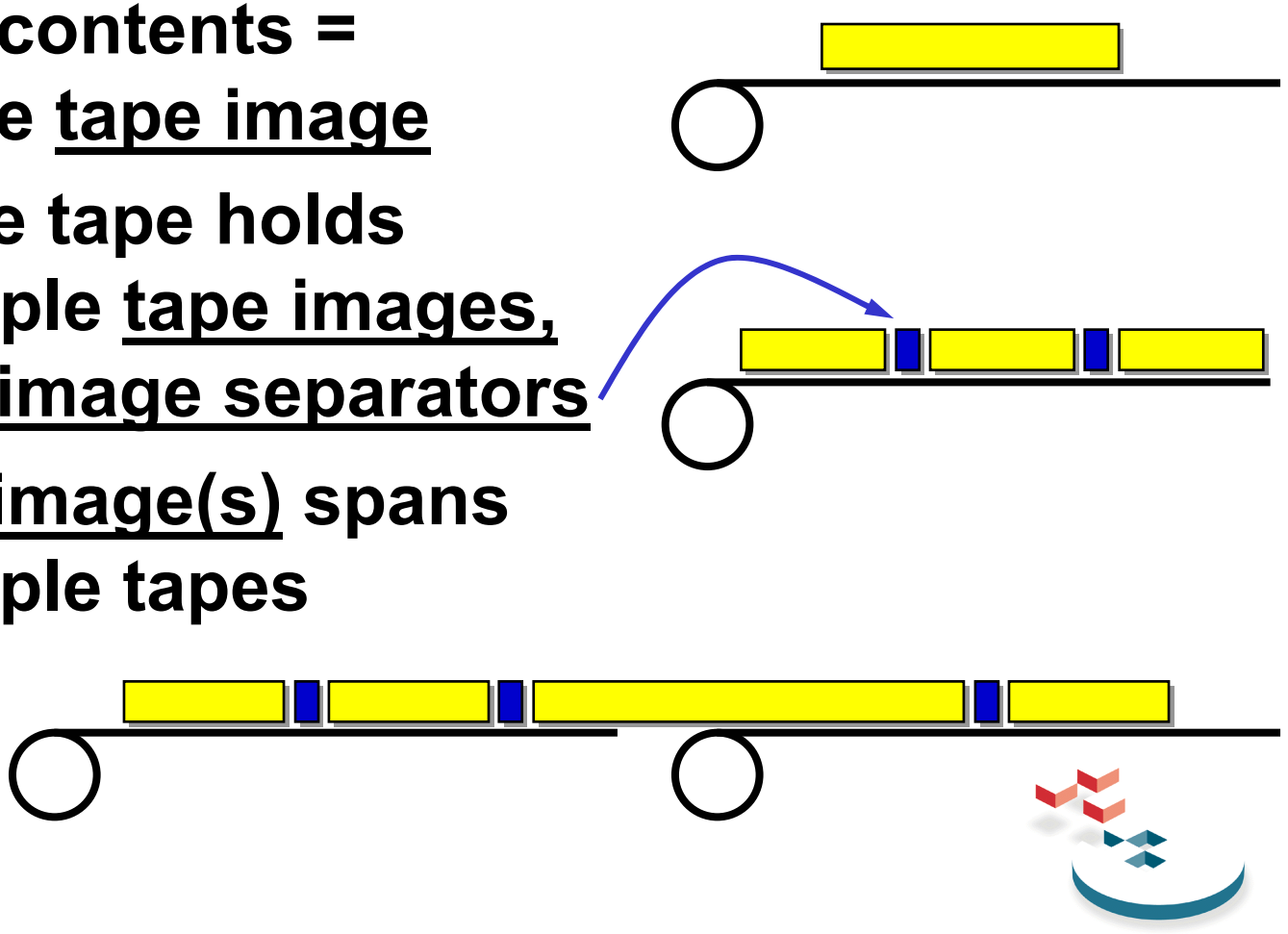
# Tape layout: *physical* tape structures (representative)

1. tape contents = single tape image
2. single tape holds multiple tape images, tape image separators
3. tape image(s) spans multiple tapes



# Tapes are not Disks: Part 1: Physical Format

- Physically:
  - Disk block ~= Tape block
  - Disk volume ~= Tape extent
    - Sequences of blocks
- But …
  - Disk: random access
  - Tape: sequential access
    - Random access tape (e.g., DECtape) ~= long thin slow disk
- Causes huge usage differences
  - Tape extent is usually written in one pass
    - Appends occur, but not update in place
  - Random access to tape is (usually) a bad idea

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# Tapes are not Disks
# Part 2: Logical Format

- Disk block ~= Tape block
- Disk volume ~= Tape extent
  - Block aggregation operations apply to both
  - Concatenate, stripe, mirror, etc.
- In OS/360-derived “mainframe” systems:
  - Disk file ~= Tape file
- In open systems:
  - Tape images usually used for packed files
  - “archives”, “backups”, ~= file system

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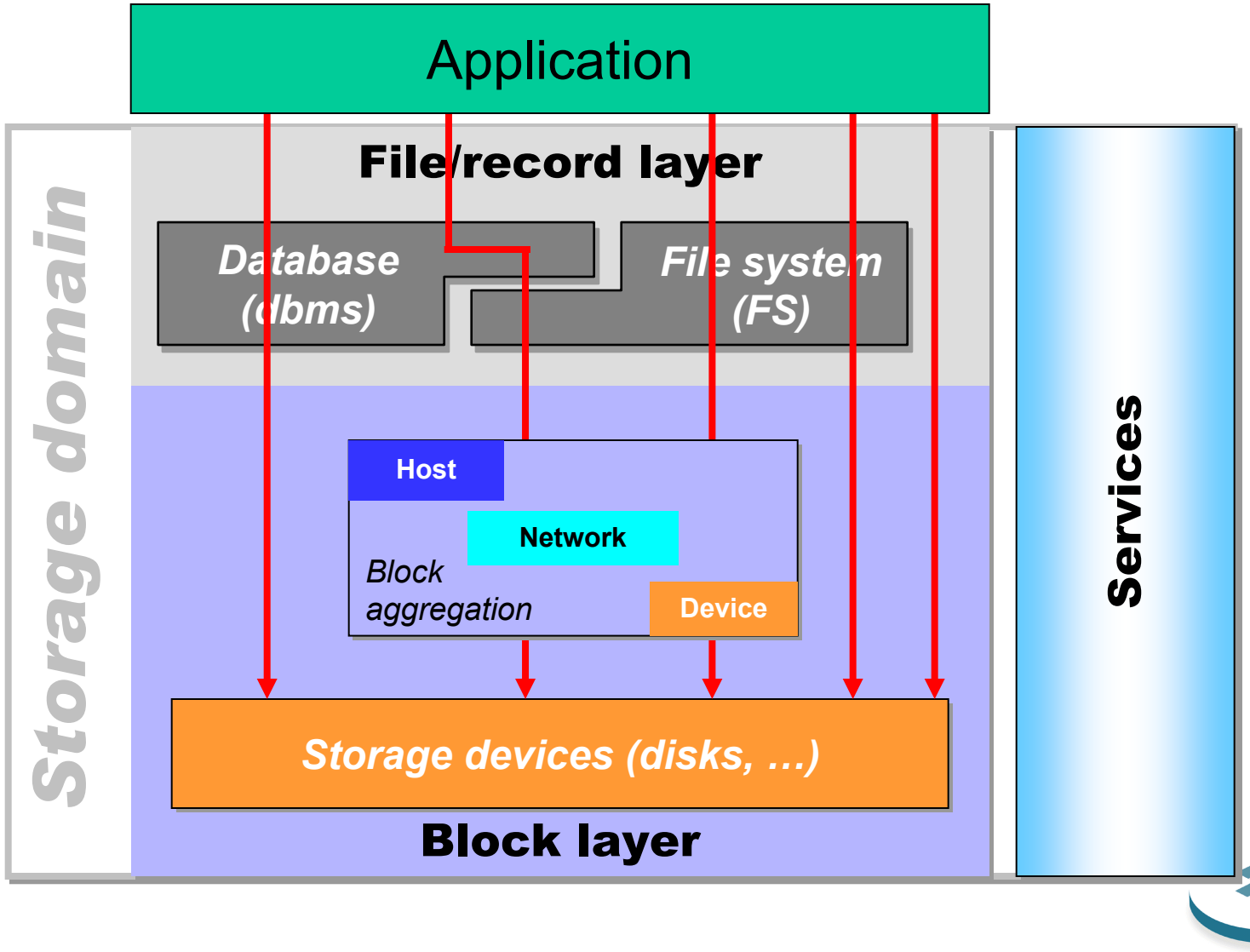
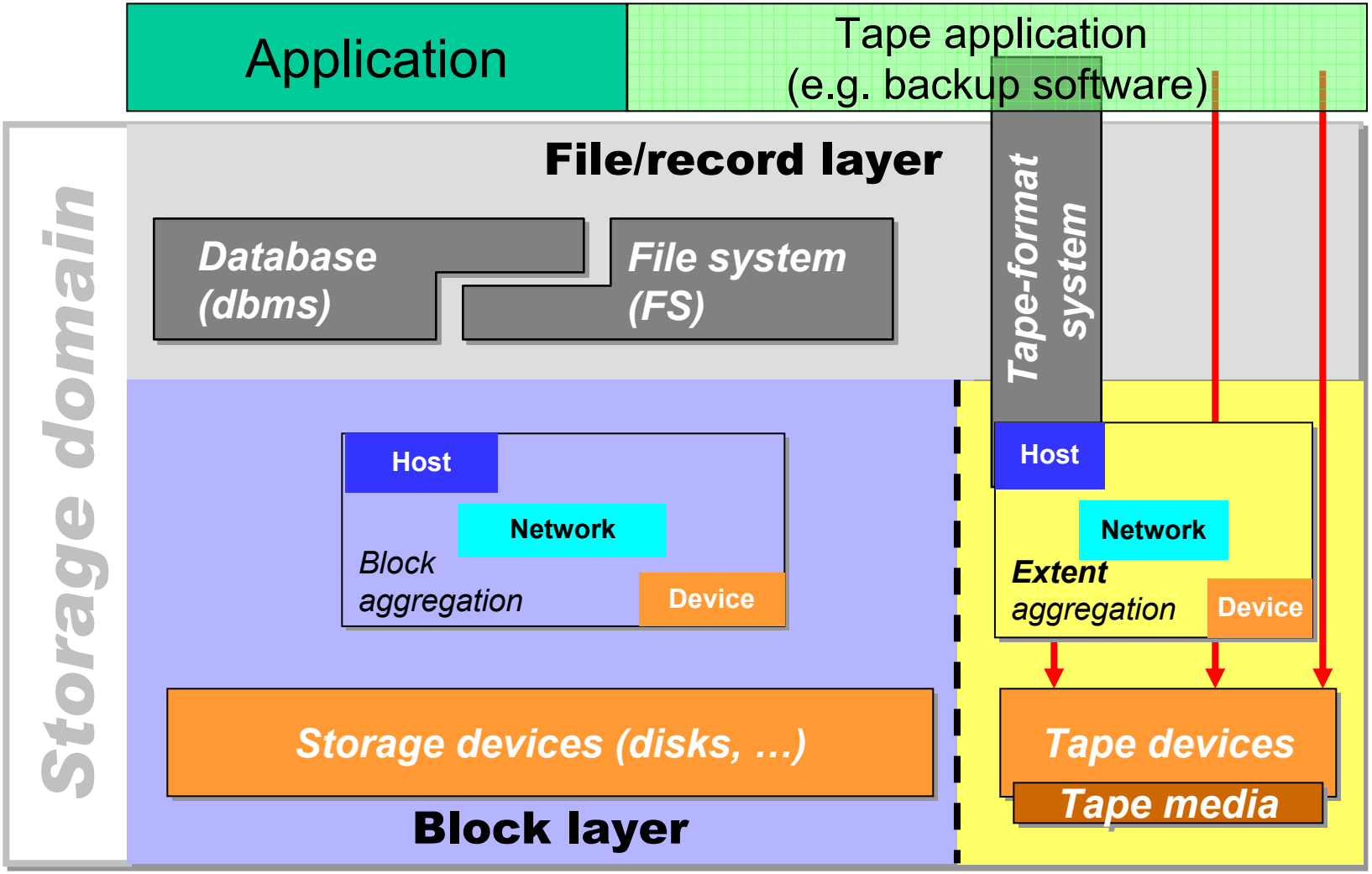
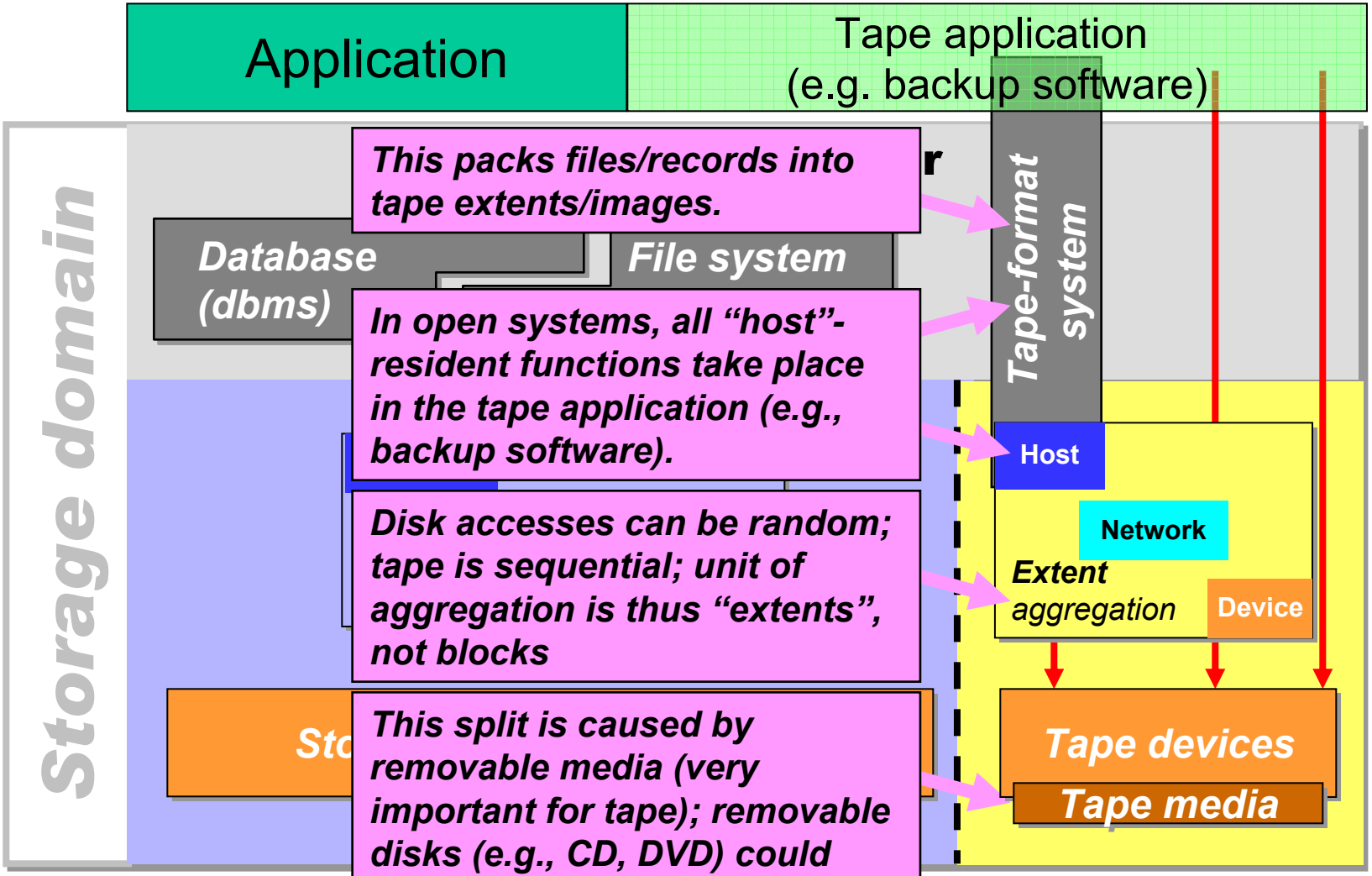
# The SNIA shared storage model



# Tape in the SNIA shared storage model



# Tape in the SNIA shared storage model



# Removable media: Significant functional impacts

- Which tape is in the drive? What's on it?
  - Tape labels, indexes
- Where's the tape I wanted?
  - Catalogs, library slot management
- How do I get that tape into the drive?
  - Operator instructions, robot commands
  - Tape device could be a single drive or multi-drive library
- Can this drive read that tape?
  - Different cartridge sizes and shapes
  - Tape formats: significantly more diverse and complex than SD/DD/HD floppy formats





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# Backup techniques focus on: what is done

- Three common Unix tape utilities
  - tar – read the filesystem and write the tape
  - dump – read the disk volume and write the tape
  - dd – bulk copy from disk volume to tape
- Diagrams show data flows for backup
  - Where the disk and tape are doesn't matter
  - Reverse the data flow arrows for restore

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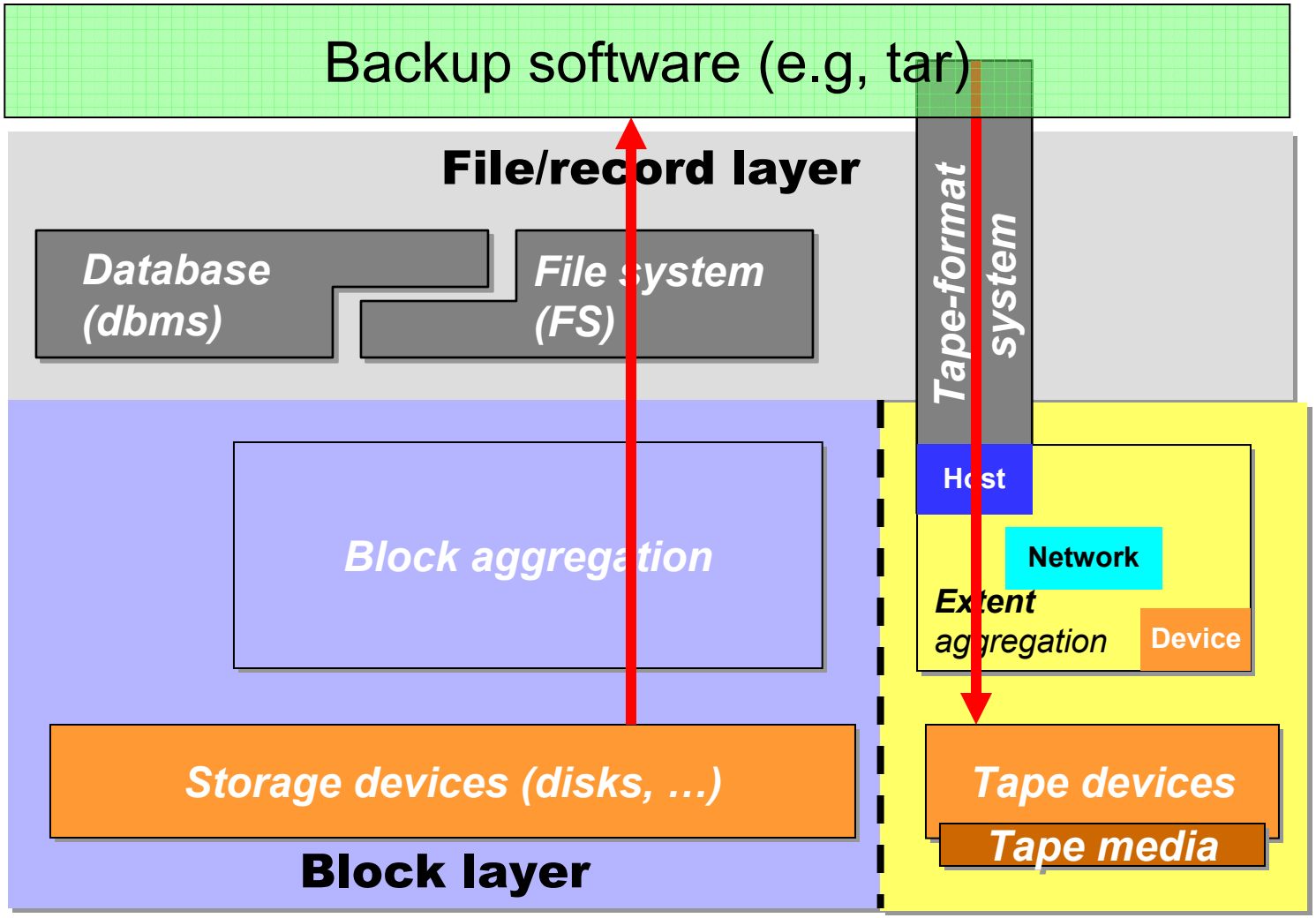
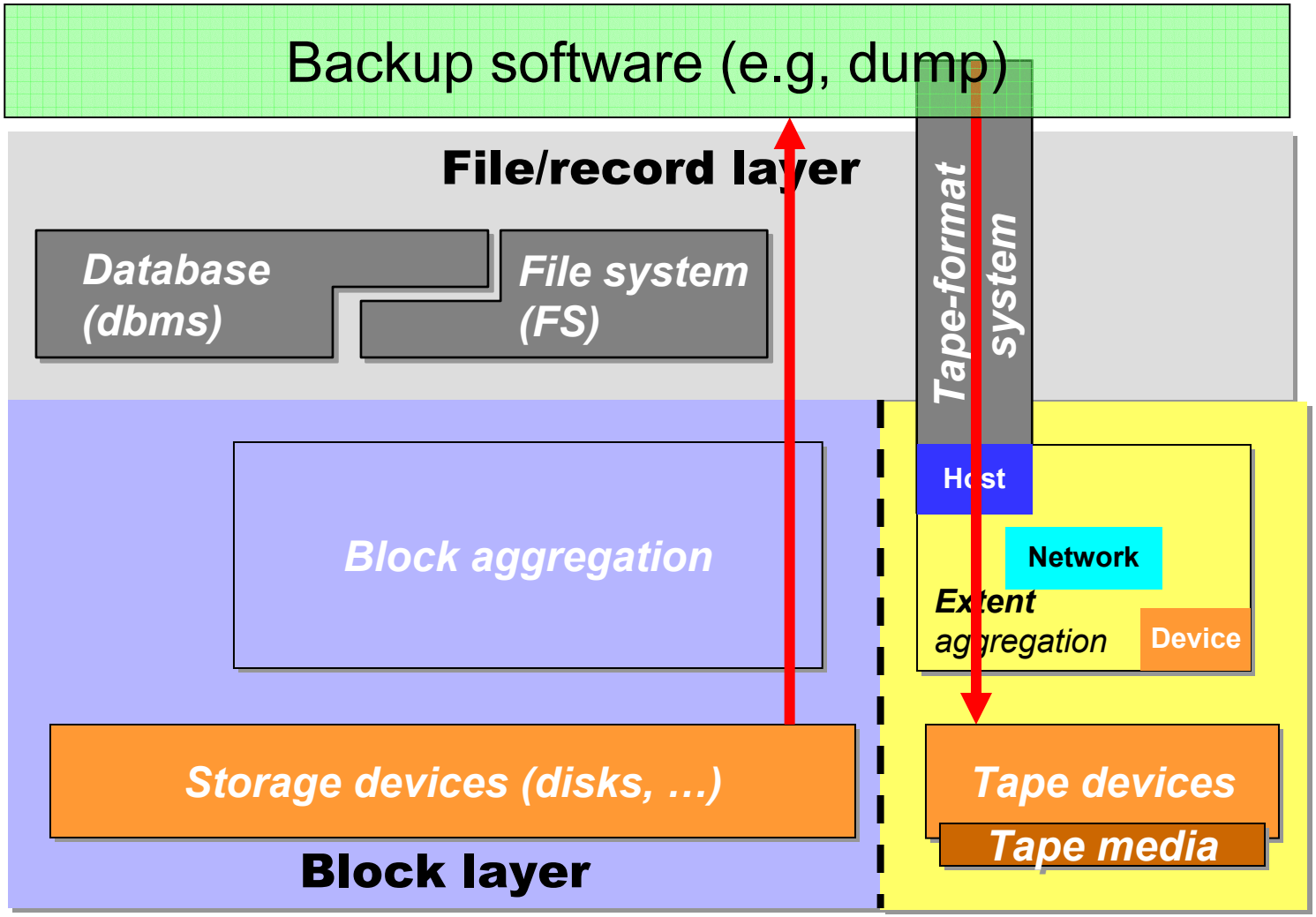
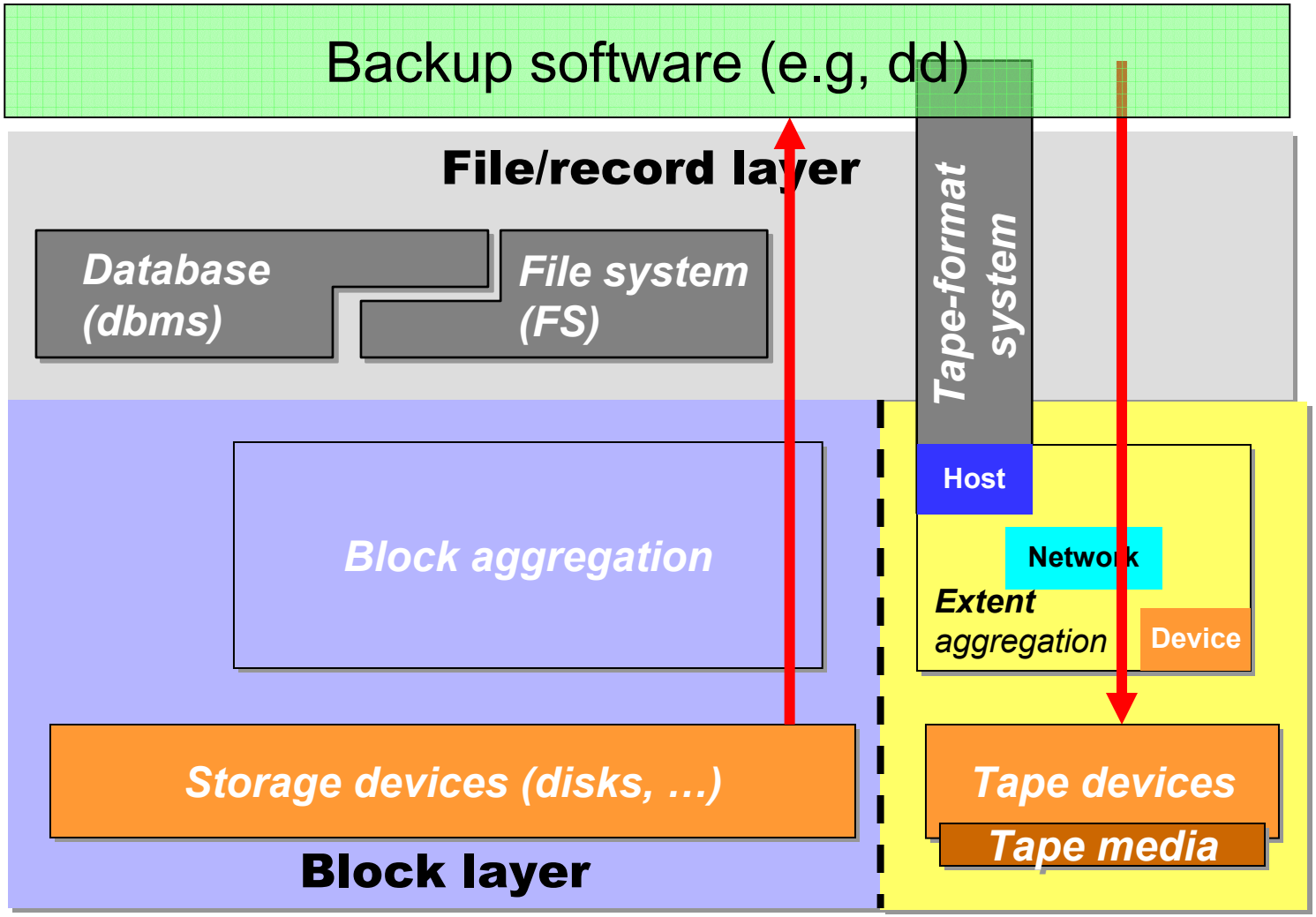
# Backup technique: Files



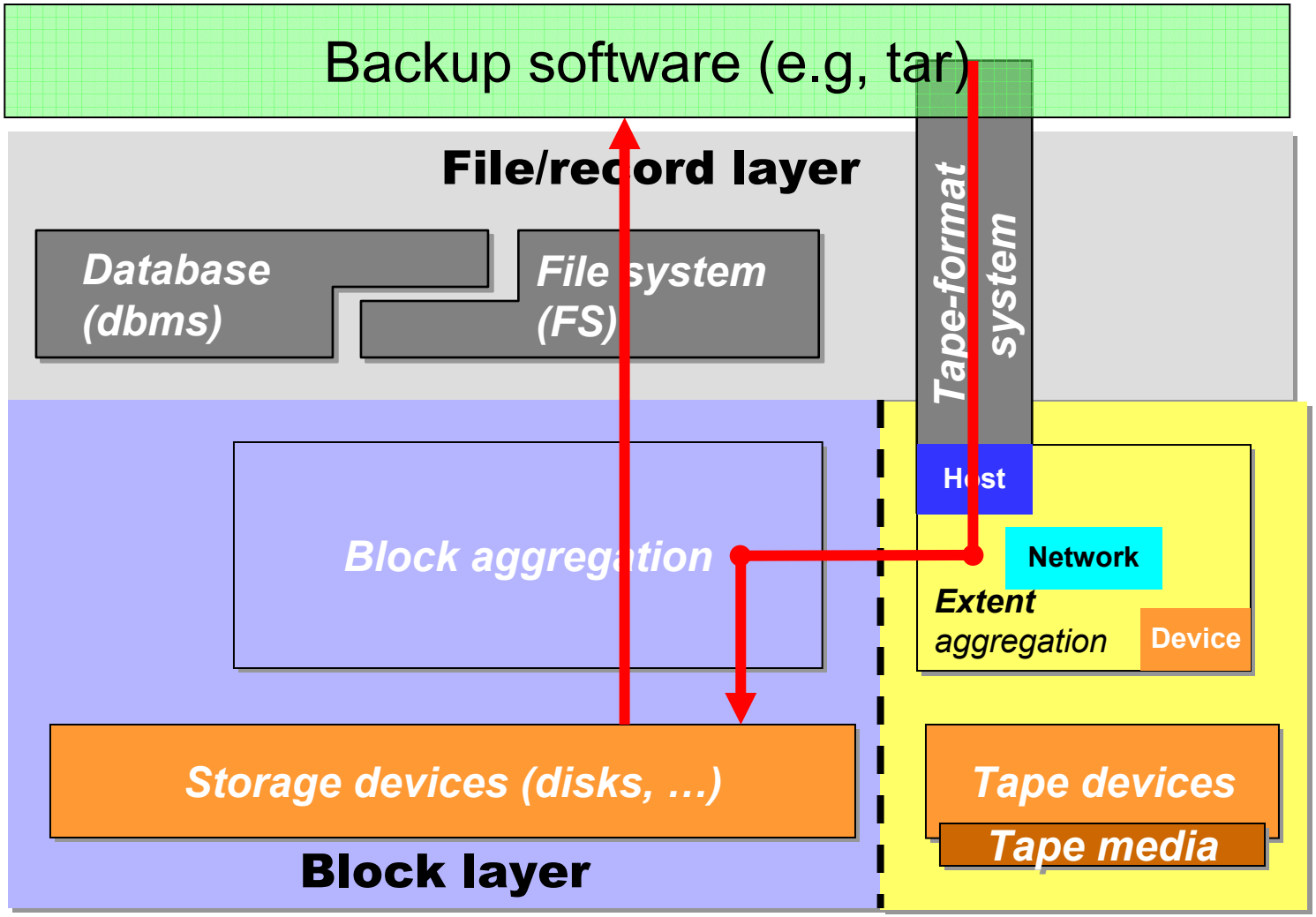
# Backup technique: File system volume



# Backup technique: Volume copy to tape



# Backup technique: Files to virtual tape



# Backup architectures focus on: where it is done

- Architecture is independent of backup technique

- How does the data move to the tape(s)?
  - Architecture examples focus on external tape libraries
    - External: on different system from backup software
  - See previous slides for internal tape
    - Internal: on same system as backup software

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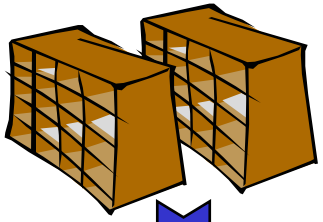
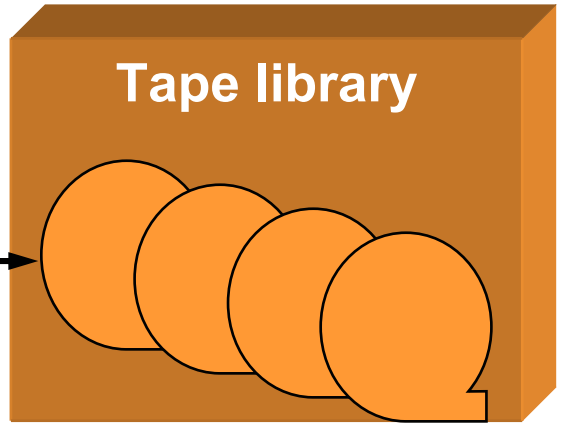
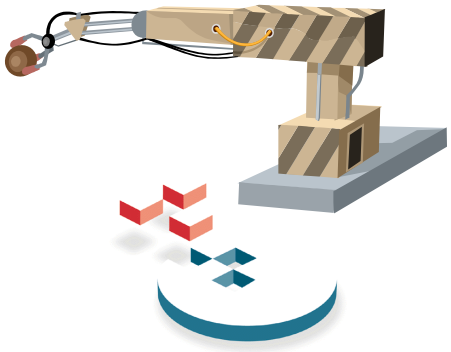
# What's in a tape library?






- Tapes (media)
  - And slots to store them
- Tape drive(s)
  - Often more than one
  - Independently usable
- Robot(s)
  - Move tapes between drives and storage slots
  - Independent command interface
- Robot command paths omitted from diagrams on following slides for clarity



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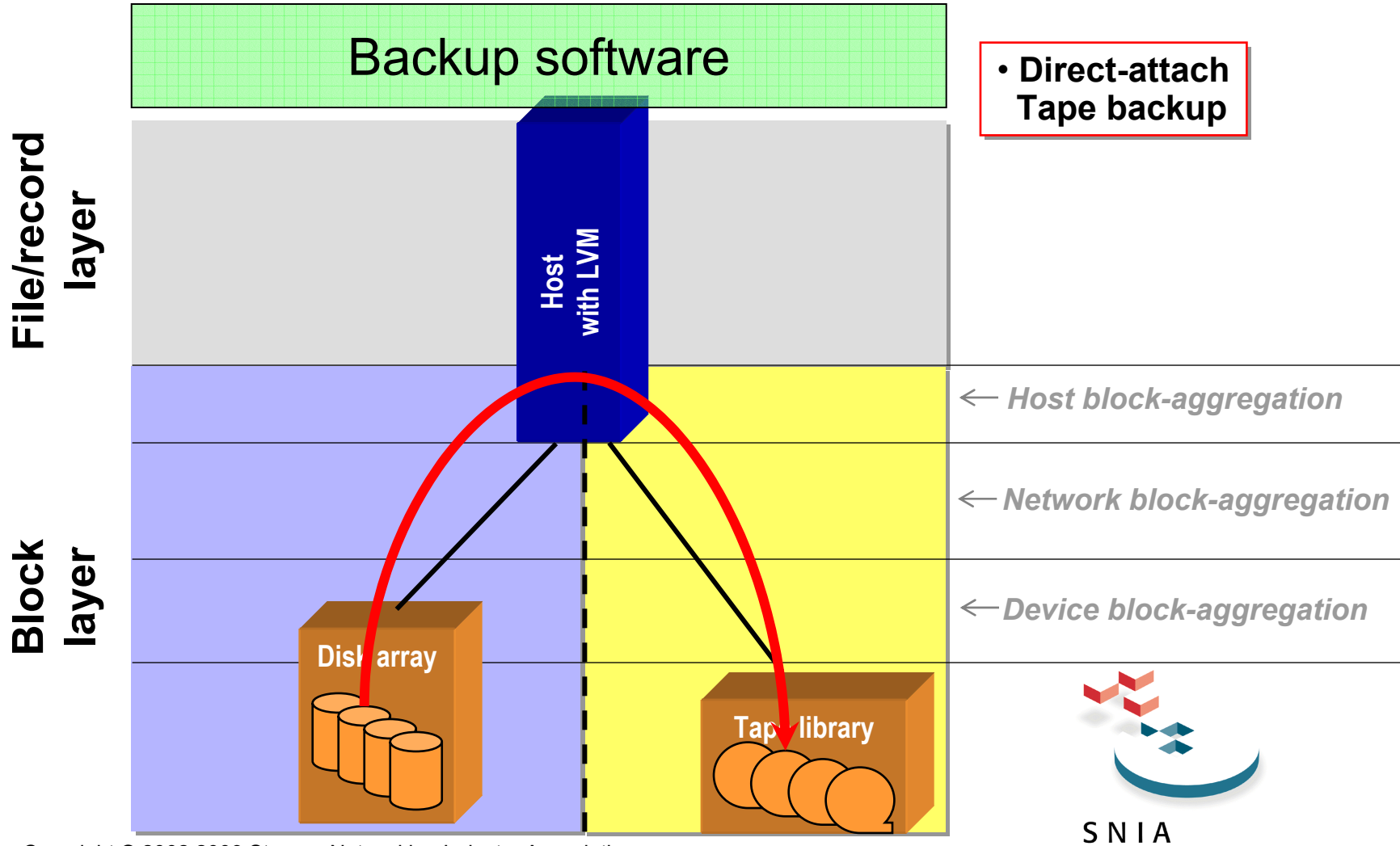
# Backup architecture: Direct-attach tape







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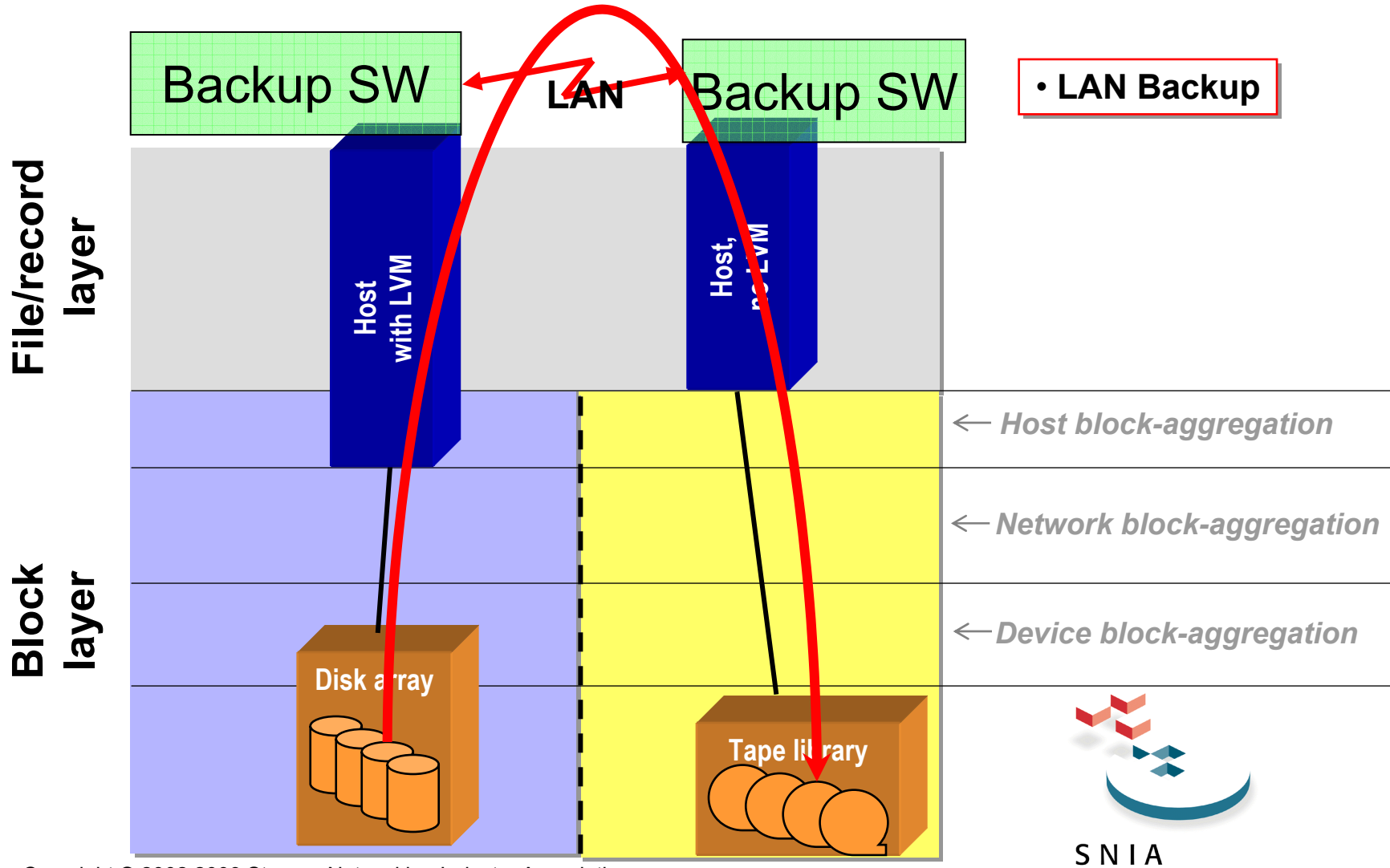
# Backup architecture: LAN-attach tape







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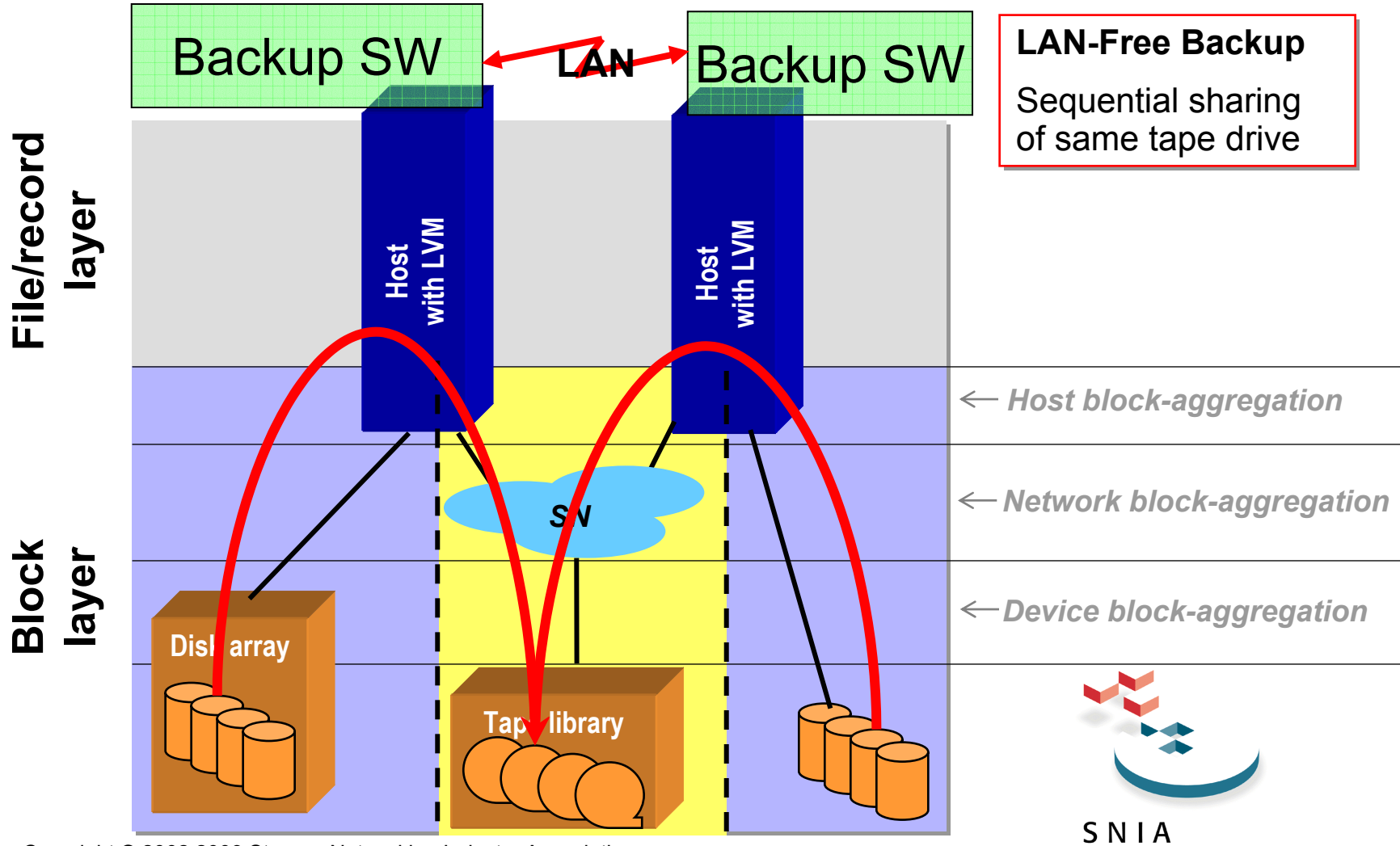
# Backup architecture: Shared tape drive







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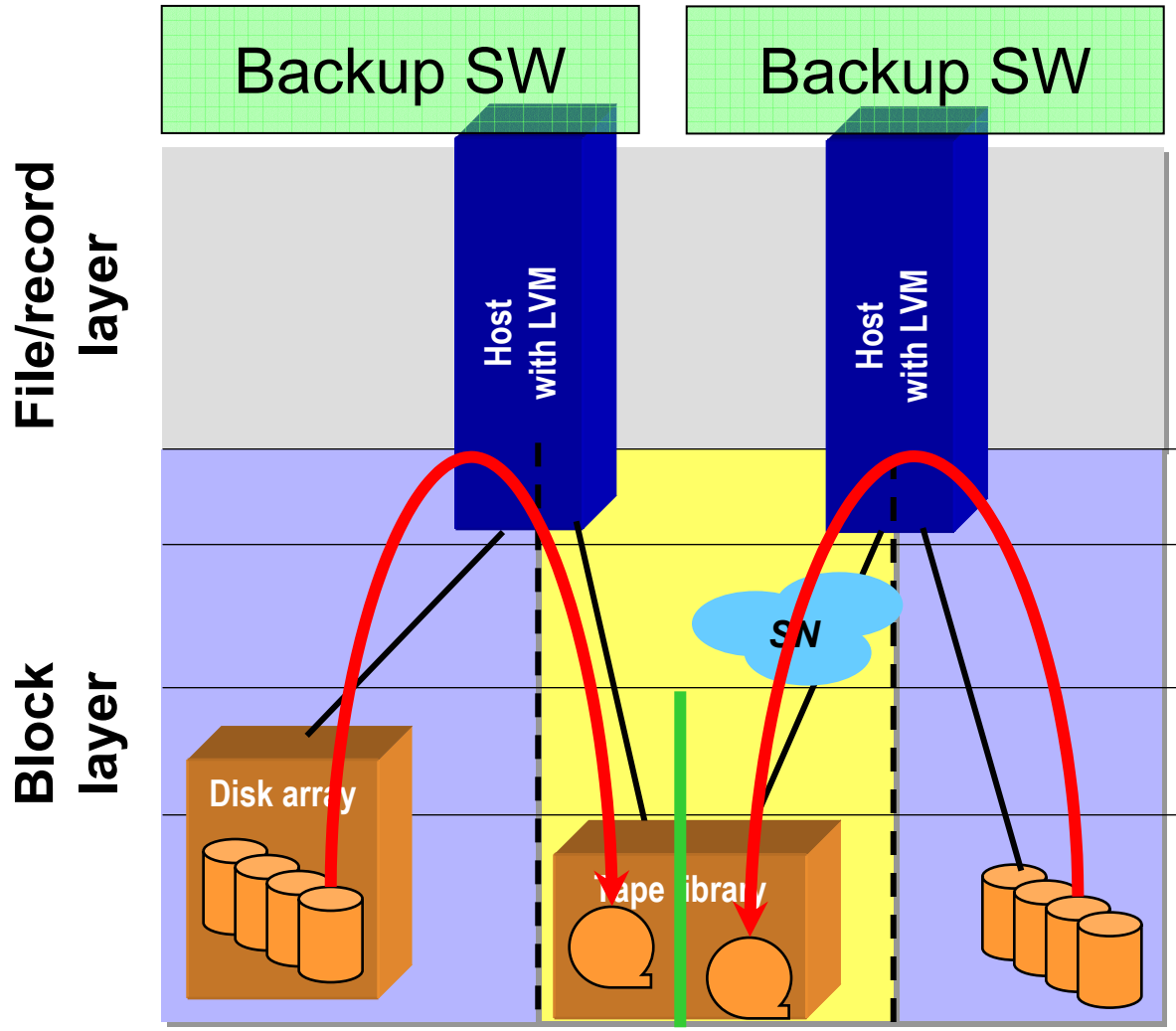
# Backup architecture: Partitioned tape library




- **Multiple backups at the same time**

  Robot, drive, and tape usage must be coordinated among backups

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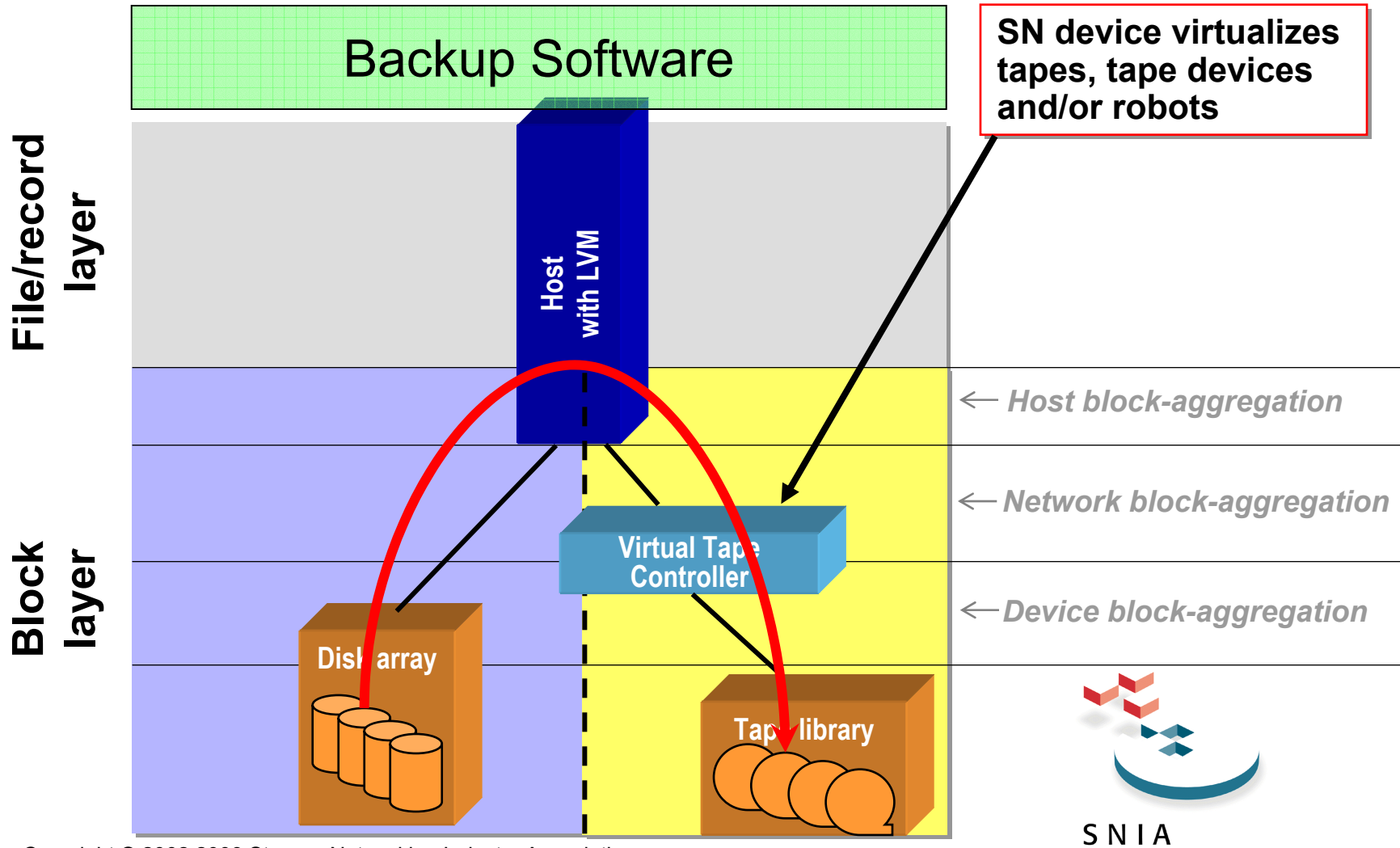
# Backup architecture: Virtual Tape Controller







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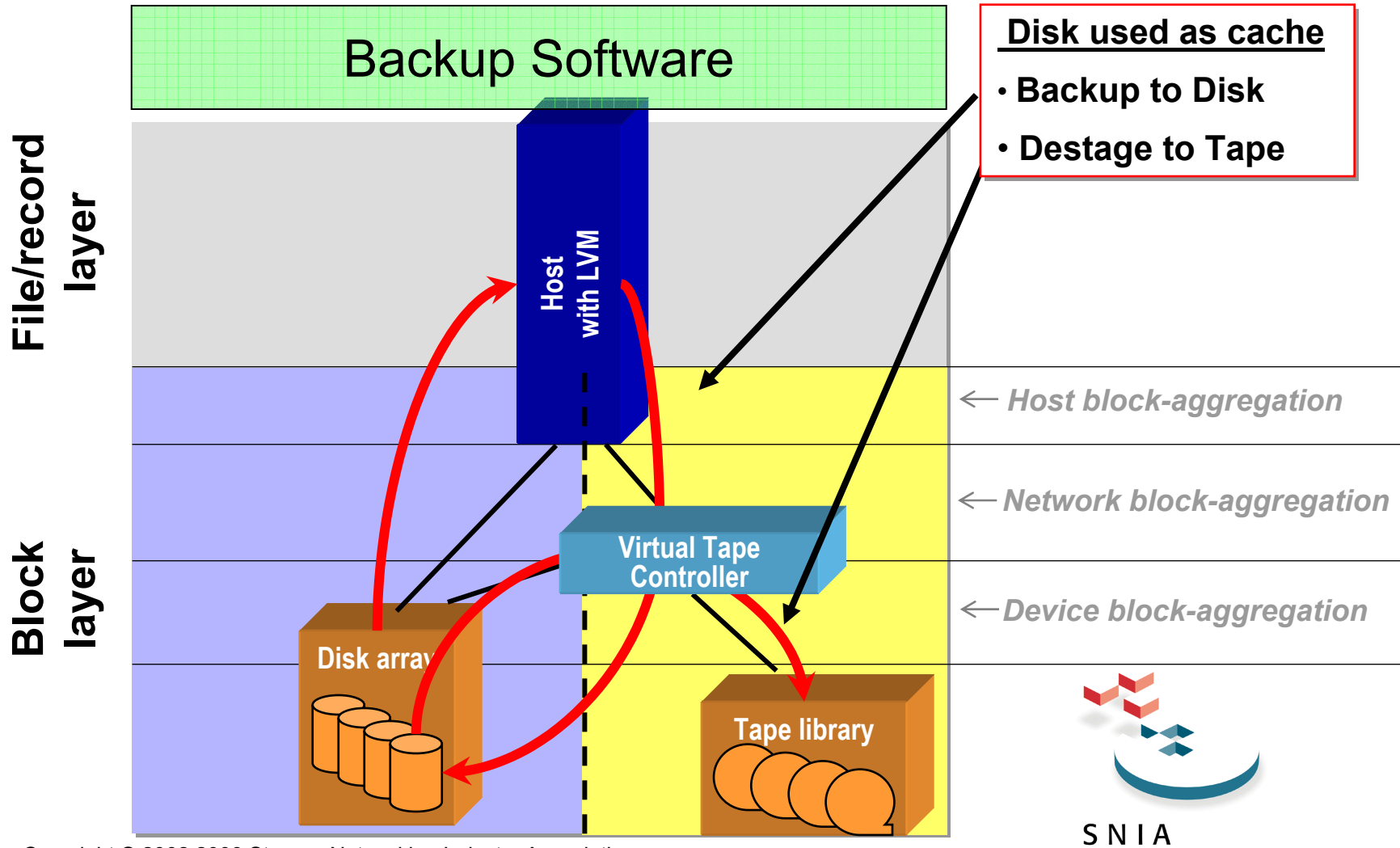
# Backup architecture: Virtual Tape Controller + Disk cache







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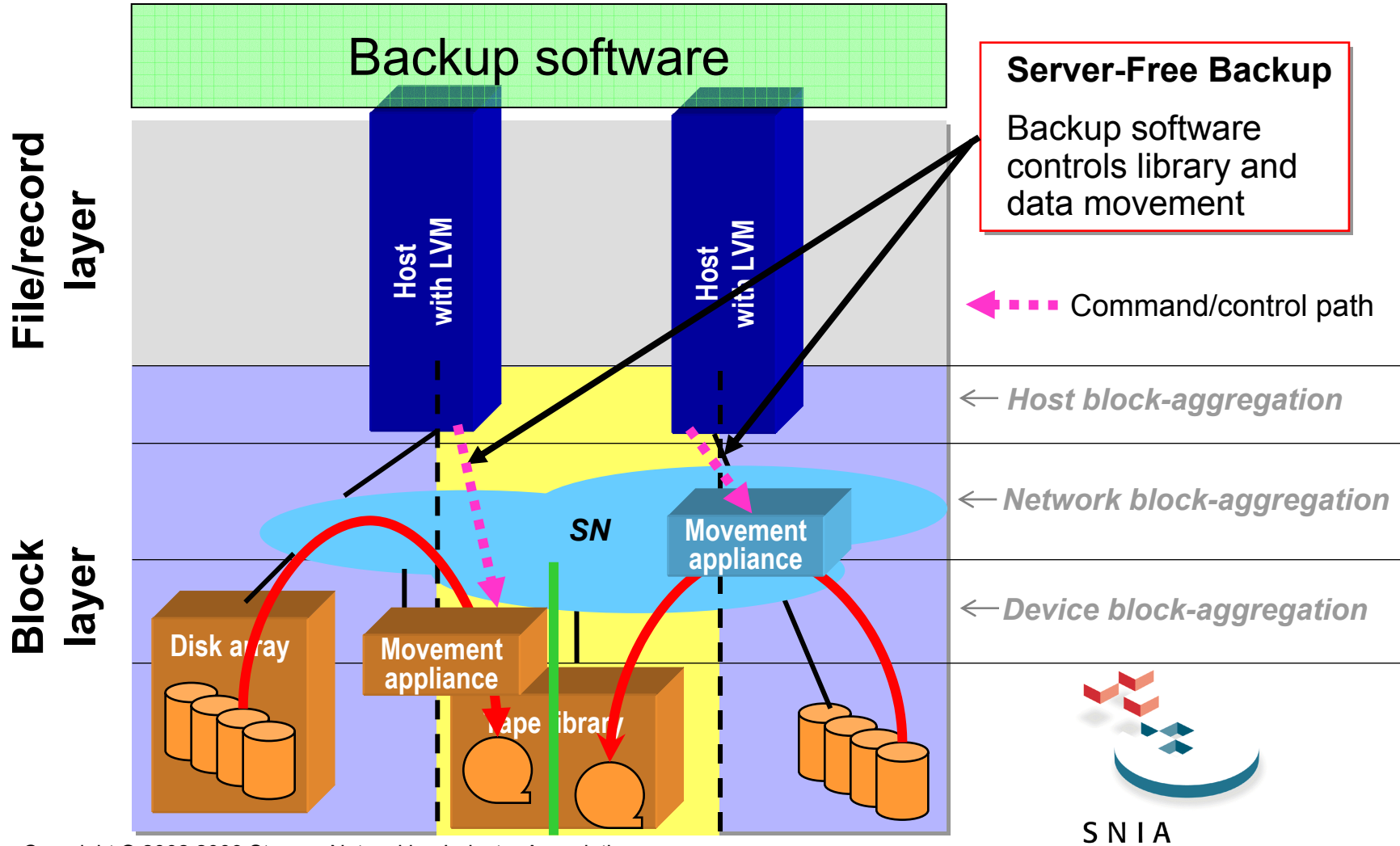
# Backup architecture: Data movers for tape







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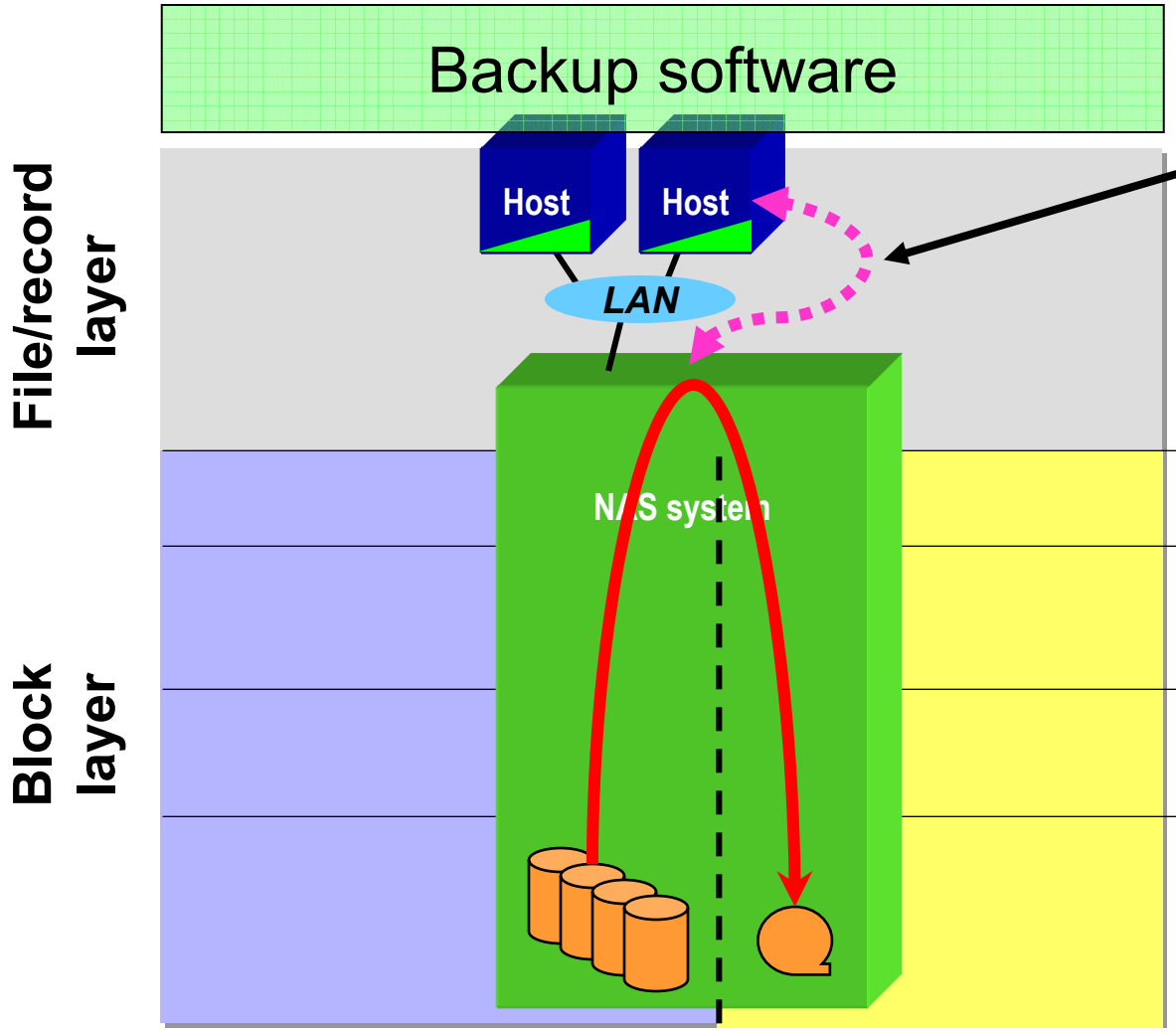
# Backup architecture: File-server with tape drive




**NDMP Local Backup**

Backup software uses NDMP to control data movement and tape

Could use NAS head instead of NAS system

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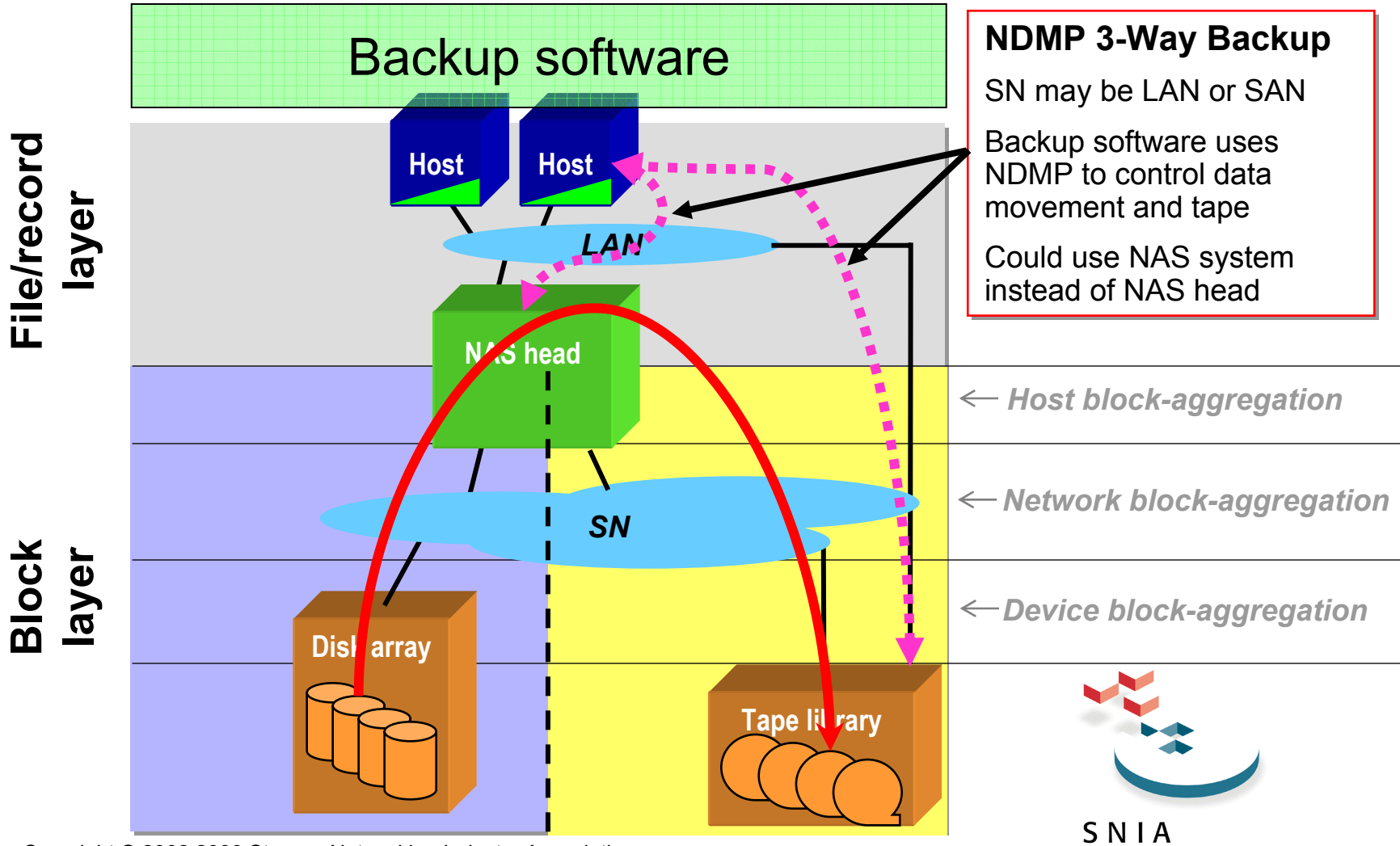
# Backup architecture: File-server with external tape







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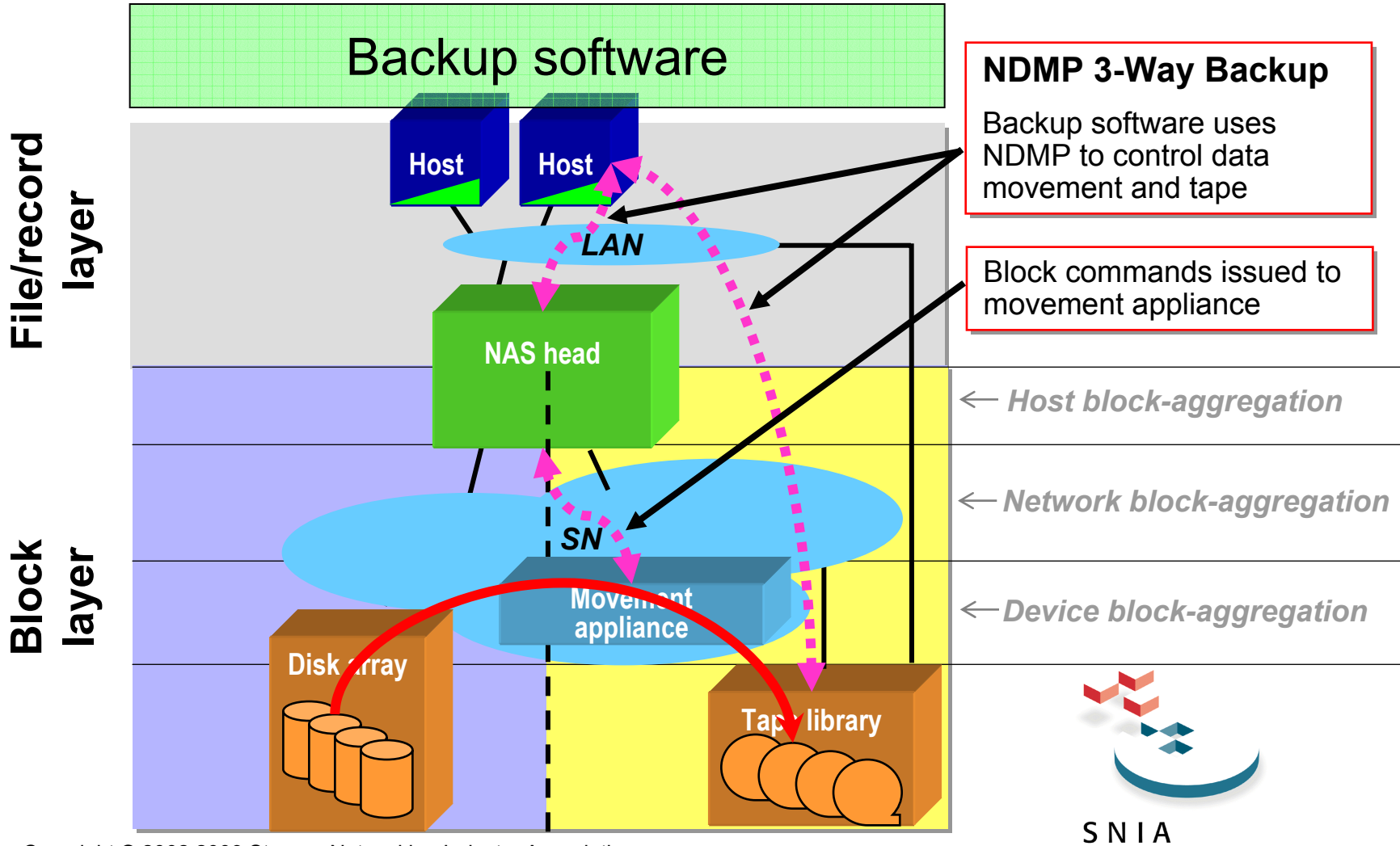
# Backup architecture: File-server with data mover







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# Conclusions

- Tape functionality addition to SNIA SSM
  - Parallel functionality to existing disk-based model
  - Backup is the motivating usage
- Open systems backup techniques
  - What can be done
  - E.g., Files (tar), filesystem (dump), device (dd)
- Open systems backup architectures
  - Where it can be done
  - Examples include LAN-free and Server-free backups
  - Also NDMP backups of fileservers

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