Serial Attached SCSI

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Introduction

Serial Attached SCSI (SAS) is a point-to-point serial protocol that moves data to and from computer storage devices such as hard drives and tape drives. SAS replaces the older Parallel SCSI (Small Computer System Interface, pronounced "scuzzy") bus technology that first appeared in the mid-1980s. SAS, like its predecessor, uses the standard SCSI command set. SAS offers backward compatibility with SATA, versions 2 and later. This allows for SATA drives to be connected to SAS backplanes. The reverse, connecting SAS drives to SATA backplanes, is not possible.

SCSI Command Set + **FC Frame format** + **Serial** = **SAS**
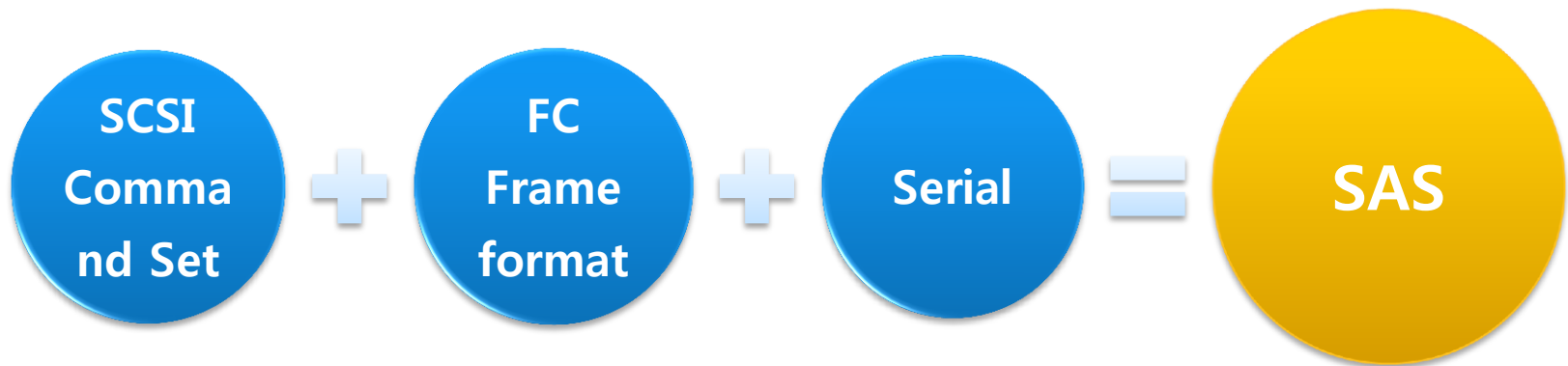
What is SAS

FC 를 대체할 SCSI 인터페이스

- **Point-to-point**
  - 6Gb I/O Module port/s or embedded port/s directly to each disk device

- **Port Expanders** 사용
  - Expanders 를 통해 각 disk enclosure 에 있는 각 디스크와 연결
  - 다음 enclosure 로 확장 (Daisy Chain) 을 위한 포트 제공
  - Expanders "are not" seen, used to daisy-chain to additional devices

- **Addressing devices** - SCSI IDs in SAS
  - Each disk has a SCSI ID assigned to it, but not "hard-assigned"
    - Set by array software, exist in order to address disks in a way applicable to the storage system
  - SAS disks have unique, permanent numbers called "World-Wide-Numbers"
    - Assigned by factory, can never be changed and are unique
    - Used to identify SAS disk to the array software

SAS Architecture

SAS Layer （ Serial SCSI Protocol Frame ）
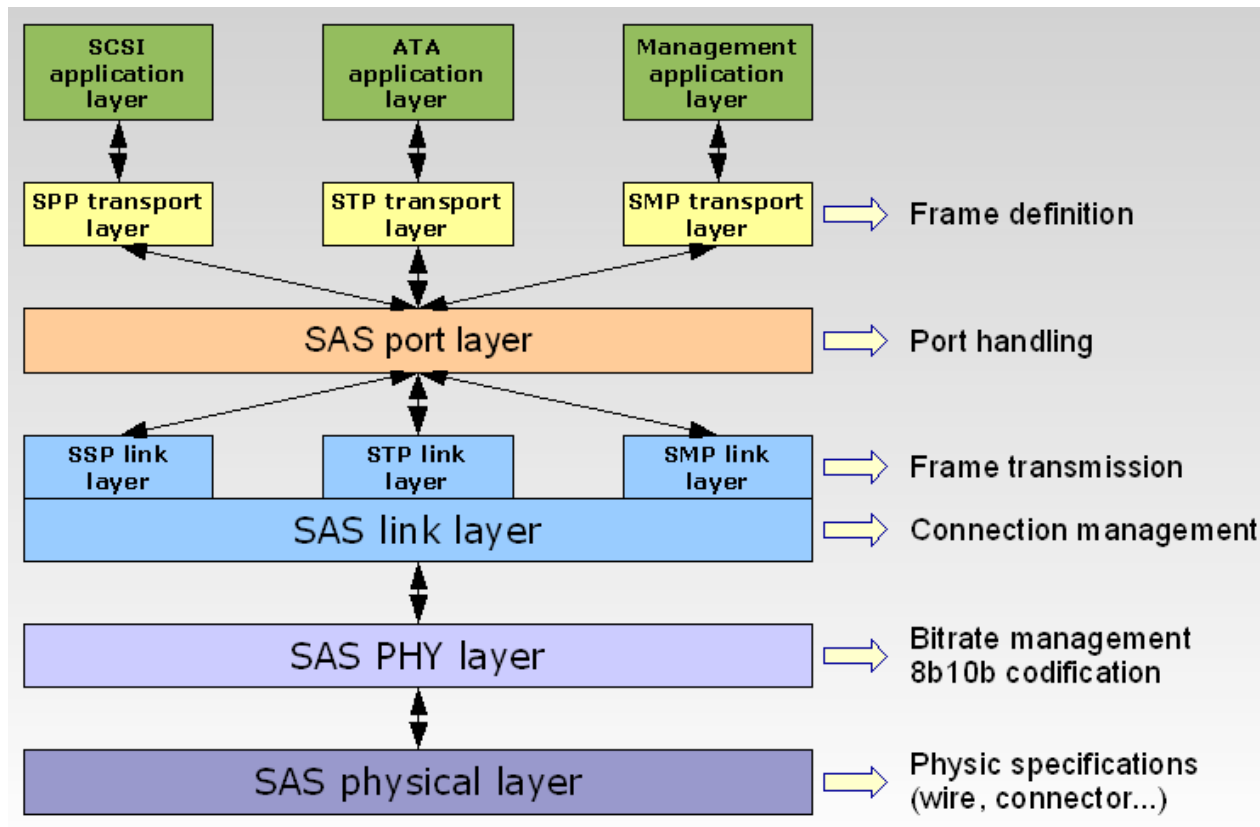
**Serial SCSI Protocol
SAS Disk Driver**

**Serial ATA Protocol
SATA Disk Driver**

**Serial Management
Protocol
SAS Expanders**

SAS 발전사

3Gb/s ➔ 6Gb/s ➔ 12Gb/s ➔ 24Gb/s ???

T10 Specification	SAS-1 & SAS1.1	SAS-2
Distinguishing Features	• Preserves legacy SCSI • SATA compatibility	• 3Gb/s compatible • Improved signaling • Zoning management • Improved scalability
Storage Features Supported/Enabled	• RAID 6 • Small Form Factor • HPC • High Capacity SAS Drives • Ultra320 SCSI replacement • Customer Choice • Blade servers	• RAS (Data Protection Info) • Security (FDE) • Clustering • Larger Topologies • SSDs • Virtualization • External storage • 4K Sector sizes • Multi-core

SAS 발전사

12Gb/s

- **High Capacity SAS – Simplifies SAS Architecture**
  - 3 TB and higher
 - Architecturally more efficient, improves enterprise system integrity

- **12Gb/s SAS**
  - 6Gb/s and 3Gb/s SATA compatible
  - Specification advancing in T10
  - On schedule for mid-2012

- **SAS Advanced Connectivity**
  - Mini-SAS HD Solutions
  - Active Copper to 20m/Optical to 100m

- **Multilink SAS for Solid State Disks (SSD)**
  - Backward compatible backplane connector
  - Meets/exceeds SSD performance requirements

SAS 발전사

3Gb/s ➔ 6Gb/s ➔ 12Gb/s ➔ 24Gb/s
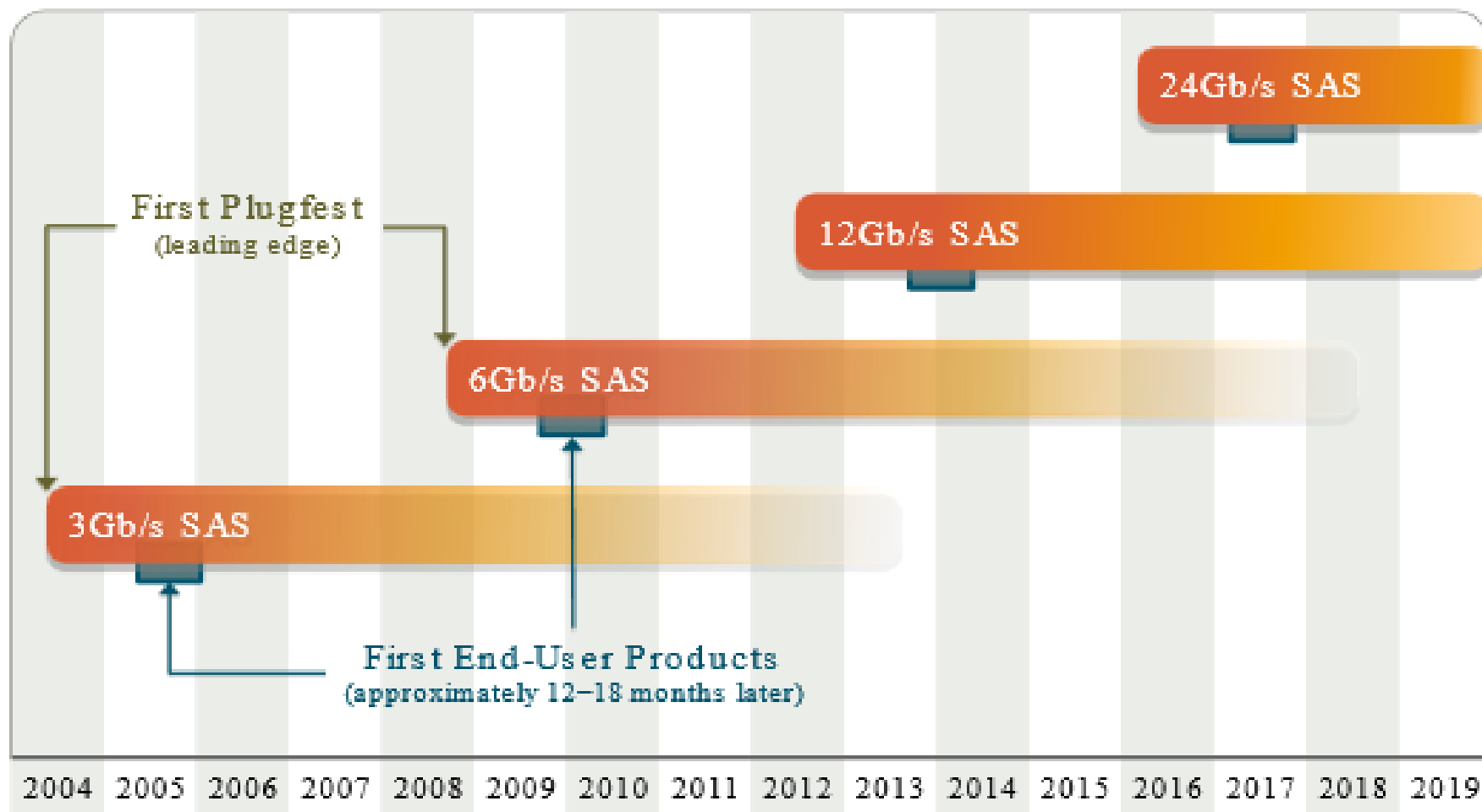
SAS Performance

6Gb/s and 12Gb/s SAS in a 4-lane port

SAS x4	6Gb/s	12Gb/s
Maximum	2400MB/s	4800MB/s
Typical	2200MB/s	4400MB/s

Storage System Performance

HDD (6Gb/s SAS)	230MB/s
SSD (6Gb/s SAS)	550MB/s
6Gb/s SAS x 4	2200MB/s
12Gb/s SAS x 4	4400MB/s
PCIe 2.x	3200MB/s
PCIe 3.0	6400MB/s

SAS Expander

Serial Attached SCSI Expanders (교환기 또는 HUB)

Figure 4-3: Direct and Expander-Attached Devices
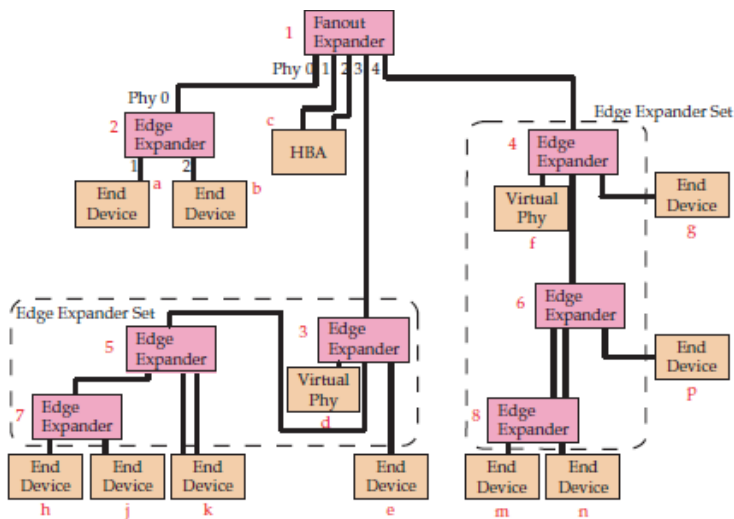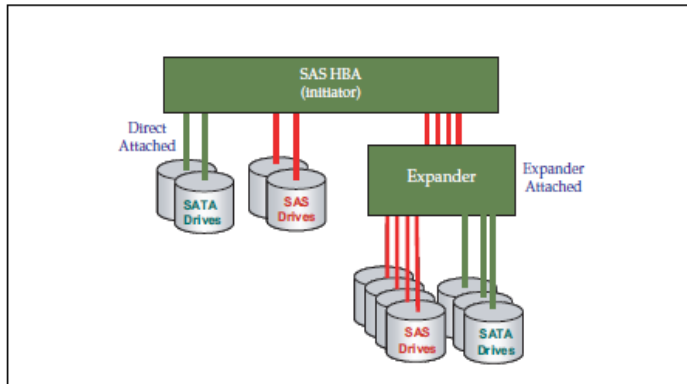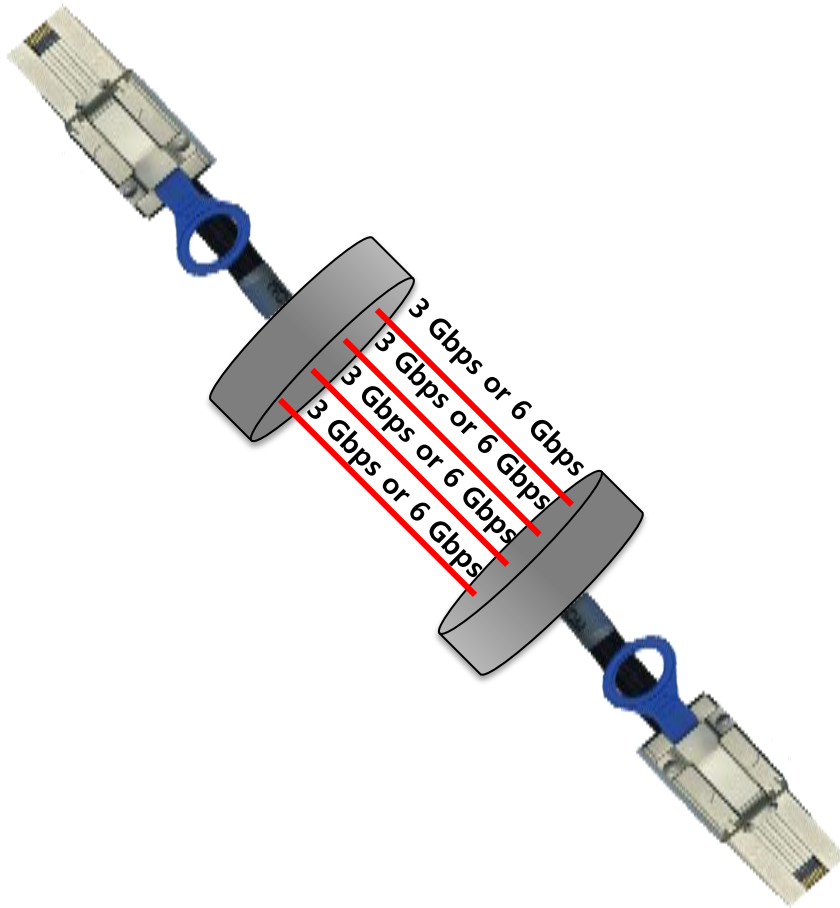
SAS Management Protocol (SMP)

두개 이상의 외부 expander 포트

다수의 SAS device 와 통신

SAS initiator 와 Target 을
연결하기 위해 필요한 것은 아님

FAN Out Expander
Edge Expander

SAS Link

SAS Link Bandwidth and Wide Ports

3 Gbps or 6 Gbps
3 Gbps or 6 Gbps
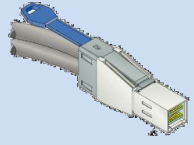3 Gbps or 6 Gbps
3 Gbps or 6 Gbps

- **Each SAS Link (Rx and Tx)**
  - 3 Gbps / 6 Gbps (full-duplex)
  - 6 Gbps / 12 Gbps (full-duplex)

- **Wide Ports**
  - Combine SAS links (6 Gbps SAS)
  - 2 ports → 24 Gbps (full-duplex)
  - 4 ports → 48 Gbps (full-duplex)

- **Concurrency Brings Higher Performance**
  - Multiple concurrent I/O's
  (lots of drives operating concurrently)
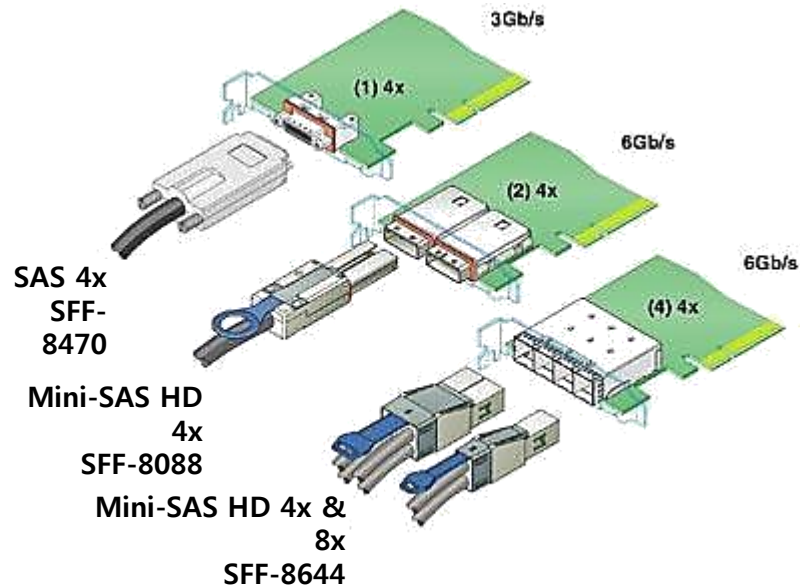
SAS Storage back-end Block Diagram
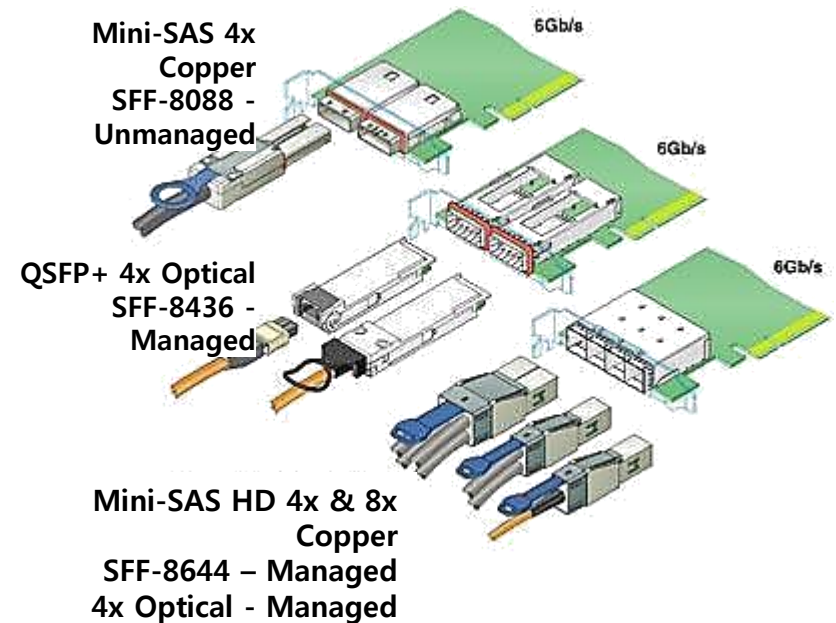
Back-end Block Diagram
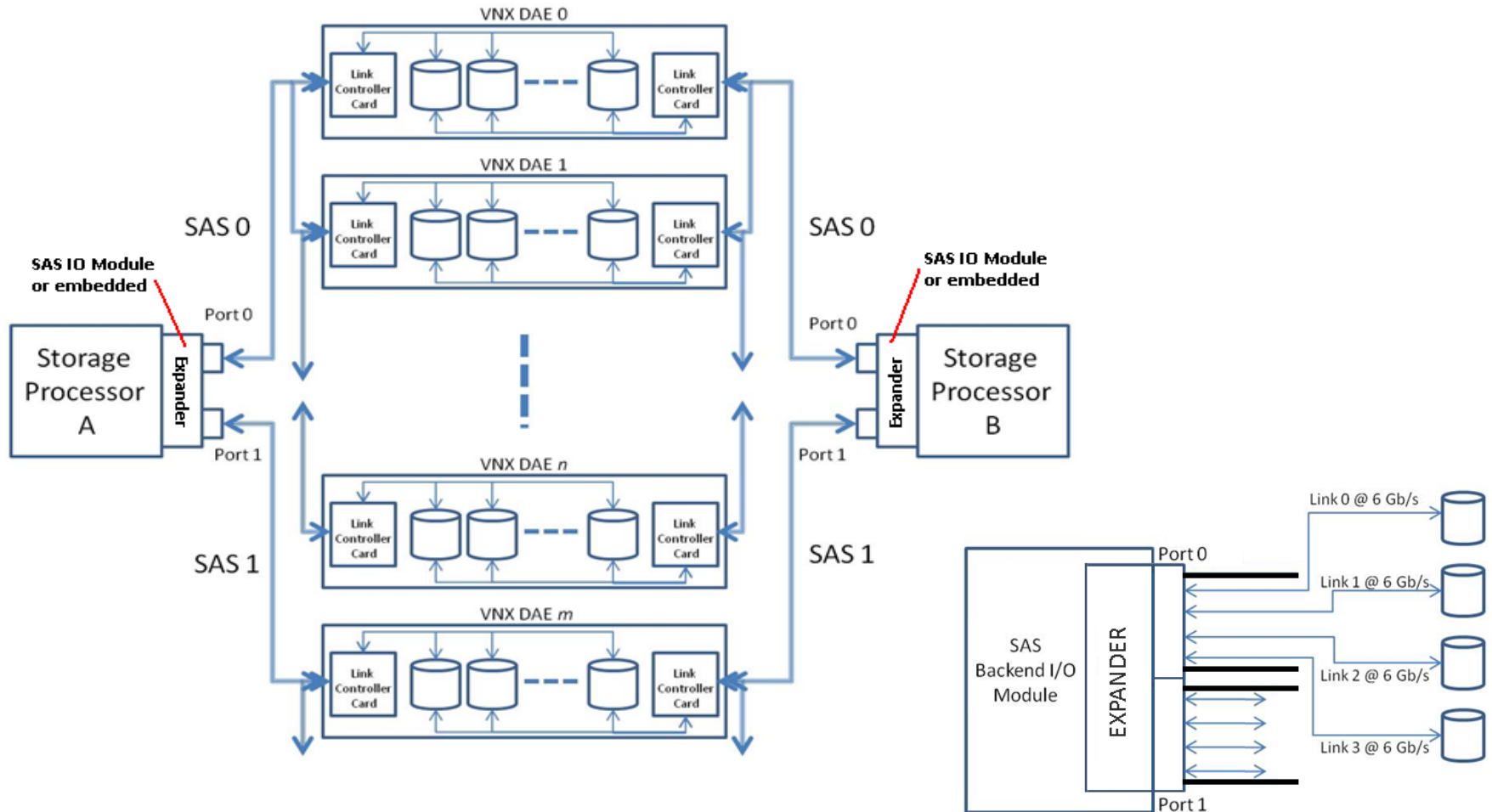
SAS Connector

Image	Codename	Other names	Ext./int.	Comment
	SFF-8482		Internal	This form factor is designed for compatibility with SATA.; however. The pictured connector is a drive-side connector.
	SFF-8470	Infiniband connector, Molex LaneLink™	External	Hi-density external connector Infiniband Connector 로 널리 알려짐
	SFF-8087	Internal mini-SAS, internal mSAS	Internal	Internal 4× connector w : 10 Gbit/s 지원
	SFF-8088	External mini-SAS, external mSAS	External	External 4× connector w : 10 Gbit/s 지원
	SFF-8644	Mini-SAS HD	External	Converged high-density connectivity active copper solution : 20m optical solution : 100m 6 Gbps / 12Gbps SAS 지원
	SFF-8680		Internal	SAS 12 Gbit/s backplane connector

SAS Connector standard

3Gb/s
(1) 4x

6Gb/s
(2) 4x

6Gb/s
(4) 4x

SAS 4x
SFF-8470

Mini-SAS HD 4x
SFF-8088

Mini-SAS HD 4x & 8x
SFF-8644

External/Unmanaged Cables

Mini-SAS 4x Copper
SFF-8088 - Unmanaged

QSFP+ 4x Optical
SFF-8436 - Managed

Mini-SAS HD 4x & 8x Copper
SFF-8644 – Managed
4x Optical - Managed

6Gb/s
6Gb/s
6Gb/s

External Active Cables

Nearline SAS

NL SAS Drives vs SATA Drives

Enterprise SATA Drive + **SAS Interface** → **NL SAS**

- SATA 디스크와 동일한 내부 구조
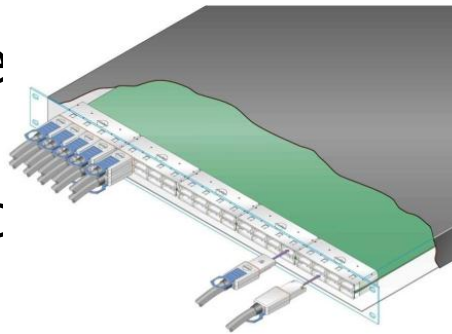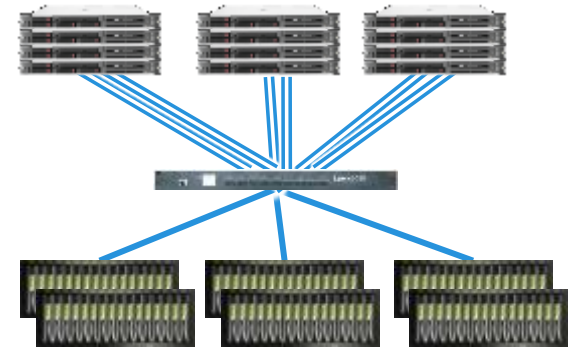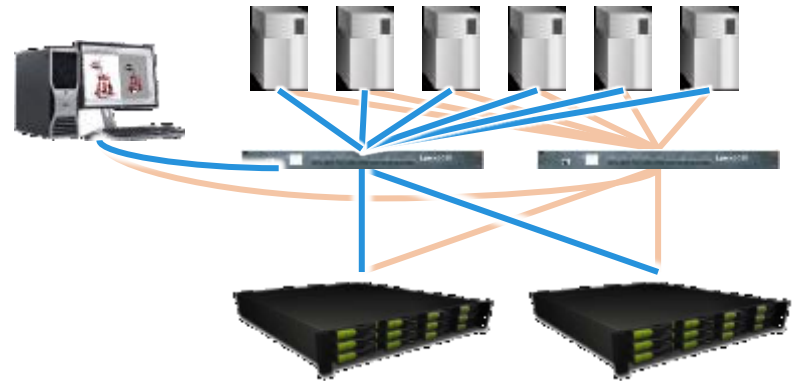- Native SAS Interface 사용 ➔ SATA 대비 30 % 성능 향상

SATA/SAS connector 호환성
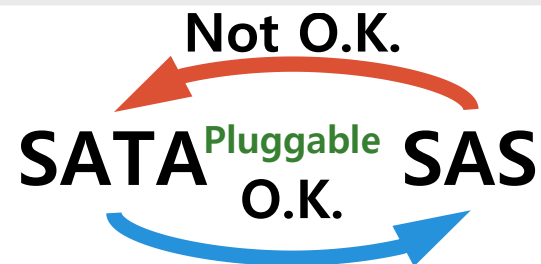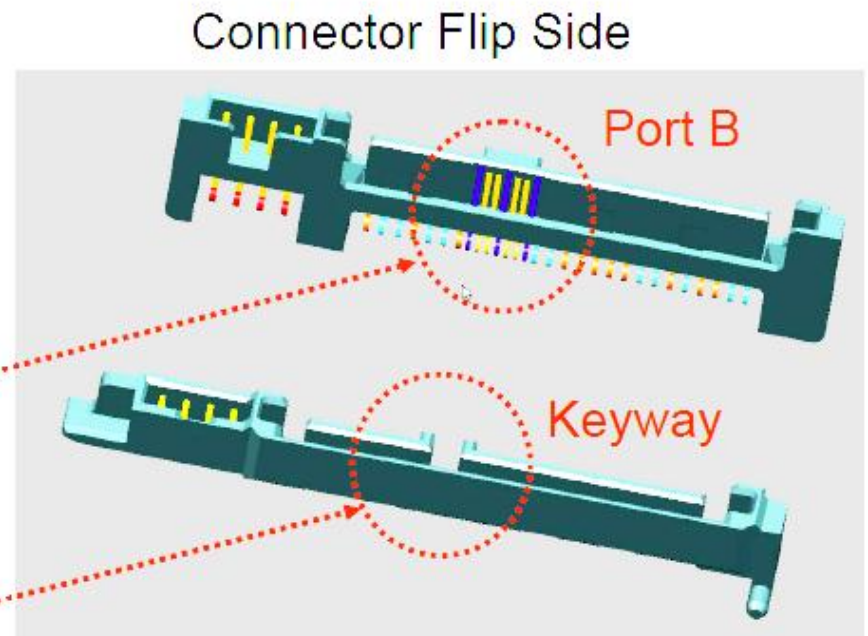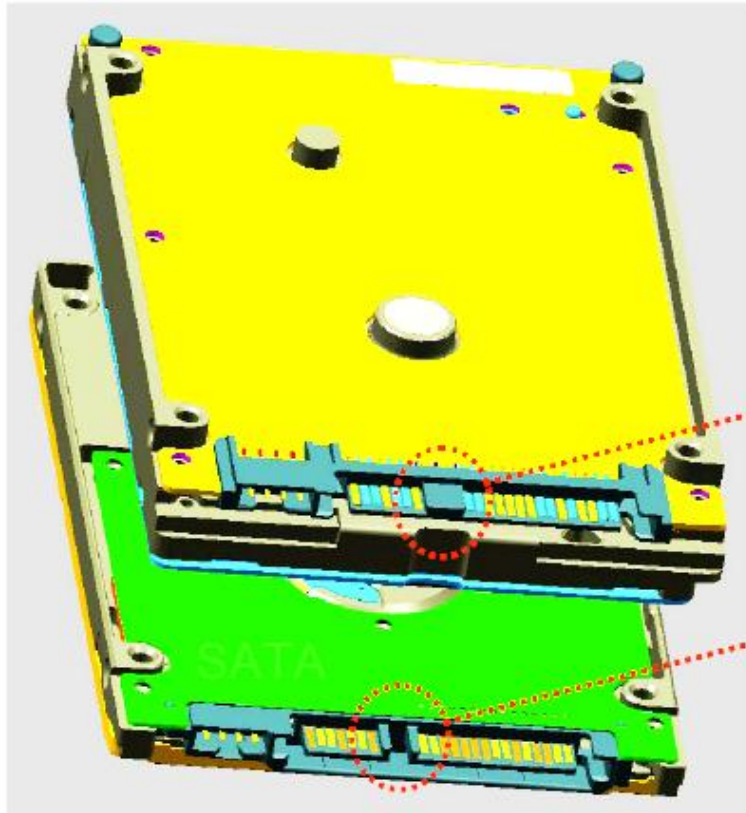
Switched SAS

SAS 는 Disk 기술이 전부이다 ? No

- SAS 스위치를 이용한 SAN 구성
- 중앙 관리
- 안정성 향상
- Improvement over cascaded connections
- Legacy protection/isolation

- 확장성 (Scalability)
- Thousands of storage
- 가용성 (Availability)
- latency and bottlenec

Serial Attached SCSI

Summary

Factor	Description
Performance	Full-duplex with link aggregation (4-ports wide ➜ 24 Gbit/s)
	SAS-1 3.0 Gbit/s SAS-2 6.0 Gbit/s SAS-3 12.0 Gbit/s SAS-4(The Serial Attached SCSI - 4 (SAS-4) draft standard will double the SAS-3 data rate, maintaining compatibility with the 6 Gbps and 12 Gbps SAS link rates. It also will adopt a more efficient signal encoding.)
Connectivity	10 m external cable
	255 device port expanders (> 65k total devices)
	SAS-to-SATA compatibility
Availability	Dual-port HDDs
	Multi-initiator point-to-point
Driver	Software-transparent with SCSI

End of Presentation