



www.plansys.com

Networks for Data Acquisition and Recording

Networks for Sensor Data Acquisition and Recording

John Walrod, Eric Todd

Planning Systems Inc.

21294 Johnson Road, Long Beach MS 39560

Phone: + 1-228-863-0007

FAX: + 1-228-863-0281

E-mail: etodd@plansys.com

jwalrod@plansys.com

Presented at the THIC Meeting at the Naval Surface Warfare
Center Carderock

Bethesda MD

October 3, 2000



The Premier Advanced Recording Technology Forum



Sensor Networks

- Take advantage of LAN technology to build higher performance systems at lower cost
- Leverage significant COTS product base into data acquisition and recording



Network Technologies

- Ethernet, ATM-SONET OC-3c, and Fibre Channel are most popular network standards for sensor networks.

Network	Data Rate [bits/s]	Baud Rate [baud]	Topology	Cable	Description
Token Ring	4 M	16 M	Ring, Star	UTP	Legacy LAN
Ethernet	10 M	20 M	Bus, Star	UTP,coax	Commonly used in low-speed sensor networks.
Desktop ATM	25.6 M	32 M	Star	UTP	In use in some sonar networks.
Fast Ethernet	100 M	125 M	Star	Fiber, UTP	Popular LAN standard. Sensor use has been limited.
100VG AnyLAN	100M	120 M	Star	Fiber, UTP	Legacy LAN
ATM TAXI	100 M	125 M	Star	Fiber	Legacy LAN
FDDI	100 M	125 M	Ring	Fiber	Legacy LAN
Systran ScramNet	133 M	150 M	Ring	Fiber, coax	Proprietary
ATM-SONET OC-3	133 M	155 M	Ring, Star	Fiber, UTP	Popular LAN standard. Widely used for sensor networks.
Fibre Channel, quarter speed	200 M	265.6 M	Ring, Star	Fiber,UTP,coax	Legacy LAN
VMIC5588 Reflected Memory	236 M	1200 M	Ring	Fiber	Proprietary. Used in real-time systems.
Fibre Channel, half speed	400 M	531.25M	Ring, Star	Fiber,UTP,coax	Legacy LAN
ATM-SONET OC-12	533 M	622 M	Ring, Star	Fiber	LAN/WAN standard. Limited use in sensor networks.
Fibre Channel, Full Speed	800 M	1062.5 M	Ring, Star	Fiber,UTP,coax	Popular LAN/SAN standard. Widely used for high speed sensor networks.
Belobox FiberLAN	848 M	1062.5 M	Ring-Hub	Fiber	Proprietary. Used in combat systems.
Gigabit Ethernet	1000 M	1250 M	Star	Fiber, UTP	Popular LAN backbone standard. Limited use in sensor networks.
ATM-SONET OC-48	1140 M	2488.32 M	Ring, Star	Fiber	WAN standard.
Fibre Channel, 2x speed	1600 M	2125 M	Ring, Star	Fiber	Emerging standard.
Fibre Channel, 4x speed	3200 M	4250 M	Ring, Star	Fiber	Emerging standard.
ATM-SONET OC-192	8541 M	9953.28 M	Ring, Star	Fiber	WAN standard.
ATM-SONET with DWDM	>10 G		Ring, Star	Fiber	Emerging standard.

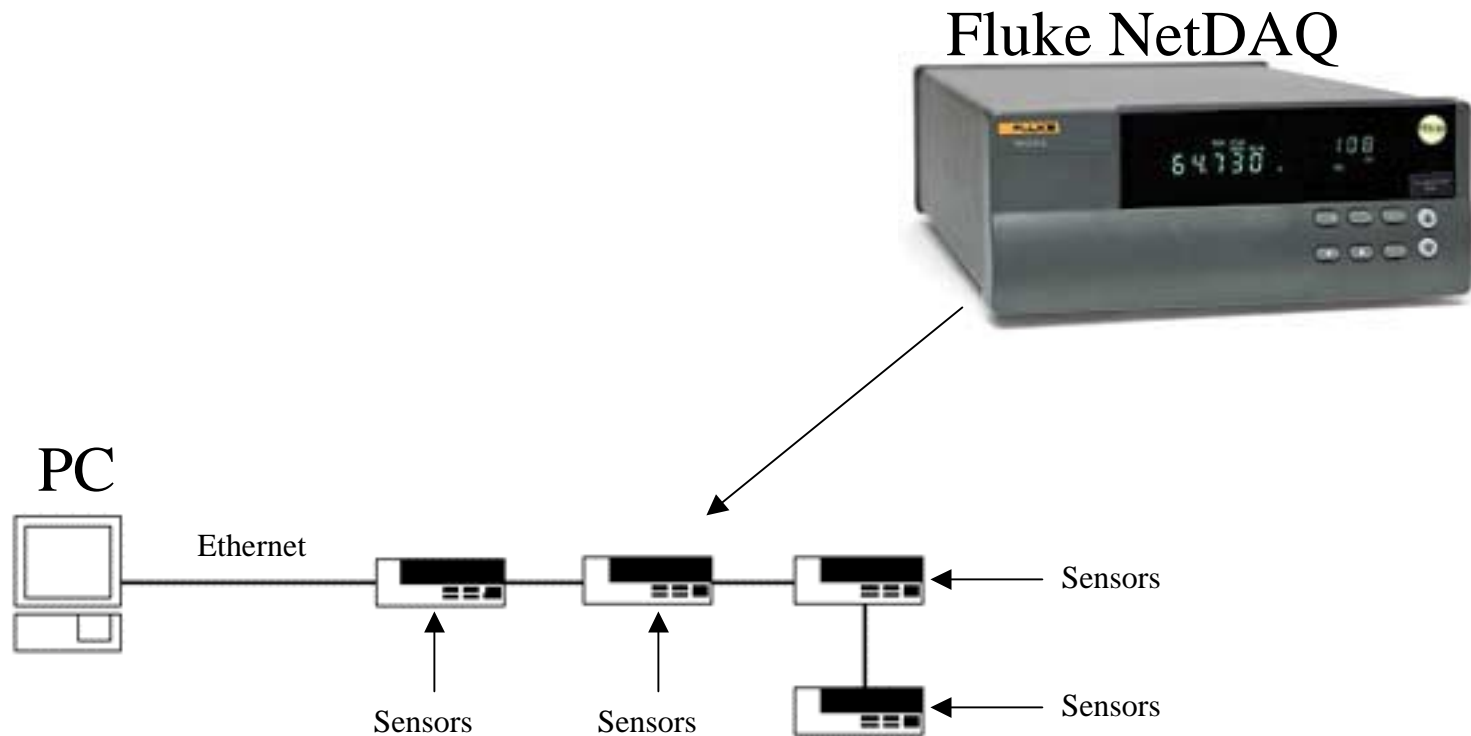


Ethernet



Ethernet Sensor Networks

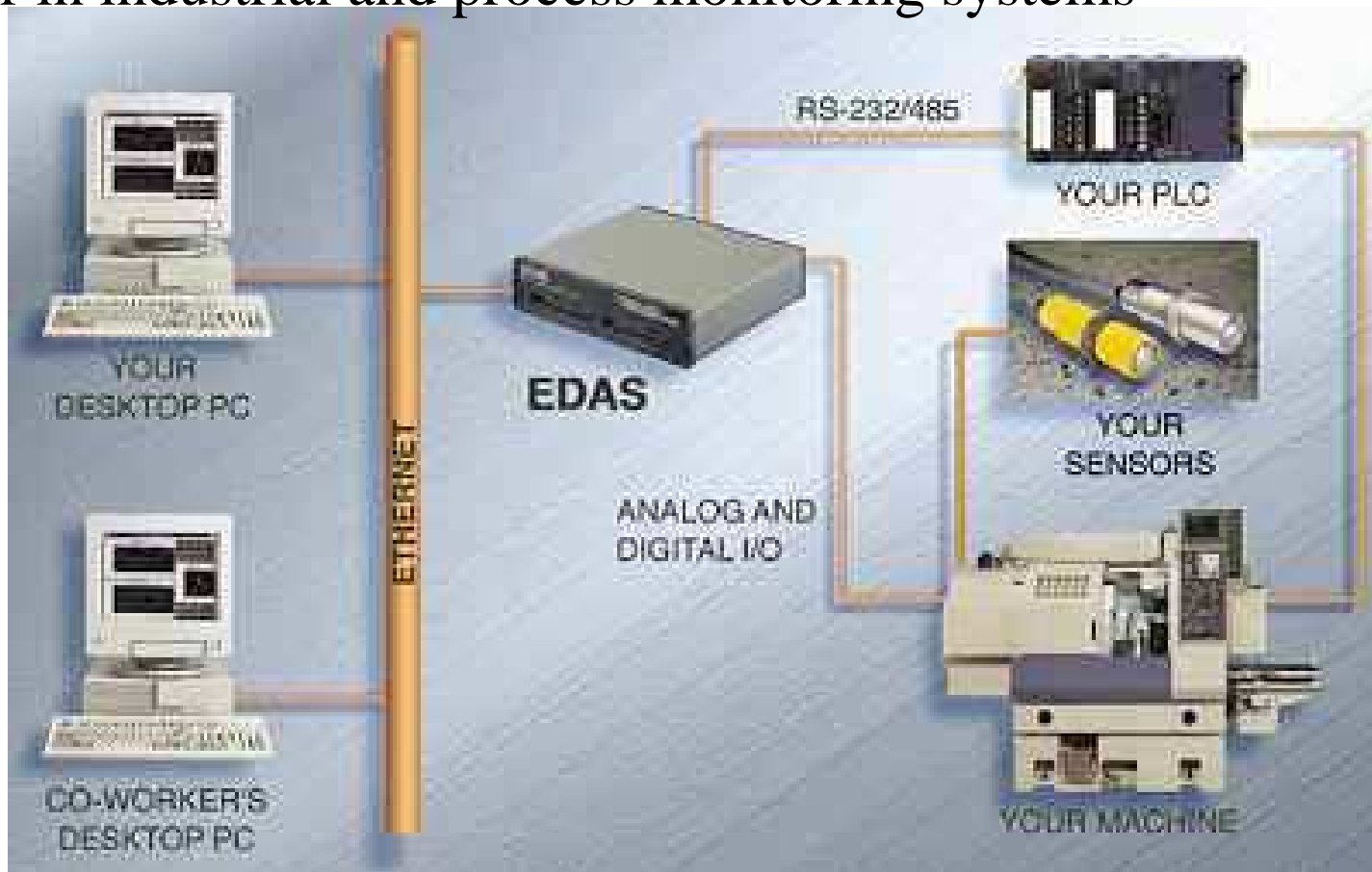
- Equipment for Ethernet-based data acquisition and recording are available from several companies including PlanSys, Fluke, Keithley, National Instruments, and Burr-Brown.





Example Data Acquisition using Ethernet

- Low Data rates: <1 Mbit/s
- Data recording typically on PC hard drive
- Popular in industrial and process monitoring systems



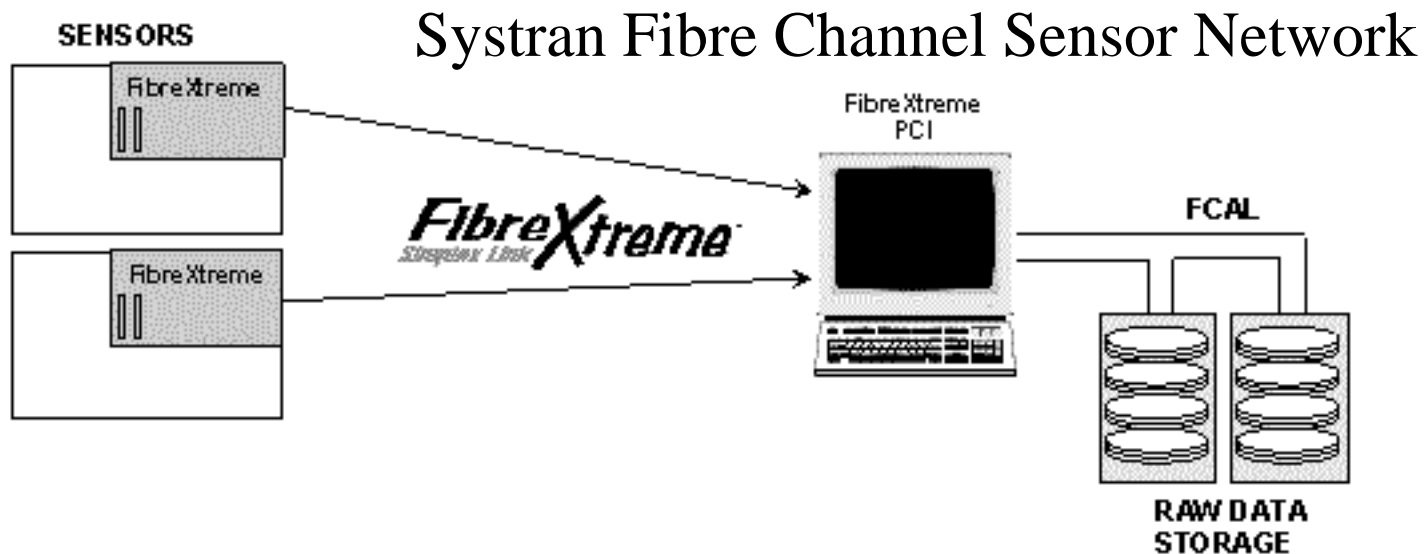


Fibre Channel



Fibre Channel Sensor Networks

- Equipment for Fibre Channel-based data acquisition and recording are available from several companies including PlanSys, Systran, and Vmetro.
- Popular in medical imaging, radar, and avionic systems where very-high speeds and intensive data storage are required.





Example Fibre Channel Networks

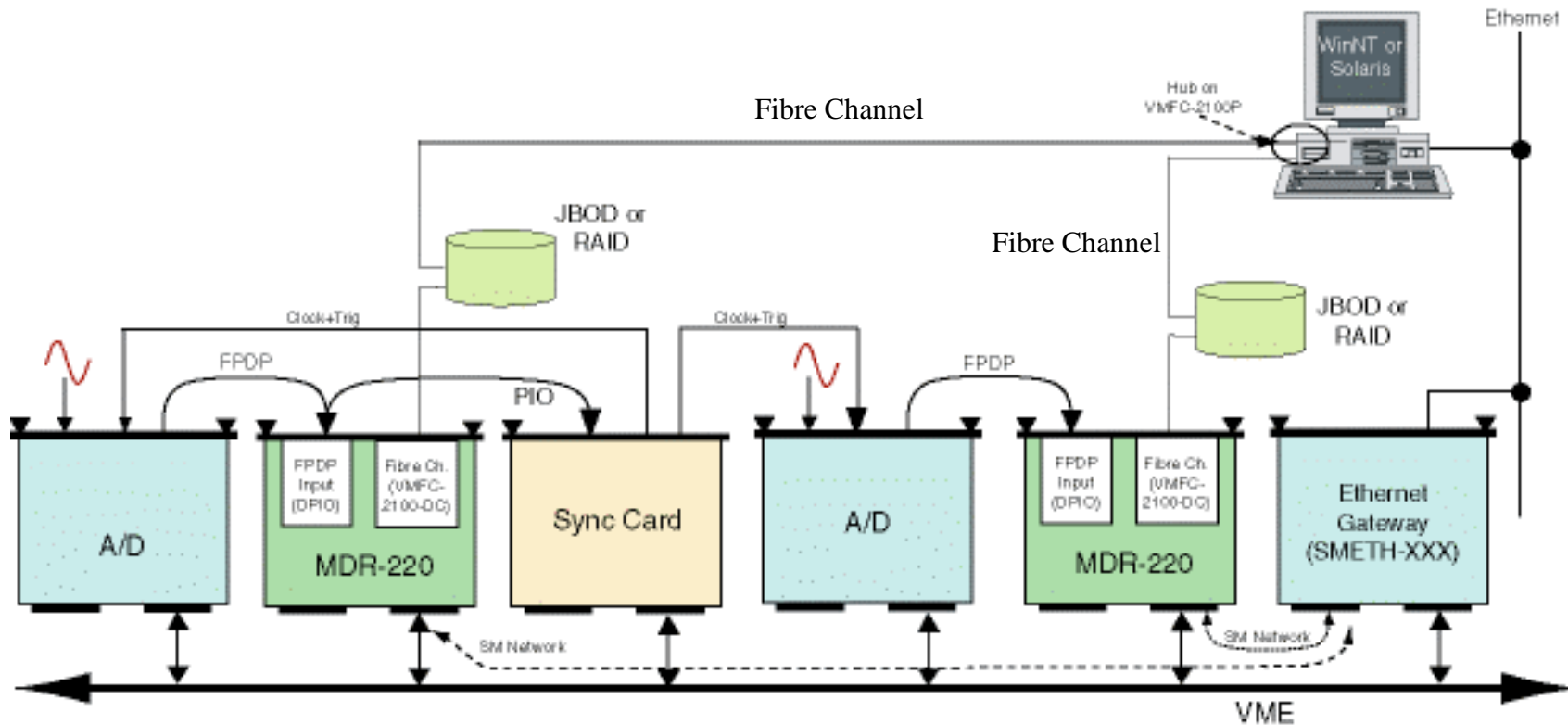
- UCLA Medical Center: Fibre Channel switches connect Unix servers to different disk subsystems containing x-ray image files.
- Amoco Corp.: Fibre Channel network provides geologists` access to seismic data models, enabling faster turnaround in locating petroleum deposits.
- Hawaiian project: Fibre Channel switches and adapters are the communication backbone for a telescope being developed in Japan for the island of Hawaii. The telescope, which will be the world`s largest single-dish optical-infrared telescope, will capture and send digital astronomical images to a data server 45 miles away. The telescope will generate several hundred megabytes to more than 10GB of data each night.

Source: Bruce Briggs and Tom Houston, "The Future of Fibre Channel", InfoStor, August 1999



2-Ch Sensor Network with Fibre Channel

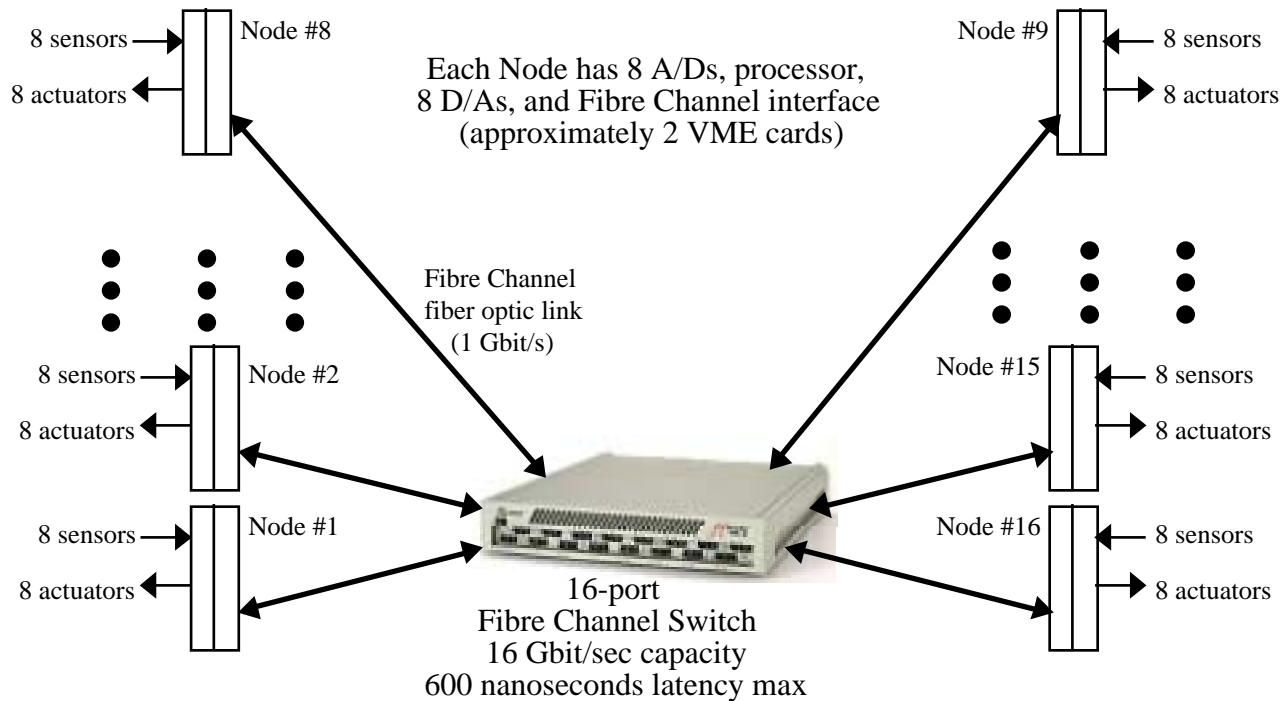
- 2 high-speed sensor channels recorded via Fibre Channel to RAID
- High Data Rates: Up to 90 Mbyte/sec



VMETRO Fibre Channel Sensor Network

256-ch Sensor/Actuator Network with Fibre Channel

- Real-time vibration control and structure monitoring



PlanSys Fibre Channel Sensor Network

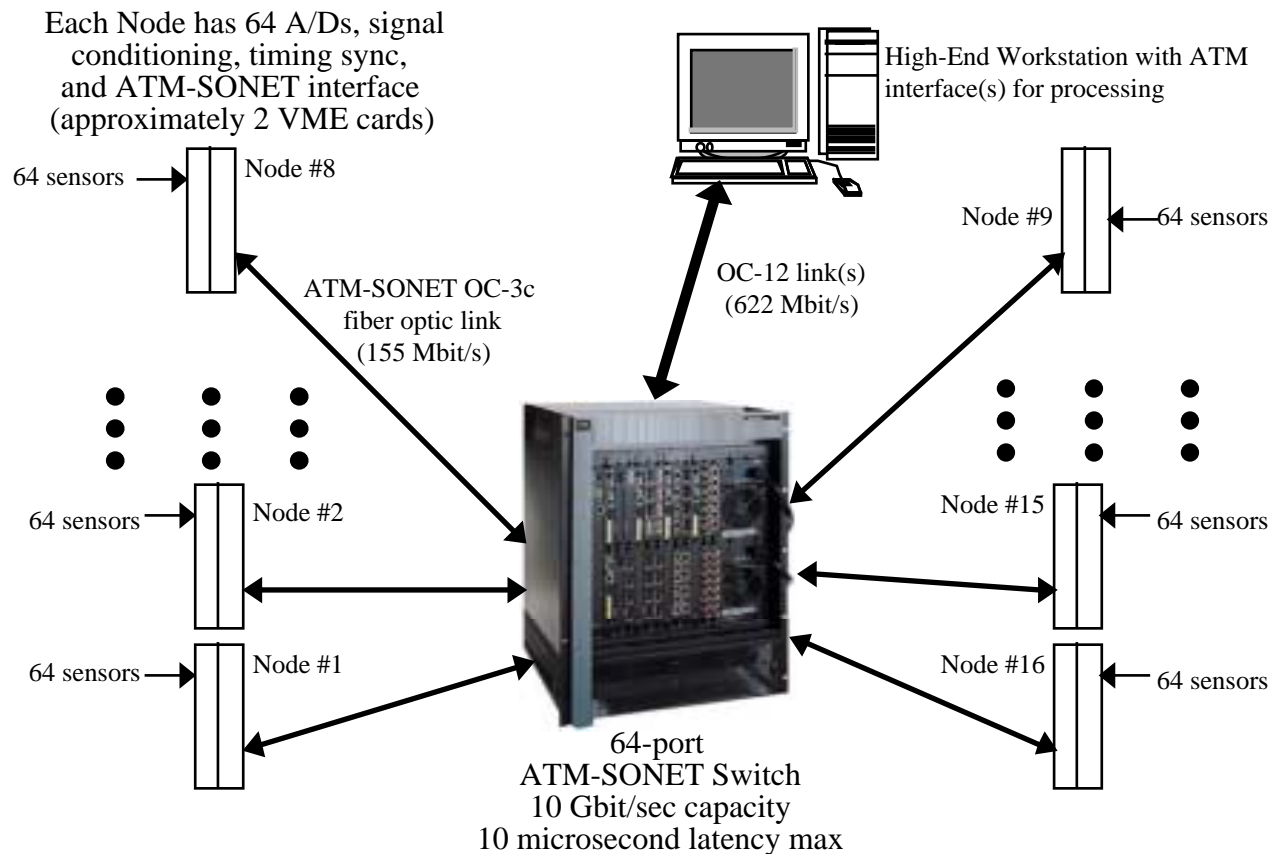


ATM



ATM Sensor Networks

- Popular high speed network. Widely deployed in Navy applications.



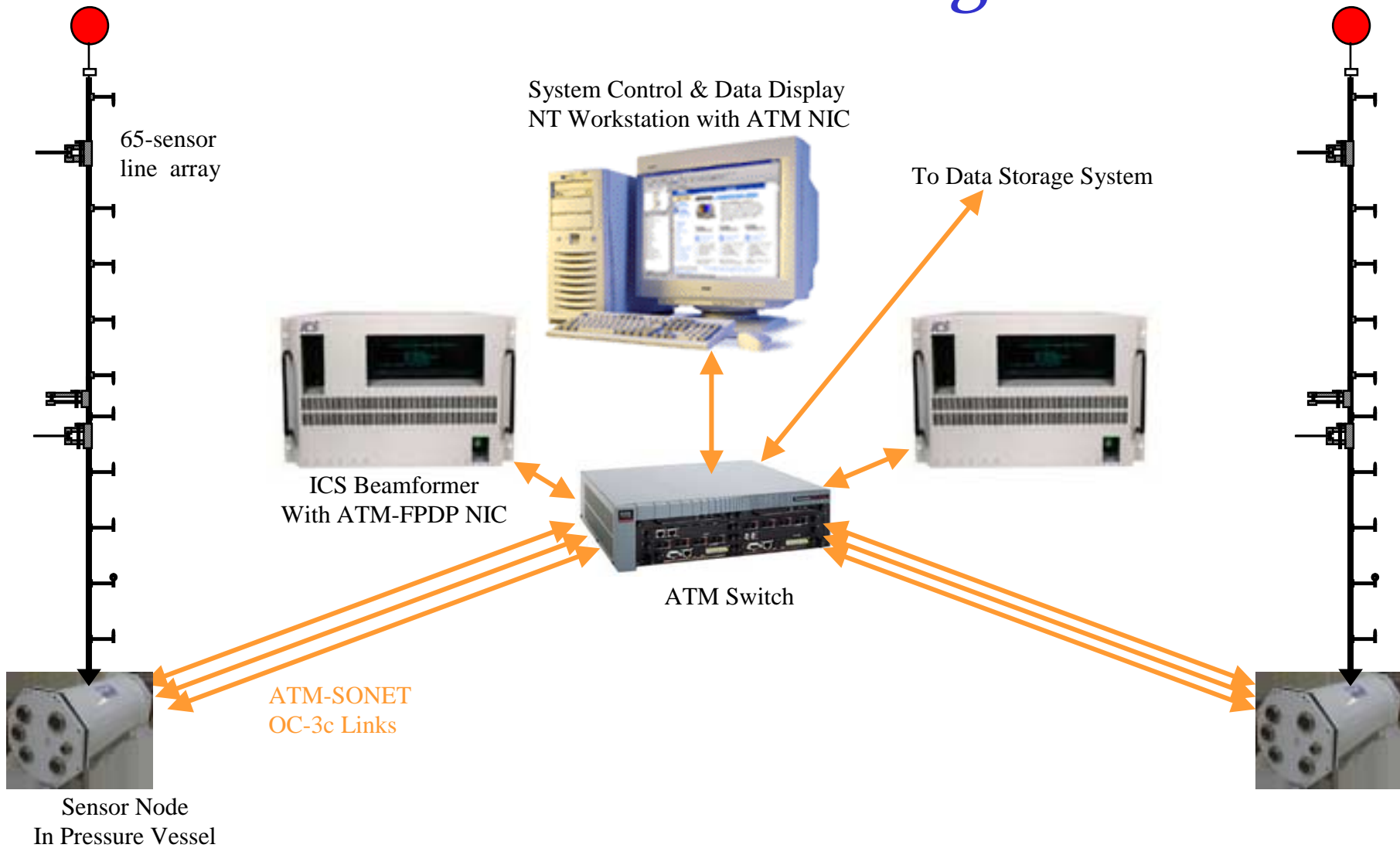
PlanSys 1024-channel sensor network with ATM



Example Navy Sensor Networks Using ATM

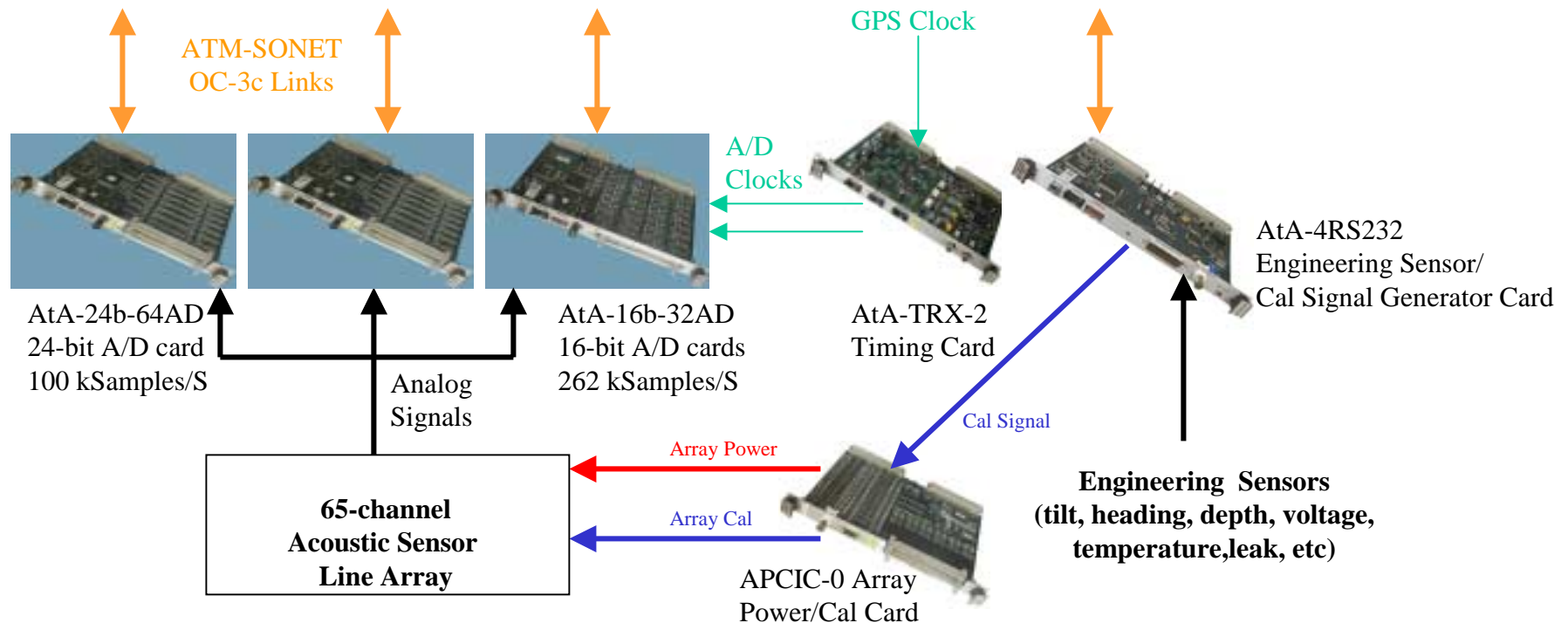
- SPAWAR FDS-c Surveillance Array
- SPAWAR ADS Surveillance Array
- SPAWAR T-AGOS class towed arrays
- NUWC ASATS portable range
- NUWC AUTEK measurement range
- NUWC towed arrays, TARS, TB-29 upgrade, MLTA
- NSWC Large Scale Vehicle On-Board Data Acq System
- NSWC Lake Pend Oreille measurement range
- NAVSEA TSMS Upgrade (proposed)
- DERA Wideband Research Towed Array
- DREA DASM(D) Towed Array (proposed)
- NATO SACLANT Towed Array
- UK Sonar 2087 Towed Array (proposed)
- Korean Navy Towed Arrays and Surveillance Arrays (proposed)
- Swedish Navy Measurement Range (UDAMS)

130-Ch Measurement Range Network

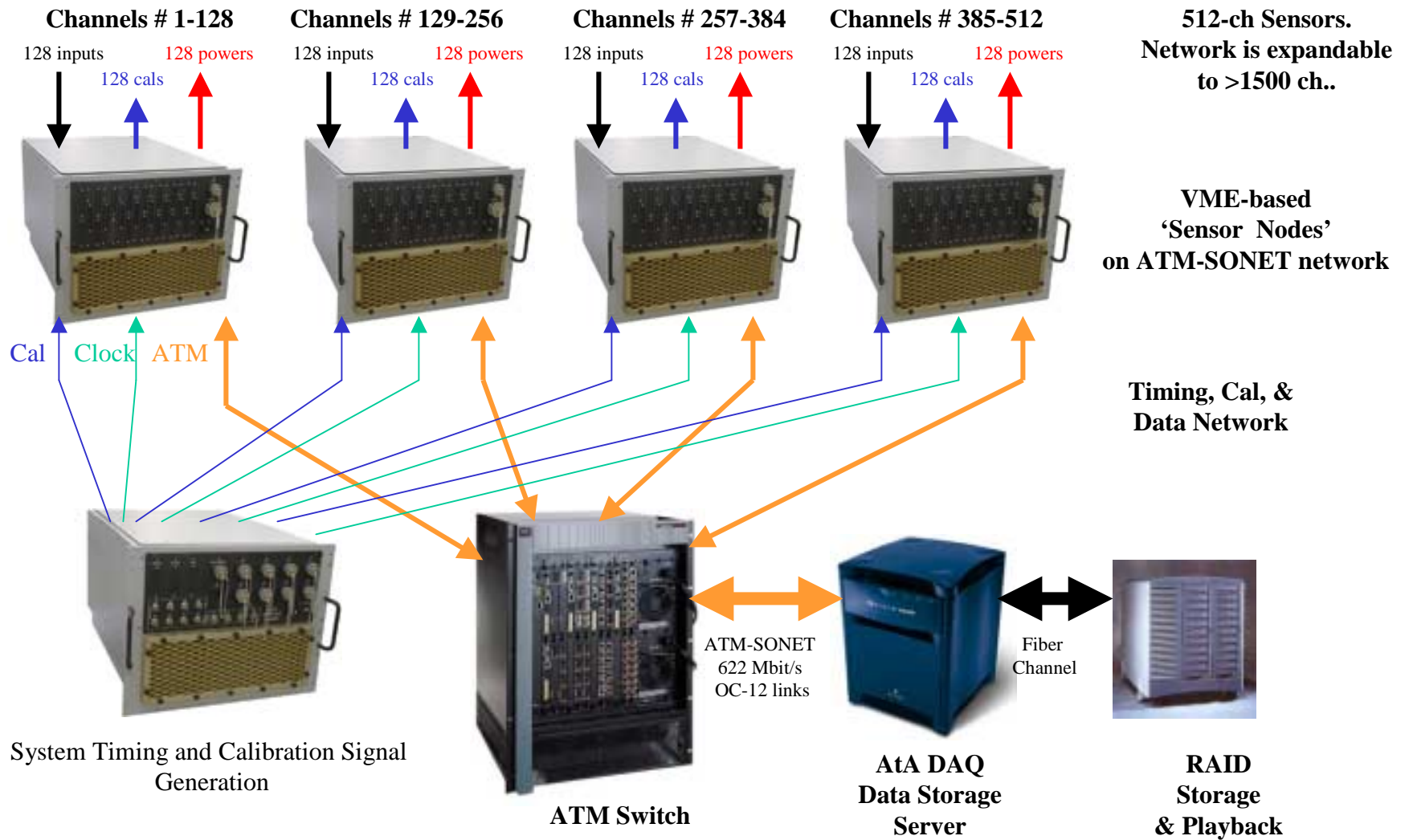


Measurement Range Sensor Node

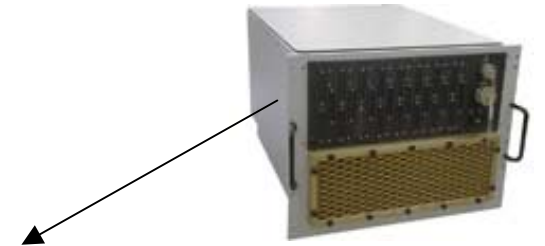
- Mid-frequency noise measurement channels
- High-frequency ranging channels
- Low-frequency engineering sensor channels
- Sample rates synchronized to GPS clock
- All data and controls accessed via ATM-SONET OC-3c network



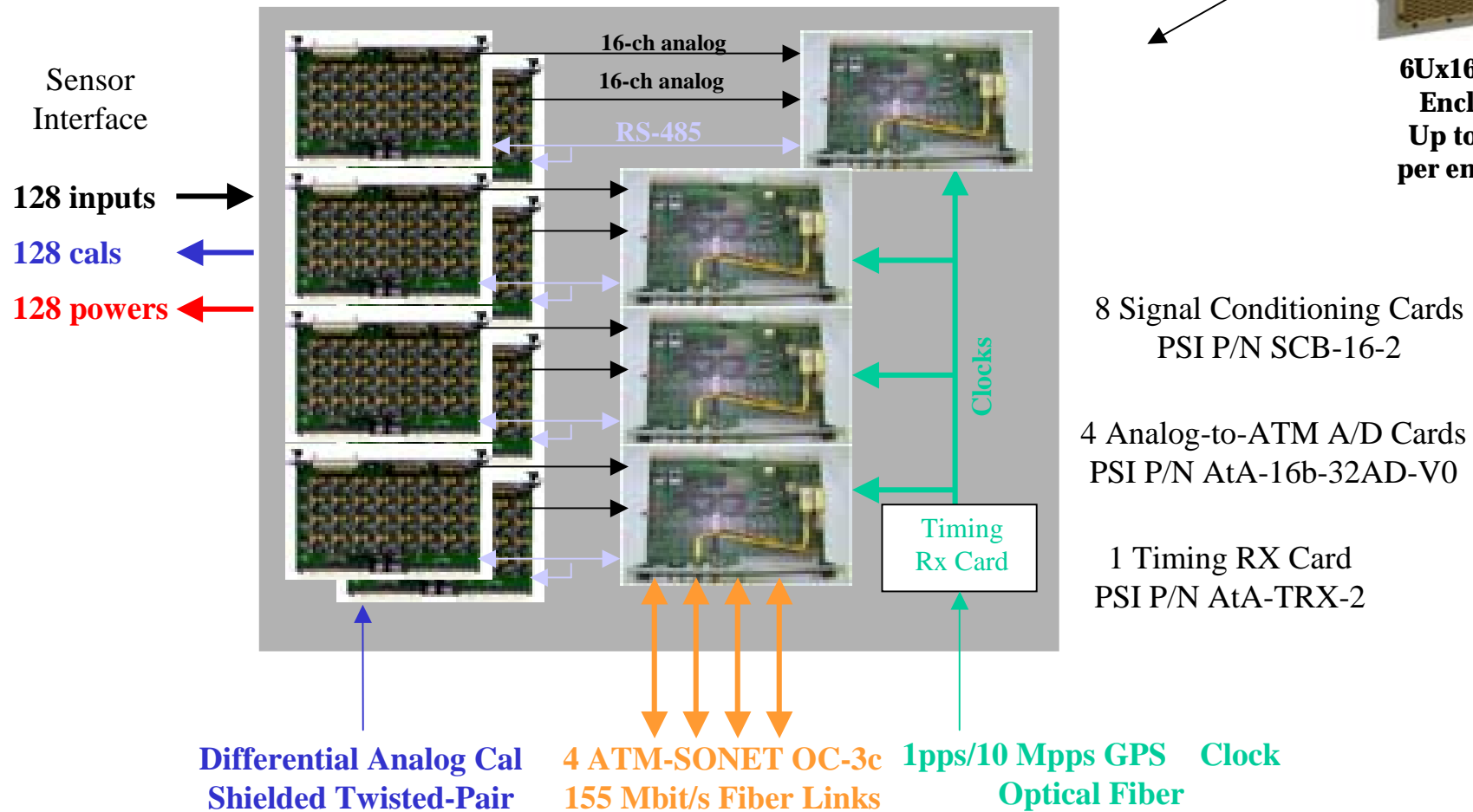
512-ch Sensor Network (ODAS) with ATM



ODAS 128-ch Sensor Node

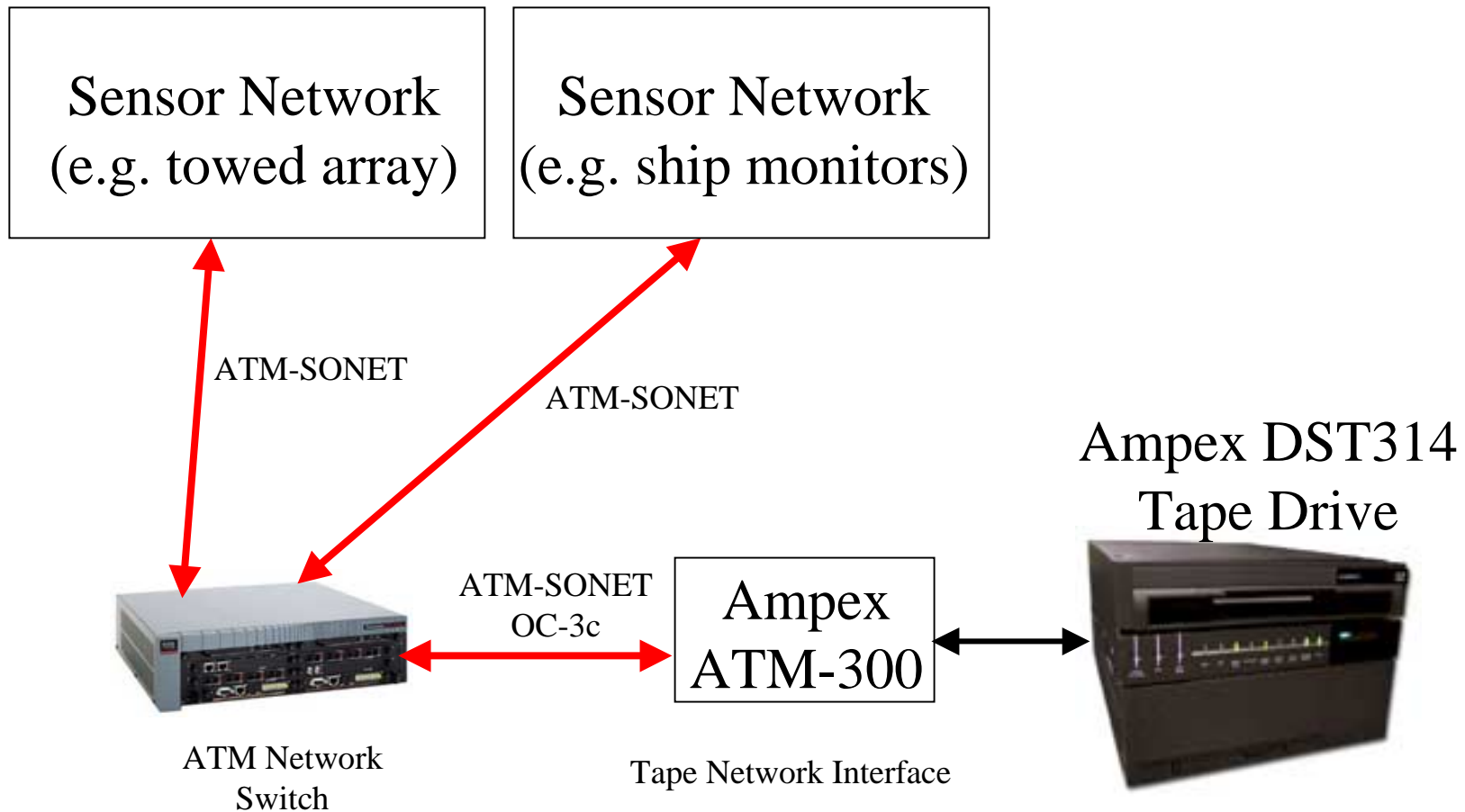


**6Ux160 VME Enclosure.
Up to 192 ch per enclosure.**





Ampex Tape Recording System for ATM Network Systems





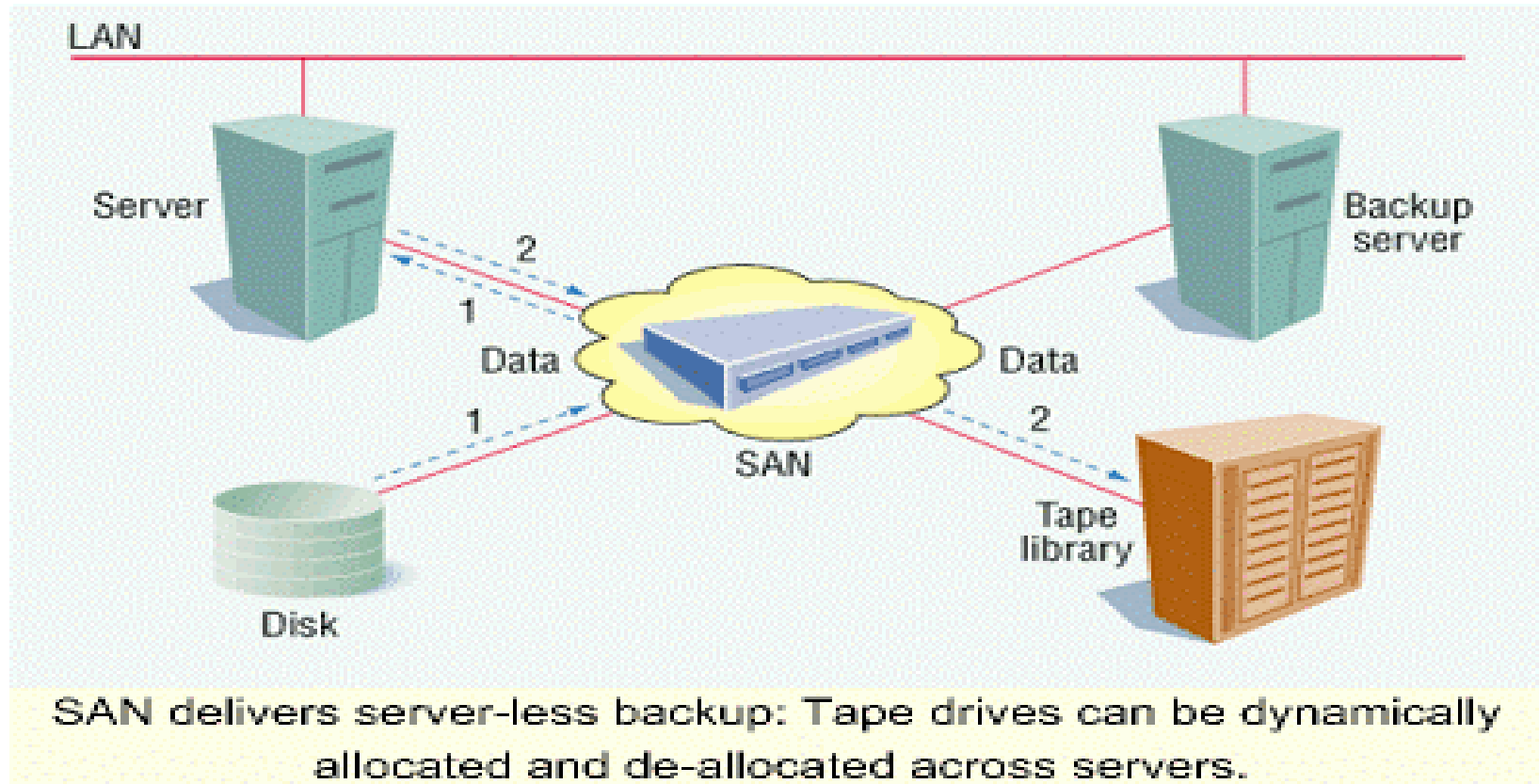
Emerging Technologies

- IP Storage Area Networks
- Optical Drive RAIDs
- Wireless Networks



Storage Area Network (SAN)

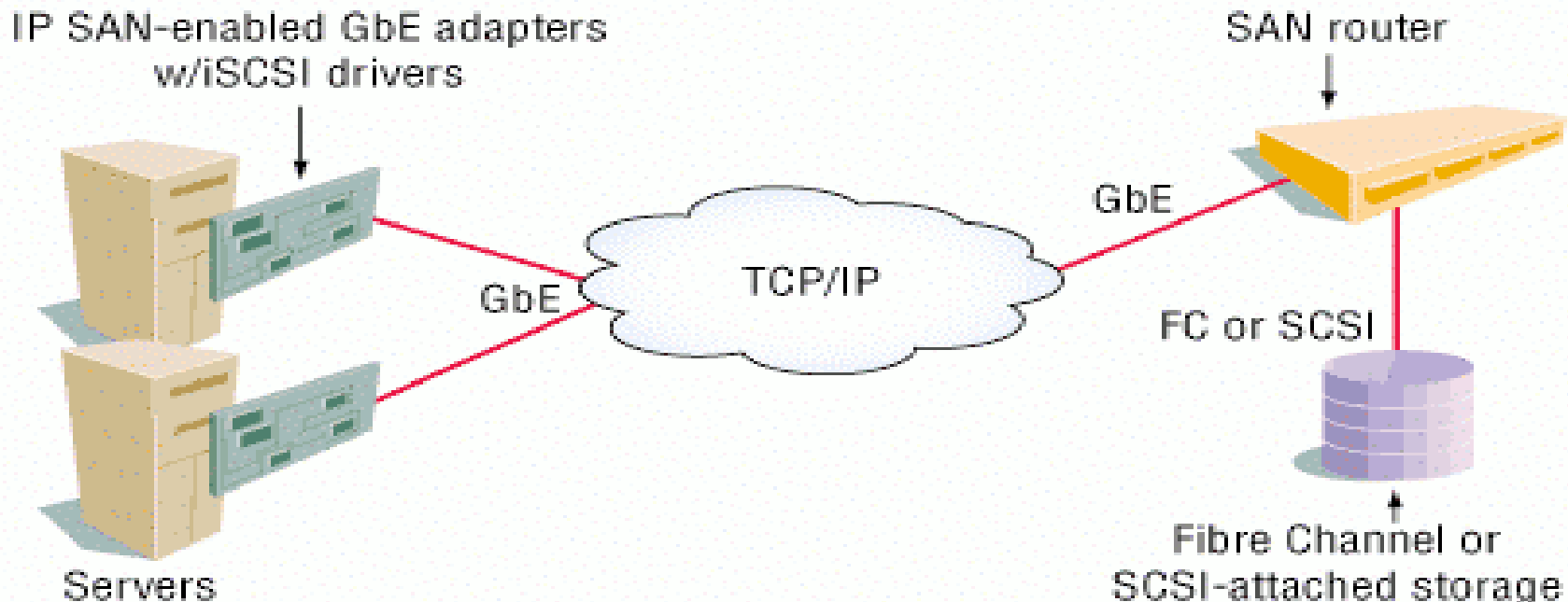
- Dedicated network for movement of storage data between servers and data storage devices. Typically Fibre Channel.





Internet Protocol Storage Area Network

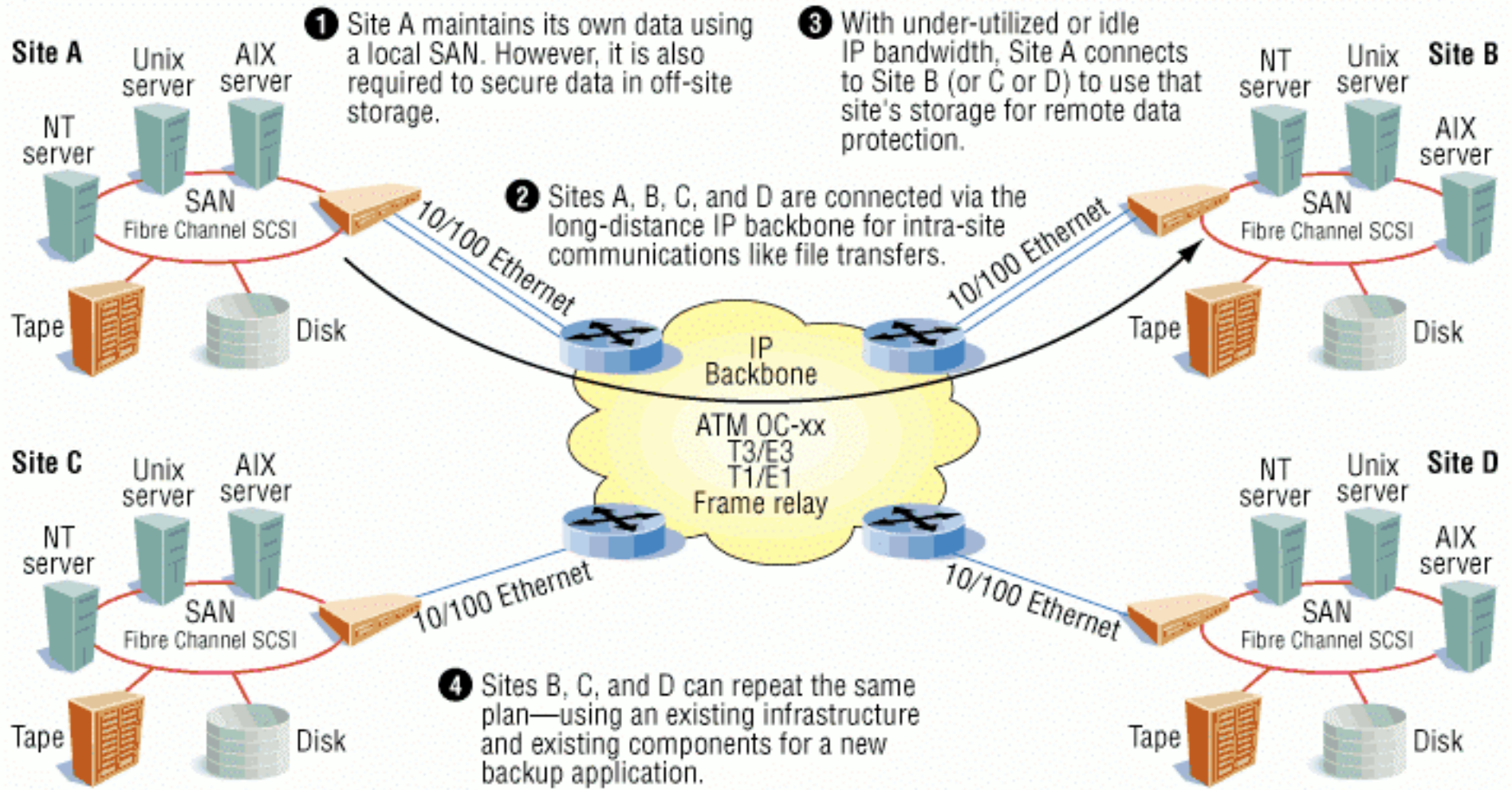
Building an IP SAN



A SAN router can link Fibre Channel and SCSI devices to servers over an IP network such as Gigabit Ethernet (GbE). Special drivers are required on each host.

Wide Area SAN over IP

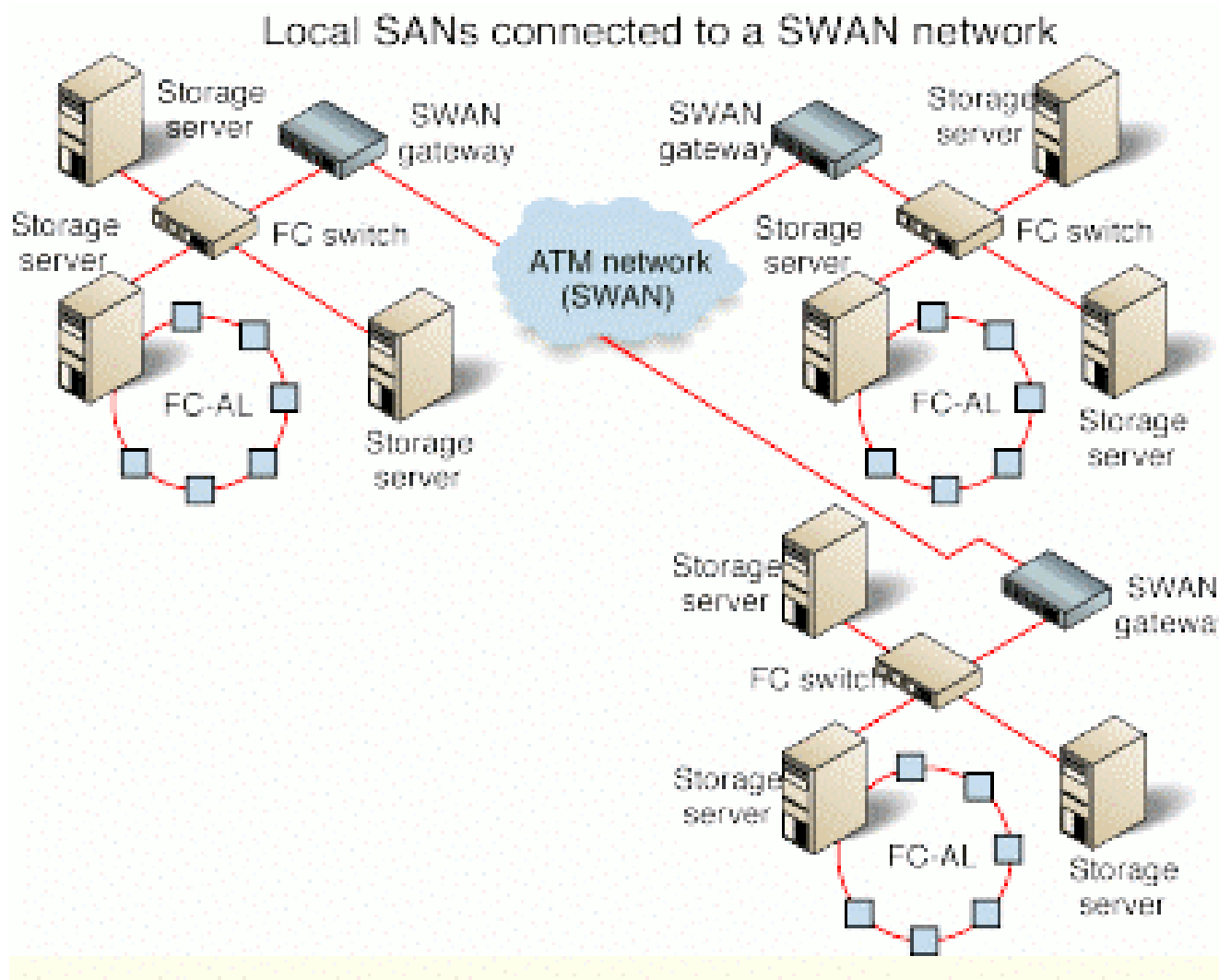
How SAN-over-IP works



IT departments can use existing storage components and infrastructures to create new backup applications.



Networking SANs with ATM





Emerging Technologies for IP SANs

Comparing IP storage methods

Name	Integration approach	Legacy storage compatibility	IP network compatibility	Companies involved	Expected availability
IP Tunneling	FC frame encapsulation	FC	(Tunneled)	Gadzoox, CNT Brocade, Cisco	2000/2001
EtherStorage	SCSI mapped to STP (Proprietary L4)	SCSI	Layers 1-3	Adaptec	Mid-2001
I-SCSI	SCSI mapped to TCP		Layers 1-4	IBM, HP, EMC, Cisco, others	2001 or later
SolP	SCSI/FCP adaptation	SCSI and FC	Layers 1-4	Nishan, unnamed partners	2000



Optical Drive RAID

"RAIDing" optical drives

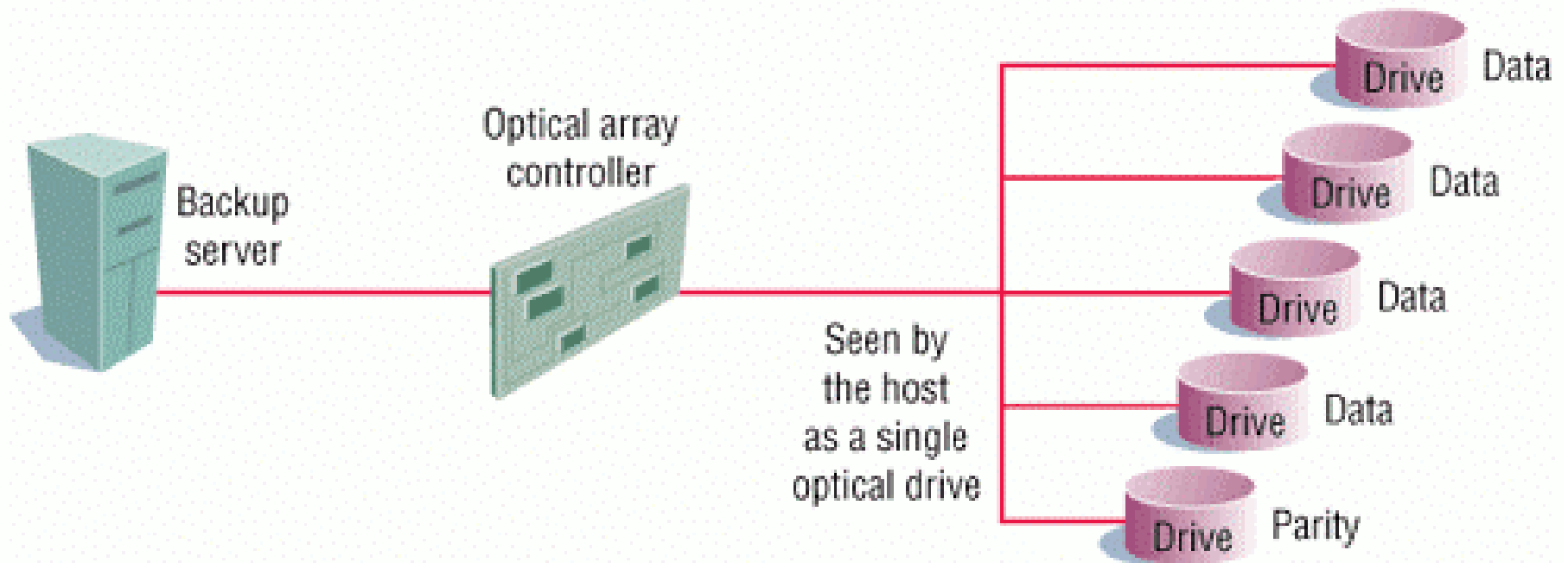
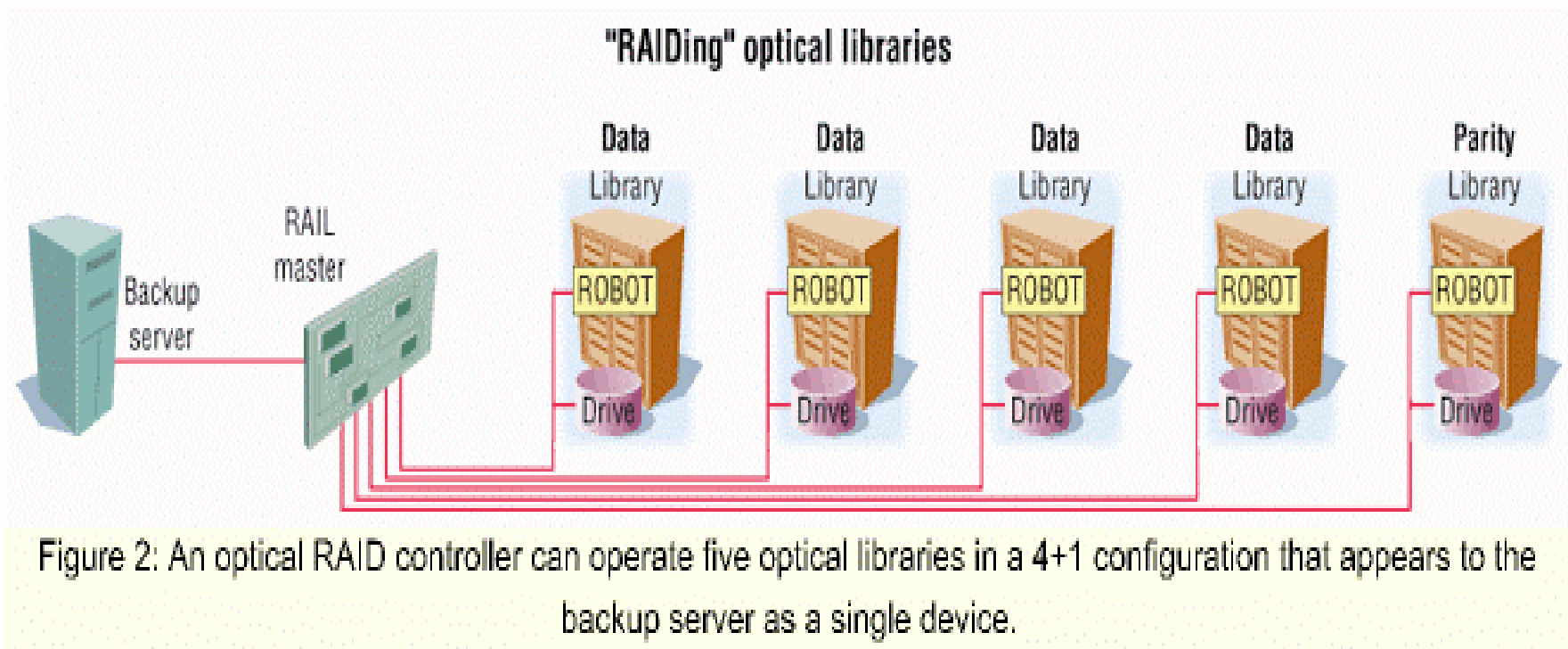


Figure 1: High availability is achieved using a 4+1 configuration, in which one optical drive is dedicated to parity.



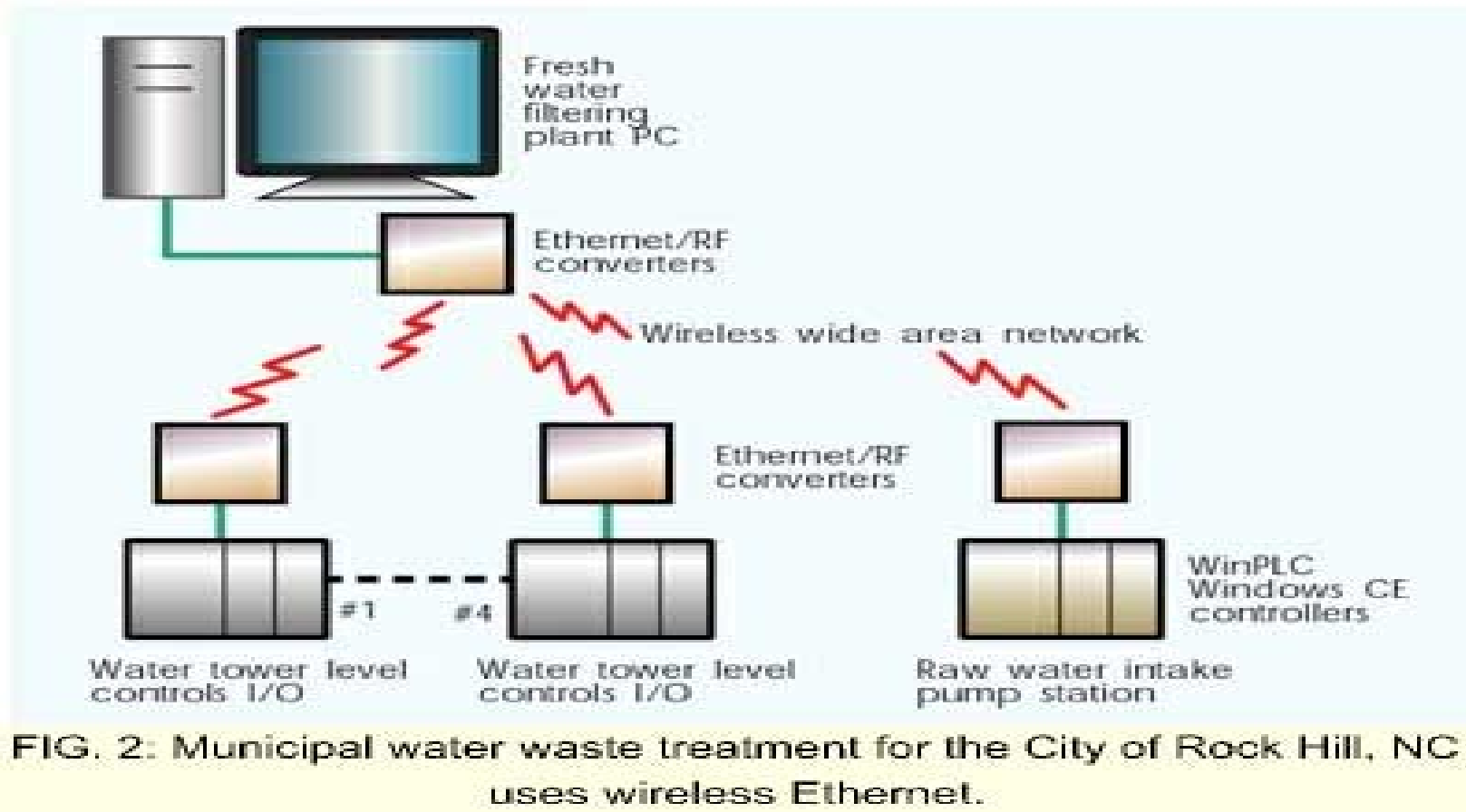
RAID Optical Library





Wireless Ethernet

- 1 Mbit/s and 11 Mbit/s products available
- Future evolution towards 50 Mbit/s expected





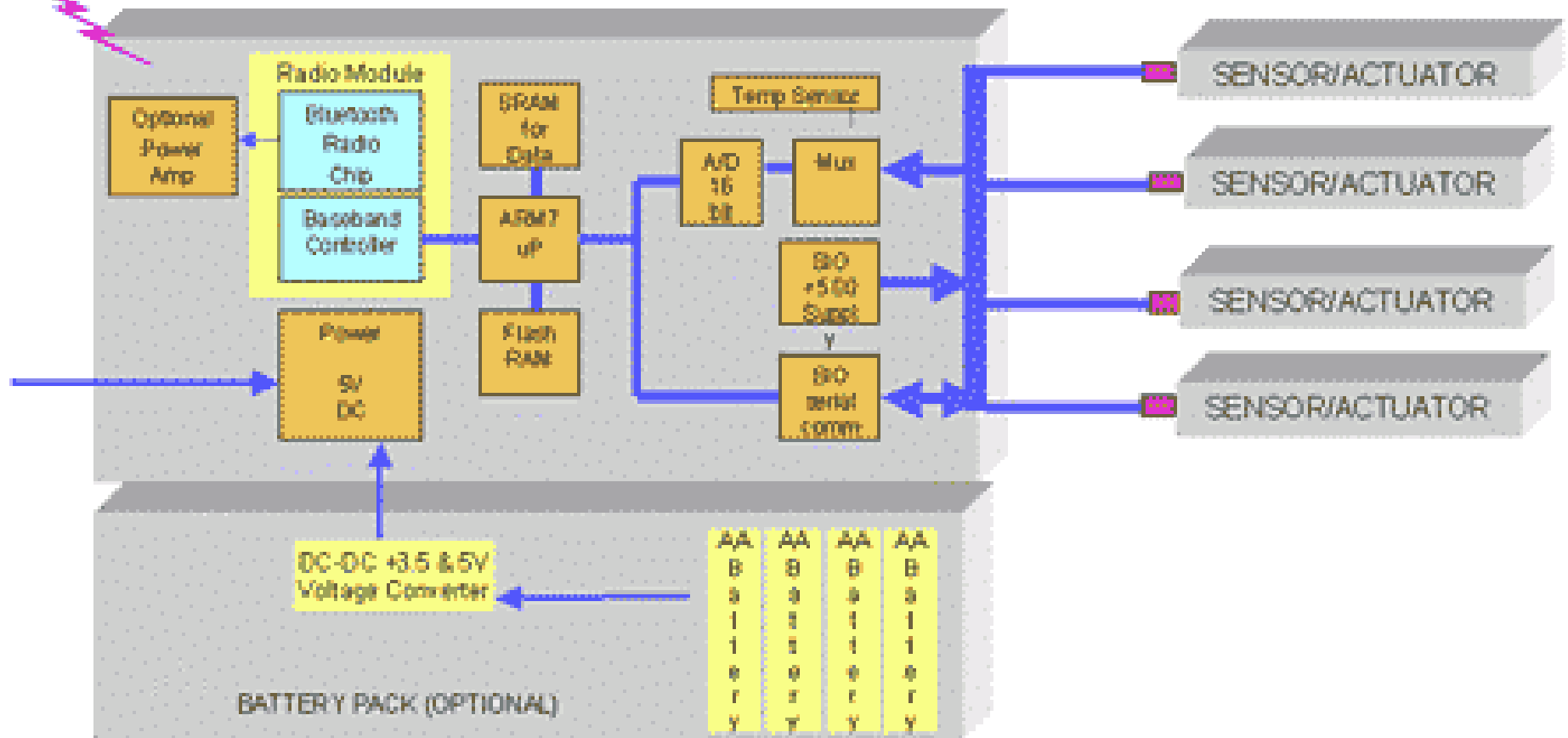
Bluetooth

- Emerging 1 Mbit/s wireless network standard. [Www.bluetooth.com](http://www.bluetooth.com)
- PlanSys predicts that Bluetooth will become a very popular network



Example 4-ch Data Acq Node using Bluetooth Wireless Network

Bluetooth
RF Link





Summary

- Ethernet, ATM, and Fibre Channel are already popular networks for sensor data acquisition and recording
- Ethernet is appropriate for low-cost, low-data rate systems
- Fibre Channel is appropriate for high-speed and large data storage
- ATM is appropriate for high-speed & large numbers of channels
- Emerging technologies such as IP SANs, Optical RAIDs, and wireless networks will enable new applications.