

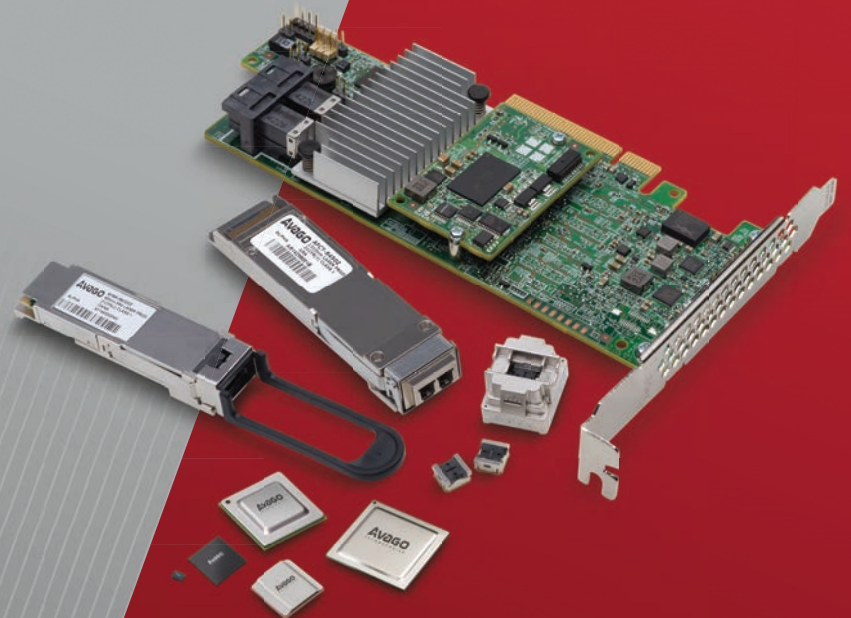
Your Imagination. Our Innovation.



Avago Product Solutions for Data Centers



Application Solutions



Empowering the Ever-Expanding Data Center

with Fast Data Speed, Extended Data Links, High
Density Connectivity and Greater Storage Capacity

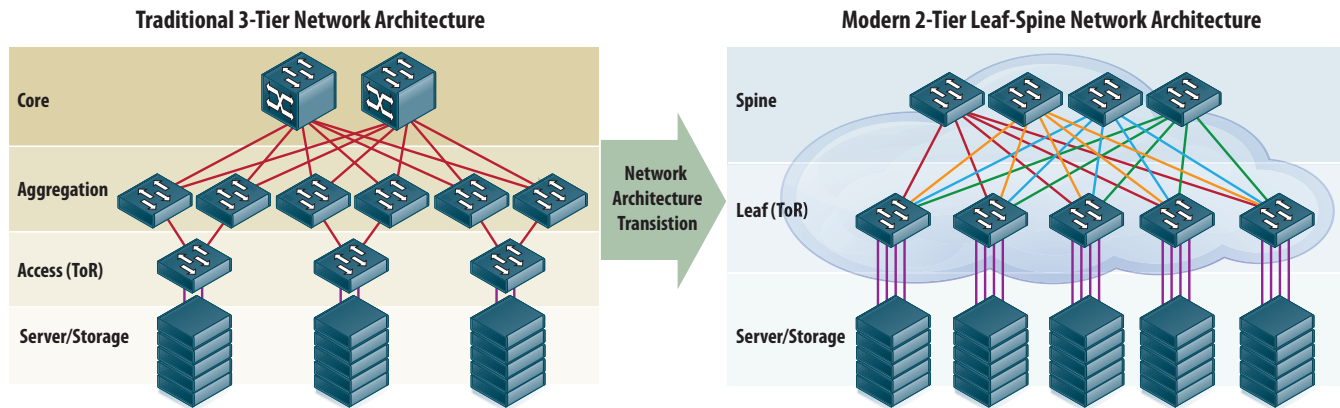
Modern data centers are expanding
in size with higher data bandwidth
support and greater storage capacity.

Data-intensive applications such as Big Data, cloud computing, video streaming services and mobile broadband internet connectivity continue to grow at an accelerating rate. The ever-expanding data volumes pose many technical challenges on data centers. Multiple terabits of data travel to and from the data center each second. Moving such massive data around the data center requires a robust infrastructure that is capable of handling high bandwidth data delivery to and from storage endpoints, servers, top-of-rack (ToR) switches and core switches.



Courtesy of Connie Zhou

Figure 1. Data Center Architecture Transistion



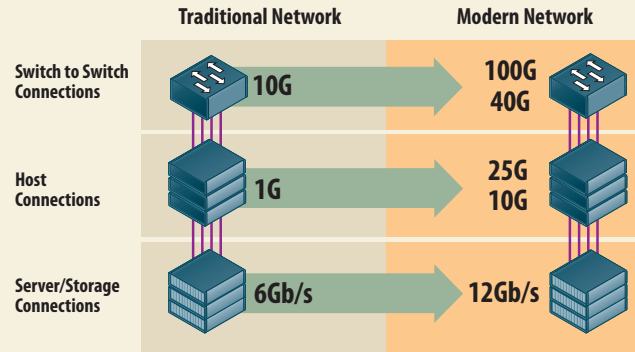
Data Center Architectural Transformation

Data centers worldwide are undergoing major transformations to keep pace with current needs and future-proofing systems to support future needs. The prevalent trend in modern data centers is the architectural shift from a traditional 3-tier network to a cloud-based 2-tier network called the leaf-spine network. The leaf-spine network is a massively scalable, distributed core architecture that can support unrestricted communications between any two hosts in the network at full bandwidth, enabling an expansive and high bandwidth data center network. Compared with a traditional 3-tier network, the leaf-spine network has higher port counts and longer data links between the switches and supports higher bandwidth data delivery to and from storage endpoints. In essence, modern data centers are expanding in size with fast data speed, extended data links, high density connectivity and greater storage capacity.

Data Speed Transformation

Another significant transformation is the upgrade of data speeds across the data center network to support higher bandwidth demands and improve data storage transfer (See Figure 2). Many data centers are being provisioned to support higher speed server Ethernet uplinks. 1G Ethernet links are being upgraded to 10 and 25 Gb/s at the host connections where servers reside. 10G Ethernet links are being upgraded to 40 and 100 Gb/s at the switch-to-switch connections. Similarly for server storage connections, SAS/SATA links are being upgraded from 6 to 12 Gb/s to facilitate faster transfer of data to and from disk subsystems. With SAS parallel processing architecture, massively scalable data storage can be provisioned to support higher cloud storage demands.

Figure 2. Data Speed Transformation



Fiber Optic Product Solutions

Speed	≤20m	≤100m	≤150m	≤550m	≤10 km
100G		CXP SR10 AOC AFBR-83EDxxZ AFBR-83PDxxZ AFBR-83CDxxZ MicroPOD™ & MiniPOD™ AFBR-77D1xZ/78D1xZ AFBR-77D2xZ/78D2xZ AFBR-77D4xZ/78D4xZ AFBR-811xyZ/821xyZ AFBR-812xyZ/822xyZ AFBR-814xyZ/824xyZ QSFP28 SR4 AFBR-89CDDZ	CXP SR10 AFBR-83EDZ AFBR-83PDZ CFP2 SR10 AFBR-8422IDZ	CXP eSR10* AFBR-83PD3Z AFBR-83PD32Z CFP2 eSR10 AFBR-8422EDZ MicroPOD & MiniPOD AFBR-77D13SZ/78D13SZ AFBR-811xy3Z/821xy3Z QSFP28 eSR4*	CFP4 LR4* AFCT-8450Z
40G	QSFP+ SR4 AOC AFBR-7QERxxZ AFBR-7IERxxZ		QSFP SR4 AFBR-79EQxZ SFBR-79EQPZ-DC1 QSFP+ iSR4 AFBR-79EixZ	QSFP+ 3SR4 AFBR-79E3PZ SFBR-79E3PZ-DC1	QSFP LR4 AFCT-88EEPZ (10 km) AFCT-88EIPZ (2 km)
25G		SFP+ SR*			
10G	SFP+ AOC AFBR-2CARxxZ		QSFP+ iSR4 AFBR-79EixZ	QSFP+ eSR4 AFBR-79EEPZ SFBR-79EEPZ-DC1 SFP+ SR AFBR-709SMZ SFBR-709SMZ-DC1	SFP+ LR AFCT-701SDZ (10km) AFCT-739SMZ (10km, Available Q3'15)
1G		SFP Copper (RJ45) ABCU-57xxxZ SBCU-5730RZ-DC1		SFP SX AFBR-57xxxZ	SFP LX AFCT-57xxxZ

* Please contact Avago marketing representative for more information.

With these transformations come major technical challenges across various levels of electrical and optical design from chips to packaging to optical components to modules and to systems. New SerDes cores are required to perform at higher speed over an extended reach copper backplane. New optical engines are required to deliver data at higher speed over extended reach fiber cabling. New data storage chip platforms are needed to ensure robust, high bandwidth data transfer to and from storage endpoints.

Avago Technologies has addressed these challenges and brought to market highly differentiated and cost-effective solutions that meet the growing needs of modern data centers:

- Comprehensive portfolio of fiber optic transceiver, transmitter and receiver module solutions supporting 1G, 10G, 25G, 40G and 100G from 20m to 10km link distance.
- Unique selection of SerDes ASIC solutions solving challenging chip-to-chip and chip-to-module interfaces for network backplane and mid-plane applications at 10G, 25G, 28G, 50G and beyond.
- Extensive portfolio of SAS/SATA RAID controllers, host bus adapters (HBAs) and server storage building blocks with unrivaled IOPS performance, high reliability and seamless scalability.
- Industry leading portfolio of PCIe switch and bridge solutions providing critical connectivity and throughput functions across various levels of the data center network.
- Broad selection of advanced HDD/SSD SoC and HDD preamplifier solutions addressing high-capacity, high-performance storage needs.

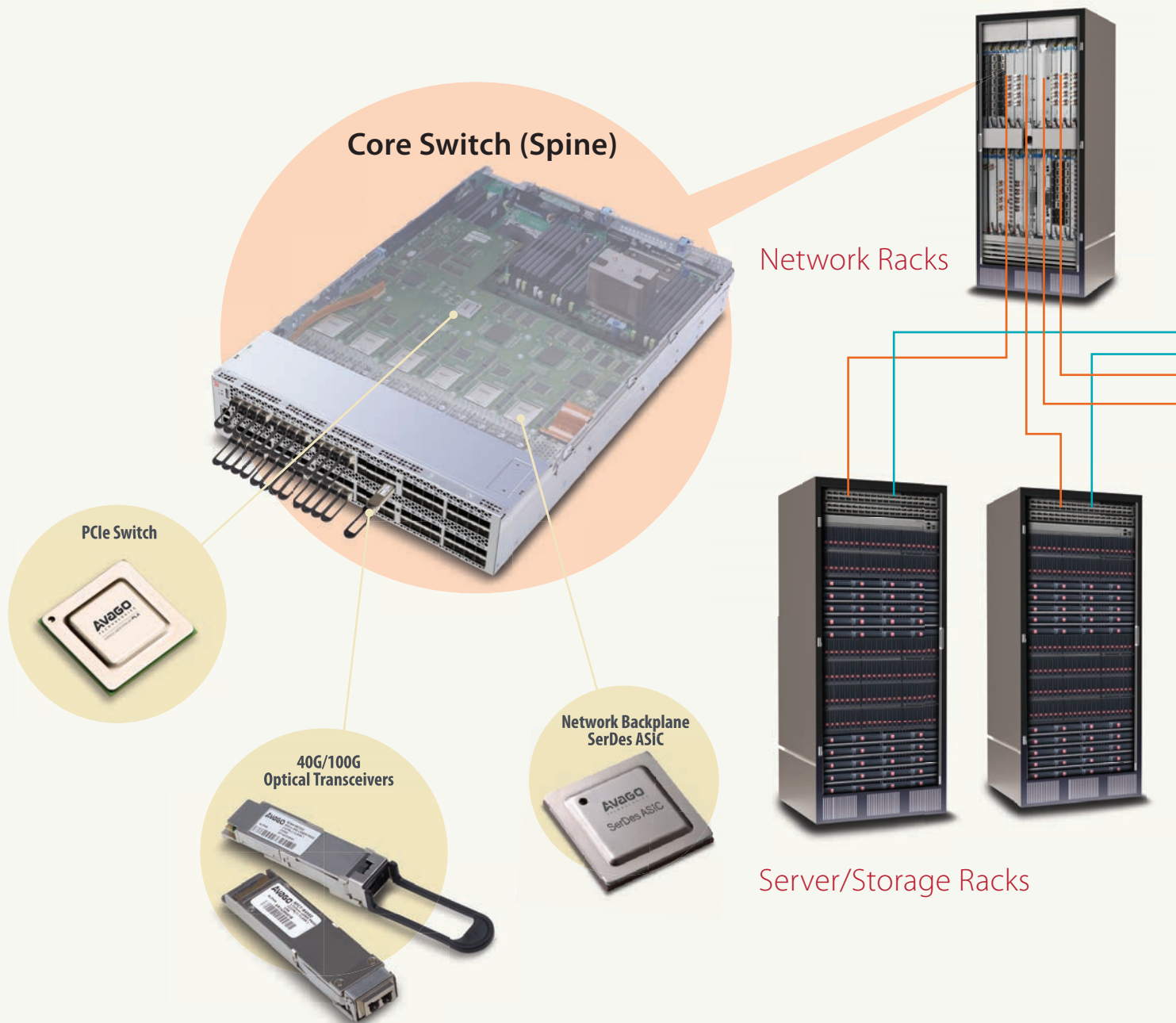
Server Storage Product Solutions

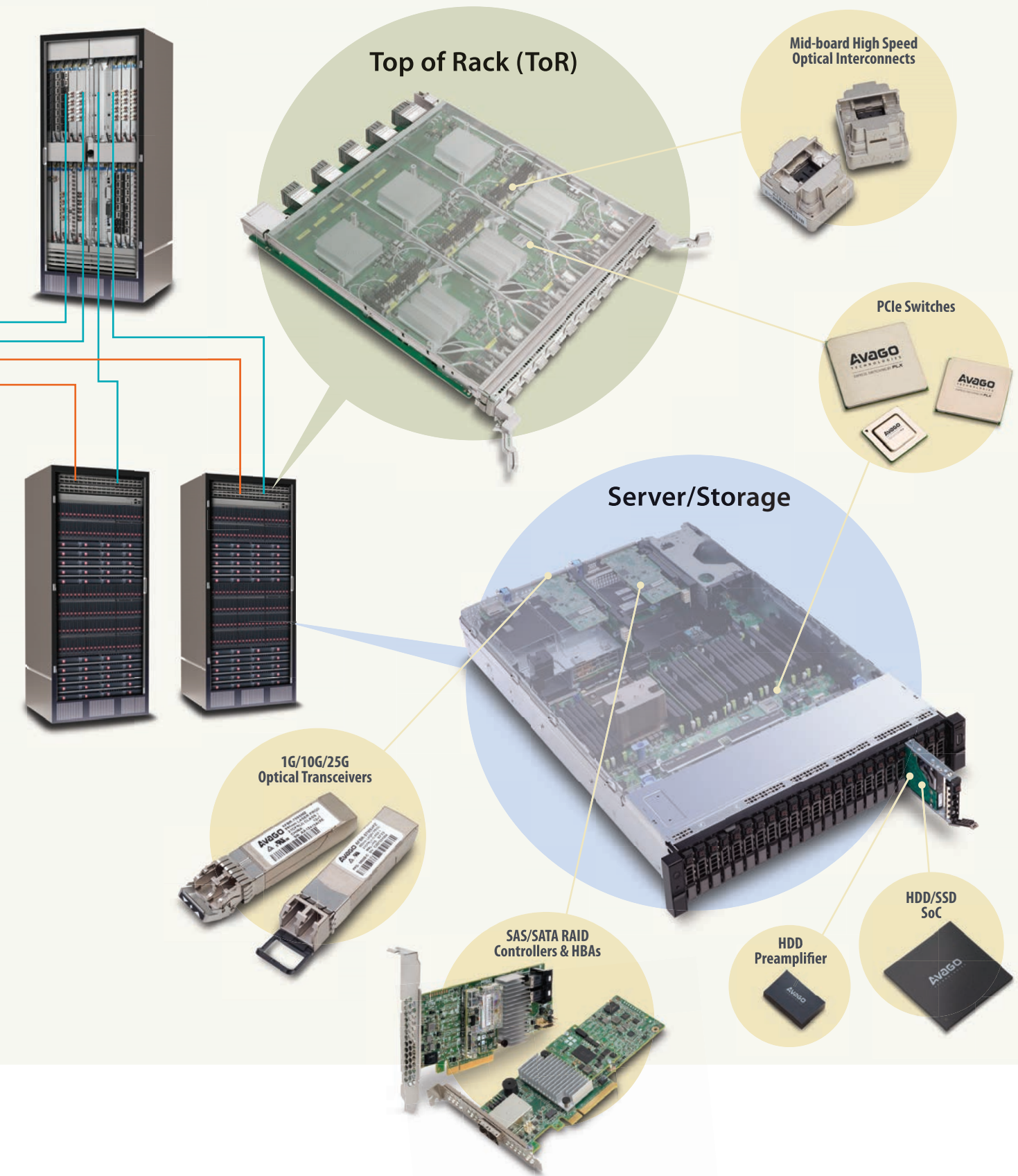
SAS Speed	I/O Controller (IOC)	RAID-on-chip (ROC)	Expander	Host Bus Adapters (HBAs)	RAID Controller Card	Shared DAS
12 Gb/s	SAS 3008	SAS 3108	SA S3X36 SAS 3X40 SAS 3X48 SAS 3X24R SAS 3X28R SAS 3X36R	HBA (3008) SAS 9300-4i4e SAS 9300-4i/8i SAS 9300-8i/8e SAS 9300-16i/16e	iMegaRAID™ (3008) SAS 9341-4i/8i MegaRAID™ (3108) SAS 9361-4i/8i SAS 9380-8e SAS 9380-4i4e	Syncro™ (3108) SAS 9361-8i SAS 9380-8e
6 Gb/s	SAS 2308 SAS 2008	SAS 2208 SAS 2108	SAS 2x36 SAS 2x24	HBA (2308) SAS 9206-16e SAS 9207-4i4e SAS 9207-8i SAS 9207-8e HBA (2008) SAS 9200-8e SAS 9201-16i SAS 9211-4i/8i SAS 9212-4i4e	iMegaRAID (2008) SAS 9240-4i/8i MegaRAID (2208) SAS 9266-8i SAS 9270-8i SAS 9271-4i/8i SAS 9286-8e	Syncro (2208) SAS 9271-8i SAS 9286-8e

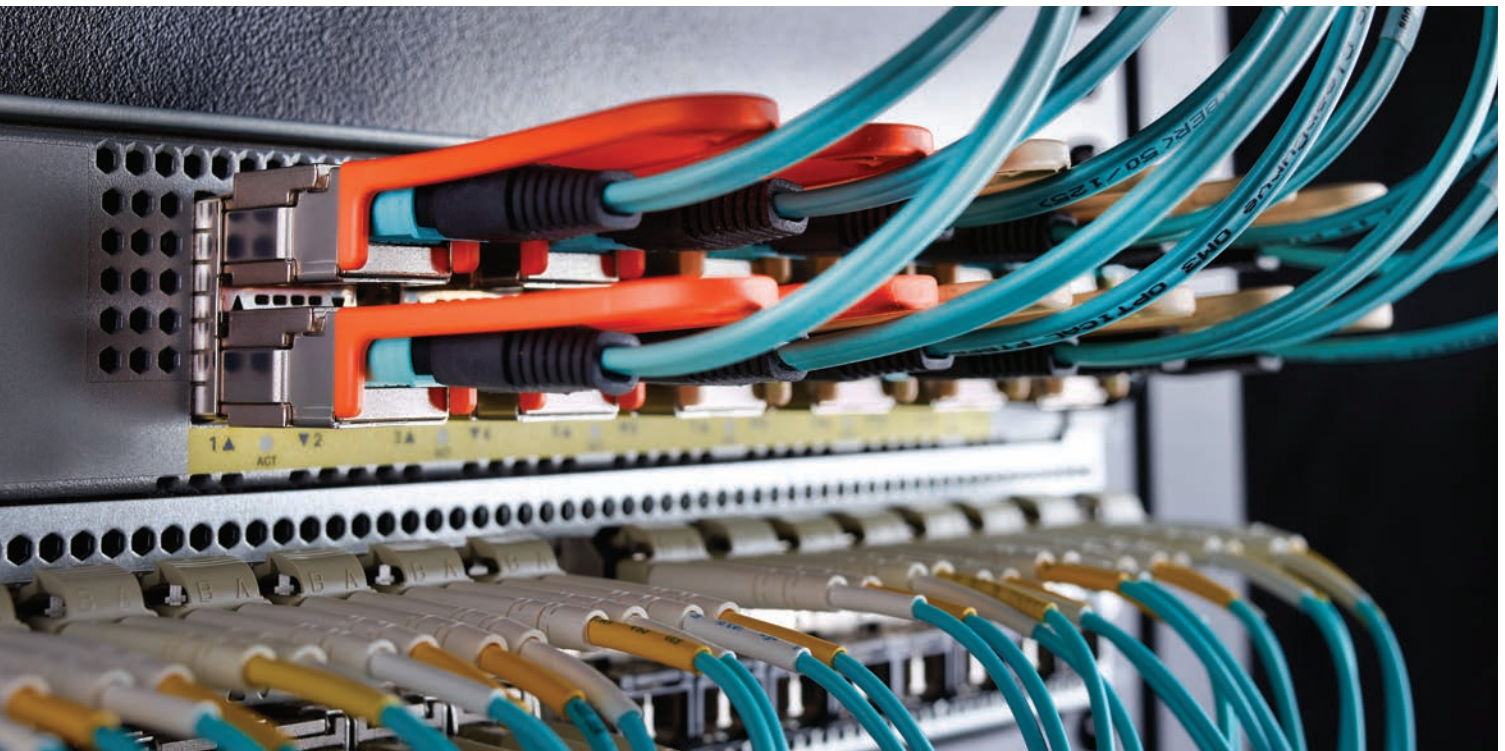
PCIe Switch Solutions

PEX9700 Series ExpressFabric PCIe Gen 3 Switch Family							
Product	PEX9797	PEX9781	PEX9765	PEX9749	PEX9733	PEX9716	PEX9712
Lanes	97	81	65	49	33	16	12
Ports	25	21	17	13	9	5	5

Avago's Broad Portfolio of Data Center Solutions





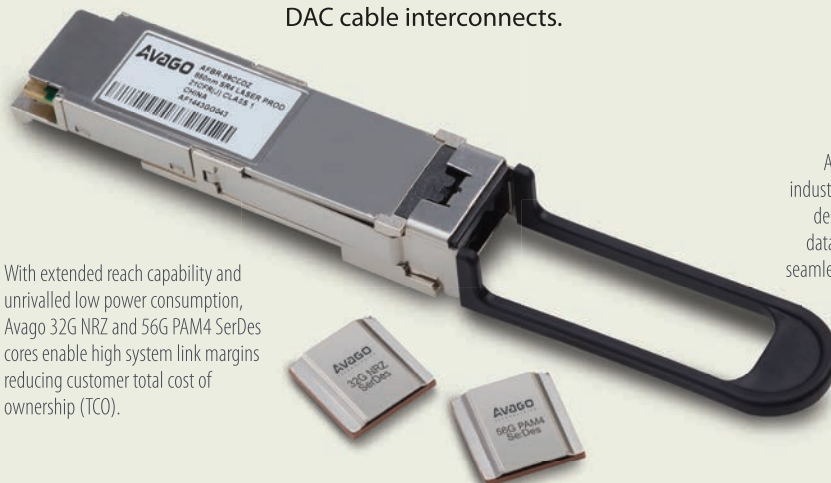


Avago's QSFP+ eSR4 is the industry's longest reach 40G multi-mode parallel optic transceiver module extending data links beyond 500 meters.

Extended Data Link Advantage

As the data center expands in size, there are many long-reach fiber links between ToR and core switches. Especially in a mega-size 40G/100G leaf-spine network, many fiber links are needed beyond the maximum link distances specified by IEEE. Avago offers a wide selection of highly-differentiated parallel optic transceiver module solutions that extend data links beyond industry standards, enabling data center operators to maintain their existing cable infrastructure and save additional CAPEX spending for data center upgrades.

At the board level in high-speed network backplanes or switches, advanced SerDes ASIC is needed to ensure signal integrity over long reach copper backplane or cabling. Avago offers a unique selection of SerDes ASIC solutions enabling long reach chip-to-chip and chip-to-module interconnects. Avago has the industry's longest reach 25G, 28G, 32G and 56G SerDes cores withstanding up to 35 dB of channel loss. These SerDes ASIC cores are optimized for driving very high-speed serial links across extended copper backplane or DAC cable interconnects.



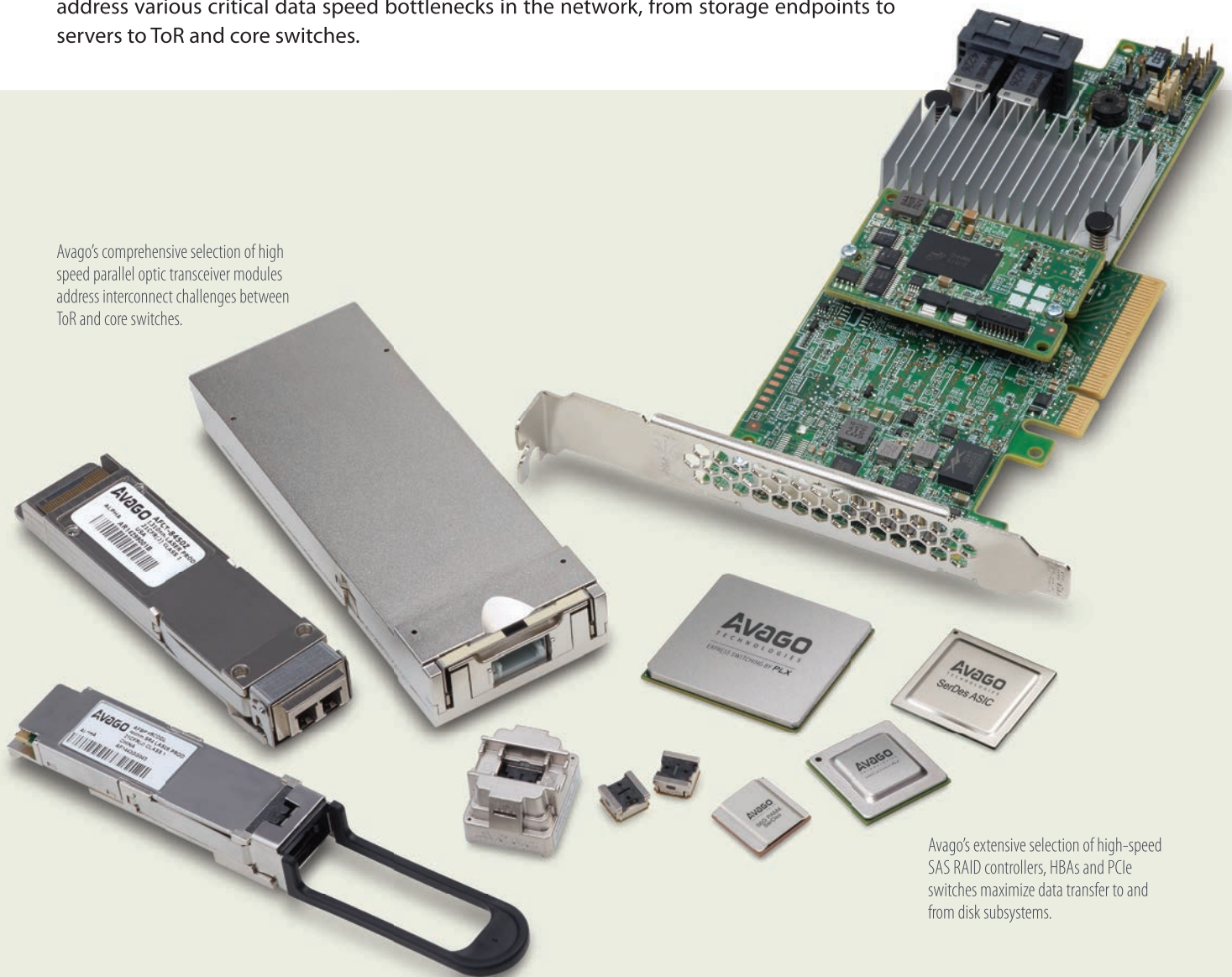
With extended reach capability and unrivalled low power consumption, Avago 32G NRZ and 56G PAM4 SerDes cores enable high system link margins reducing customer total cost of ownership (TCO).

Avago's 100G QSFP28 SR4 is the industry's first 100G QSFP SR4 device designed for 100GbE short-range datacenter interconnects, enabling seamless transition from 40G to 100G using QSFP form factor.

Fast Data Speed Advantage

The need for more data bandwidth has prompted rethinking of the electrical and optical design for the data center and, hence, drives the development of new high-speed fiber optic and chip solutions to satisfy higher bandwidth demands. Avago has developed and introduced a broad array of high-speed fiber optic and advanced chip solutions that address various critical data speed bottlenecks in the network, from storage endpoints to servers to ToR and core switches.

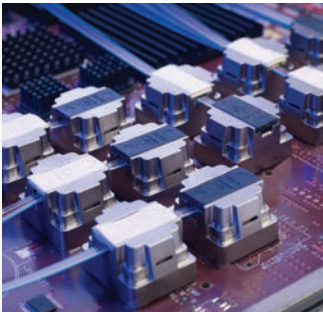
Avago's comprehensive selection of high speed parallel optic transceiver modules address interconnect challenges between ToR and core switches.



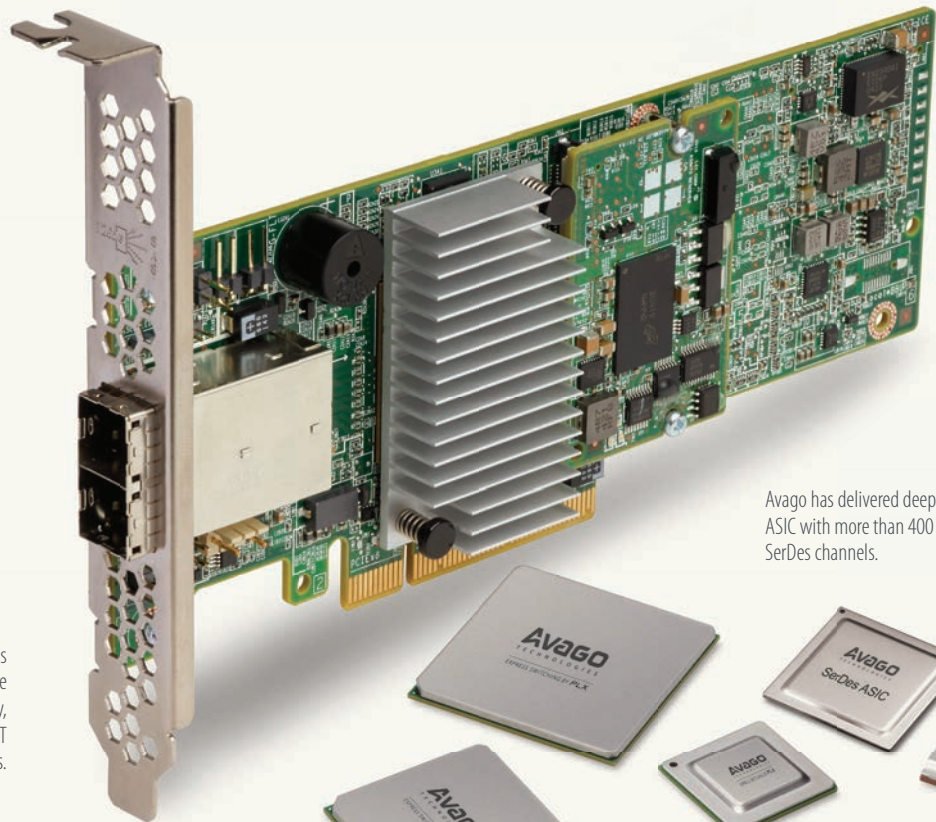
Avago's extensive selection of high-speed SAS RAID controllers, HBAs and PCIe switches maximize data transfer to and from disk subsystems.

High Density Connectivity Advantage

Achieving high density connectivity between equipment, whether from storage to server, server to ToR switch, or ToR switch to core switch, minimizes the number of equipment needed and improves system efficiency. More importantly, minimizing footprint and power consumption translates to CAPEX savings for data center builders and IT departments. Avago offers a wide range of high density optical and chip- and board-level connectivity solutions that deliver maximum connectivity and enable efficiency at scale.



Avago's MicroPOD and MiniPOD embedded modules offer unparalleled channel density, bandwidth and design flexibility for board and system-level interconnect.



Avago's 16-port 12Gb/s SAS 93xx HBAs with high-density storage ports provide maximum server storage connectivity, enabling data center builders and IT departments to deploy fewer servers.

Avago has delivered deep sub-micron ASIC with more than 400 high-speed SerDes channels.

Avago's ExpressFabric PEX9700 switch family enables users to connect multiple hosts to a high number of endpoints via scalable, high-bandwidth, non-blocking interconnection.



Greater Storage Capacity Advantage

As data bandwidth and cloud storage demands continue to grow, greater storage capacity is needed at the data center. New HDD recording technology such as Array Reader Magnetic Recording (ARMR) is needed to enhance recording capacity in HDDs in order to address the ever-expanding storage requirements. Compared with other magnetic recording technologies, ARMR offers over 25% gain in areal density delivering significant enhancement in HDD storage capacity. Avago is the industry leader in enterprise storage solutions with a broad portfolio of advanced HDD preamplifiers and read-channel SoCs for next-generation ARMR-based HDDs. Leveraging unique analog, 12 Gb/s SAS and 6 Gb/s SATA SerDes, and DDR memory I/O technologies, Avago provides advanced HDD chip solutions addressing high-capacity, high-performance storage needs.

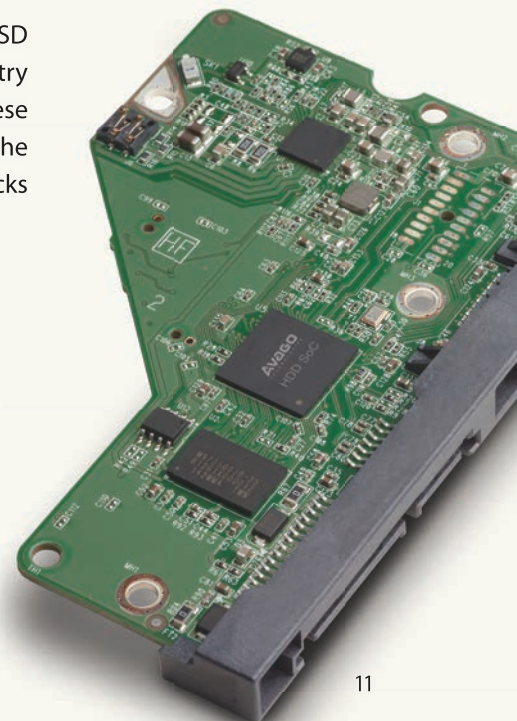


Avago is also the industry leader in data center SSD SoCs. Based on purpose-built SSD IP and flash controller system designs, Avago custom SSD SoCs are leading the industry transition from 6 Gb/s SATA SSDs to multi-lane 8 Gb/s PCIe and 12 Gb/s SAS SSDs. These next-generation high performance SSDs will unleash the performance advantage of the latest non-volatile technologies and solve today's bandwidth and throughput bottlenecks in the data center.

Avago's multi-channel preamplifiers deliver maximum performance with minimal power consumption in a small silicon footprint.



Avago's read-channel SoCs are the industry's smallest in silicon footprint and lowest in power consumption, while delivering superb drive performance, maximum areal density and unmatched data integrity.





Your Imagination. Our Innovation

Avago Technologies is a leading designer, developer and global supplier of a broad range of analog, digital, mixed signal and optoelectronics components and subsystems with a focus in III-V compound semiconductor design and processing. Backed by an extensive portfolio of intellectual property, Avago products serve four primary target markets: wireless communications, wired infrastructure, enterprise storage, and industrial and other. Avago has a global employee presence and rich heritage of technical innovation spanning over six decades.

Avago has strong market positions across a broad range of market segments with highly differentiated products that include:

- Film Bulk Acoustic Resonator (FBAR) Filters
- RF Front End Modules
- Parallel Optics Transceivers
- High Speed SerDes ASIC
- HDD Read Channel & Preamplifiers
- RAID and SAS I/O Controllers
- PCIe Switches
- Optocouplers
- Motion Encoders
- Industrial Fiber Solutions
- LED Display & Signage Solutions



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