

# A New Standard Lowers the Cost *of Fiber-to-the-Desktop & Fiber-to-the-Home*

*John Struhar, DMTS*  
*Lucent Technologies, Inc.*

**Lucent Technologies**  
Bell Labs Innovations



# Agenda

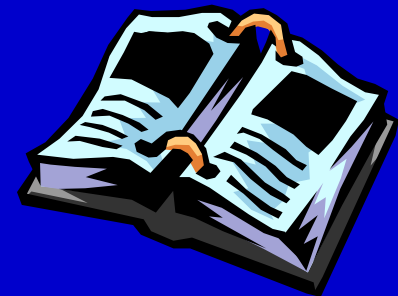
## *100BASE-SX*

---

Lucent Technologies  
Bell Labs Innovations



- Why the standard?
- Key elements of TIA/EIA-785
- Centralized fiber as a complementary technology
- Installed fiber-to-the-home system
- Interoperability demonstration



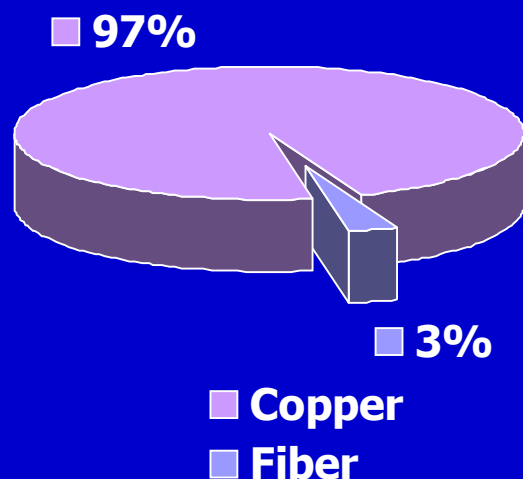
# Fiber & Copper Ports in LANs

*Slow, But Steady Progress*

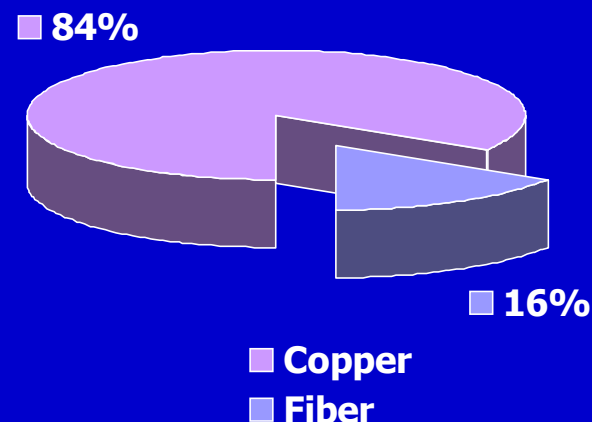
Lucent Technologies  
Bell Labs Innovations



1999



2004



Source: "Copper vs. Fiber: What the Users Want" Cahners In-Stat Group, July 2000

# Horizontal Fiber

## *Cahner's Report Conclusions*

Lucent Technologies  
Bell Labs Innovations



- Component prices have dropped to within 50% of copper
- Overall price of a fiber LAN has dropped to within 20% of a copper LAN
- Connectors have been simplified & cost under \$5.00
- Fiber optic cable has become stronger & more flexible than copper

Source: "Copper vs. Fiber: What the Users Want" Cahners In-Stat Group, July 2000

# Horizontal Fiber

## *Cahner's Report Conclusions-continued*

Lucent Technologies  
Bell Labs Innovations



- Media converters cost under \$250.00 & add mere nanoseconds of latency
- Gigabit Ethernet over Cat 5 UTP has impacted the momentum behind Cat 6
- 10 Gigabit Ethernet supports only fiber & standards-compliant products will be available in 2002
- Wavelength division multiplexing (WDM) technologies have blown the top off of fiber's previous bandwidth limits

Source: "Copper vs. Fiber: What the Users Want" Cahners In-Stat Group, July 2000

# Cahner's In-Stat Group

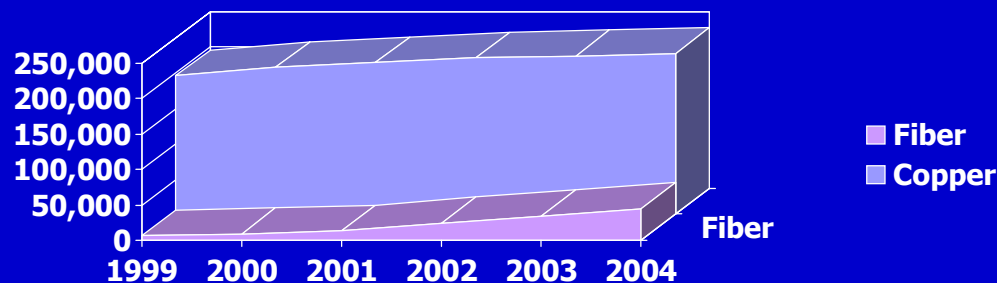
## Conclusion

Lucent Technologies  
Bell Labs Innovations



*"While copper cabling is still expected to dominate throughout the forecast period, its growth has obviously matured."*

*"Cahner's In-Stat Group believes the real growth opportunities lie with fiber, which has a CAGR of 48.2% through 2004."*



Source: "Copper vs. Fiber: What the Users Want"  
Cahners In-Stat Group, July 2000

# The Copper Upgrade Path

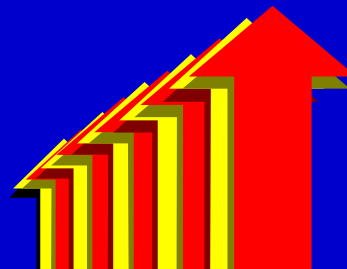
*10 Mbps Ethernet to 100 Mbps Fast Ethernet*

Lucent Technologies  
Bell Labs Innovations



- 10 Mbps Ethernet: 10BASE-T electronics
- 100 Mbps Fast Ethernet: 100BASE-T electronics
- 10 or 100 Mbps: 10/100 100BASE-T electronics

*Smooth upgrade, no electronics change required*



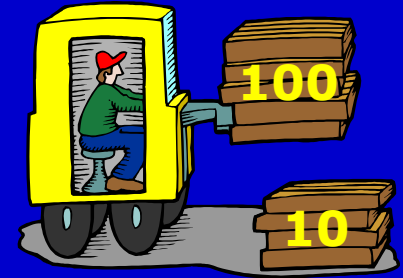
# The Fiber Upgrade Path

*10 Mbps Ethernet to 100 Mbps Fast Ethernet*

Lucent Technologies  
Bell Labs Innovations



- Two different IEEE 802.3 standards
- 10 Mbps Ethernet (10BASE-FL)
  - Operating wavelength: 850 nm
  - Distance: 2 km
- 100 Mbps Fast Ethernet (100BASE-FX)
  - Operating wavelength: 1300 nm
  - Supported distance: 2 km
- Two different wavelengths that don't interoperate
- Customer migration strategy:



**Forklift upgrade of fiber LAN electronics!**



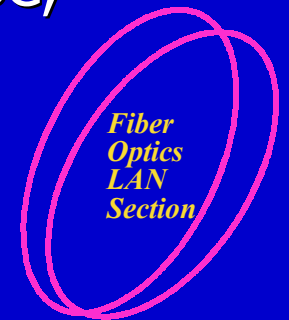
# Short Wavelength Fast Ethernet

## *History*

Lucent Technologies  
Bell Labs Innovations



- TIA Fiber Optics LAN Section growing LAN electronics membership, January 1998
- "Short Wavelength Fast Ethernet Alliance" meeting, Dallas, March, 1998
- Presentation to TIA FO-2.2 subcommittee, Vancouver, BC, June, 1998
- SP-4360 issued: December, 1998
- TIA standard work completed: March 23, 2001
- ANSI public review close date: May 7, 2001
- Submitted for ANSI board of standards review (BSR): May 8, 2001
- Available from Global Engineering Documents: June, 2001



# Short Wavelength Fast Ethernet

## *Goals*

---

Lucent Technologies  
Bell Labs Innovations



- *Clear, simple and inexpensive upgrade path from 10 Mbps to 100 Mbps fiber Ethernet*
- *Decrease in the cost of 100 Mbps fiber-to-the-desktop*

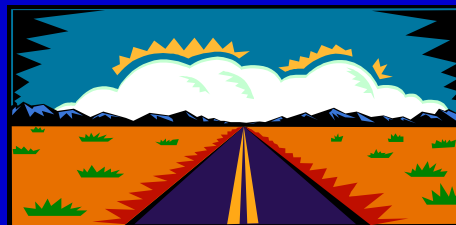
# The New Standard

*TIA/EIA-785*

Lucent Technologies  
Bell Labs Innovations



- *A low cost, low risk, & easy migration path*
- 300 meter support
- Uses off-the-shelf, short wavelength optics
- Auto-negotiation with current 850 nm, 10 Mbps Ethernet devices
- Interoperability (parallel detection) for installed base of 10BASE-FL devices



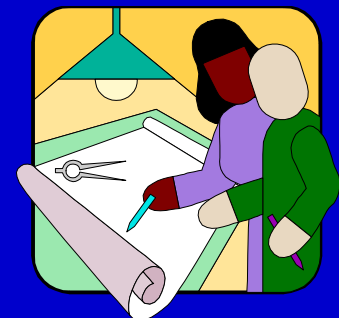
# The New Standard

## *TIA/EIA-785-Continued*

Lucent Technologies  
Bell Labs Innovations



- Designed for 62.5 or 50  $\mu\text{m}$  multimode fiber
- Connectors per TIA/EIA-568-B.3
- Cabling structure ready for Gigabit Ethernet
- Standard developed by TIA F.O. 2.2 committee
- Supported by broad array of vendors
  - LAN electronics
  - Fiber cable & apparatus
  - Optoelectronic device
  - Auto-negotiation silicon



# TIA/EIA-785

## *Two Components-100BASE-SX*

Lucent Technologies  
Bell Labs Innovations



- Physical Medium Dependent (PMD)-*Mandatory*
  - Derived from ISO/IEC 9314-3:1990 (FDDI PMD)
  - Exceptions same as for IEEE Std. 802.3-1998
  - Labeling identifies product capabilities
- Media conversion & auto-negotiation-*Optional*
  - Allows Ethernet/Fast Ethernet ports to communicate during link establishment
  - Brings Ethernet auto-negotiation into the fiber optic environment

# What the Standard is Not

## *100BASE-SX*

---

Lucent Technologies  
Bell Labs Innovations



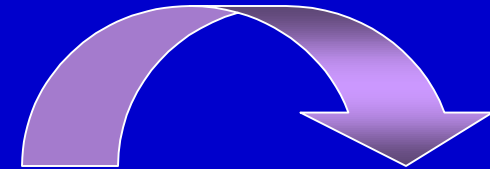
- A replacement for 100BASE-FX
- Compatible with 100BASE-FX
- Currently designed for VCSEL transceivers



# Why Short Wavelength?

## *100BASE-SX*

Lucent Technologies  
Bell Labs Innovations



- Cost of 10/100 Mbps-capable optics
  - 850 nm *less than 1/2 the cost* of 1300 nm
  - 100BASE-SX volumes could reduce cost further
- Cabling structure Gigabit Ethernet capable
  - Serial, short wavelength (850 nm) most cost-effective
  - Long wavelength (1300nm) WWDW solution 2-4x cost & losing support in IEEE 10 Gbps 802.3ae draft standard

# Why 300 meters?

## *100BASE-SX*

Lucent Technologies  
Bell Labs Innovations



- Different architectures for different media types
  - UTP copper: Hierarchical Star-100 meters (1984)
  - Multimode fiber: Centralized fiber-300 meters (1995)
- TIA/EIA-568-B.1
  - Approved for publication 12-00, available 2Q01
  - Supports centralized fiber optic cabling
- ISO/IEC 11801
  - Next release in development
  - Supports centralized fiber optic cabling
- EN50173
  - Next release in development
  - Supports centralized fiber optic cabling

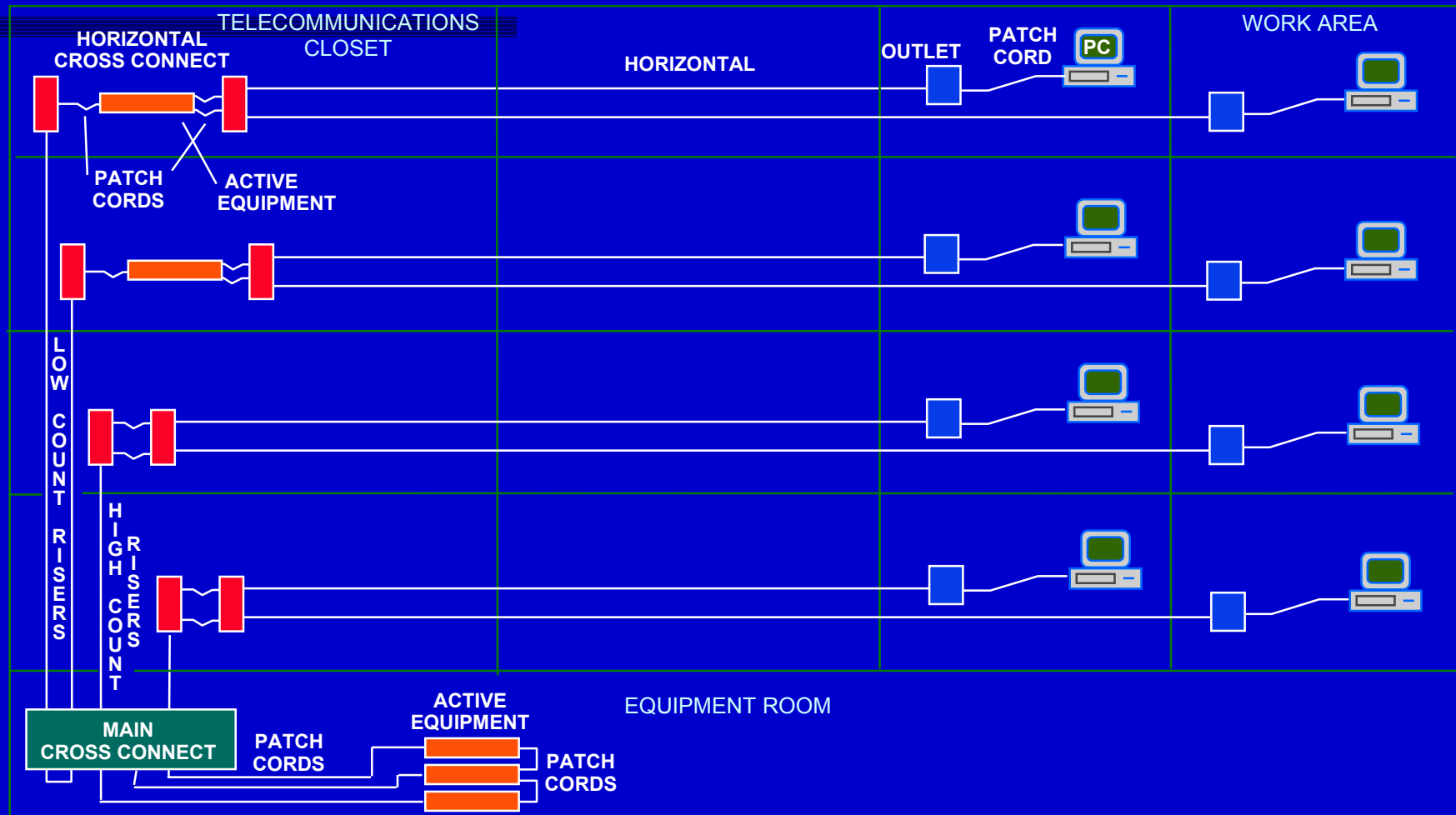




# Hierarchical Star Architecture

*Optimized for UTP Copper (100 Meter Limit)*

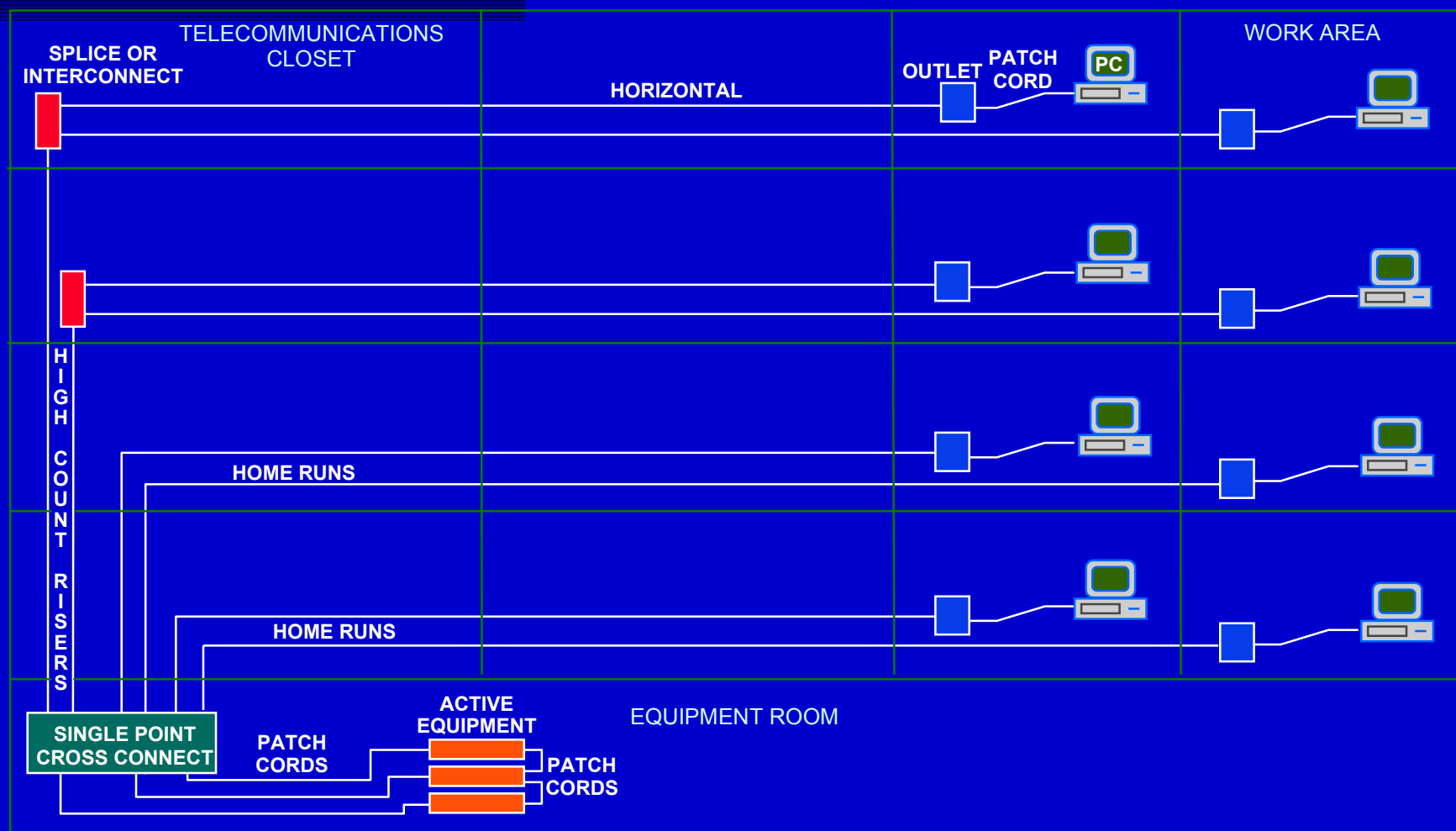
Lucent Technologies  
Bell Labs Innovations



# Centralized Fiber Optic Cabling

*Designed for Fiber (300 Meter Limit)*

Lucent Technologies  
Bell Labs Innovations



# Complementary Technologies

## *To The Desktop*

---

Lucent Technologies  
Bell Labs Innovations



- 100BASE-SX
  - 300 meter support specified
  - Less expensive fiber optic devices
- Centralized Fiber Optic Cabling
  - 300 meter support specified
  - Lower total “installed first cost”

*Deploying both technologies together  
can make good economic sense*

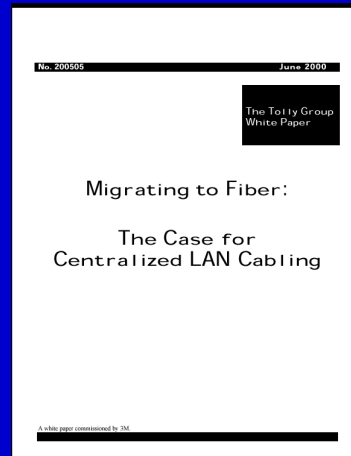
# Tolly Group Report

*August 2000*

Lucent Technologies  
Bell Labs Innovations



- “Migrating to Fiber: The Case for Centralized LAN Cabling”
- Includes telecommunication room savings analysis
- 300 meter support required
- Study commissioned by 3M



# Tolly Building Costs

*Floors, Walls, Shelves, Filtered Power,  
Lighting, A/C Ducts & UPS\**

Lucent Technologies  
Bell Labs Innovations



- 60,000 ft<sup>2</sup> bldg., 267 users

- *TC Rooms*

- Distributed

- 10' x 11'
      - \$32,226.35

- Centralized

- 2.5' x 4'
      - \$13,328.25

- *Main Equipment Room*

- Distributed

- 20' x 20'
      - \$33,361.90

- Centralized

- 20' x 22'
      - \$37,428.30

- 240,000 ft<sup>2</sup> bldg., 1067 users

- *TC Rooms*

- Distributed

- 10' x 11'
      - \$32,226.35

- Centralized

- 2.5' x 4'
      - \$13,328.25

- *Main Equipment Room*

- Distributed

- 30' x' 40'
      - \$47,629.40

- Centralized

- 34' x' 40'
      - \$56,893.20

\*Information current as of 7-2000

Copyright © 2001 Lucent Technologies, Inc., All rights reserved.

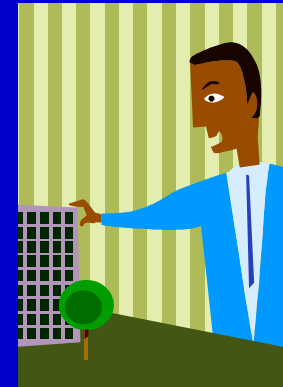
# Centralized Fiber Optic Cabling

*Tolly Installed Cost Savings-60,000 ft<sup>2</sup> Building\**

Lucent Technologies  
Bell Labs Innovations



- 267 users
- 1 main equipment room
- Copper total costs (5 TC rooms)
  - Cat 5e: \$962.76/user
  - Cat 6: \$972.85/user
- Fiber total costs\*\* (2 TC rooms)
  - 1/2 TC rooms/floor
  - \$806.80/user
- Claimed fiber system savings
  - \$41,587.56 (vs. Cat 5e)
  - \$44,279.30 (vs. Cat 6)



\*Information current as of 7-2000; \*\*Fiber system costs based on 3M Volition™ products

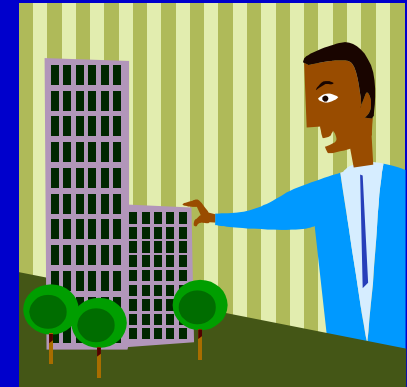
# Centralized Fiber Optic Cabling

*Tolly Installed Cost Savings-240,000 ft<sup>2</sup> Building\**

Lucent Technologies  
Bell Labs Innovations



- 1,067 users
- 1 main equipment room
- Copper total costs (23 TC rooms)
  - Cat 5e: \$996.00/user
  - Cat 6: \$1006.10/user
- Fiber total costs\*\* (11 TC rooms)
  - 1/2 TC rooms/floor
  - \$773.09/user
- Claimed fiber system savings
  - \$237,770.11 (vs. Cat 5e)
  - \$248,537.05 (vs. Cat 6)



\*Information current as of 7-2000; \*\*Fiber system costs based on 3M Volition™ products

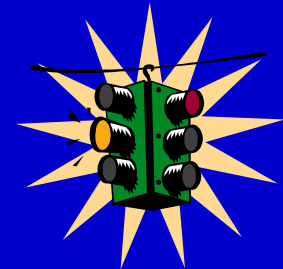
# Infrastructure Caveats

*Proceed With Caution*

Lucent Technologies  
Bell Labs Innovations



- Performance varies among fiber optic cables
- Performance varies among fiber optic apparatus (connectors, splices, etc.)
- Fiber infrastructure represents small percentage of total system cost
- Consider highest speed future application when selecting your infrastructure





# Tolly White Paper

## *Summary Excerpts*

---

Lucent Technologies  
Bell Labs Innovations



*"...with the advent of new centralized LAN cabling designs, fiber now enjoys a cost advantage as well: Reducing the size of telecommunications rooms, and even removing many of them, throughout the campus means significant reductions in quantifiable, capital costs, plus additional savings in recurring costs..."*

*"...users can expect to reap significant savings in a centralized architecture over time versus a distributed model."*

# Centralized Fiber Caveats

*Benefits May Be Limited In Existing Buildings*

Lucent Technologies  
Bell Labs Innovations



- Hardware may not easily be reused or resold
- Floor space not be easily reused
- Building modifications may be expensive
- ANSI/TIA/EIA 569-A requires 1 TC room/floor
- New installs may be easier sale

*...“but: even partial reclamation of TC room space  
can result in major cost savings”*

Source: Tolly Group Report: “Migrating to Fiber: The Case for Centralized LAN Cabling”, July 2000

# Life-Cycle Savings

*Tolly Says Difficult to Quantify, Yet Significant*

Lucent Technologies  
Bell Labs Innovations



- Environment control
  - Filtered, uninterruptible power
  - HVAC
- Spare hardware (idle ports)\*
- Maintenance & availability
- Improved performance
- Elimination of copper upgrade(s)
  - "Can save hundreds of thousands of dollars"

*"This consideration alone makes fiber a compelling choice"*

\*OIDA "Local Optical Networking" Conference, March 5-6, 2001

Copyright © 2001 Lucent Technologies, Inc., All rights reserved.

# Centralized Fiber Cabling

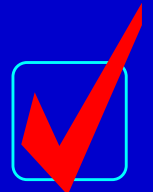
## *Installed System Examples\**

Lucent Technologies  
Bell Labs Innovations



- Crossroads
- Georgetown University
- Parsons Behle & Latimer
- NASA Goddard Space Flight Center
- George Washington University
- Corning Erwin, NY Plant
- Smith Barney
- J. Paul Getty Center
- Siemens ICN
- Guilford County School System
- Bally's Las Vegas
- Metropolitan Nashville Public Schools
- U.S.A.F. Research Laboratory, Wright Patterson Air Force Base
- Hilton Hawaiian Village

\*Various published sources



# What About Hierarchical Star?

Lucent Technologies  
Bell Labs Innovations



*Cabling & Electronics (Source: J. Clayton, Bell Labs, 2-99)*

**Fiber Premium Only 40%**

	10/100 Copper	10/100 Mbps Fiber	Fiber Premium*
4-fiber riser Cross-connect	Category 5	Multimode 62.5 $\mu$ m	1.7x
	Category 6		1.5x
12-fiber riser Interconnect	Category 5	Multimode 62.5 $\mu$ m	1.6x
	Category 6		1.4x

\* Premium for fiber hierarchical star (further possible reduction with centralized fiber optic cabling). 10/100 Mbps optics pricing may also be reduced as volumes increase (currently low volume market). These numbers represent minimum estimated costs for 100BASE-SX solution and do not include auto-negotiation silicon.




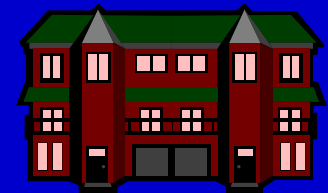
# Fiber-to-the-Home

*Local Community System-100BASE-SX*

Lucent Technologies  
Bell Labs Innovations



- System designed by **ERICSSON**  (Sweden)
- Broadband local access in apartments
- 100BASE-SX installed in thousands of homes
- Scalable system
- Multiple services (10 or 100 Mbps)
  - High speed Internet & Intranet
  - IP telephony
  - Video
  - Security



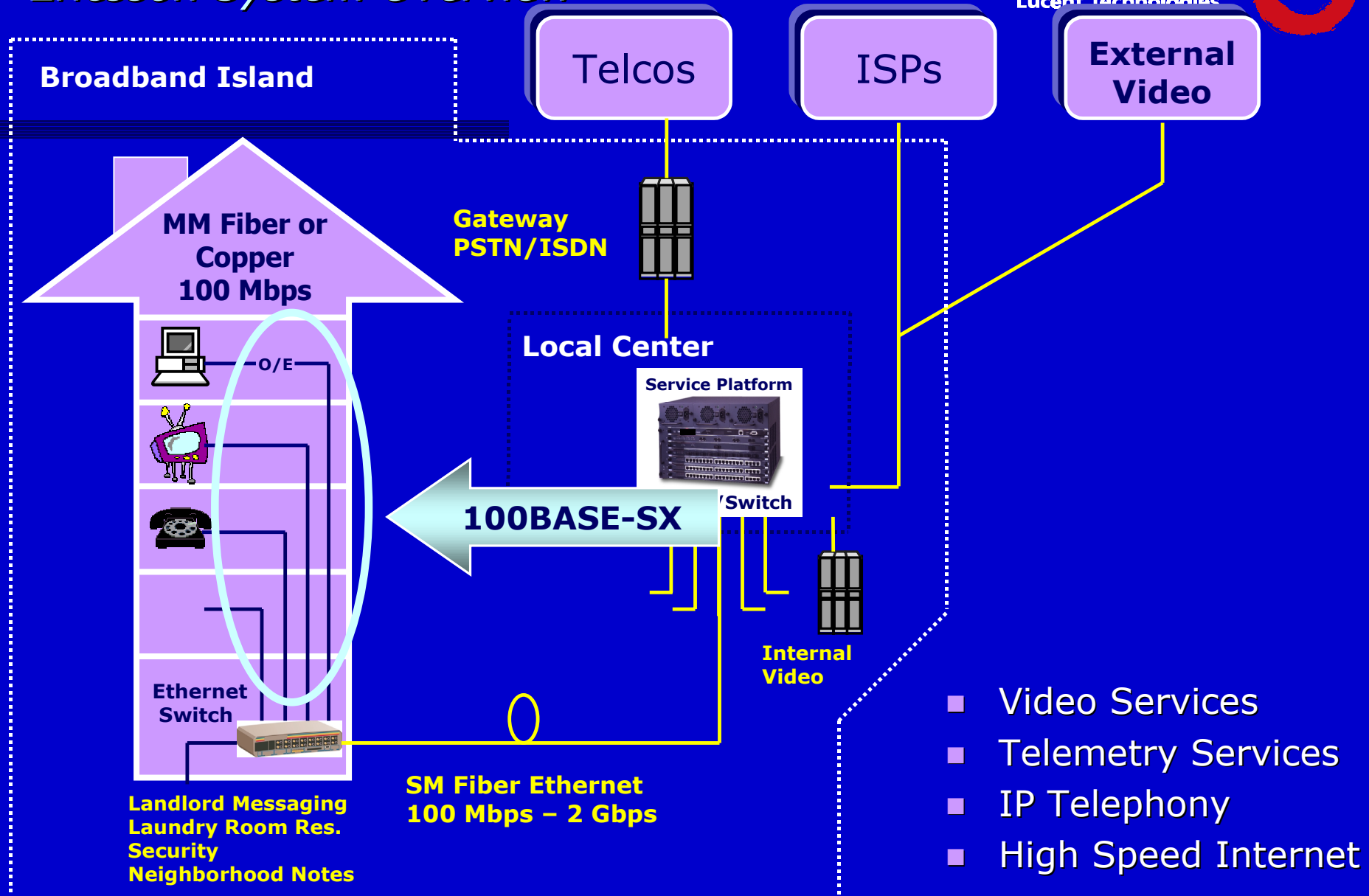
# Local Community System

## Ericsson System Overview

Lucent Technologies  
Bell Labs Innovations



Lucent Technologies



# Local Community System

## *House (Building) Node*

Lucent Technologies  
Bell Labs Innovations



- Concentrates traffic onto 1 pair of fibers
- 300 meter distance to apartment node
- Contains Ethernet layer 2 switch
- Up to 96 full duplex 10/100 ports





# Local Community System

## *Apartment Node*

Lucent Technologies  
Bell Labs Innovations



- 100BASE-SX technology
- Supports 300 meters
- Auto-negotiation standard
- AC power supplied in apartment



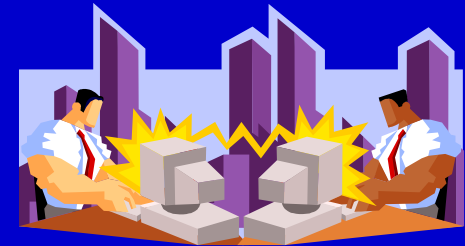
# 100BASE-SX Electronics

## *Partial List*

Lucent Technologies  
Bell Labs Innovations



- Allied Telesyn International (ATI)
  - 100 Mbps SX media converters
  - 10/100 SX NIC card (under development)
- IMC Networks
  - 10/100 Mbps SX media converters
  - 100BASE-SX NIC card
- Micro Linear
  - Fast Ethernet media converter IC (ML6651)
- Sun Conversion Technologies
  - 100 Mbps SX media converters
  - 100 Mbps SX NIC card
- Transition Networks
  - 10/100 Mbps SX media converters
  - 10/100 Mbps SX NIC cards



# 100BASE-SX Sample Savings

## *Media Converter Price Comparison*

Lucent Technologies  
Bell Labs Innovations



- Transition Networks
  - Shipping since 4th quarter 1999
- Long wavelength (1300nm)
  - E-100BTX-FX-04
  - UTP/Fiber
  - List Price: \$345
- Short wavelength (850nm)
  - E-100BTX-SX-01
  - UTP/Fiber
  - List Price: \$265



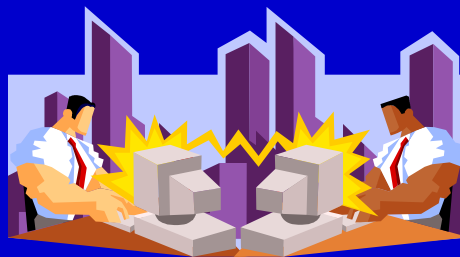
# Demonstration at BICSI

## *100BASE-SX Interoperability*

Lucent Technologies  
Bell Labs Innovations



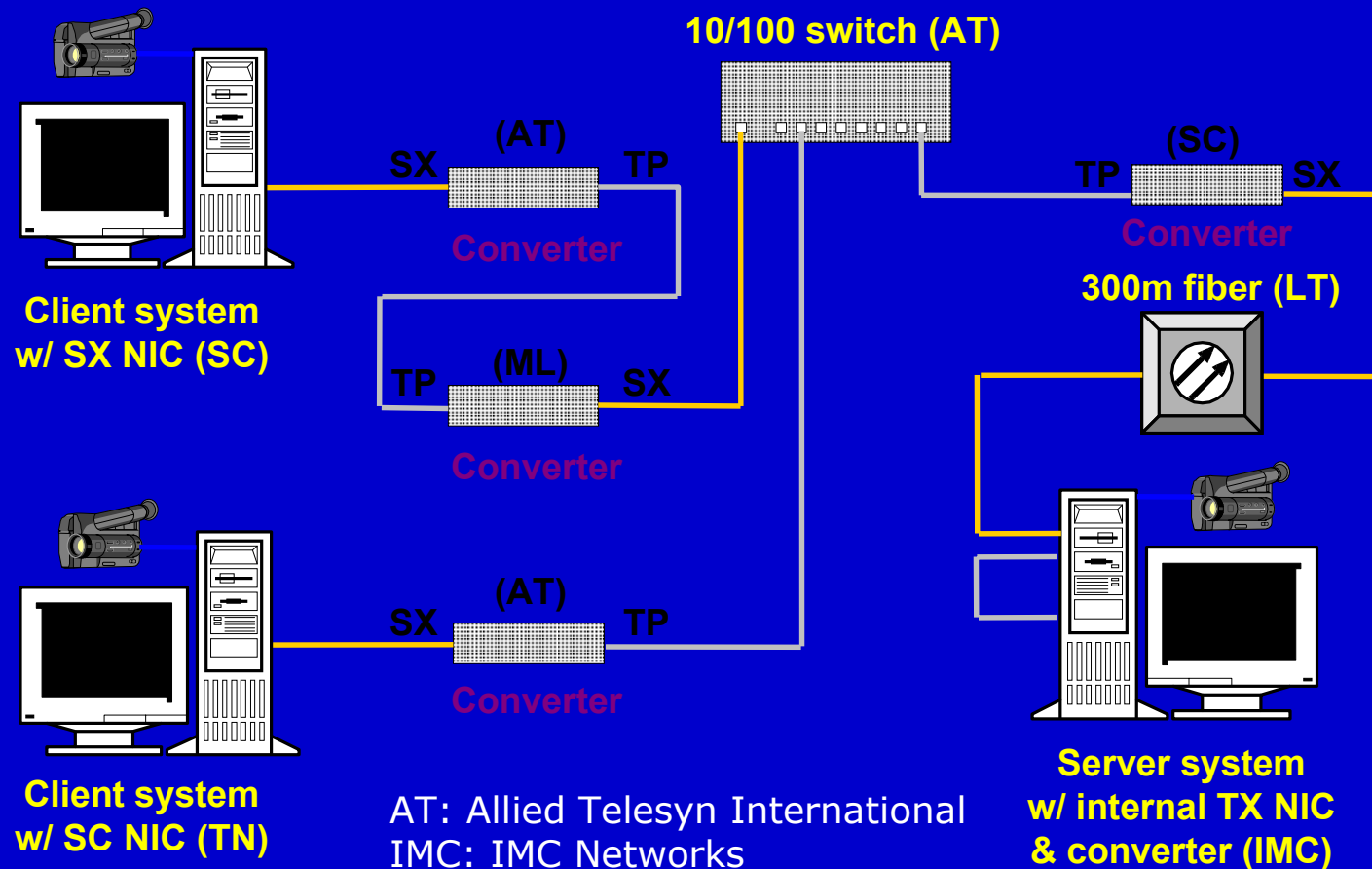
- Multiple vendor participation
- 10BASE-FL compatibility
- 300 meter fiber link length
- Auto-negotiation functionality
- High bandwidth multiple session streaming video



# Partial Configuration

## *100BASE-SX Interoperability*

Lucent Technologies  
Bell Labs Innovations



AT: Allied Telesyn International  
IMC: IMC Networks  
LT: Lucent Technologies  
SC: Sun Conversion Technologies  
TN: Transition Networks

# 100BASE-SX

## *Summary*

---

Lucent Technologies  
Bell Labs Innovations



- TIA/EIA-785 (100BASE-SX)
- Provides fiber upgrade path to Fast Ethernet
- 850nm operating wavelength for lower cost
- Ideal for fiber-to-the-desk & fiber-to-the-home
- 300m support for centralized or hierarchical star cabling architecture
- Status
  - TIA ballot closed March 23, no comments
  - ANSI ballot closed May 7
- Interoperability demonstration: Booth #78

# 100BASE-SX

## *References*

---

Lucent Technologies  
Bell Labs Innovations



- TIA/EIA-785 Standard
  - Global Engineering, 1-800-854-7179
  - <http://www.global.ihs.com>
  - ANSI public review closed on May 7
- TIA Fiber Optics LAN Section Web Site
  - [www.fols.org](http://www.fols.org)
  - 100BASE-SX Fast Ethernet White Paper
- Tolly Group White Paper
  - [www.tolly.com](http://www.tolly.com)
  - "Publications", "White Papers", Document Number 200505
- BICSI LAN & Internetworking Design Manual
  - Ethernet Networking (Chapter 9)
- "Selecting a Small-Form-Factor Fiber Optic Connector for Private Networks"
  - <http://www.lcalliance.com/lcinterface/pdfs/lc.pdf>

**Lucent Technologies**  
Bell Labs Innovations



**Lucent Technologies**  
Bell Labs Innovations

