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FIBRE CHANNEL INDUSTRY ASSOCIATION

Fibre Channel is Here to Stay.

What's New?

Roadmap to the Future!

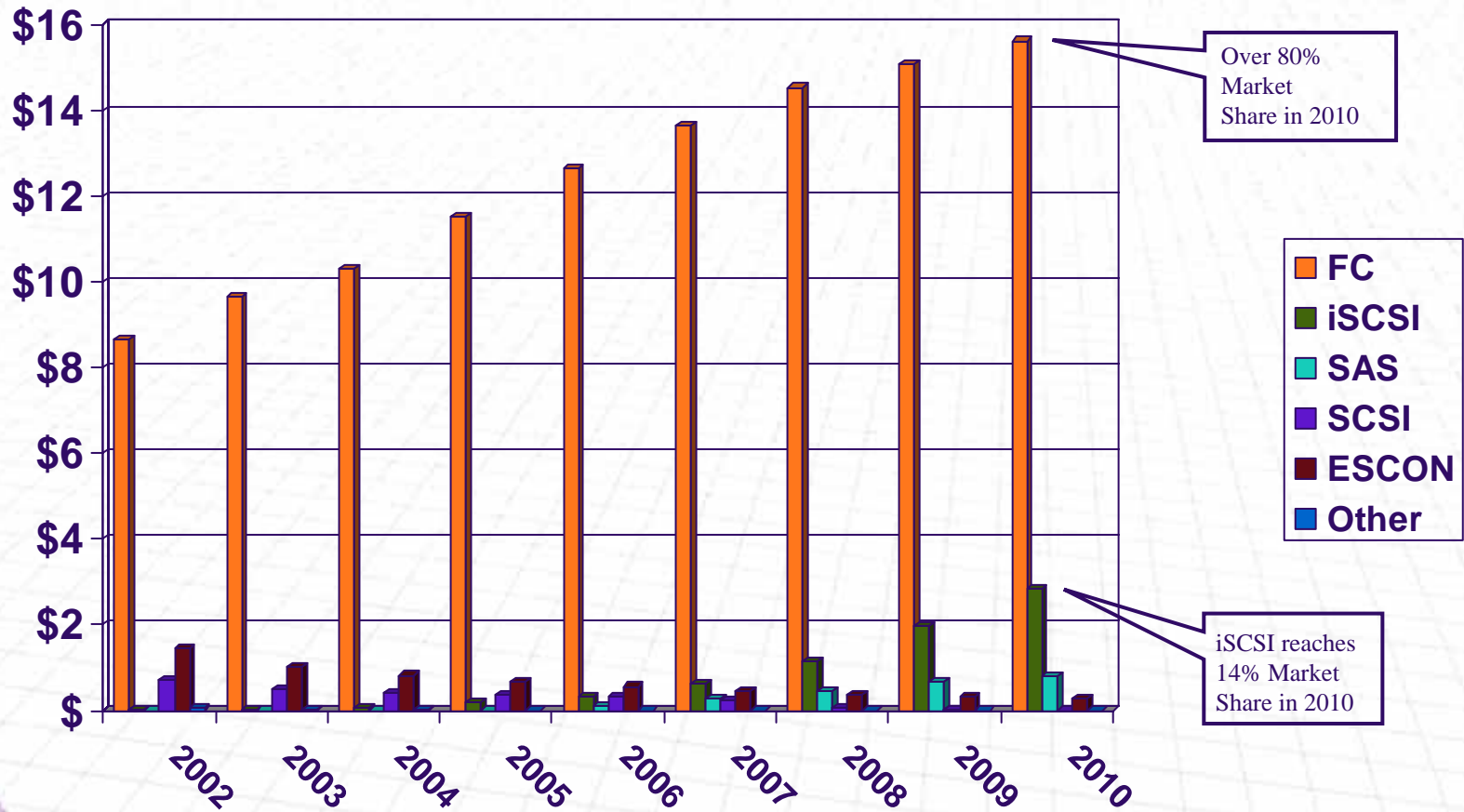**Storage Networking World FALL 2006**
Orlando, Florida

Fibre Channel Continuous Evolution

- **FC has been the major storage system interconnect since the mid 90s**
  - **FC now dominates the SAN and external storage market place with over 90% market share**
- **How will FC continue to Meet customers' evolving needs?**
  - **Faster speeds**
  - **Bandwidth/Cost leadership**
  - **Investment protection**
  - **Additional capabilities**
  - **Lower cost solutions**
  - **Simplified solutions (Plug-n-play**

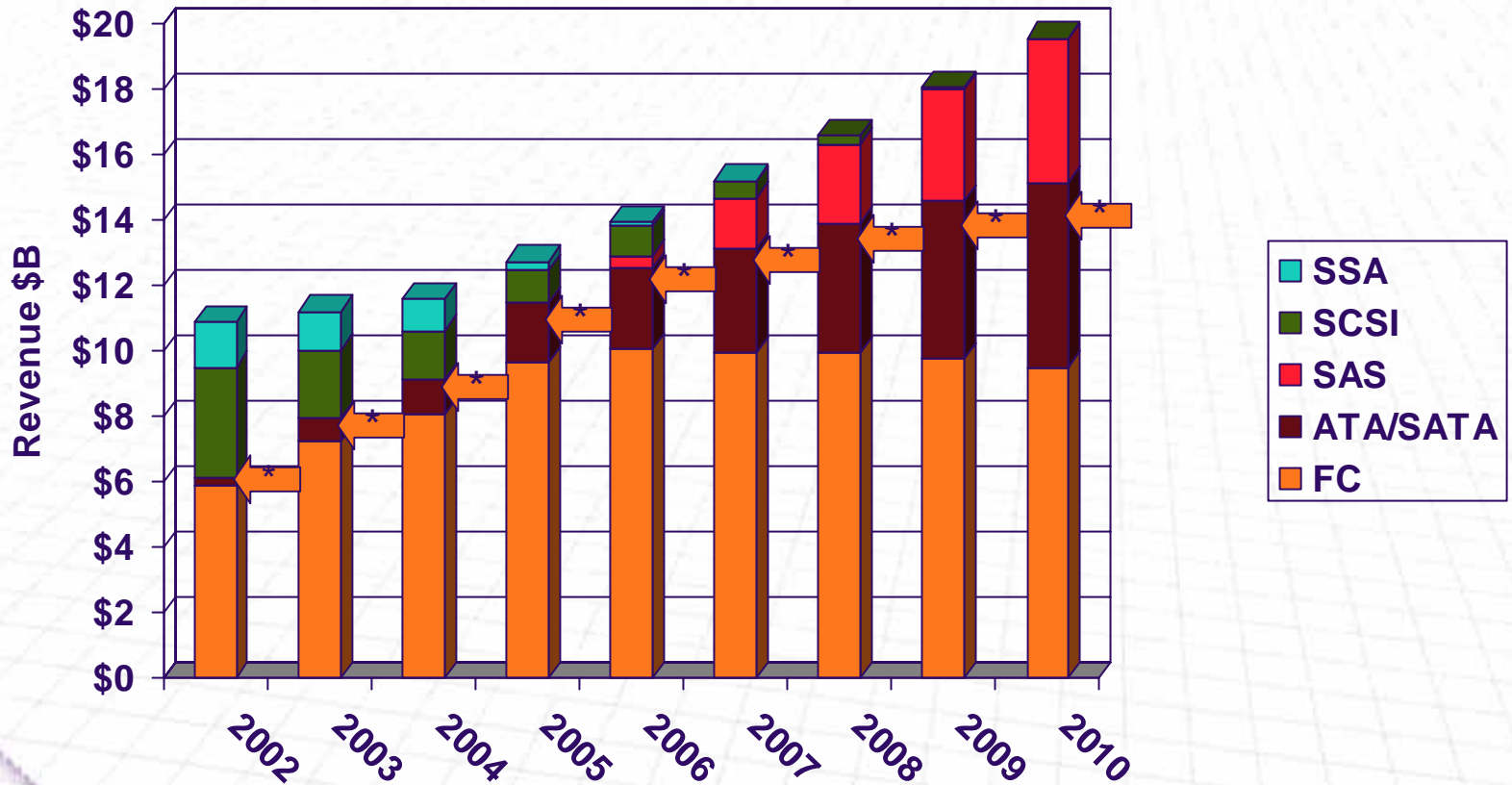## *Future-Proof Your Storage Investments*

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Continuous SAN Market Growth

**Block External Controller-Based Disk Storage
By Host Interface Revenue**

Over 80% Market Share in 2010

iSCSI reaches 14% Market Share in 2010

Legend:
- FC
- iSCSI
- SAS
- SCSI
- ESCON
- Other

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Continuous Back-End Market Growth

**Block External Controller-Based Disk Storage
By HDD Interface Revenue**

Legend:
- SSA
- SCSI
- SAS
- ATA/SATA
- FC

Y-axis: Revenue $B ($0 to $20)

X-axis: 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010

Source: Gartner External Controller-Based Disk Storage
WW 2006-2010, 6 October 2006 (FICON Included in Fibre Channel)

* Estimate of FC+SATA over FC Infrastructure.
  Source: FCIA

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Fibre Channel Speeds – 3 Connection Types

- **FC specifies 3 connection types**
  - FC-Base2
  - FC-Base10
  - FC-BaseT
  - *All speeds of each type Auto-negotiate best speed w/o any user intervention!*
  - *Each speed within its connection type is backward compatible 2 generations!*
- **FC-Base2**
  - Predominant FC interconnect
  - Used for fabric Edge and ISL
  - Also used for Disk and Tape Drives
  - All speeds single lane serial streams
  - Optics and copper cabling, SFP/SSF
- **FC-Base10**
  - Used for ISL (2.5x-3x bandwidth of edge)
  - *4G Edge/10G ISL migrates to 8G Edge/20G ISL migrates to 16G Edge/40G ISL, etc*
- **FC-BaseT**
  - Used to plug FC into Enet installations
  - Copper only (Cat5/5e/6 cables)
  - RJ-45 connector
  - User can use FC without changing any existing or new Ethernet cabling!

ISL Core
(FC-Base10 or Base2)

Edge *(FC-Base2)*

Ethernet *(FC-BaseT)*
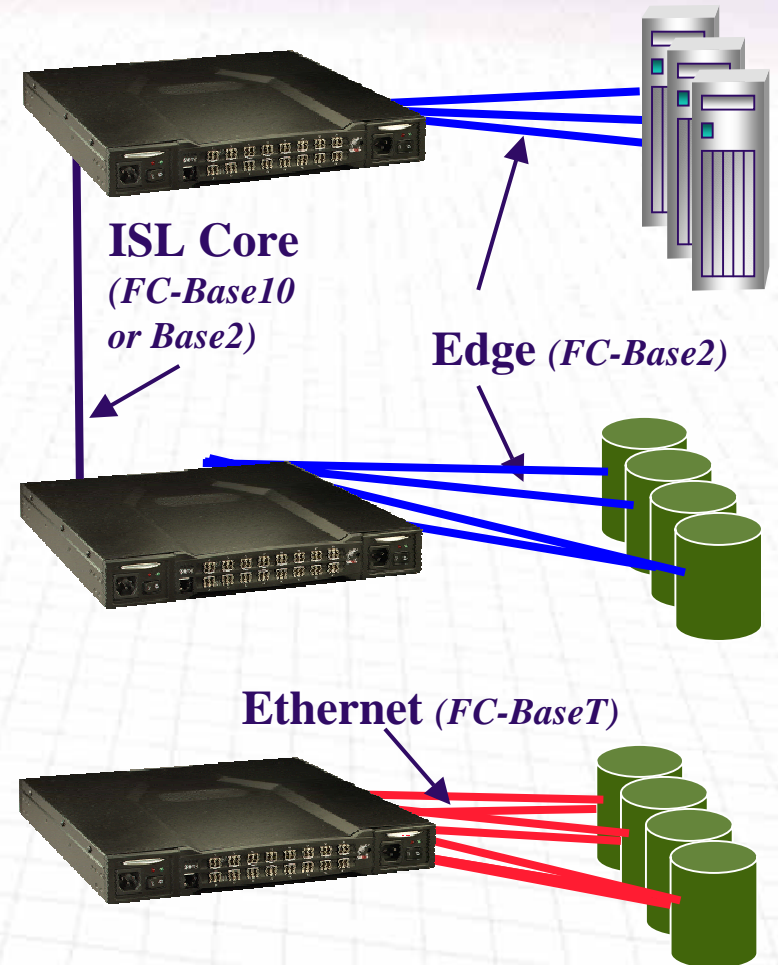
FCIA Fibre Channel Speed Roadmap
(Page 1 of 3)

Product Naming	Throughput (MBps)	Line Rate (GBaud)†	T11 Spec Technically Completed (Year)‡	Market Availability (Year)‡
1GFC	200	1.0625	1996	1997
2GFC	400	2.125	2000	2001
4GFC	800	4.25	2003	2005
8GFC	1600	8.5	2006	2008
16GFC	3200	17	2009	2011
32GFC	6400	34	2012	Market Demand
64GFC	12800	68	2016	Market Demand
128GFC	25600	136	2020	Market Demand

Base2*

Base10** See Page 2 of 3 of this Roadmap

BaseT*** See Page 3 of 3 of this Roadmap

*Base2 used throughout all applications for Fibre Channel infrastructure and devices. Each speed maintains backward compatibility at least two previous generations (I.e., 4GFC backward compatible to 2GFC and 1GFC)
**Base10 commonly used for ISLs, core connections, and other high speed applications demanding maximum bandwidth. (See page 2 of 2 of this roadmap for Base10)
***BaseT used in common Ethernet copper infrastructures incorporating CAT5/5e/6 cables and RJ-45 connectors (see page3 of this roadmap for FC-BaseT)
†Line Rate: All Base2 speeds are single-lane serial stream
‡Dates: Future dates estimated

Courtesy of FCIA

Base2*

See Page 1 of 3 of this Roadmap

Base10**

Product Naming	Throughput (MBps)	Line Rate (GBaud)†	T11 Spec Technically Completed (Year)‡	Market Availability (Year)‡
10GFC	2400	10.52	2003	2004
20GFC	4800	21.04	2007	2008
40GFC	9600	42.08	TBD	Market Demand
80GFC	19200	84.16	TBD	Market Demand
160GFC	38400	168.32	TBD	Market Demand

BaseT***

See Page 3 of 3 of this Roadmap

***Base2** used throughout all applications for Fibre Channel infrastructure and devices. (see page 1 of this roadmap for FC-Base2)
****Base10** commonly used for ISLs, core connections, and other high speed applications demanding maximum bandwidth. Each Base10 speed maintains backward compatibility at least two previous generations (I.e., 40GFC backward compatible to 20GFC and 10GFC)
*****BaseT** used in common Ethernet copper infrastructures incorporating CAT5/5e/6 cables and RJ-45 connectors (see page3 of this roadmap for FC-BaseT)
†**Line Rate**: Base10 rates listed are for serial stream methodologies. However, final output speed may be generated with aggregated methodologies such as XAUI
‡**Dates**: Future dates estimated

Courtesy of FCIA

FCIA Fibre Channel Speed Roadmap
(Page 3 of 3)

Base2* | See Page 1 of 3 of this Roadmap

Base10** | See Page 2 of 3 of this Roadmap

BaseT***

Product Naming	Throughput (MBps)	Equivalent Line Rate (GBaud)†	T11 Spec Technically Completed (Year)‡	Market Availability (Year)‡
1GFC	200	1.0625	2006	2007
2GFC	400	2.125	2006	2007
4GFC	800	4.25	2006	2007
8GFC	1600	8.5	TBD	Market Demand
10GFC	2400	10.52	TBD	Market Demand

*Base2 used throughout all applications for Fibre Channel infrastructure and devices. (see page 1 of this roadmap for FC-Base2)
**Base10 commonly used for ISLs, core connections, and other high speed applications demanding maximum bandwidth. (see page 2 of this roadmap for FC-Base10)
***BaseT used in common Ethernet copper infrastructures incorporating CAT5/5e/6 cables and RJ-45 connectors. Except for 10GFC FC BaseT, each BaseT speed maintains backward compatibility at least two previous generations (I.e., 4GFC backward compatible to 2GFC and 1GFC)
†Equivalent Line Rate: BaseT rates listed are equivalent data rates for serial stream methodologies. However, final output speed is generated with aggregated methodologies.
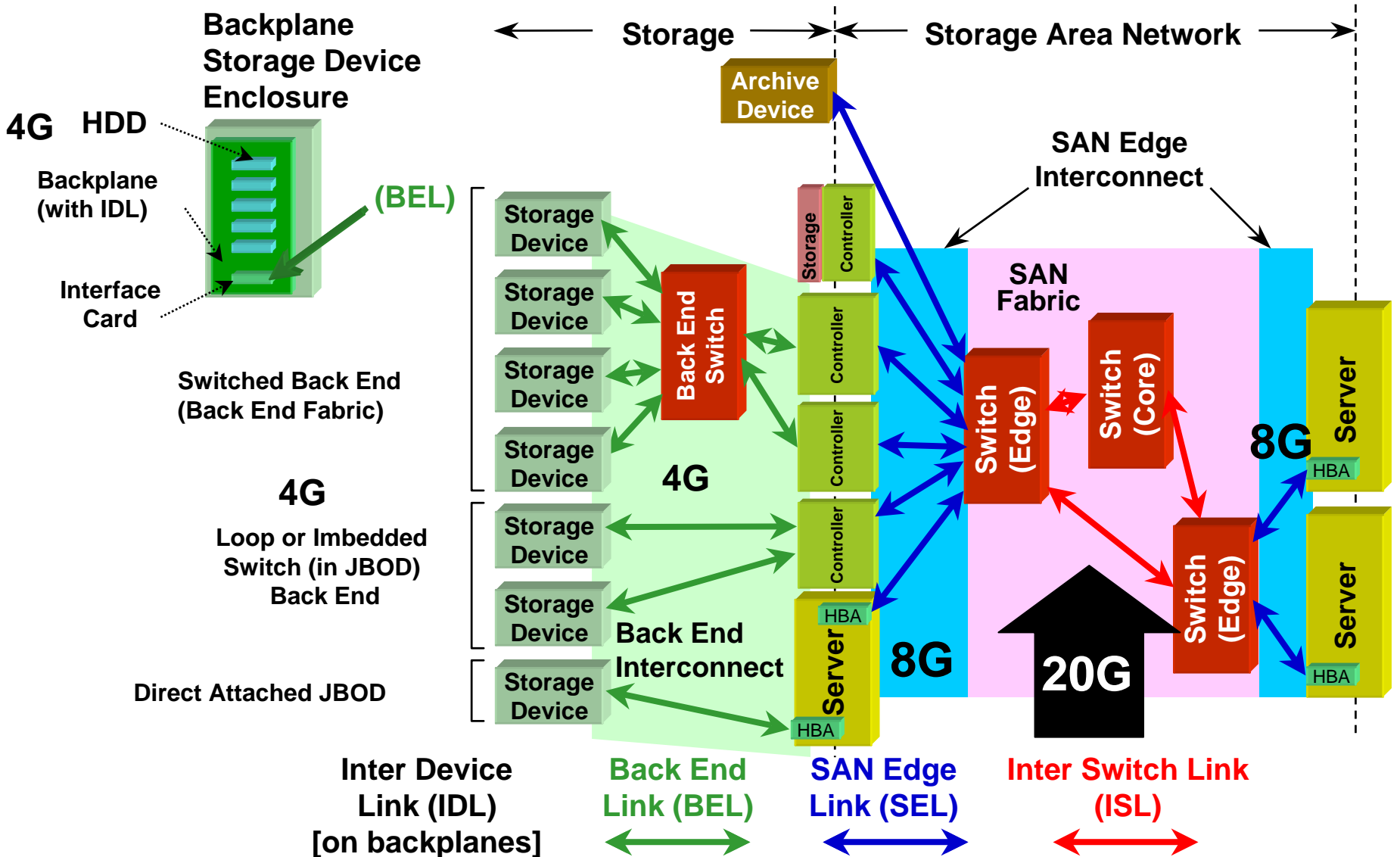‡Dates: Future dates estimated

Courtesy of FCIA

SAN Speed Migration Example – Today's Typical 4GFC Edge with 10GFC ISL

Courtesy of FCIA

Speed Migration Example (**cont**) – 4GFC Edges move to 8GFC Edges causes 10GFC ISL Core to Choke!

Courtesy of FCIA
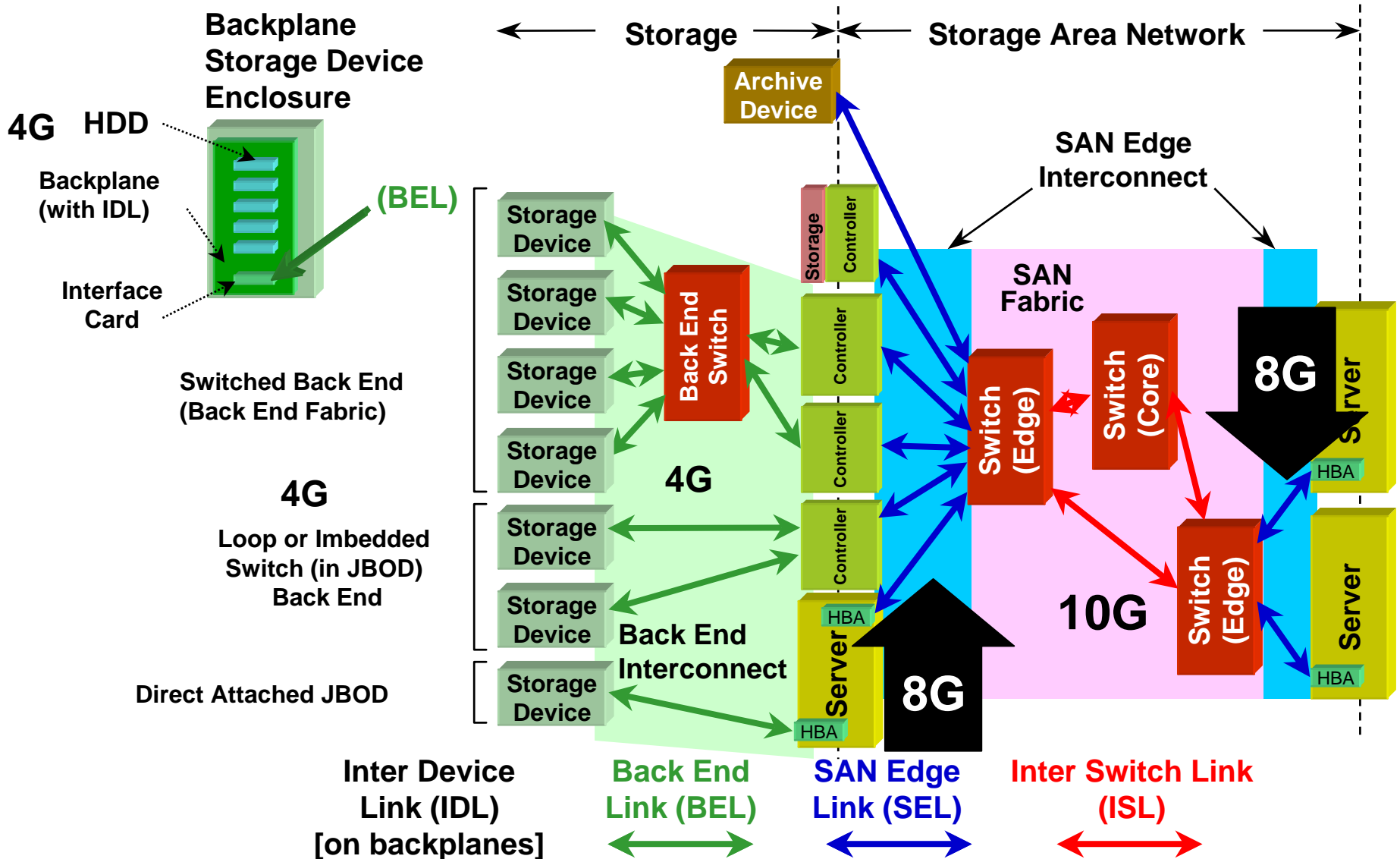
Speed Migration Example (cont) – Upgrade from 10GFC to 20GFC ISL returns 2.5x – 3x speed Edge bandwidth to ISL

Courtesy of FCIA

FC Roadmap - Fastest Speeds

- **2GFC Dominates current shipping SANs**
  - Twice 1 GbE speeds and more efficient

- **4GFC Fibre Channel solutions**
  - Fastest storage interconnect available today

- **8GFC Under development**
  - Active development of 8GFC, standard stable end of December 2006
  - Focused on low cost, backward compatibility & fast time-to-market for Edge and ISL

- **10GFC Deployed today for Inter-Switch Links**
  - Provides 2.5x – 3x ISL core bandwidth for 4GFC edge links
  - Migrates to 20GFC to maintain 2.5x-3x (useabe line rate) ISL bandwidth for 8GFC edge links, 40GFC ISL for 16GFC Edge rates, 80G for 32G, etc

- **16GFC Fibre Channel on the horizon**
  - 8G Edge and ISL links migrate to 16G Edge and ISL links or for maximum ISL bandwidth use 40GFC ISL with 16GFC Edge

Roadmap All the Way to 128GFC!

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There's More to Fibre Channel than being just the Fastest Storage Interface On Earth!

New Fibre Channel Standards for Protocols, APIs, and Management

Fibre Channel
Easier and More Secure than Ever!

FC Roadmap - Standards Innovation

- **FC-SP: Security Protocol**
  - Authentication with DH-CHAP
  - Encryption supported
  - Currently in letter ballot
  - Products starting now
- **FC-SCM: Simplified Configuration and Management**
  - Moves FC into smaller SAN markets
  - Plug-n-play level easy install, maintain
  - Currently in FCIA requirements phase
- **FC-SATA: SATA Tunneling over FC**
  - Brings native tiered storage to FC
  - Technical specifications complete
  - Products within 12 months

FC Roadmap - Standards Innovation

- **IFR: Inter-Fabric Routing**
  - Provides heterogeneous fabric routing
  - Improves scalability and interoperability
  - Technical specifications complete
  - Products within 6 months
- **NPIV: N-Port ID Virtualization**
  - Makes the port ID autonomous from the server
  - Improves the sharing of physical HBA's for Hypervisors
  - Specification Complete
  - Products already proven in the mainframe market
- **FAIS: Fabric Application Interface Specification**
  - Standardizes the interface to the fabric
  - Specification complete
  - Speeds time-to-market and improves interoperability
  - Products within 12 months

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Fibre Channel: The Storage of Business

- *Dominates* **the SAN market today**
- **Fibre Channel has a clear roadmap to provide:**
  - Higher performance
  - Additional capabilities (Security, Tiered Storage, Intelligence…)
  - Enablers for new markets
- **Easy to learn, use and implement**
- **Protects and future proofs storage investments**
- **Comprehensive end to end solution**

Fibre Channel: Unchallenged in Storage

Fibre Channel is Here to Stay - Period

Roadmap for YOUR SAN!

November 2006