# Obligatory rubric

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# SNIA shared-storage model

## A work in progress …



## An architectural overview
### April 2001

# Contents

- **SNIA Introduction**

- **The SNIA storage model**
    - **Purpose and benefits**
    - **Layers, functions, and services**

- **Applying the SNIA storage model**
    - **Common storage architectures**

- **Conclusions**

# SNIA Overview

- **Open forum**
  - **Work Groups open to all members**
  - **Public intellectual property policy**

- **Volunteer organization**
  - **Agenda determined by industry and member interests and participation**
  - **200+ members and growing**

- **Technical and market development efforts**
  - **Technical efforts: primarily a "feeder" organization to accredited standards organizations**

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# Standards Development Examples

- **Fibre Channel HBA-API**

- **MIBs and CIM extensions for storage**
  - **CIM Schemas for Disk Arrays, Media Libraries, NAS, and Fibre Channel Interconnect Components**

- **SCSI-3 Extended Copy command**
  - **Has been picked up by T10**

- **NDMP version 4**
  - **Work in progress**

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# Interoperability Efforts

- **Sponsored Interoperability Demonstrations**
    - **HBA-API, Third party copy, FC Switches, etc.**
    - **Multiple venues, Multiple vendors**

- **CIFS initiative**
    - **Conference and interoperability demonstrations**

- **SNIA Technology Center**
    - **Permanent lab and test facilities, fixtures**

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# Contents

- **SNIA Introduction**

- **The SNIA storage model**
  - **Purpose and Benefits**
  - **Layers, functions, and services**

- **Applying the SNIA storage model**
  - **Common storage architectures**

- **Conclusions**

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# Shared Storage Model: Purpose

- **Present a simple model for shared storage architectures**

- **Use it to describe common examples graphically**

- **Expose, for each one:**
  - **What services are provided, where**
  - **Where interoperability is required**
  - **[future] Pros and cons of the architecture**

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# Shared Storage Model: Benefits

- **A common "architecture vocabulary"**

- **Reference comparisons between common solutions**

- **Help to align the industry**
  - **Customers can better structure their choices**
  - **Vendors can better explain their differences**

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# What the model is, and what it is not
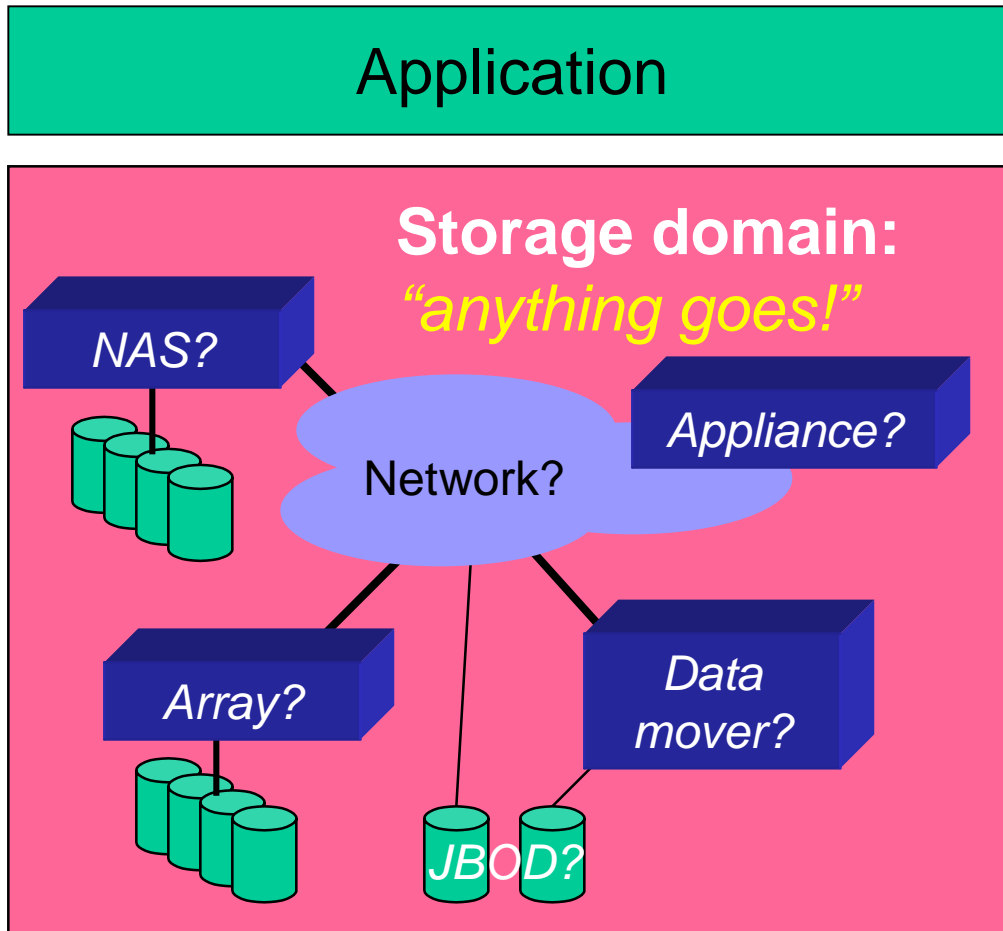
**It is:**

- A *framework* that captures the functional layers and properties of a storage system

**It is not:**

- A *specification*, an *architecture*, a *design*, a *product*, a *recommendation*, or an *installation*

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# Classic storage model



Application

**Storage domain:**
*"anything goes!"*

NAS?

Network?

Appliance?

Array?

Data mover?

JBOD?

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# The SNIA shared storage model

**Application**

**Storage domain**

**File/record subsystem**

**Database (dbms)**

**File system (FS)**

**Host-based block-aggregation**

**Block aggregation**

**SN-based block-aggregation**

**Device-based block-aggregation**

**Storage devices (disks, …)**

**Block subsystem**

**Services subsystem**

- Discovery, monitoring
- Resource mgmt, configuration
- Security, billing
- Redundancy mgmt (backup, …)
- High availability (fail-over, …)
- Capacity planning

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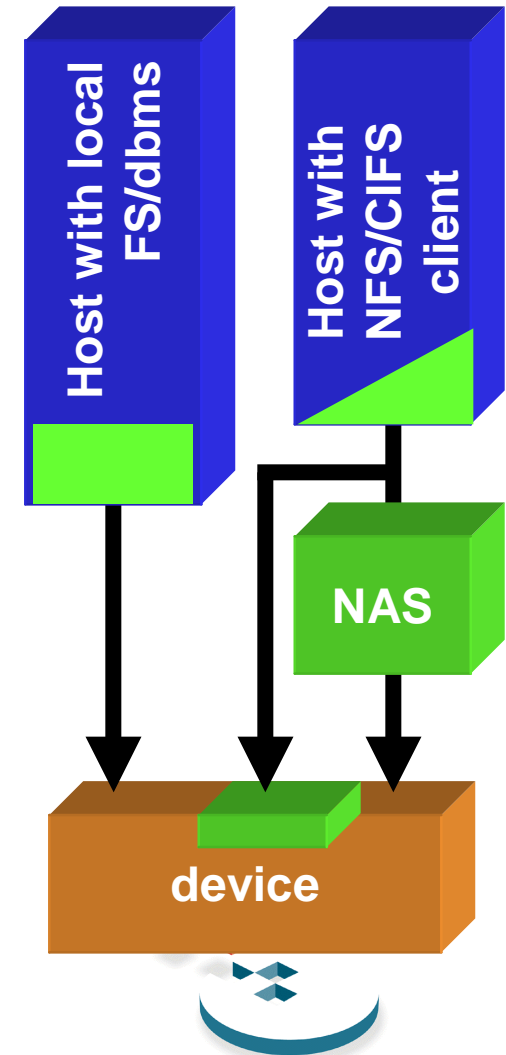# File/record subsystem
## What can be done

- **Database management systems**
  - **tuples → tables**
  - **tables → table-spaces**
  - **table-spaces → volume**

- **File systems**
  - **files → volume**

- **New types**
  - **http caches: a kind of distributed file system?**

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# File/record subsystem
## Where it can be done

- **Host-side**
  - **file systems and databases**
  - **NFS, CIFS, etc. are client-server splits inside the file system**

- **SN-based**
  - **NAS head**

- **Device-based**
  - **NAS functions in array box**

Host with local FS/dbms

Host with NFS/CIFS client

NAS

device

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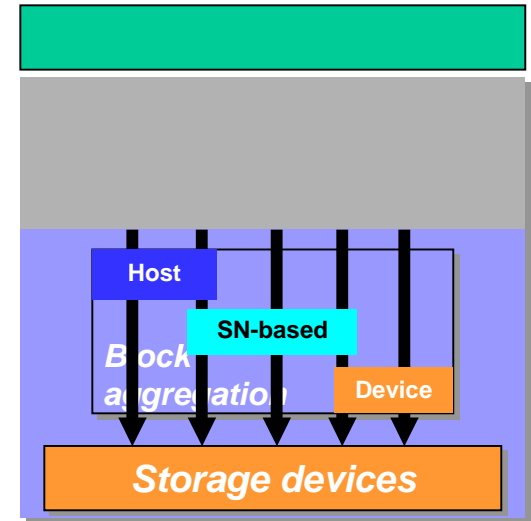
# Block subsystem
## What can be done

- **Space management**
  - **making a large store from many small ones**
  - **packing many small stores into one large one**

- **Striping**
  - **for performance (load balancing, throughput)**

- **Redundancy**
  - **full          (local & remote mirroring, RAID-1, -10, …)**
  - **partial      (RAID-3, -4, -5, …)**
  - **point-in-time copy**

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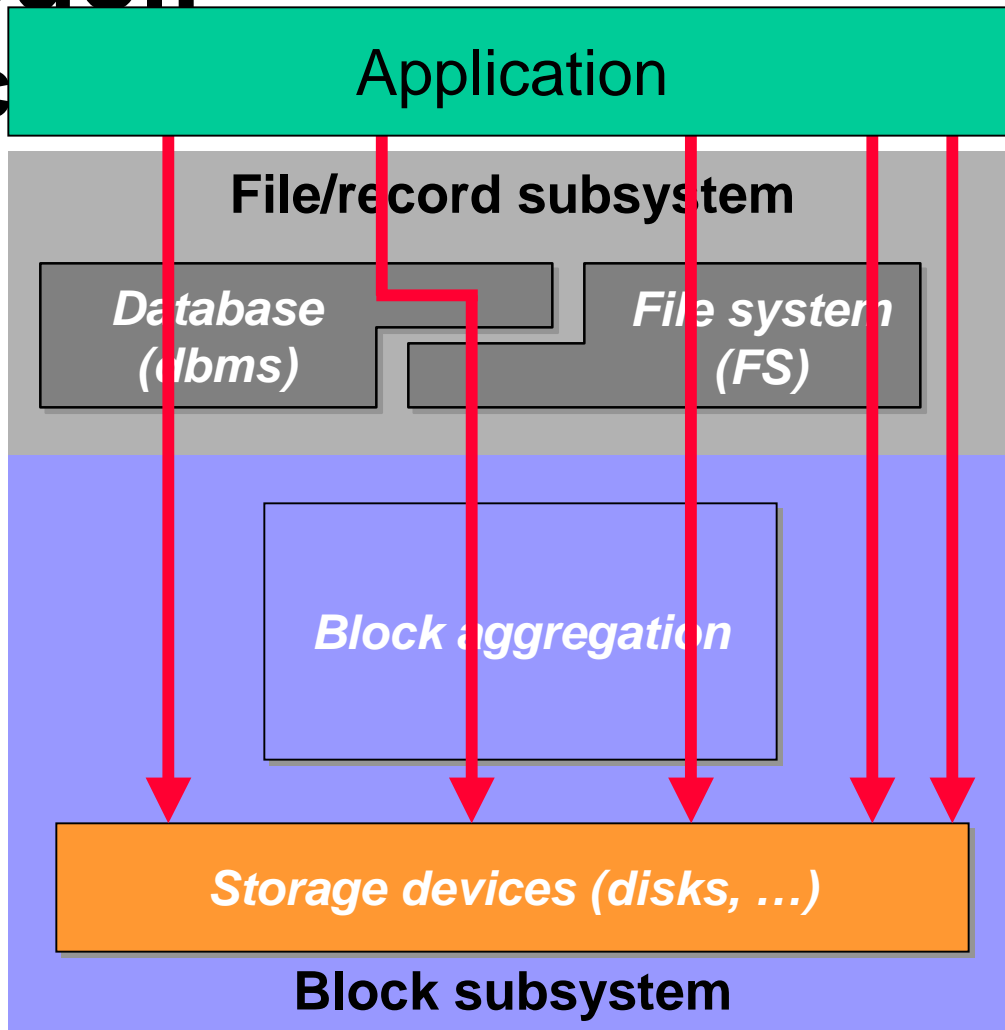
# Block subsystem
## Where it can be done

- **Host-side**
  - logical volume managers
  - device drivers, HBAs

- **SN-based**
  - HBAs, specialized SN appliances

- **Device-based**
  - array controllers (e.g., RAID)
  - disk controllers (e.g., sparing)



Host

SN-based

Block aggregation

Device

Storage devices

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# The SNIA shared storage model:
## Acc

**Application**

**File/record subsystem**

**Database (dbms)**

**File system (FS)**

**Block aggregation**

**Storage devices (disks, ...)**

**Block subsystem**

*Note: all 8 possible paths can be used!*

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# The SNIA shared storage model
## Ser...

**Application**

**File/record subsystem**

**Database (dbms)**

**File system (fs)**

**Block aggregation**

**Storage devices (disks, …)**

**Block subsystem**

**Services subsystem**

Discovery, monitoring

Resource mgmt, configuration

Security, billing

Redundancy mgmt (backup, …)

High availability (fail-over, …)

Capacity planning

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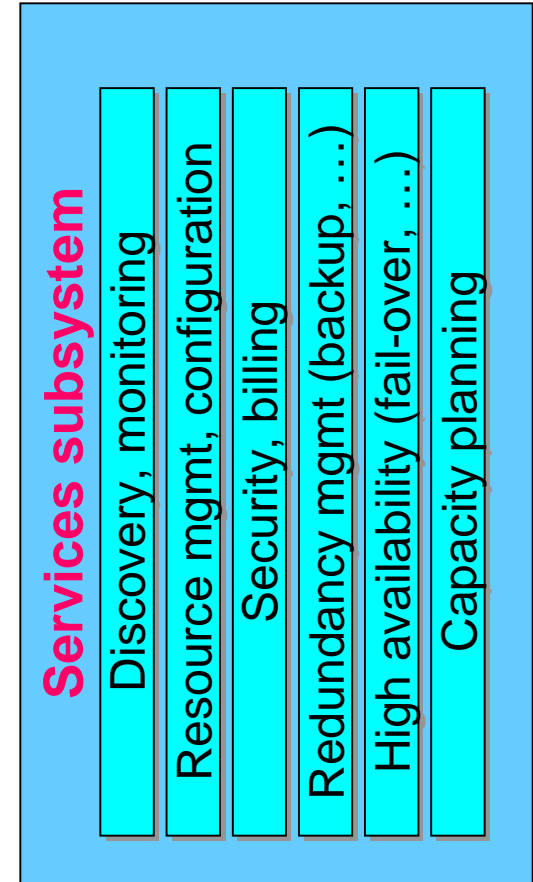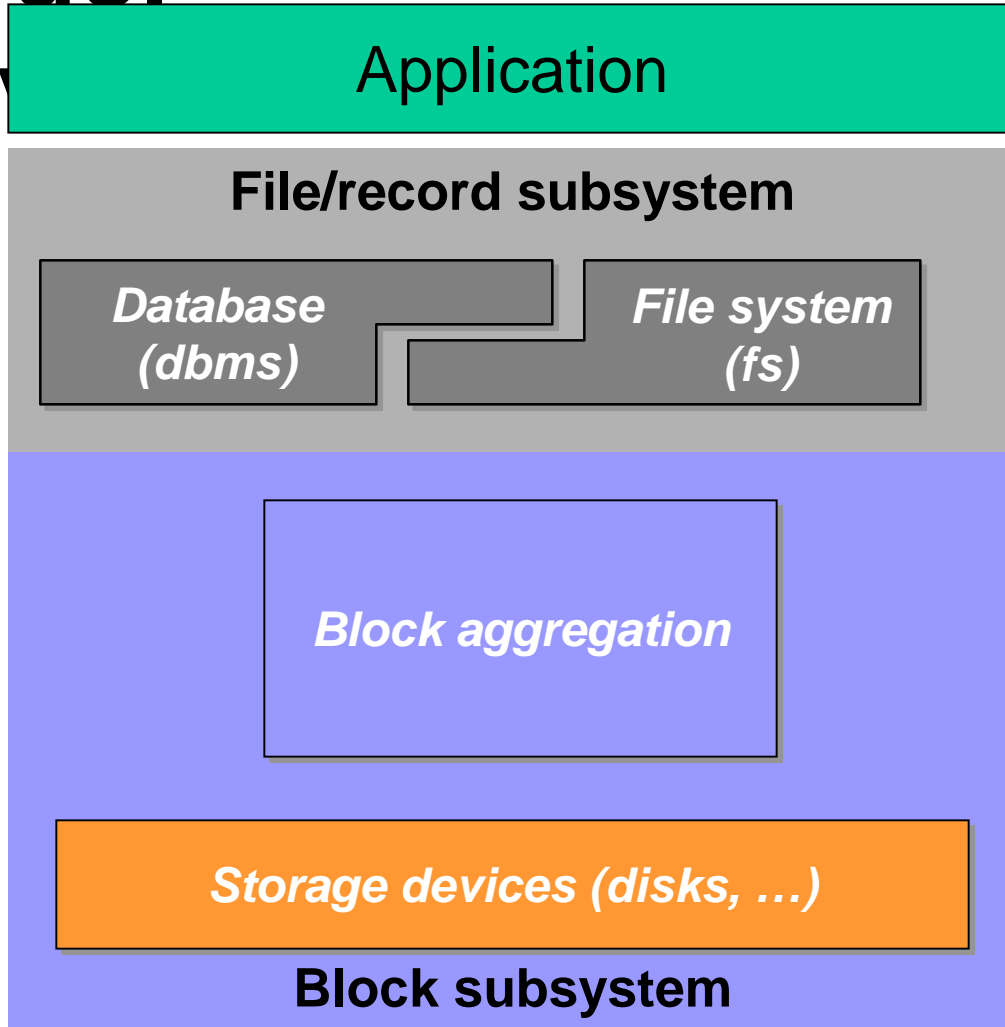
# Caching

## … can be added to almost any layer



Application

File/record subsystem

Host. with LVM and software RAID

Host. with LVM

Host

Host

*Cache*

LAN

NAS head

NAS head

*Cache*

*Cache*

Block subsystem

*Cache*

SN

*Cache appliance*

Disk array

*Cache*

*Cache*
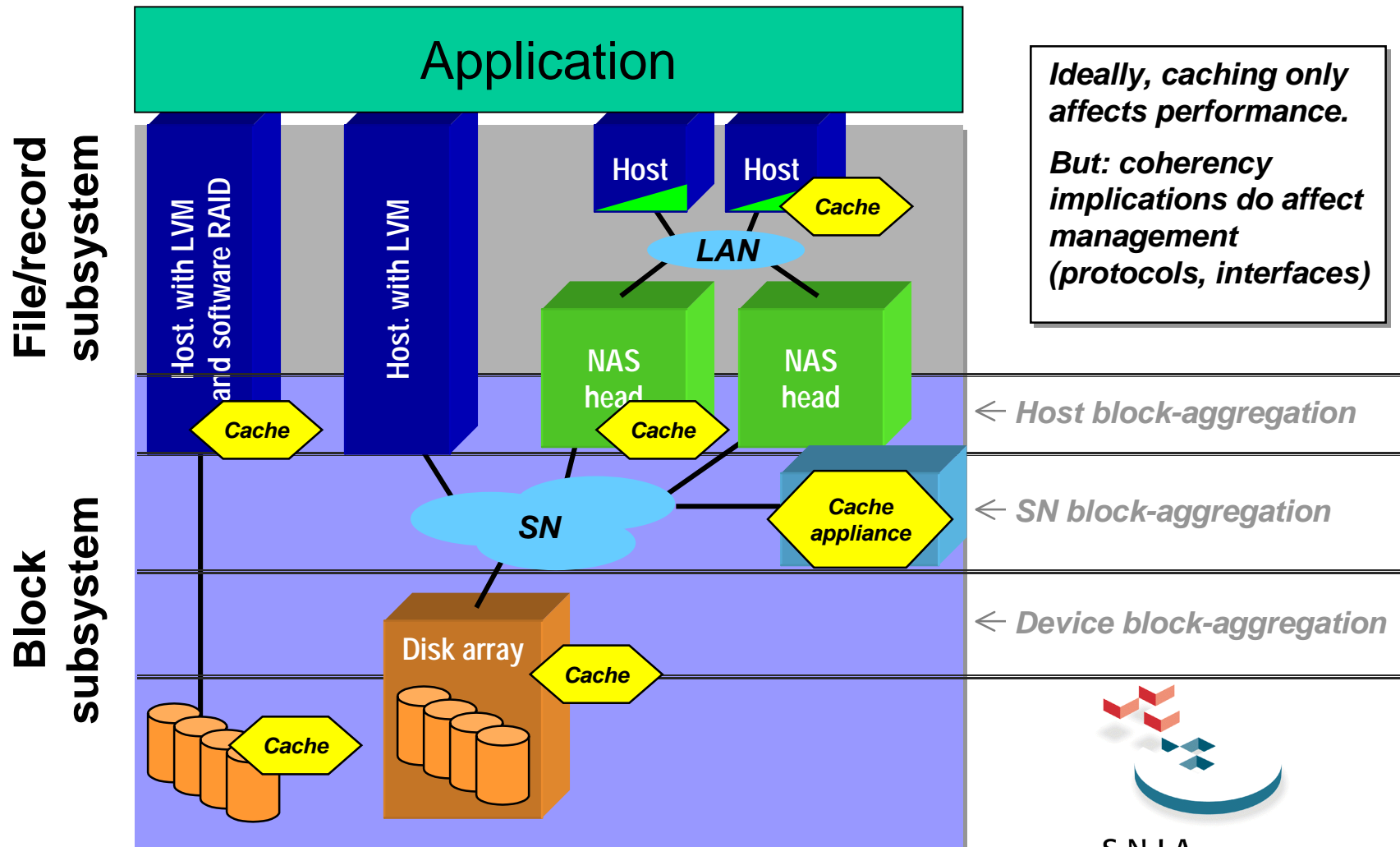
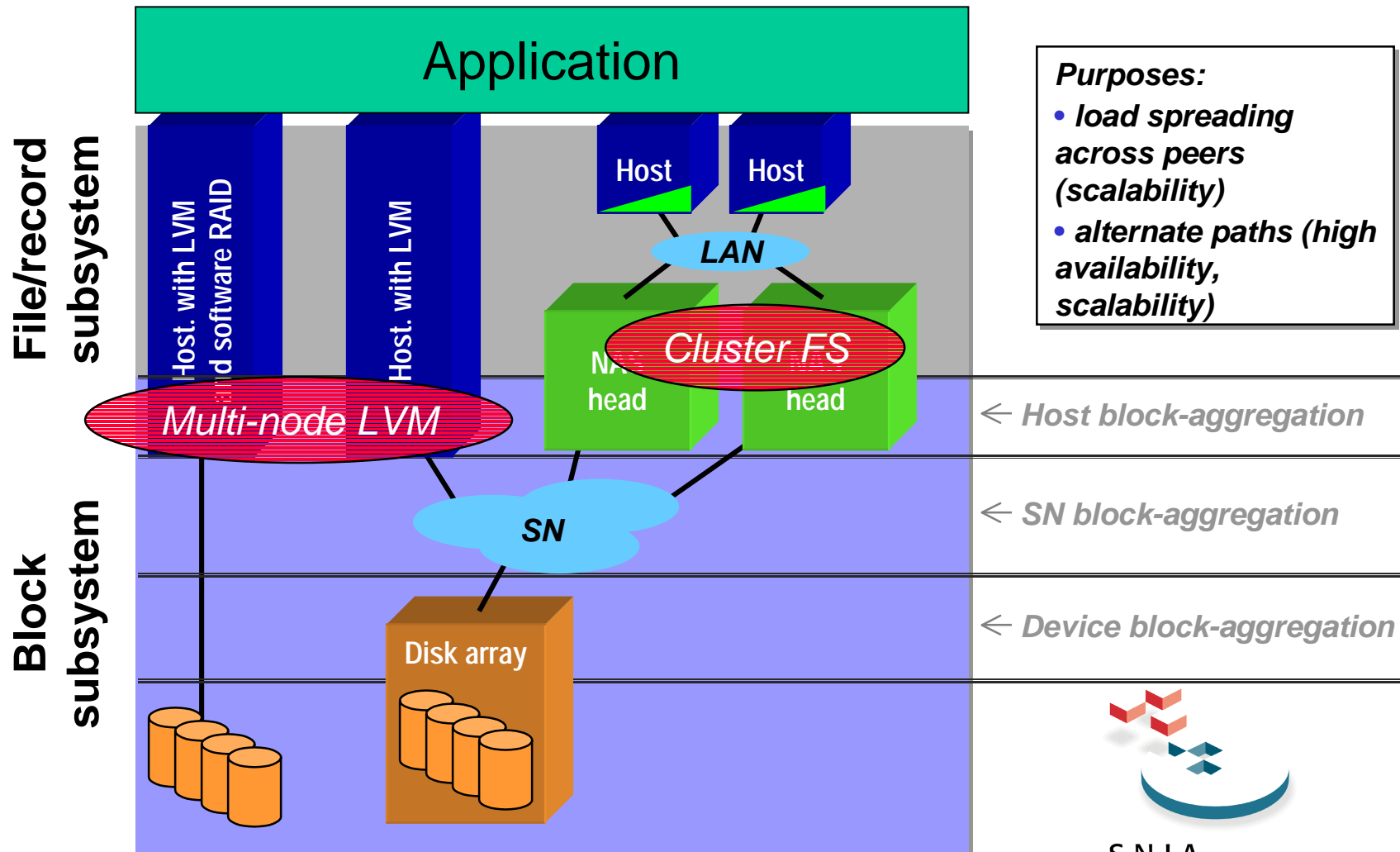*Ideally, caching only affects performance.*

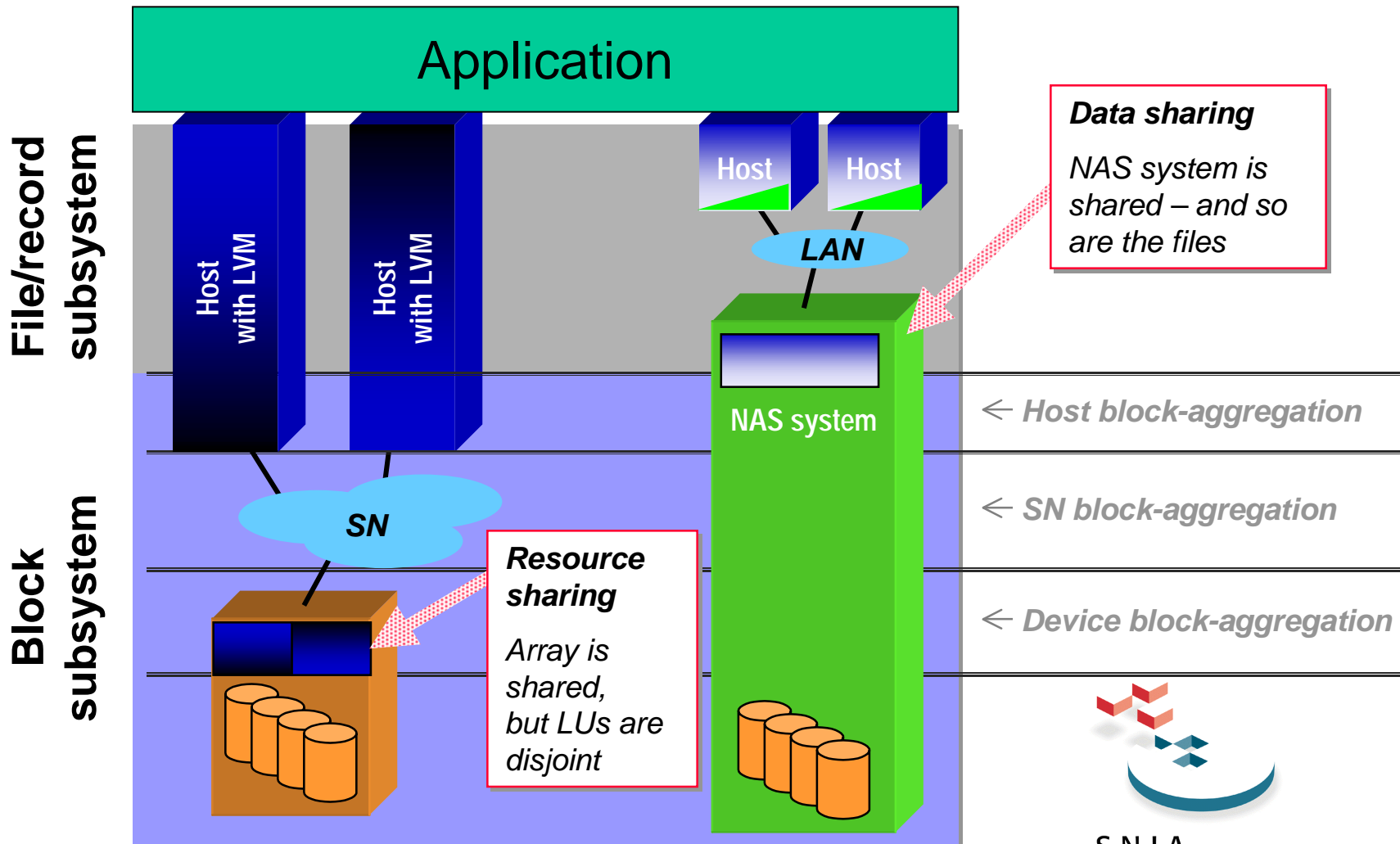*But: coherency implications do affect management (protocols, interfaces)*

← *Host block-aggregation*

← *SN block-aggregation*

← *Device block-aggregation*

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# Clustering
## Intra-box aggregation



Application

File/record subsystem

Host. with LVM and software RAID

Host. with LVM

Host

Host

LAN

Cluster FS

NAS head

NAS head

Multi-node LVM

← Host block-aggregation

SN

← SN block-aggregation

Block subsystem

Disk array

← Device block-aggregation

**Purposes:**
- **load spreading across peers (scalability)**
- **alternate paths (high availability, scalability)**

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# Sharing
## Content sharing <u>and</u> resource sharing

**Application**

**File/record subsystem**

Host with LVM

Host with LVM

Host

Host

**LAN**

**Data sharing**

NAS system is shared – and so are the files

← *Host block-aggregation*

**NAS system**

**SN**

**Block subsystem**

**Resource sharing**

Array is shared, but LUs are disjoint

← *SN block-aggregation*

← *Device block-aggregation*

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# Q: "SAN" versus "NAS"?
# A: a poorly-formed question

- **Q: <u>hardware</u>: FibreChannel vs Ethernet vs InfiniBand?**

- **Q: <u>API</u>: blocks vs files (aka "NAS") vs objects (OSD)?**

- **Q: <u>protocol</u>: FCP vs TCP/IP vs … ?**

- **A: (to all the above) *it depends* …**

- **Storage network *(<u>SN</u>)*:**
  - **any (mostly) dedicated network, installed (mostly) for storage traffic**
  - ***<u>whatever</u>* the hardware, API, or protocol**

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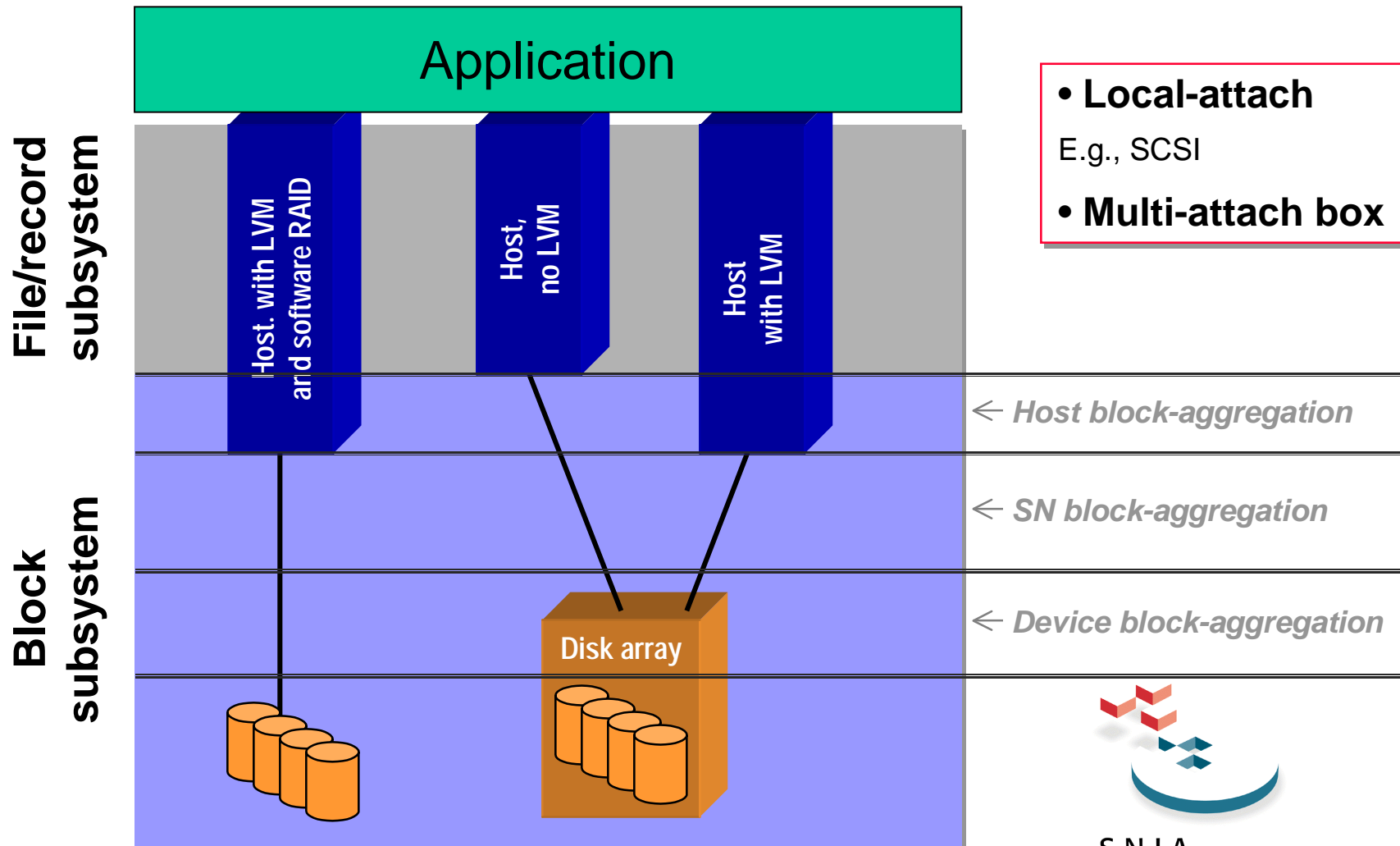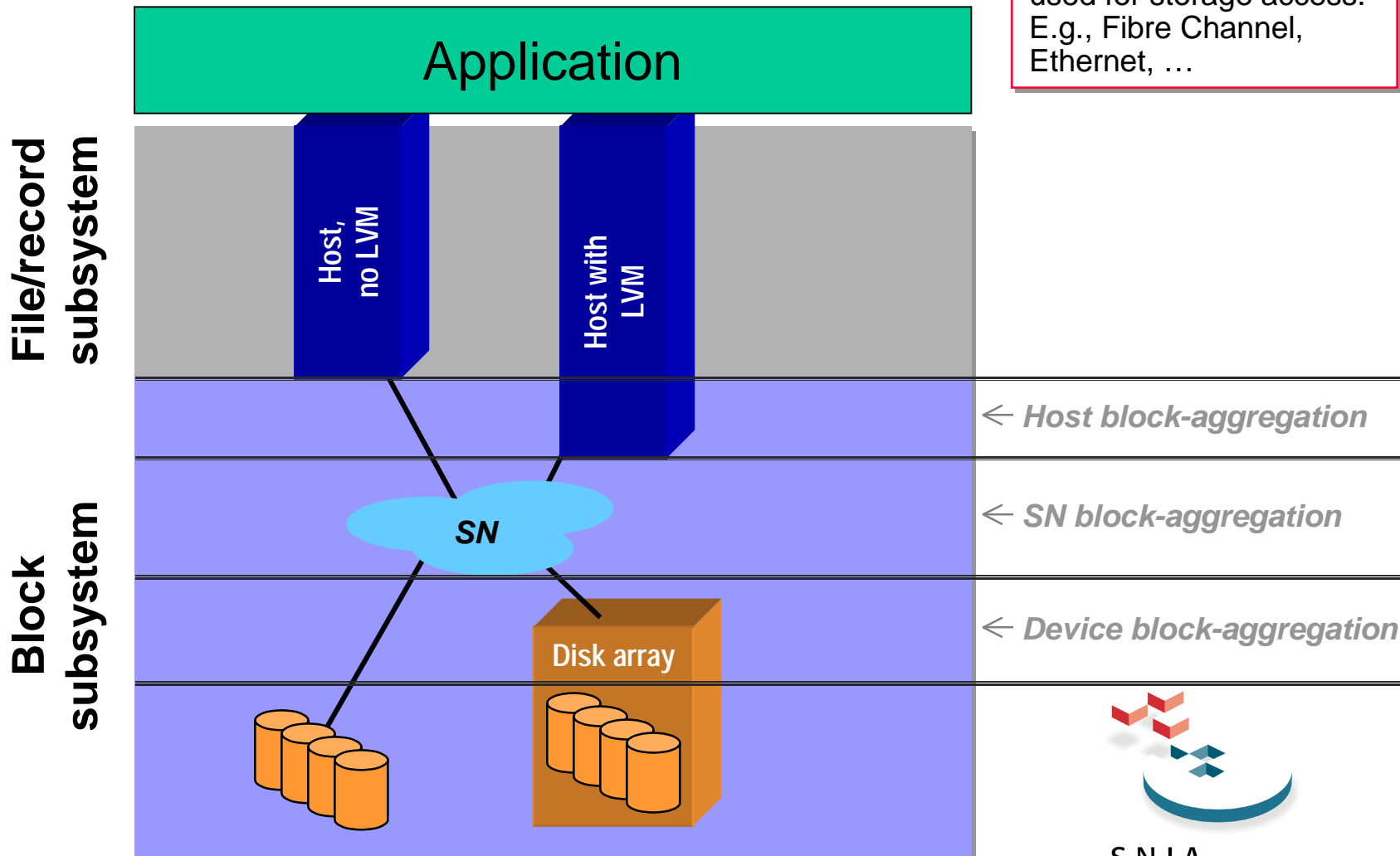Storage Networking Industry Association

# Some common storage architectures

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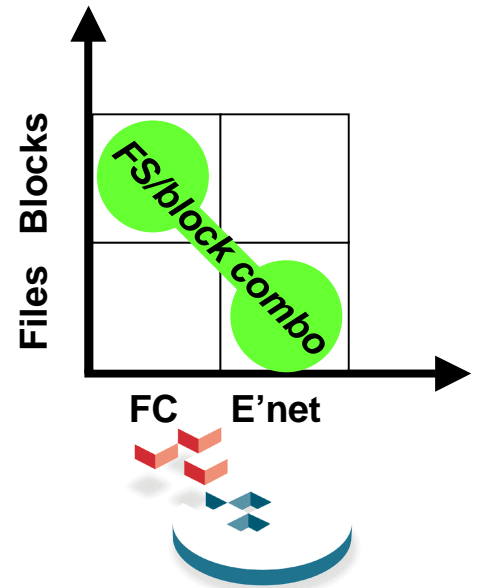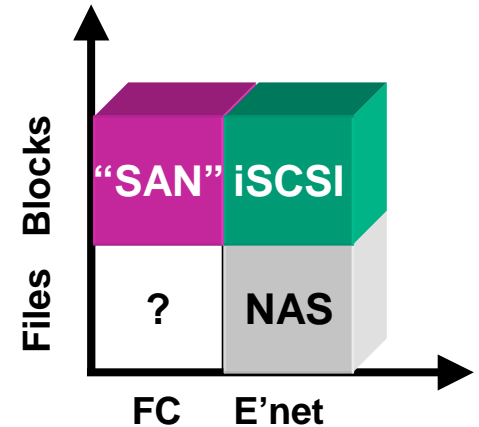
**Mapping the SNIA model onto some current implementations**

# Direct-attached block storage

Application

**File/record subsystem**

Host. with LVM and software RAID

Host, no LVM

Host with LVM

- **Local-attach**

  E.g., SCSI

- **Multi-attach box**

← *Host block-aggregation*

← *SN block-aggregation*

**Block subsystem**

← *Device block-aggregation*

Disk array

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# SN-attached block storage



"SN" = any network used for storage access. E.g., Fibre Channel, Ethernet, …

**Application**

**File/record subsystem**

Host, no LVM

Host with LVM

← *Host block-aggregation*

**SN**

← *SN block-aggregation*

**Block subsystem**

Disk array

← *Device block-aggregation*

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# SN-attached block storage with metadata server



**Application**

**File/record subsystem**

**Block subsystem**

Host, no LVM

Host with LVM

*SN*

**Block-aggregation metadata server**

**Disk array**

**Aggregation map (metadata) is supplied by an external server**

← *Host block-aggregation*

← *SN block-aggregation*

← *Device block-aggregation*

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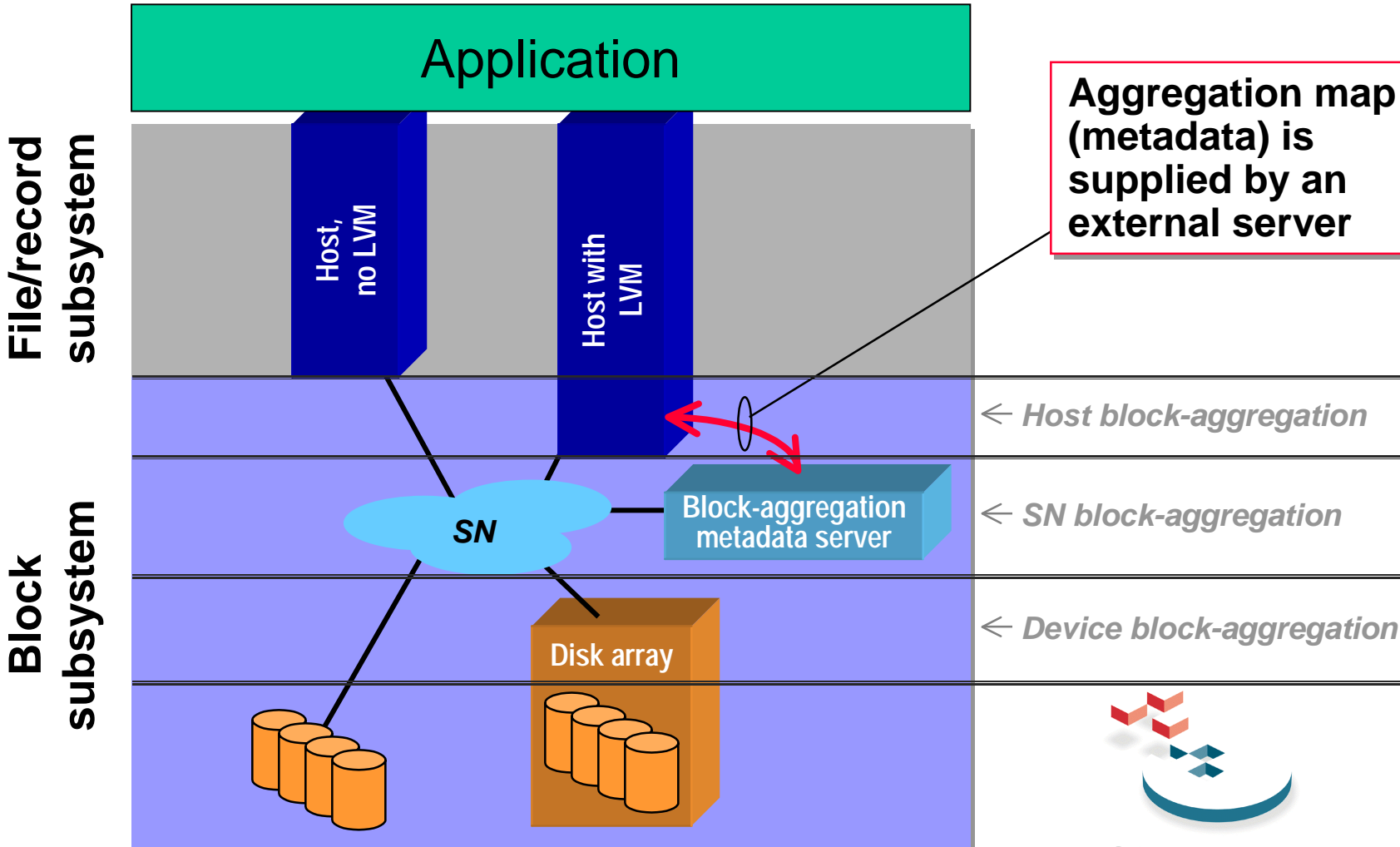
# Block storage aggregation in a SN appliance



Application

File/record subsystem

Host with LVM

Host, no LVM

aka "SN virtualization"

Functions: LVM, caching

← *Host block-aggregation*

SN

Aggregation appliance

← *SN block-aggregation*

Block subsystem

← *Device block-aggregation*

Disk array

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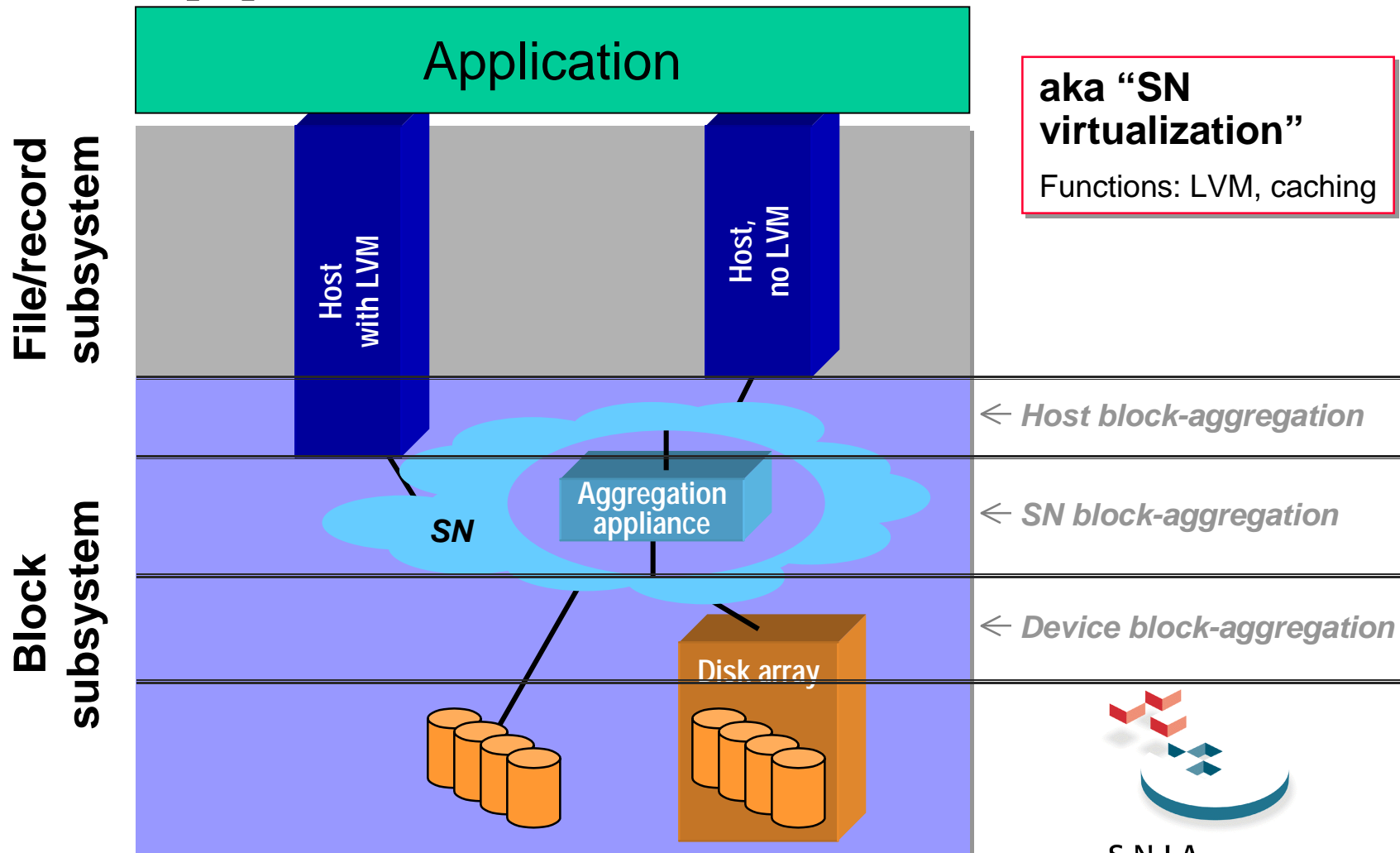
# Multi-site block storage

Functions: point-in-time copy, caching, local & remote mirroring, …

**Application**

**Application**

Host. with LVM

Host. with LVM

**WAN**

**WAN**

*SN*

Aggregation appliance

Aggregation appliance

**WAN**

Disk array

Disk array
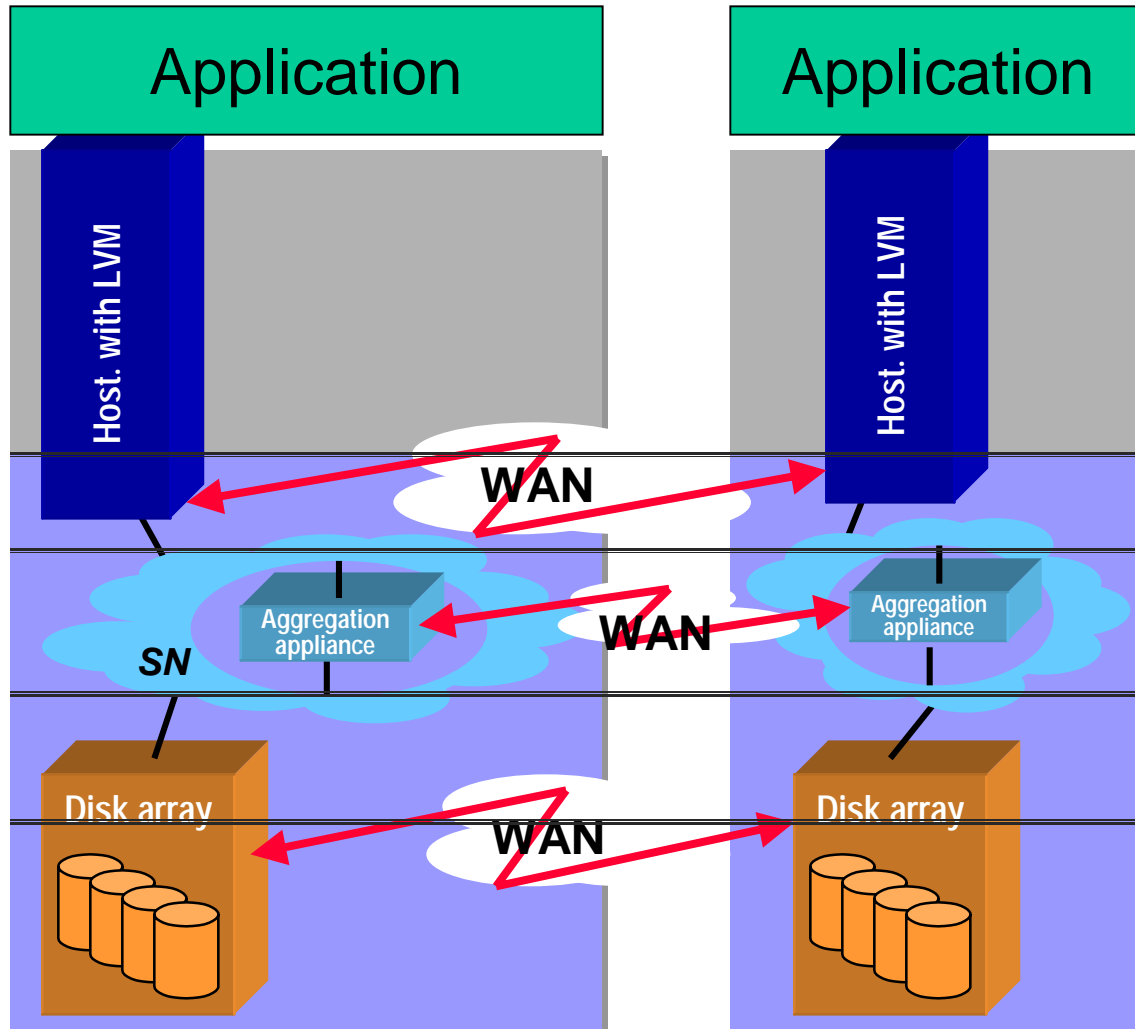
**Host-to-host**

**SN appliance**

**Device-to-device**

← *Host block-aggregation*

← *SN block-aggregation*

← *Device block-aggregation*

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# File server



LAN-attached "NAS" system

May have SN, block aggregation, etc, hidden inside the NAS system box

Application

Host    Host

LAN

File/record subsystem

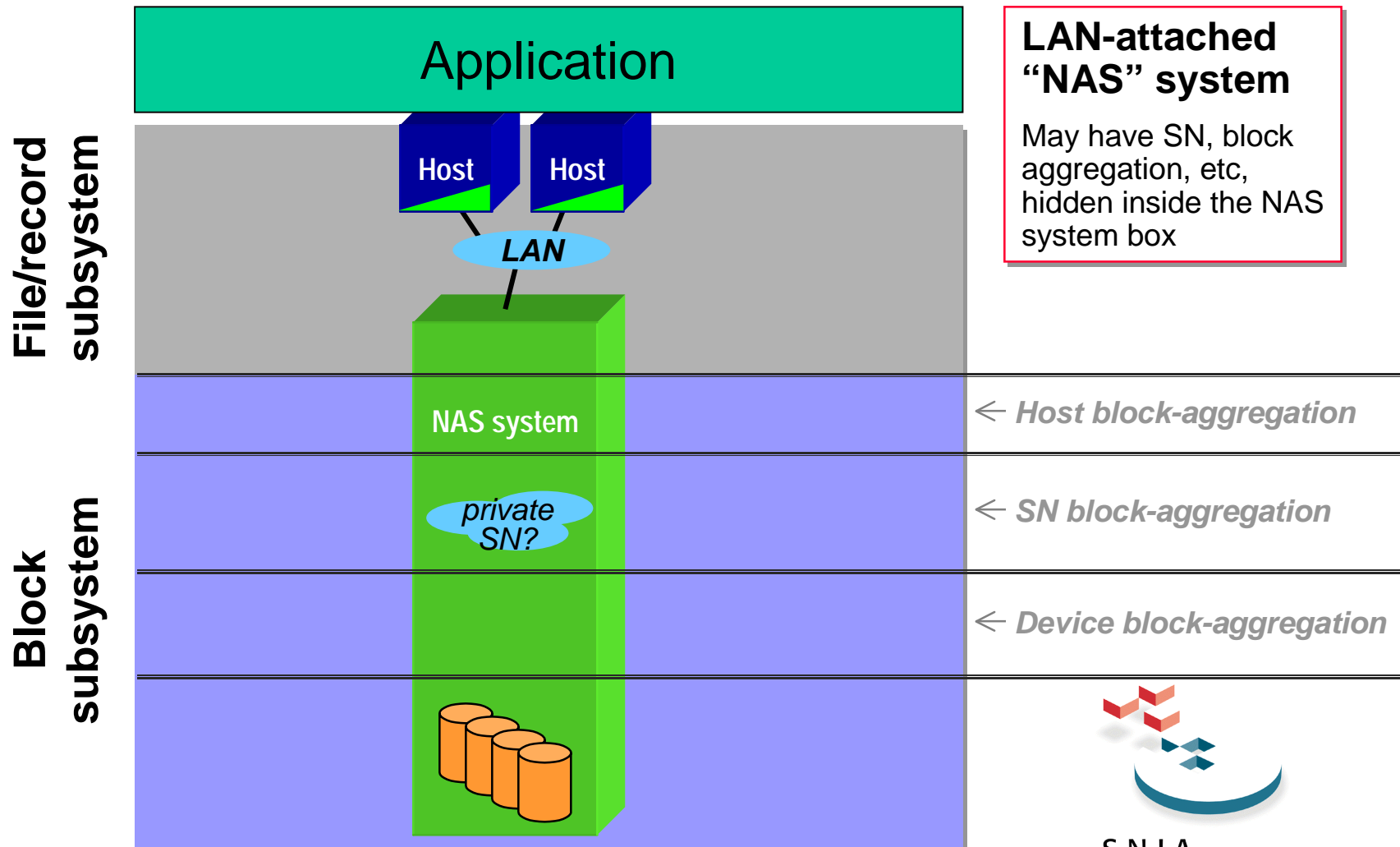NAS system

← *Host block-aggregation*

Block subsystem

*private SN?*

← *SN block-aggregation*

← *Device block-aggregation*

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# File server controller ("NAS head")



Application

No storage in the file server controller box

Host

Host

LAN

NAS head

SN

Disk array

File/record subsystem

Block subsystem

← *Host block-aggregation*

← *SN block-aggregation*

← *Device block-aggregation*

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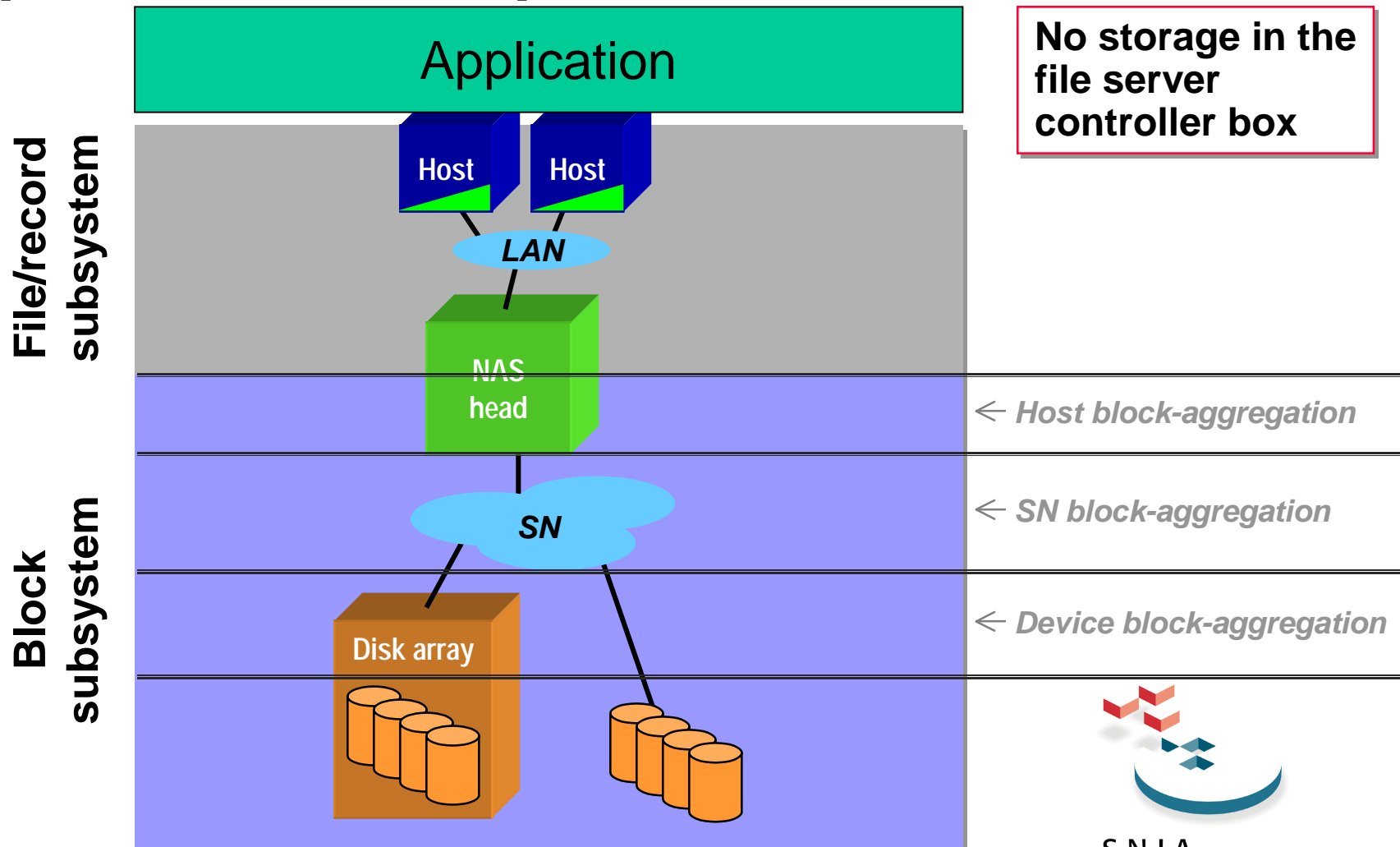Storage Networking Industry Association

# NAS/file server metadata manager ("asymmetric")
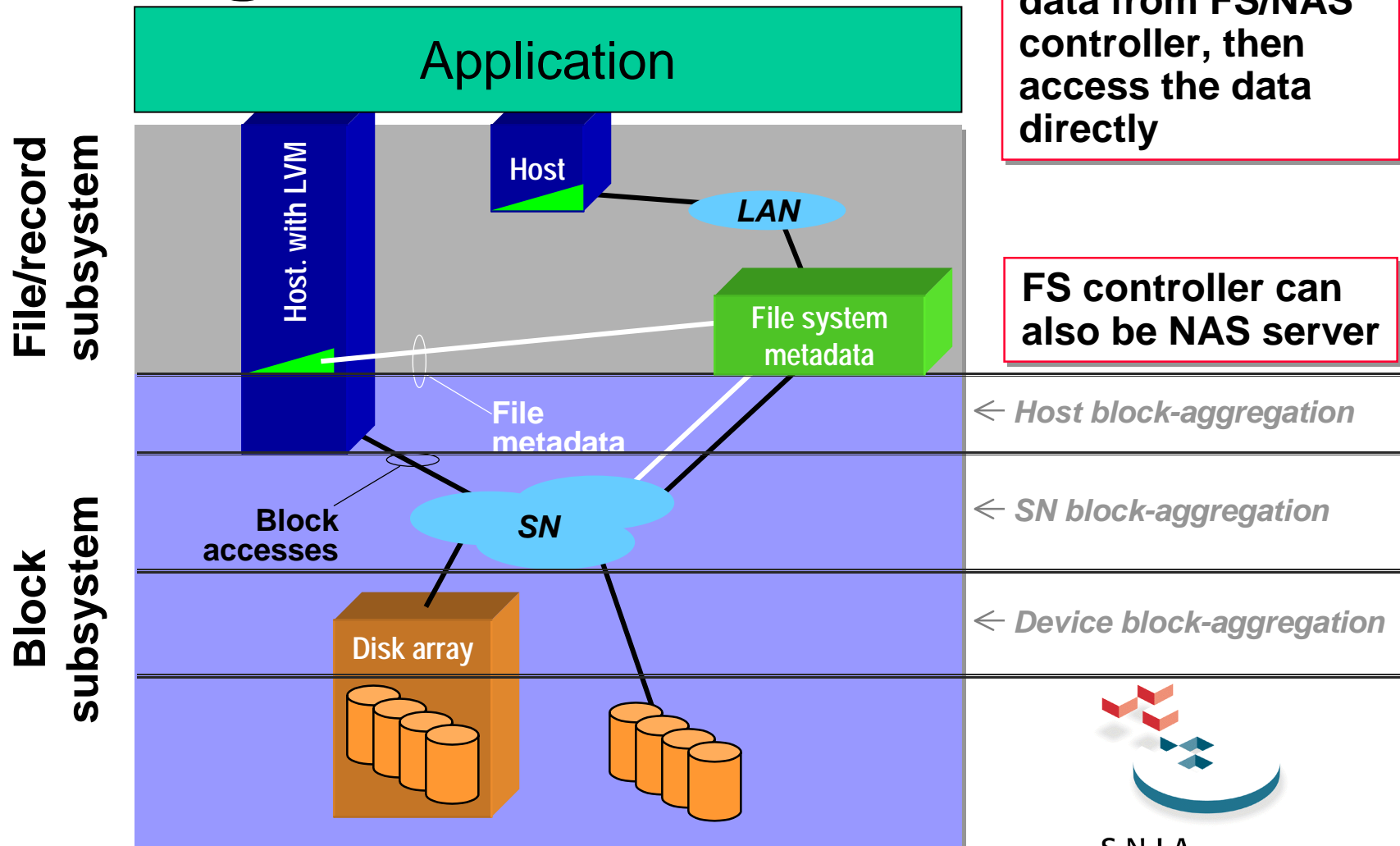
**Hosts get file meta-data from FS/NAS controller, then access the data directly**

**FS controller can also be NAS server**

Application

**File/record subsystem**

Host. with LVM

Host

*LAN*

File system metadata

File metadata

← *Host block-aggregation*

Block accesses

*SN*

← *SN block-aggregation*

**Block subsystem**

Disk array

← *Device block-aggregation*

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# Object-based Storage Device (OSD), CMU NASD



Application

File/record subsystem

Block subsystem

Host

Host

LAN

File metadata

Object metadata

OSD device

Security metadata

← *Host block-aggregation*

← *SN block-aggregation*

← *Device block-aggregation*

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# Summary & conclusions



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# The SNIA storage model

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# Block subsystem

## Sample architectures



Application

File/record subsystem

Block subsystem

Host. with LVM and software RAID

Host. with LVM

Host, no LVM

*1. Direct-attach*
*2. SN-attach*
*3. SN aggregation*

← *Host block-aggregation*

Aggregation appliance

*SN*

← *SN block-aggregation*

Disk array

← *Device block-aggregation*

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# File/record subsystem
## Sample architectures

Application
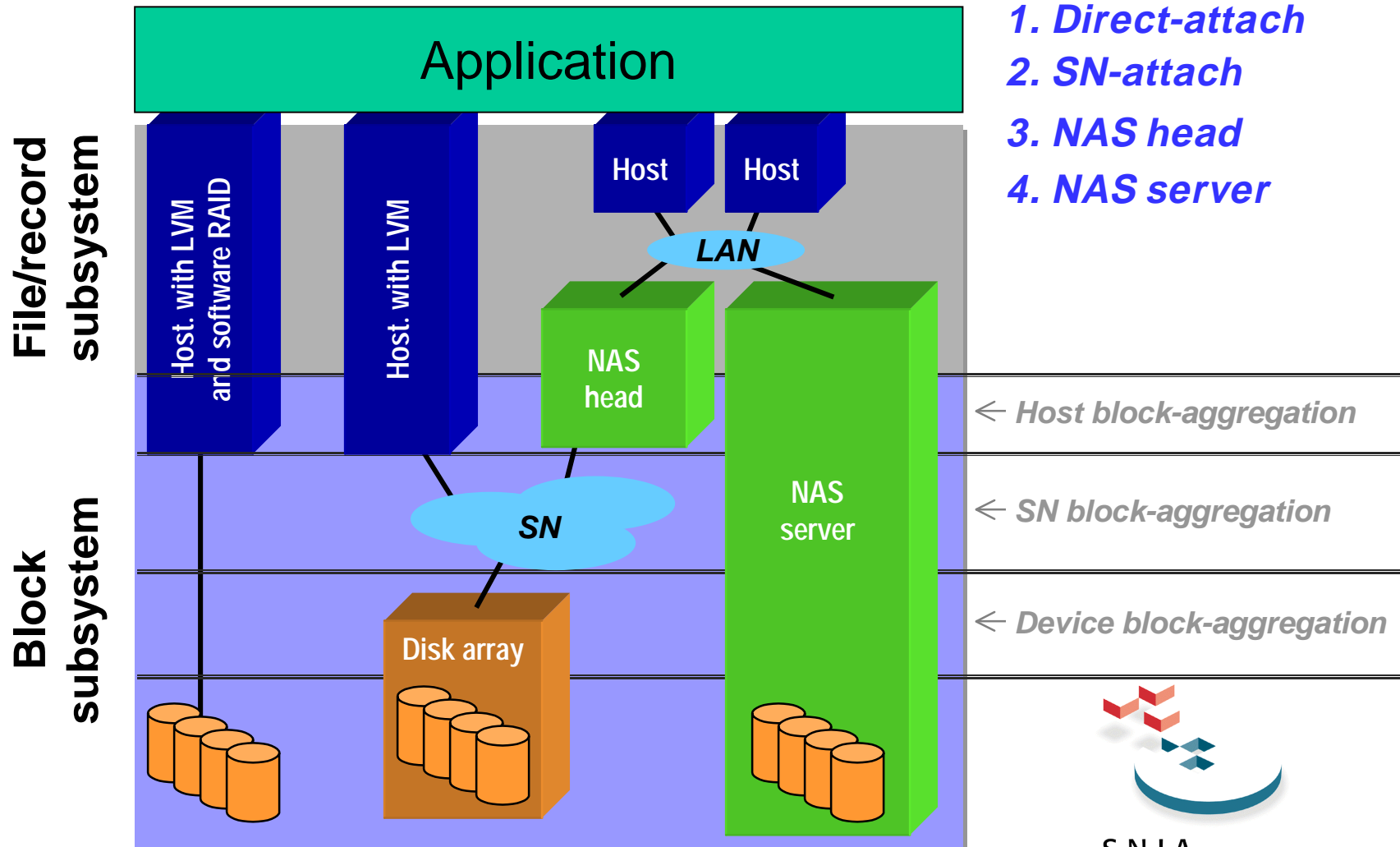
*1. Direct-attach*
*2. SN-attach*
*3. NAS head*
*4. NAS server*

**File/record subsystem**

Host. with LVM and software RAID

Host. with LVM

Host

Host

*LAN*

NAS head

NAS server

← *Host block-aggregation*

**Block subsystem**

*SN*

← *SN block-aggregation*

Disk array

← *Device block-aggregation*

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# Uses for the model

- **Vendors**
  - **place products in the space of architectures**
  - **clarify product differences**

- **Customers**
  - **understand vendor offerings better**

- **The industry**
  - **basis for common definitions, communication, understanding, interoperability**

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# Conclusions

- **The SNIA shared storage model is both simple and useful**
  - **to highlight similarities and differences**
  - **as a basis for comparisons**

- **Still a work in progress**
  - **data movers, tape drives, …**
  - **better comparisons …**
  - **suggestions?**

- **The SNIA-TC welcomes input:**
  - **<snia-tc@snia.org>**

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# Acknowledgements
## and co-conspirators

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