



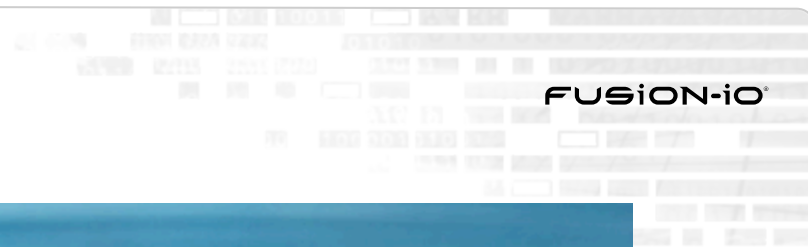
August 23, 2012

LESSONS FROM THE FRONT LINES AND A LOOK TO THE FUTURE

Gary Orenstein, SVP of Products, Fusion-io, @garyorenstein



A RETROSPECTIVE





INITIAL STAGE OF NAND FLASH DEPLOYMENT

FUSION-io

Applications

Block I/O



NAND FLASH



ARCHITECTURAL DIFFERENCES

FUSION-iO

Applications

Block I/O

Architected like
a disk

Architected like
memory

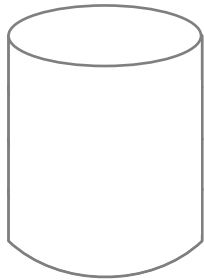


MEMORY-LIKE ARCHITECTURE

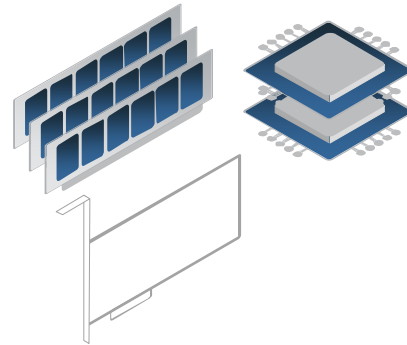
FUSION-io

Applications

Block I/O



SSD approach



Flash as Memory approach



BEYOND BLOCK I/O ACCESS

FUSION-io

Applications

Block I/O

SSD
SAS
SATA

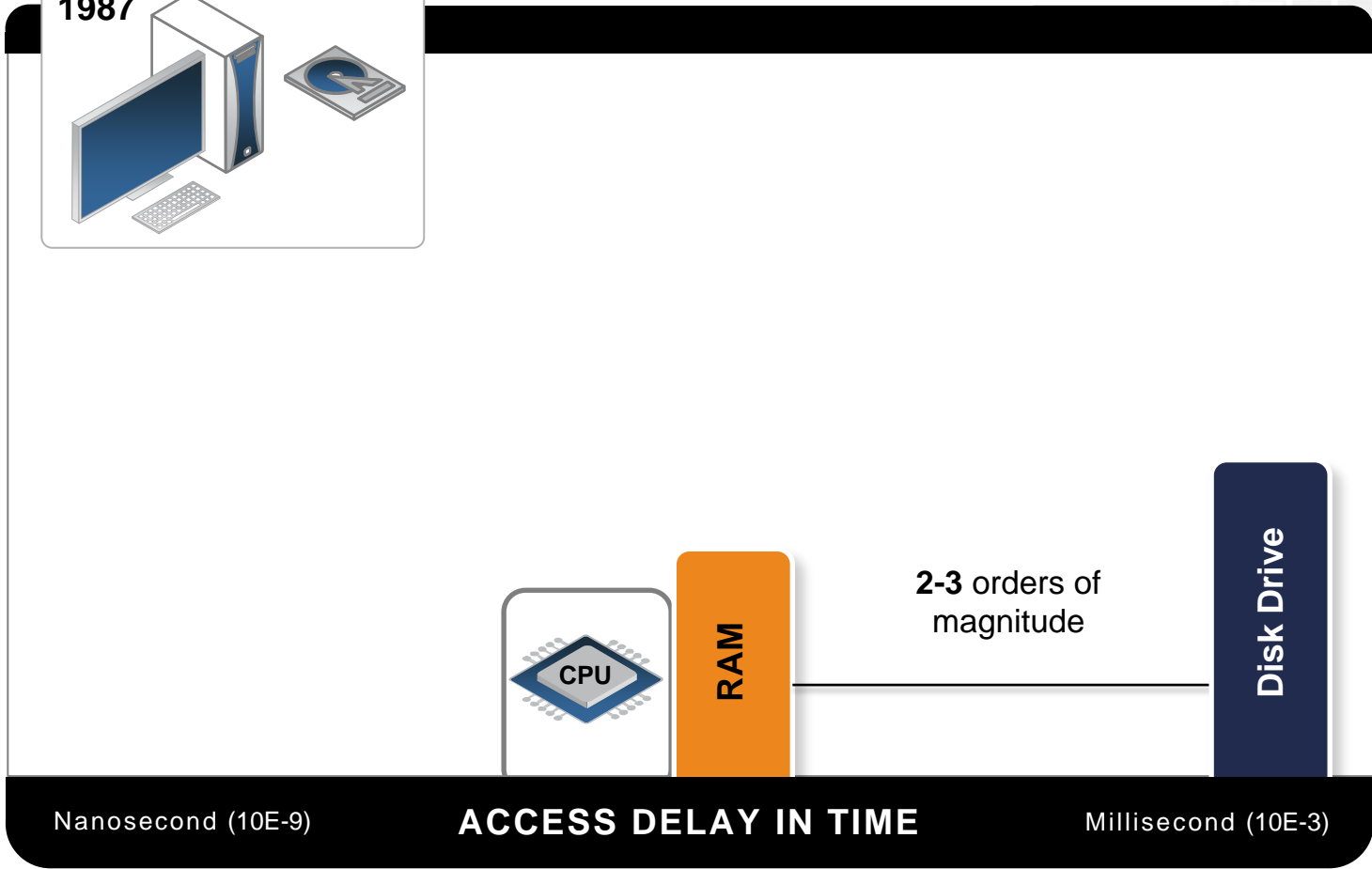
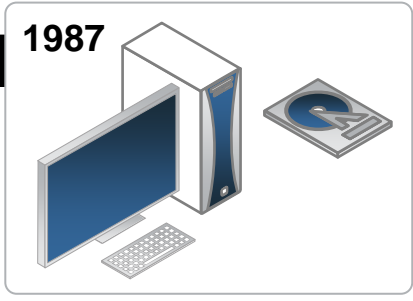
Block and Enhanced I/O

Memory

Flash as Memory



WHERE THE INDUSTRY STARTED

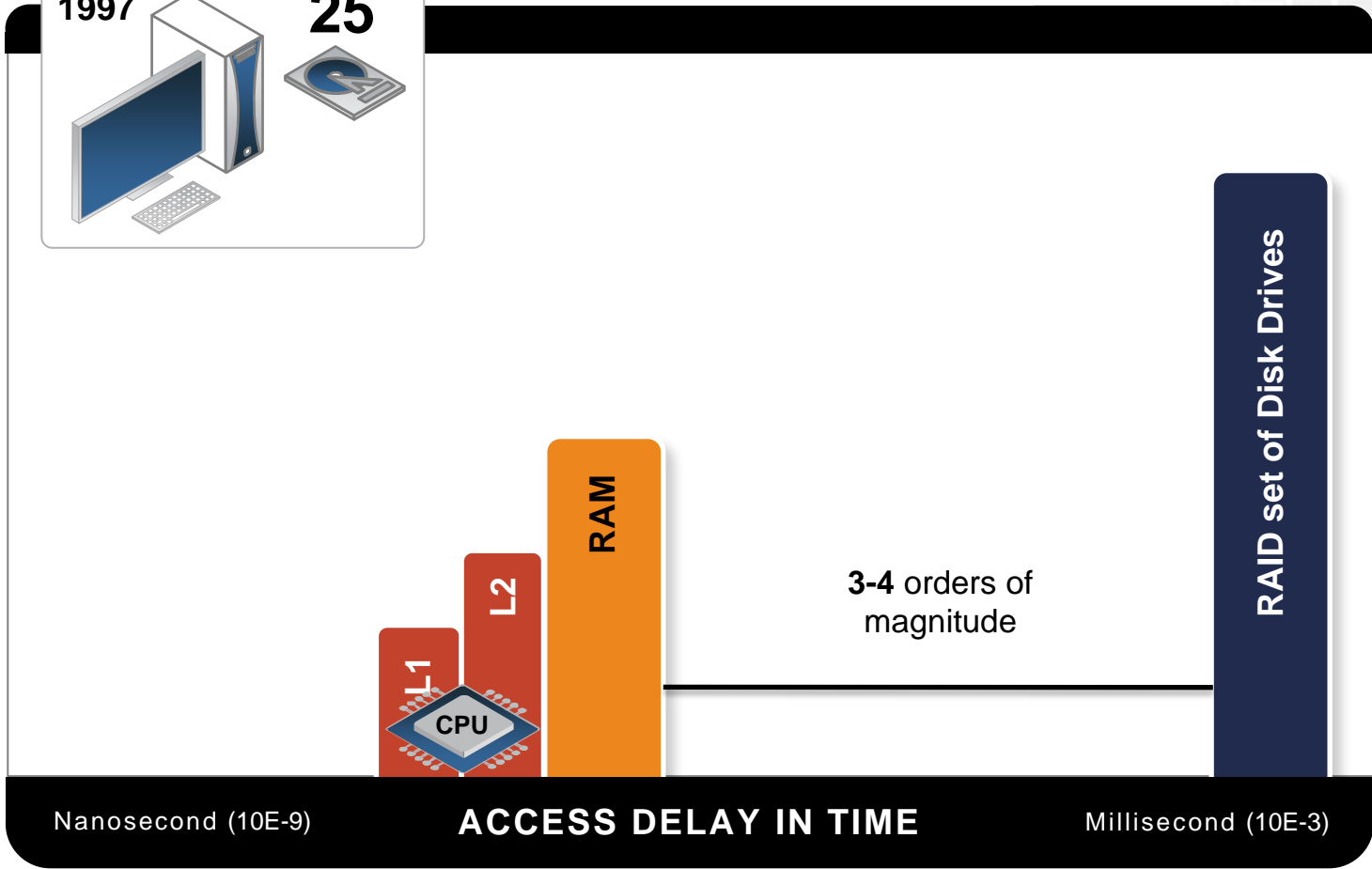
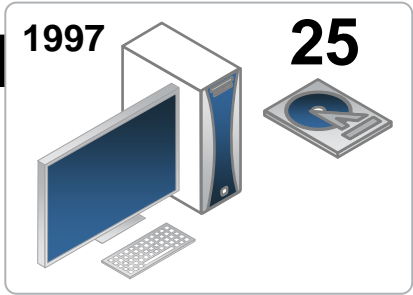


Nanosecond (10E-9)

Millisecond (10E-3)



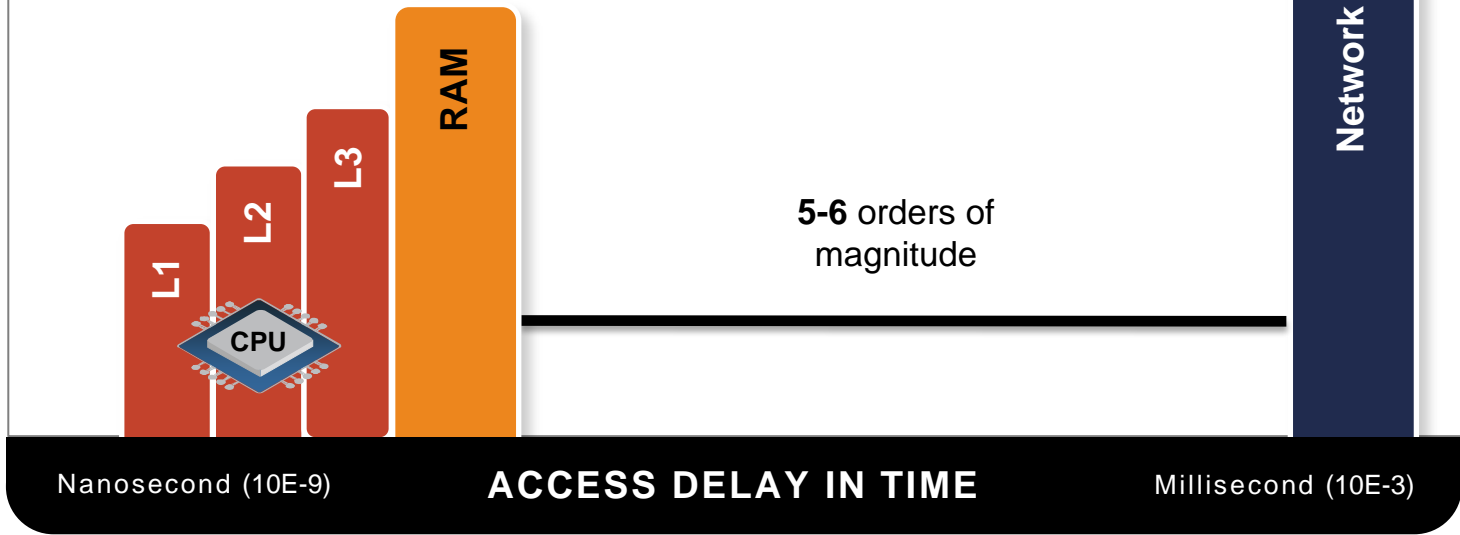
WHERE THE INDUSTRY WENT





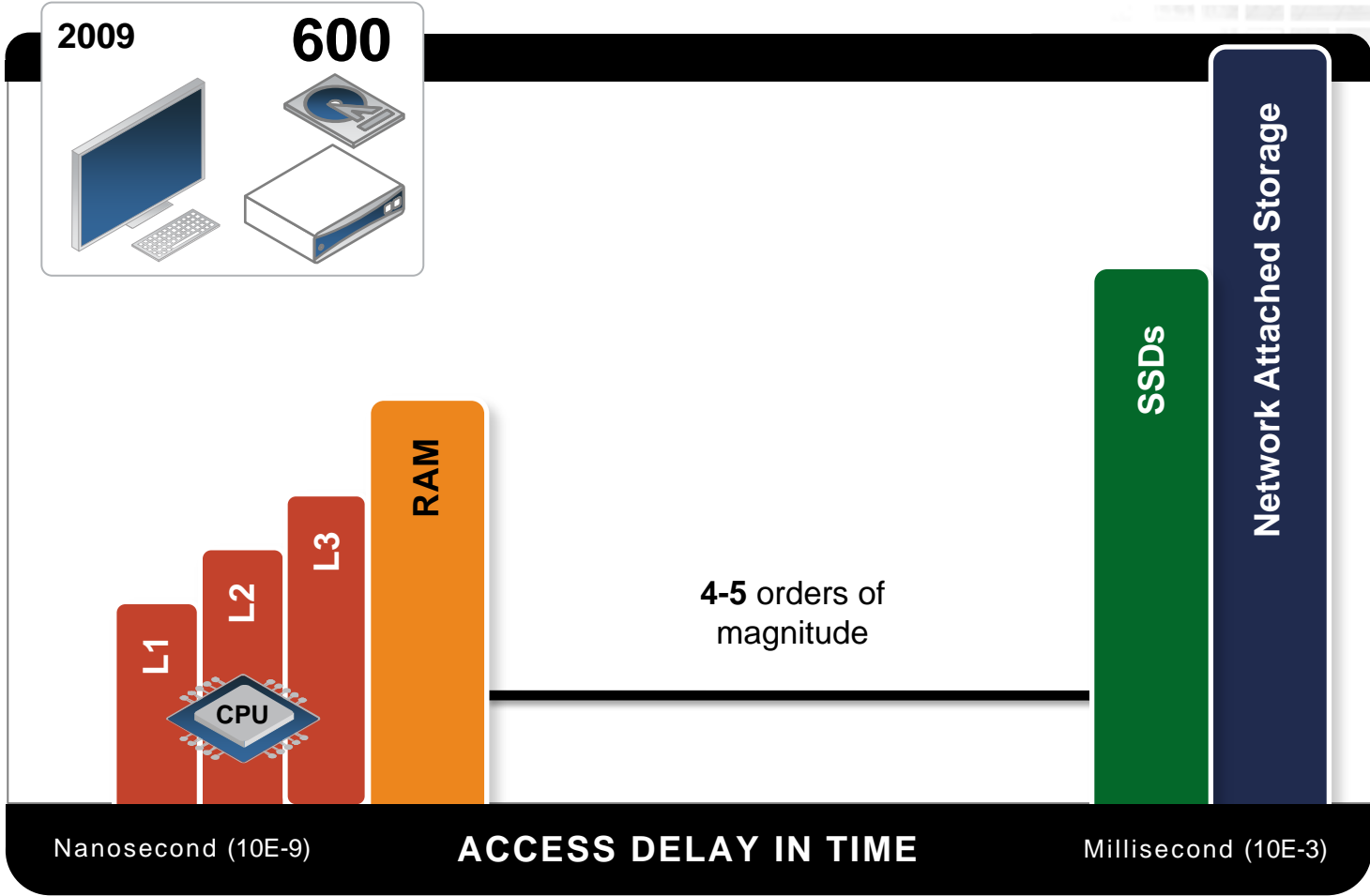
WHERE THE INDUSTRY IS TODAY

2009 **600**





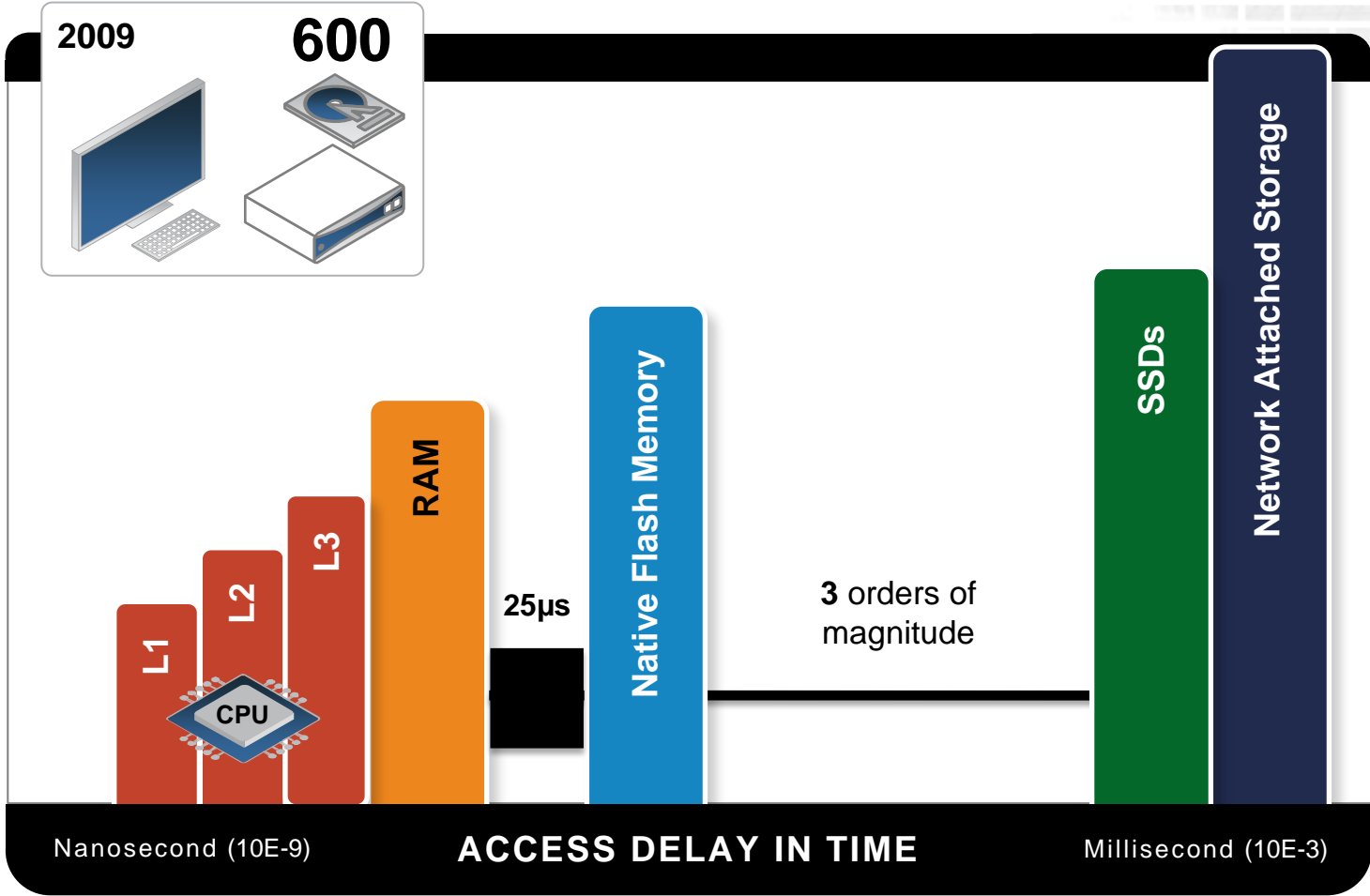
SSDS ARE ONLY SOMEWHAT BETTER





NATIVE FLASH MAXIMIZES VALUE POTENTIAL

FUSION-io





A BIT ABOUT LATENCY

FUSION-io





LATENCY EXAMPLES



		X 1 billion Human Scale	
L1 cache reference	0.5 ns	0.5 sec	One heart beat





LATENCY EXAMPLES



		X 1 billion Human Scale	
L1 cache reference	0.5 ns	0.5 sec	One heart beat
Main memory reference	100 ns	100 sec	Brushing your teeth





LATENCY EXAMPLES



		X 1 billion Human Scale	
L1 cache reference	0.5 ns	0.5 sec	One heart beat
Main memory reference	100 ns	100 sec	Brushing your teeth
Send 2K bytes over 1 Gbps network	20 μs	5.5 hours	From lunch to 5PM





LATENCY EXAMPLES



		X 1 billion Human Scale	
L1 cache reference	0.5 ns	0.5 sec	One heart beat
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Send 2K bytes over 1 Gbps network	20 μ s	5.5 hours	From lunch to 5PM
Native Flash Memory Access	25 μs	7 hours	Flight from Hawaii to Fiji





LATENCY EXAMPLES









		X 1 billion Human Scale	
L1 cache reference	0.5 ns	0.5 sec	One heart beat
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Send 2K bytes over 1 Gbps network	20 μ s	5.5 hours	From lunch to 5PM
Native Flash Memory Access	25 μ s	7 hours	Flight from Hawaii to Fiji
SSD random read	150 μs	1.7 days	A normal weekend





LATENCY EXAMPLES



		X 1 billion Human Scale		
L1 cache reference	0.5 ns	0.5 sec	One heart beat	
Main memory reference	100 ns	100 sec	Brushing your teeth	
Send 2K bytes over 1 Gbps network	20 μs	5.5 hours	From lunch to 5PM	
Native Flash Memory Access	25 μs	7 hours	Flight from Hawaii to Fiji	
SSD random read	150 μs	1.7 days	A normal weekend	
Disk seek	10 ms	16.5 weeks	A semester in university	

A black rearview mirror is centered against a blue sky with light clouds. The mirror's frame is black, and the glass is white. The word "Storage" is written in a red, rounded, sans-serif font across the center of the mirror. The text is oriented as if seen through the mirror, appearing to be on the opposite side of the glass.

Storage



amazon web services™



AWS PORTFOLIO

FUSION-io

Your Applications

Management & Administration

Web Interface AWS Management Console	Identity & Access IAM Identity Federation Consolidated Billing	Deployment & Automation AWS Elastic Beanstalk AWS CloudFormation	Monitoring Amazon CloudWatch
--	--	---	--

Application Platform Services

Content Distribution Amazon CloudFront	Messaging Amazon SNS Amazon SQS Amazon SES	Search Amazon CloudSearch	Distributed Computing Elastic MapReduce Amazon SWF	Libraries & SDKs Java, PHP, Python, Ruby, .NET
--	--	-------------------------------------	---	---

Foundation Services

Compute Amazon EC2 Auto Scaling	Storage Amazon S3 Amazon EBS AWS Storage Gateway	Database Amazon RDS Amazon DynamoDB Amazon SimpleDB Amazon ElastiCache	Networking Amazon VPC Elastic Load Balancing Amazon Route 53 AWS Direct Connect
--	--	---	--

AWS Global Infrastructure

Availability Zones	Edge Locations
Regions	



S3 API – BUCKET AND OBJECT OPERATIONS

DELETE Bucket

- DELETE Bucket lifecycle
- DELETE Bucket policy
- DELETE Bucket website

GET Bucket (List Objects)

- GET Bucket acl
- GET Bucket lifecycle
- GET Bucket policy
- GET Bucket location
- GET Bucket logging
- GET Bucket notification
- GET Bucket Object versions
- GET Bucket requestPayment
- GET Bucket versioning
- GET Bucket website
- HEAD Bucket
- List Multipart Uploads

PUT Bucket

- PUT Bucket acl; PUT Bucket lifecycle
- PUT Bucket policy; PUT Bucket logging
- PUT Bucket notification; PUT Bucket requestPayment
- PUT Bucket versioning; PUT Bucket website

DELETE Object

- Delete Multiple Objects

GET Object

- GET Object ACL
- GET Object torrent
- HEAD Object
- POST Object

PUT Object

- PUT Object acl
- PUT Object – Copy
- Initiate Multipart Upload

Upload Part

- Upload Part – Copy
- Complete Multipart Upload
- Abort Multipart Upload
- List Parts

The image features a black background with a central bright point from which numerous thin, white lines radiate outwards. At the end of each line is a small, glowing white circle, creating a starburst or fiber optic effect. The text "Flash Disk" is centered in the middle of the image in a white, bold, sans-serif font.

Flash Disk

A graphic featuring a central red glow with numerous purple and blue light rays radiating outwards, resembling fiber optic cables or data connections. The text "Flash Memory" is centered over this background.

Flash Memory

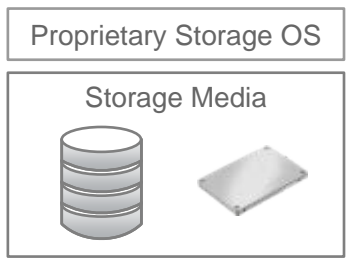


SOFTWARE DEVELOPMENT KIT ADVANTAGES

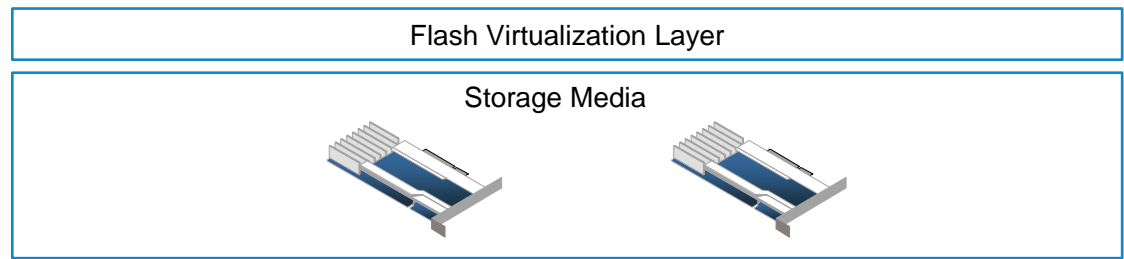
FUSION-io



Conventional access



Traditional Storage

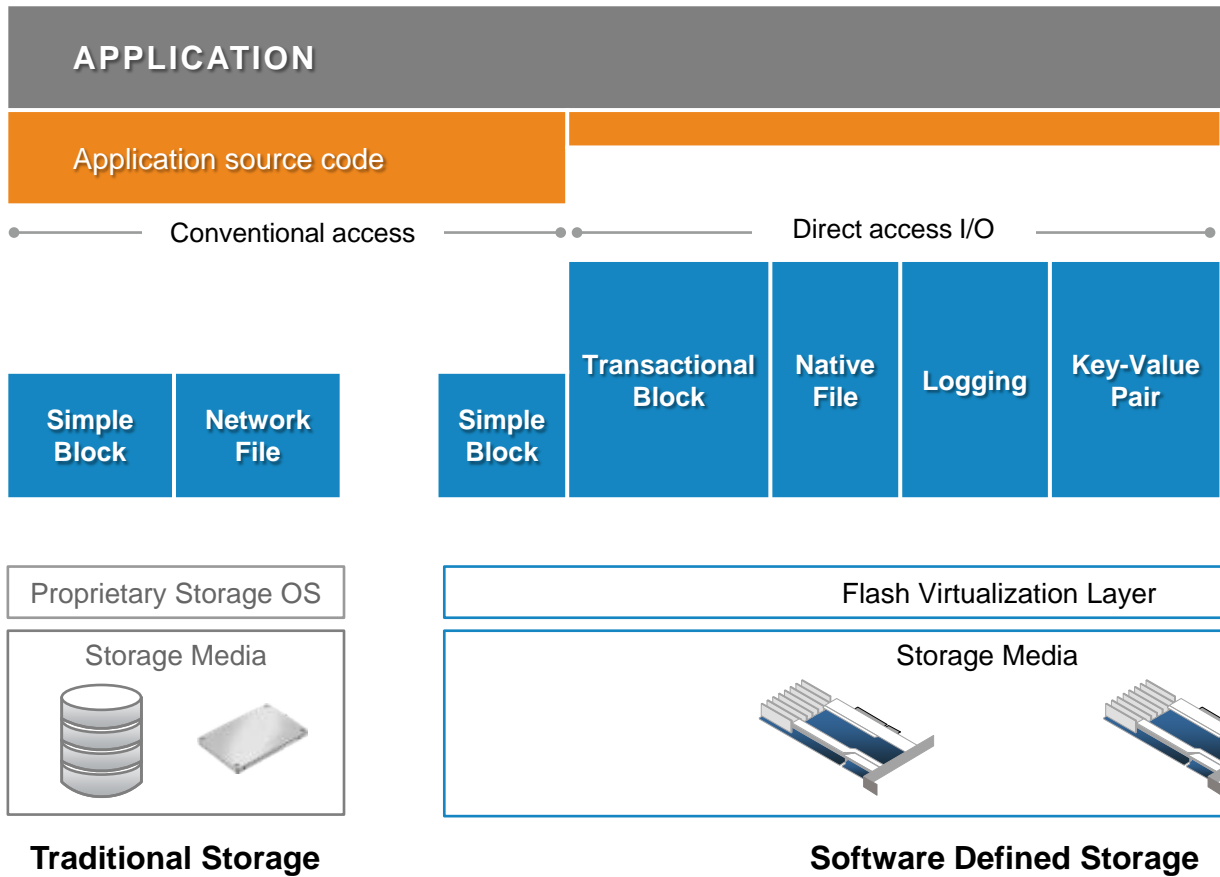


Software Defined Storage



SOFTWARE DEVELOPMENT KIT ADVANTAGES

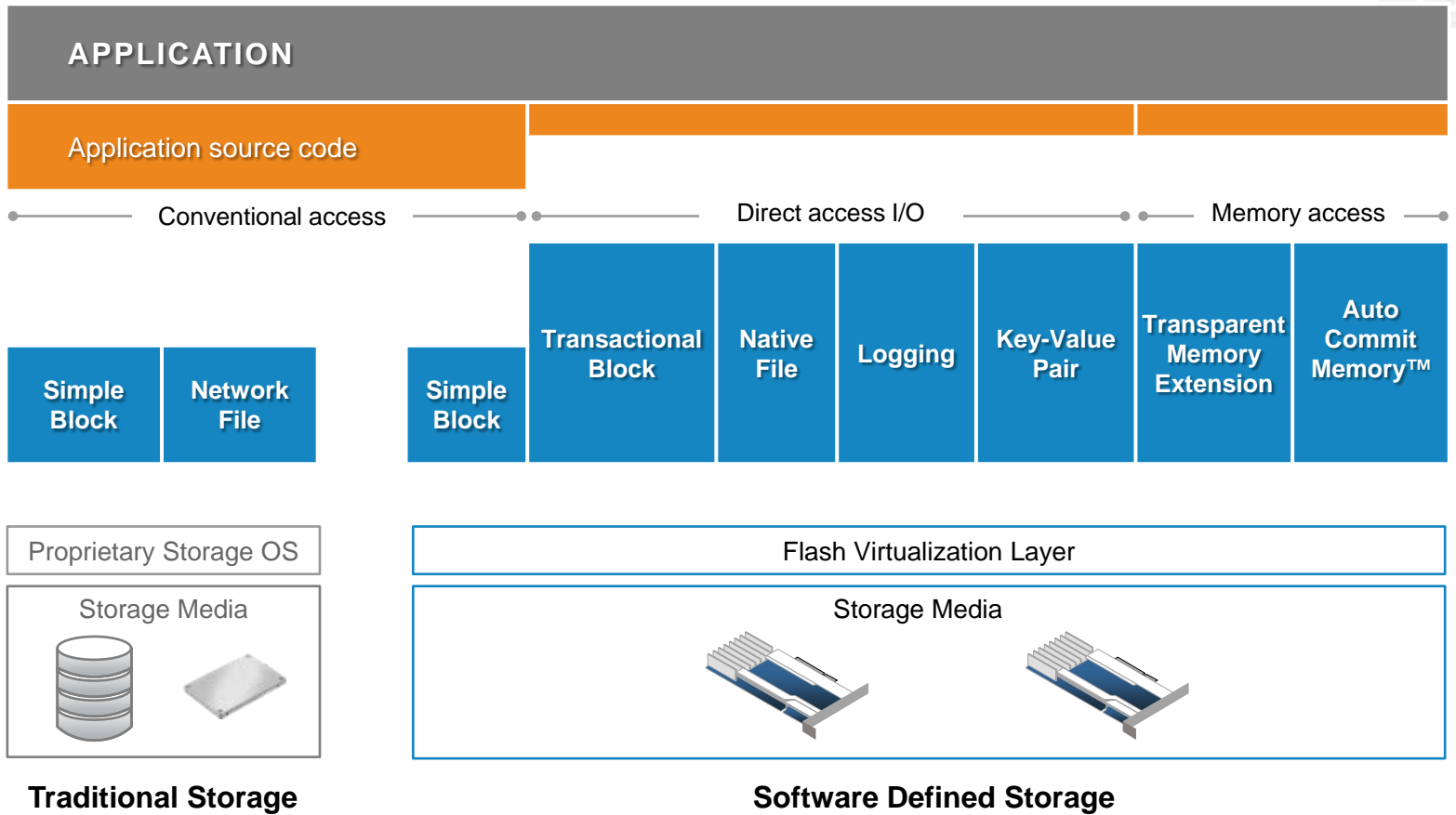
FUSION-io





SOFTWARE DEVELOPMENT KIT ADVANTAGES

FUSION-io®





STANDARDS





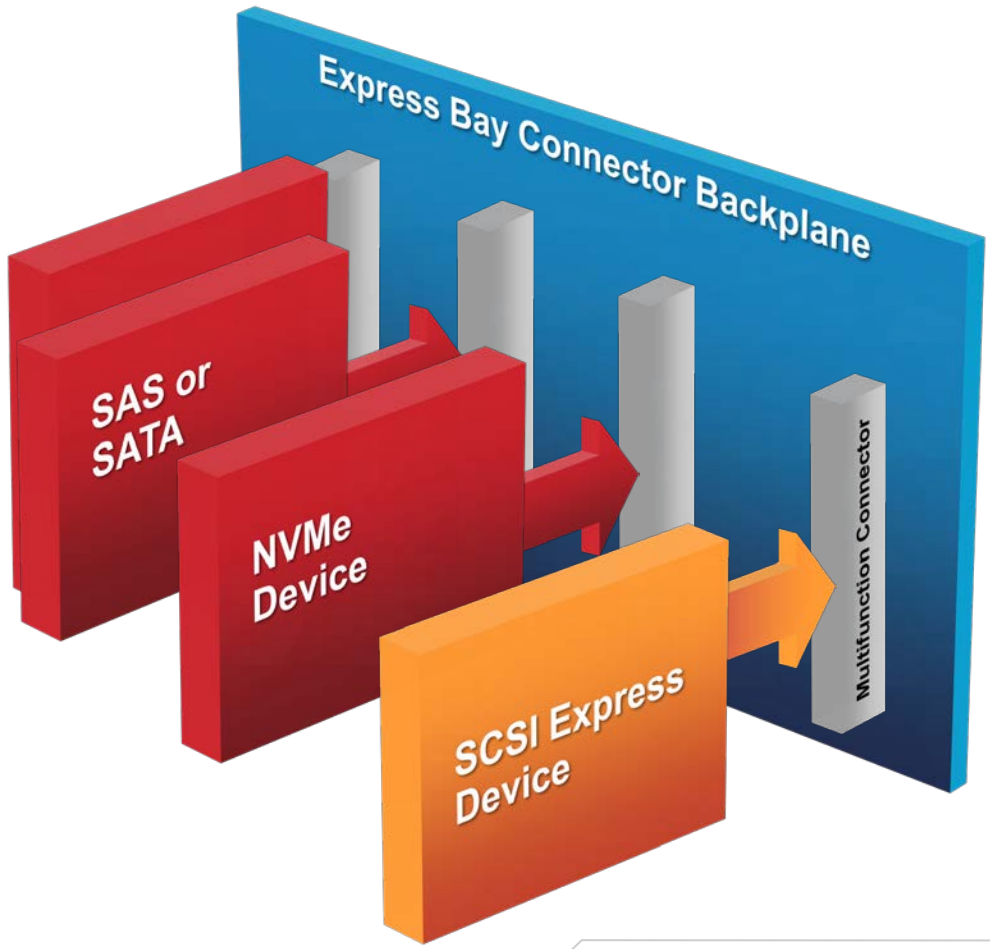
STANDARDS ACTIVITIES



SCSI/ EXPRESS

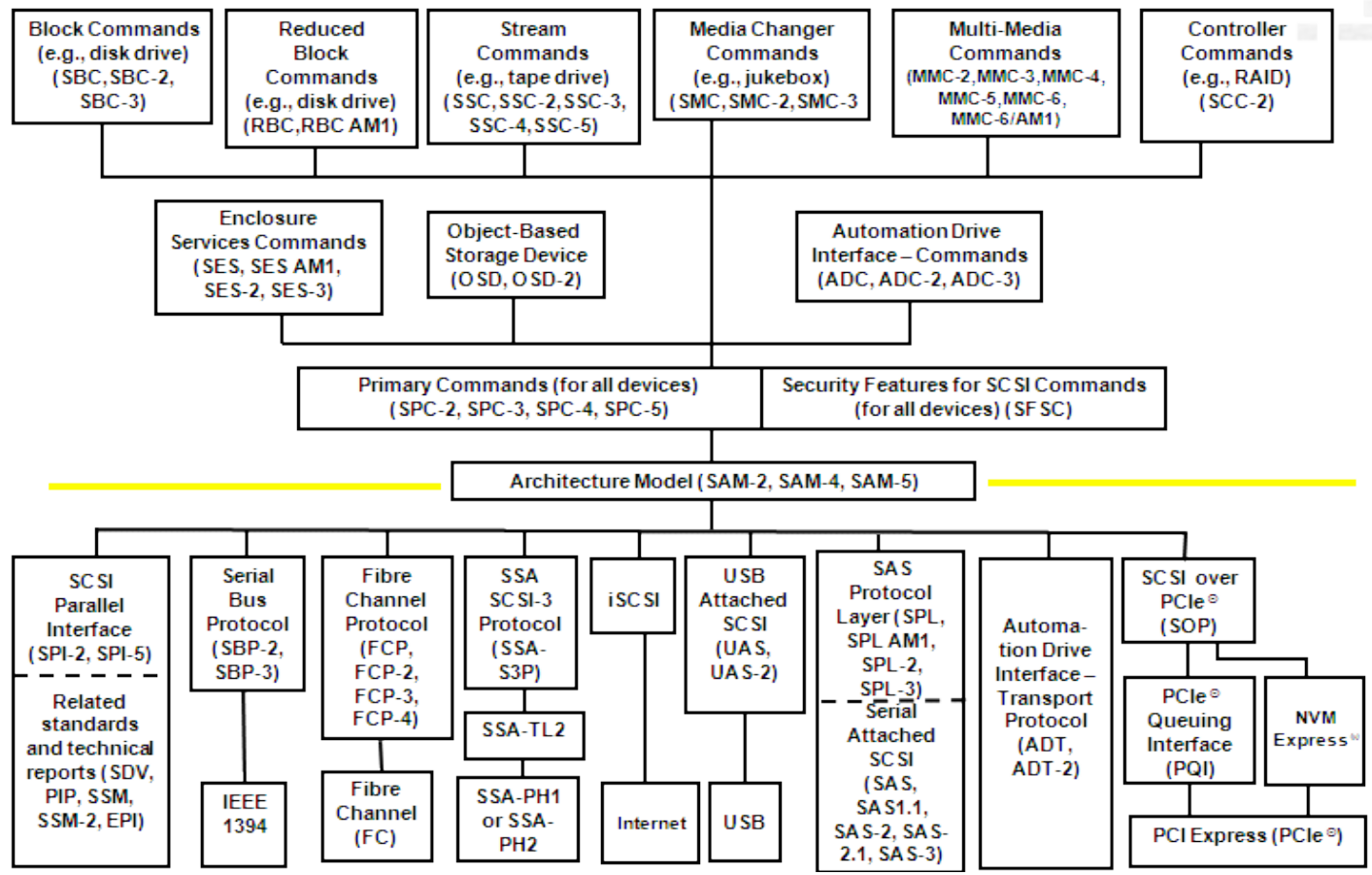


SCSI EXPRESS BAY





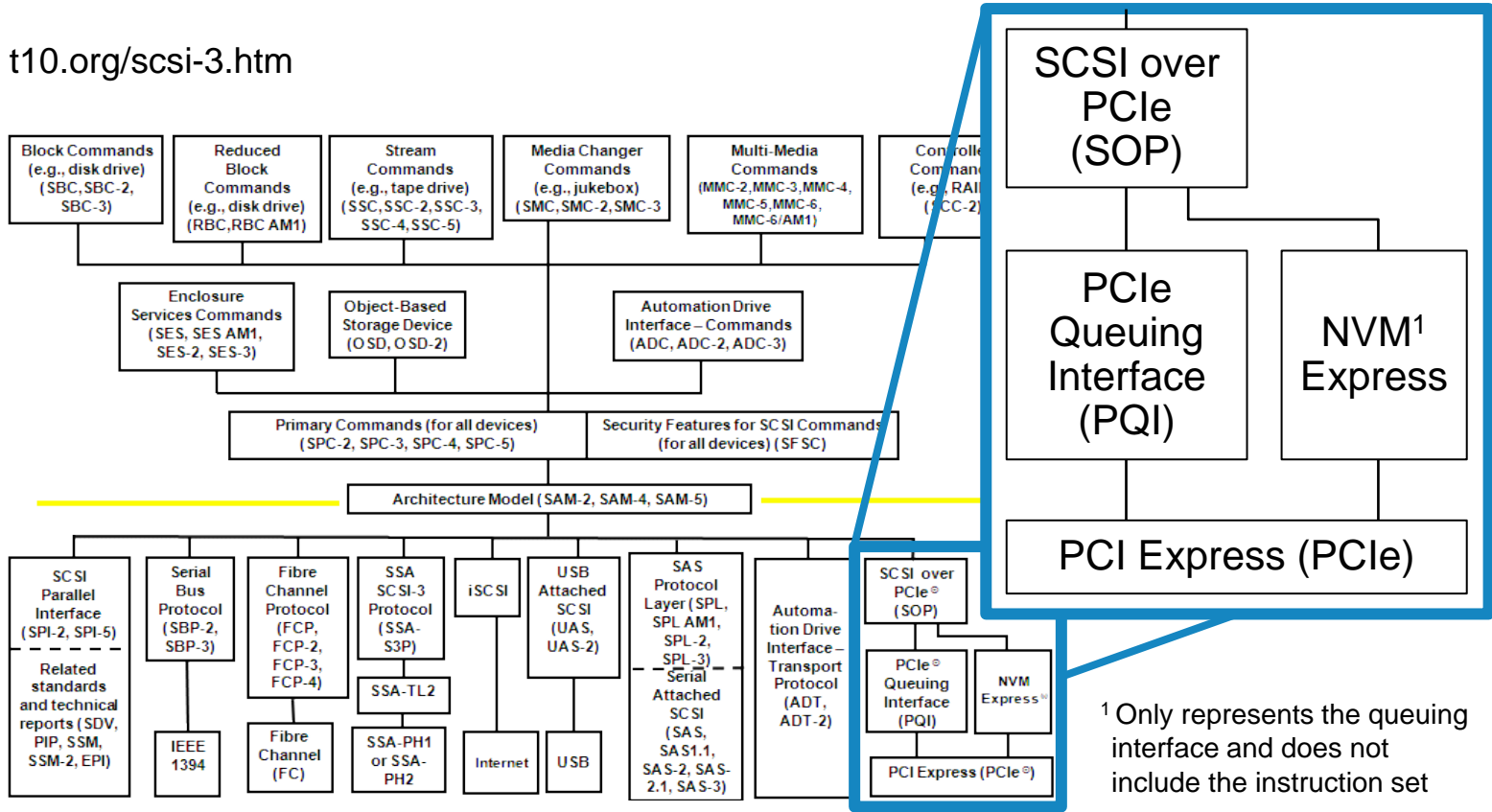
SCSI ARCHITECTURE





SCSI STANDARDS ARCHITECTURE

t10.org/scsi-3.htm





FLASH DEPLOYMENT ARCHITECTURES

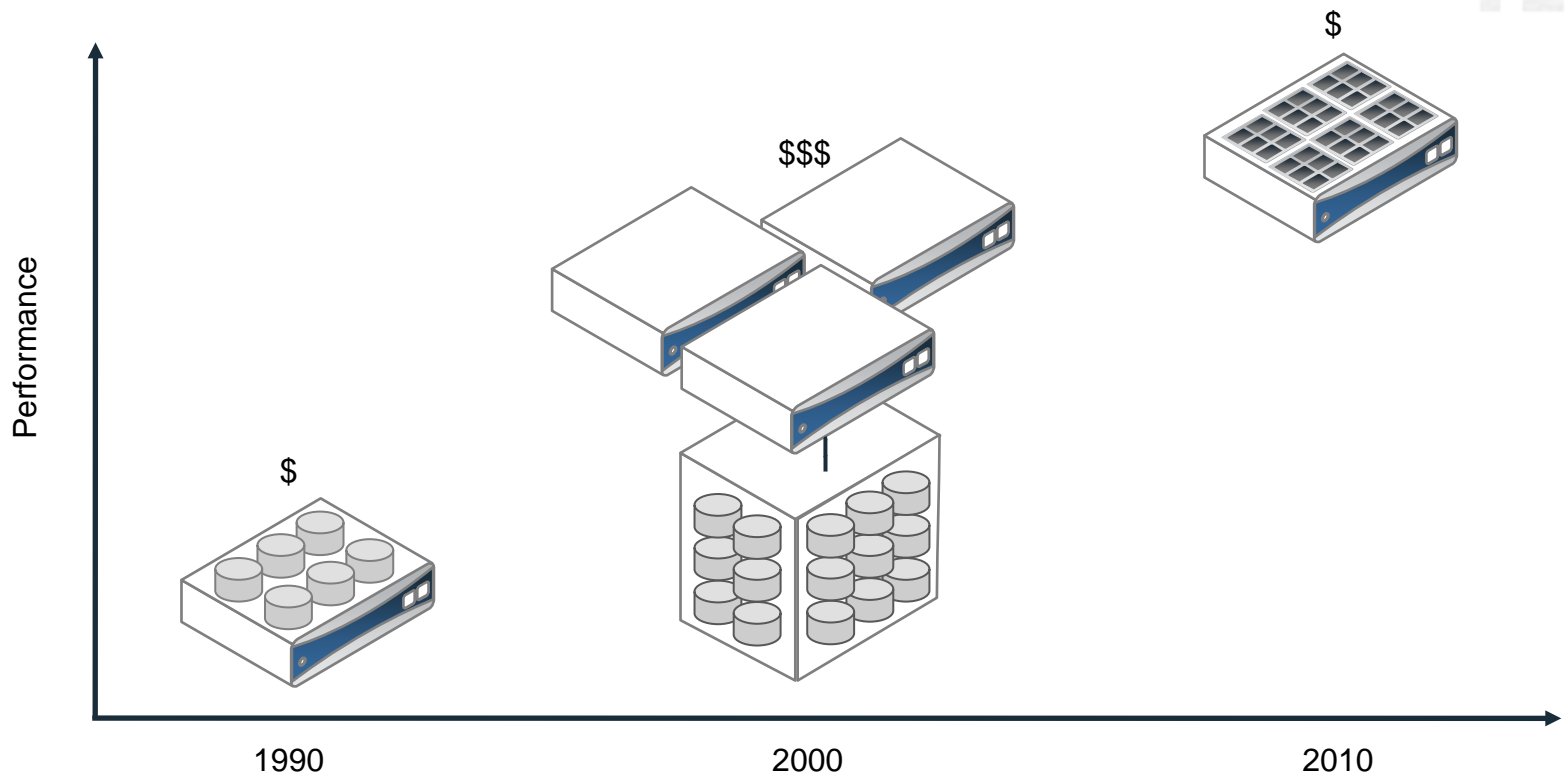
FUSION-io





A NEW APPROACH IS NEEDED

FUSION-io

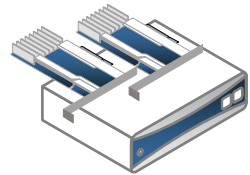
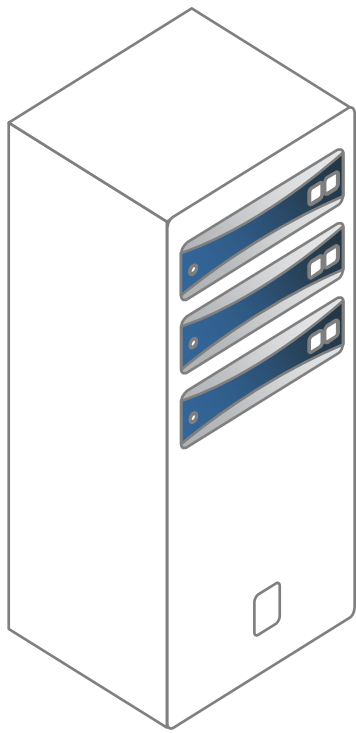




THE POWER OF A SAN

FUSION-io

IN A 1 U SERVER





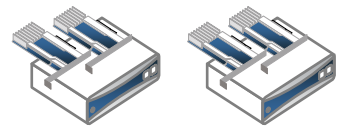
ACCELERATION SOLUTIONS

FUSION-io

Direct

Max Acceleration

- Lowest latency
- Smallest footprint
- For I/O intensive applications





ACCELERATION SOLUTIONS

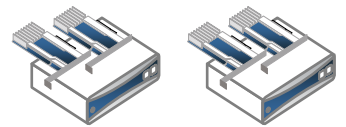
FUSION-io

Direct

Shared

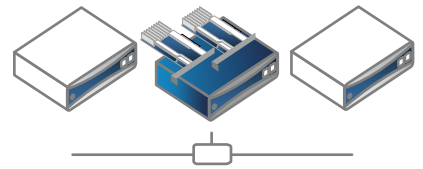
Max Acceleration

- Lowest latency
- Smallest footprint
- For I/O intensive applications



Max Scalability

- Multi-protocol
- Platform Independent
- For clustered architectures



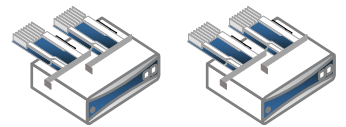


ACCELERATION SOLUTIONS

Direct

Max Acceleration

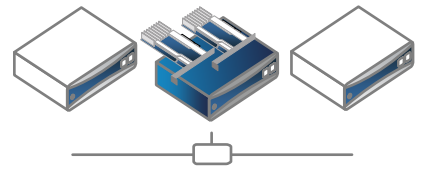
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- For I/O intensive applications



Shared

Max Scalability

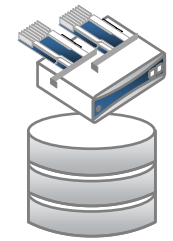
- Multi-protocol
- Platform Independent
- For clustered architectures



Caching

Max Interoperability

- Drop-in SAN/NAS acceleration
- Storage workload reduction
- Greater VM density





Application Centric

- ▶ VM or Server-based
- ▶ File, application, and VM visibility
- ▶ Before block conversion
- ▶ Avoids network latency

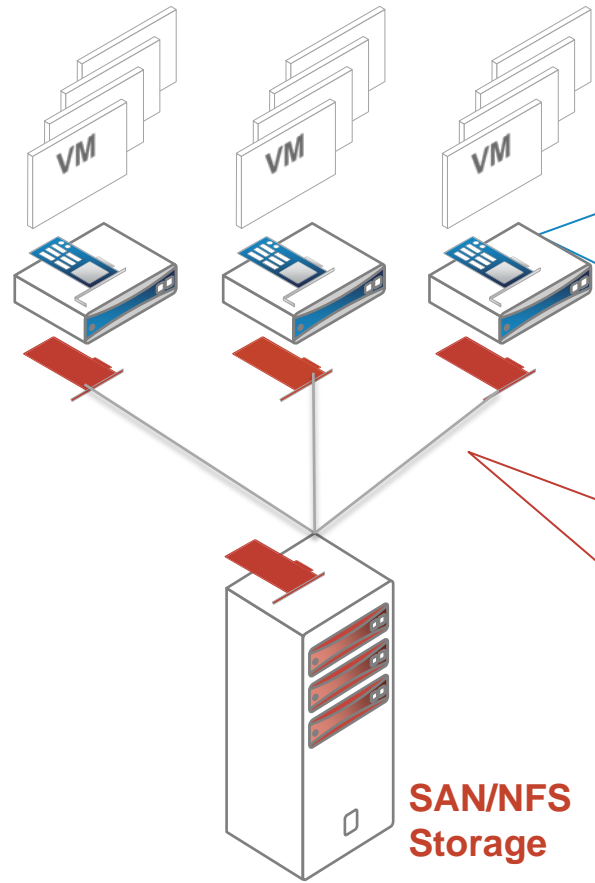
Array Centric

- ▶ Downstream, block-level
- ▶ After file-to-block conversion
- ▶ After VMs merge
- ▶ SAN lock-in
- ▶ Storage side incurs network latency



APPLICATION AND ARRAY CACHING

FUSION-io



- SQL Server
- Oracle
- Exchange
- SharePoint

110101010100
100101011101
000101010100

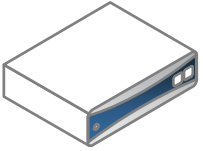
**SAN/NFS
Storage**



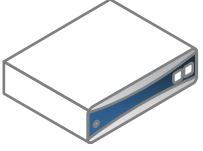
YESTERDAY'S TIERED ARCHITECTURE THINKING

FUSION-io

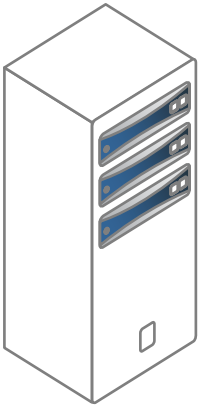
Application



Database



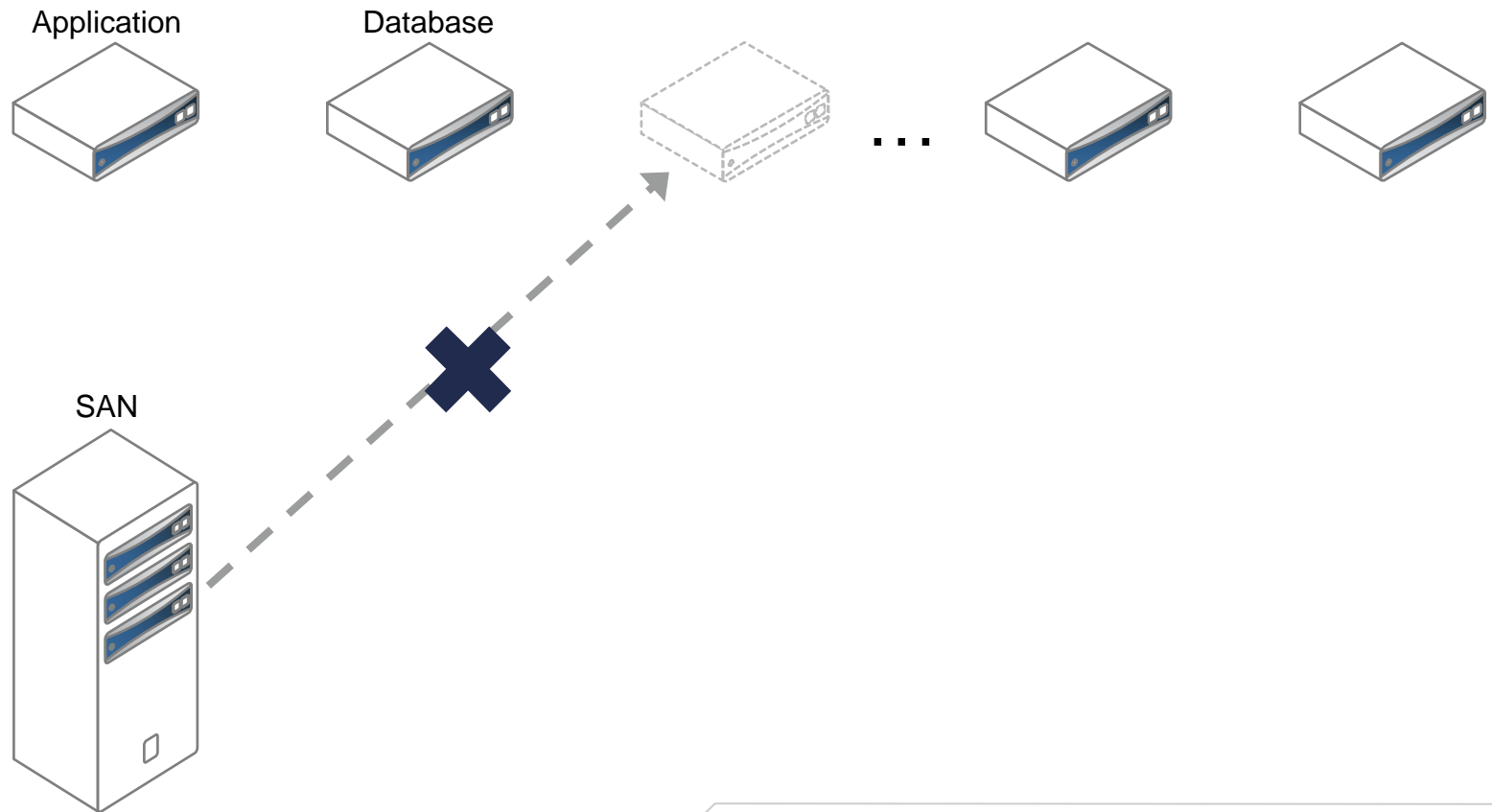
SAN





SERVER CENTRIC DEPLOYMENTS

FUSION-io

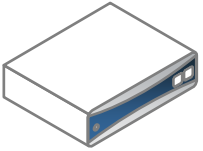




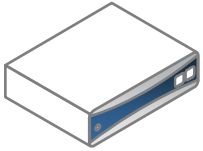
SOLUTION – SOFTWARE-DEFINED STORAGE

FUSION-io®

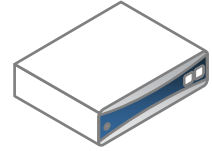
Application



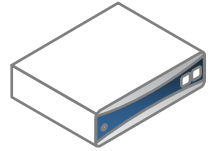
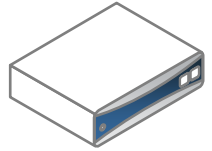
Database



Shared Storage



...





MARKET GROWTH ACCELERATORS

FUSION-io





THANK YOU

@GARYORENSTEIN