Optical Fiber: Bringing Bandwidth to the Classroom, Cost Effectively

ASCUE - June 11, 2003

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3M Company -Telecommunications Division

TIA

Fiber Optics LAN Section

Outline – Agenda

- Background – FOLS – Cost model, Network design Standards updates
- The New Fiber - Characteristics
- Basic Network Designs
  - Applying designs to Education
  - Examples of net designs - Dorms, Admin, Engineering
- Design impact on Network costs
- FOLS Cost model
  - Review of Assumptions
  - Review model format
  - Interactive cost modeling

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Fiber Optics LAN Section

- Formed in 1993, Part of TIA's Fiber Optics Division
- Mission: To create a resource where people can learn about the technical advantages and affordability that optical transmission brings to customer-owned networks.
- Members: 3M/Volition, AMP/Tyco Electronics, Corning, Corning Cable Systems, Leviton Voice & Data, Micro Linear Corporation, OFS, Optek Technology, Panduit, Ortronics, Sumitomo Electric Lightwave and Transition Networks, Fluke Networks, and others.
- **www.fols.org**

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Background & History

- Aug 2000 – Tolly Group white paper “Migrating to Fiber – The Case for Centralized Cabling”
- 2001 – First version of FOLS cost model
  - Focused on SFF connectors, and media converters
  - Implemented conclusions of Tolly study with “real world” scenarios.
- April/May 2003 – Version 2 of cost model developed
  - Updated new lower cost fiber and copper switches and other products
  - Doubled the number of scenarios
    - Added very low cost and Zone configurations

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Ground Breaking Research

- Provides a third party total cost analysis of Copper and Fiber LANs
  - For the first time, includes costs of all copper switches, NICs, and active product components
  - Utilizes fiber LAN architecture (“Centralized vs. Distributed”)
  - Includes costs of telecommunications closets

THE TOLLY GROUP

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The Main Theme

http://www.tolly.com/results/whitepapers.htm Doc. 200505

http://mmm.com/market/telecom/enterprise/volition/literature.jhtml#WhitePapers

- Disparity in costs is largely attributable to the erroneous presumption that fiber-optic networks should be designed exactly like copper infrastructures.
- Designing fiber-optic networks based upon the design characteristics of fiber often can save thousands of dollars compared to copper.

Migrating to Fiber
The Case for Centralized LAN Cabling

- "To the list of fiber's well-known benefits of exceptionally high bandwidth and immunity to EMI, we can now add the benefit of significant cost reductions."

- Lower costs are partly attributable to simplified connector design and high-density, small-form-factor connectors.

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Distributed vs. Centralized

- Distributed
  - accommodates the 100-meter limit of UTP copper cable.
  - necessitates media conversion in the telecommunications room.
  - Typically, consists of high-speed uplinks
- Centralized
  - not bound by copper's 100-meter limitation, nor do they require media conversion from one physical medium to the other.

- The comparison uses standards-based design

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TIA Fiber Optics LAN Section Study

How Do Costs Compare Today?

A comparison of installed first costs shows that fiber offers a cost-effective solution for horizontal cabling applications in a variety of scenarios. In fact, fiber offers considerable initial savings, considering installed first costs alone.

Enabling technologies...

- New cabling architectures optimized for fiber
- Short wavelength fiber LAN electronics
- Small-form-factor (SFF) fiber connectors

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Zone, Tiny TR, Telecom Enclosure Update

- TR42.3 has drafted Telecom Enclosure (official name)
  - Currently out for ballot – will go for "default" ballot in July
  - Will eventually be an addendum to TIA 569B
- TR42.1 has drafted a TE cabling implementation document
  - Will be out for ballot in July
  - Will become an addendum for TIA 568 B.1
- Both expected to be complete in October

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Fiber Misconceptions

"Not Your Father's Fiber"

Size

- Perception: Copper cable is smaller than fiber cable
- Fact: Fiber is 15% smaller

Rating

- Perception: Copper is more fire-resistant
- Fact: Fiber is Plenum-rated, compatible with infrastructure

Weight

- Perception: Copper weighs less than fiber
- Fact: Fiber components are heavier, but fiber cable is lighter

Strength

- Perception: Fiber is fragile
- Fact: Fiber is 4+ times stronger than copper

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Fiber's New Characteristics

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Fiber's New Characteristics

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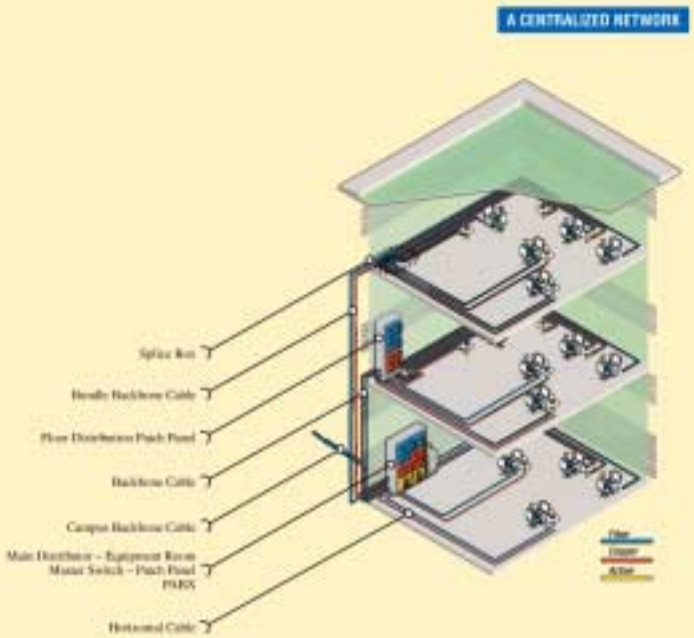
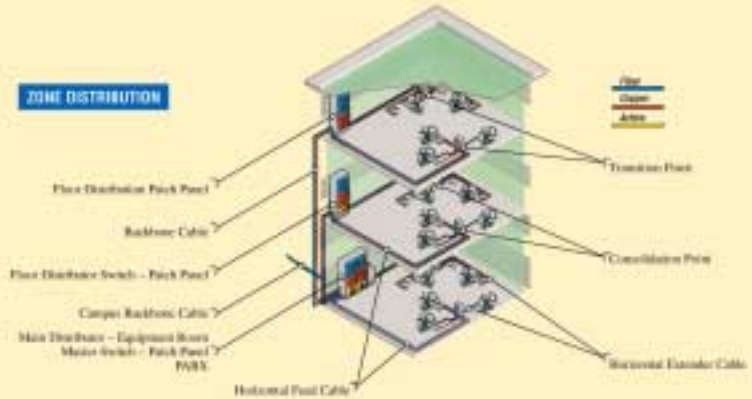
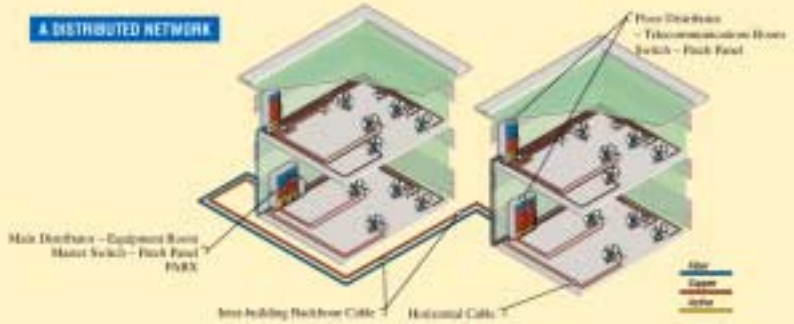
Fiber's New Characteristics

A Multi-design Network

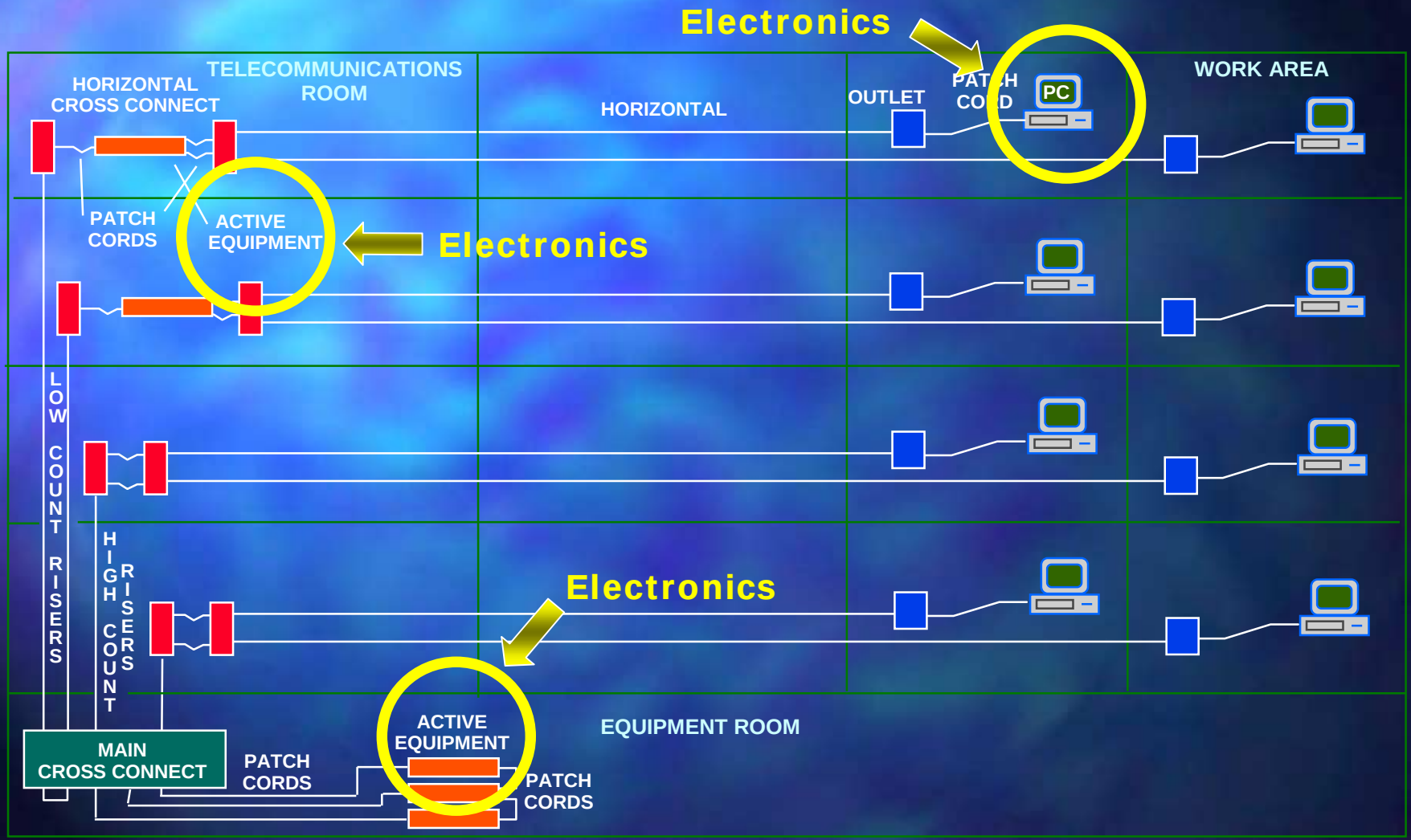






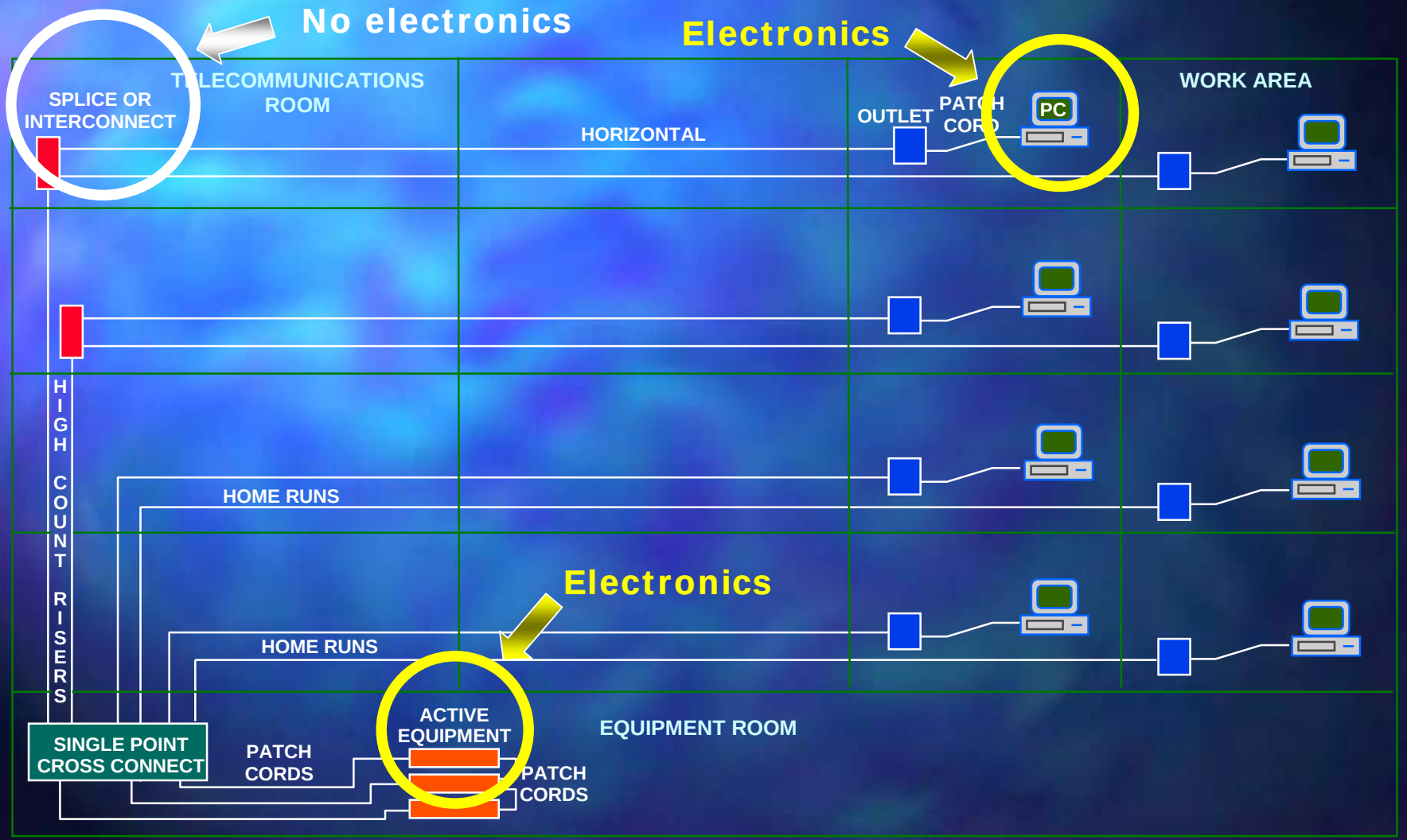
Cabling System Architectures

Hierarchical Star, Optimized for UTP Copper (100 Meter Limit)



Cabling System Architectures

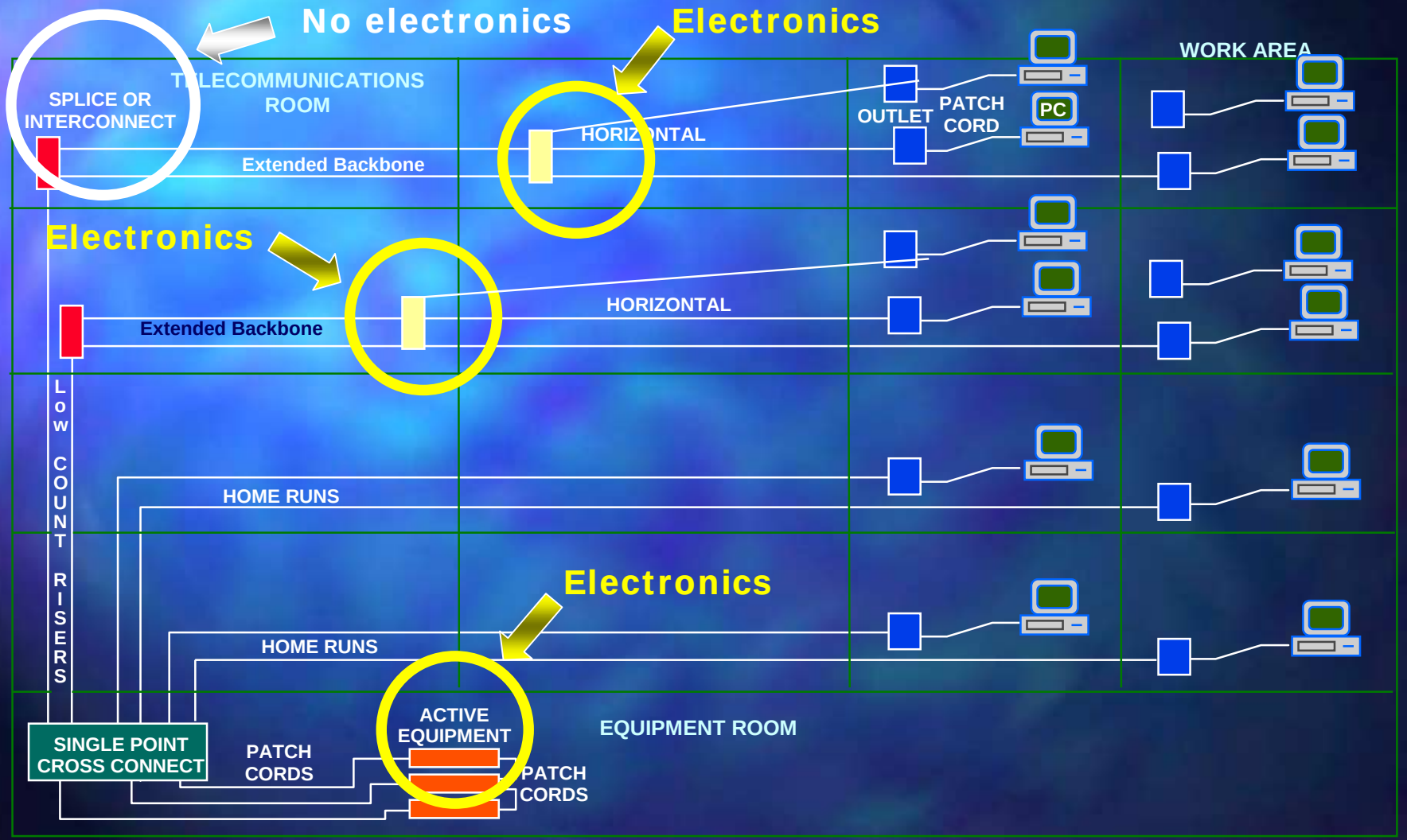
Centralized Fiber, Designed for Fiber (300 Meters)



Standardized in TIA/EIA-568-B.1 & ISO-11801, 2nd Ed.

Cabling System Architectures

Zone Designs – Expanding Backbone bandwidth while integrating traditional copper components



Will be Standardized in TIA/EIA-568-B.1 and TIA/EIA-569-B

Traditional Design

LEGEND:

= Fiber Backbone Cable

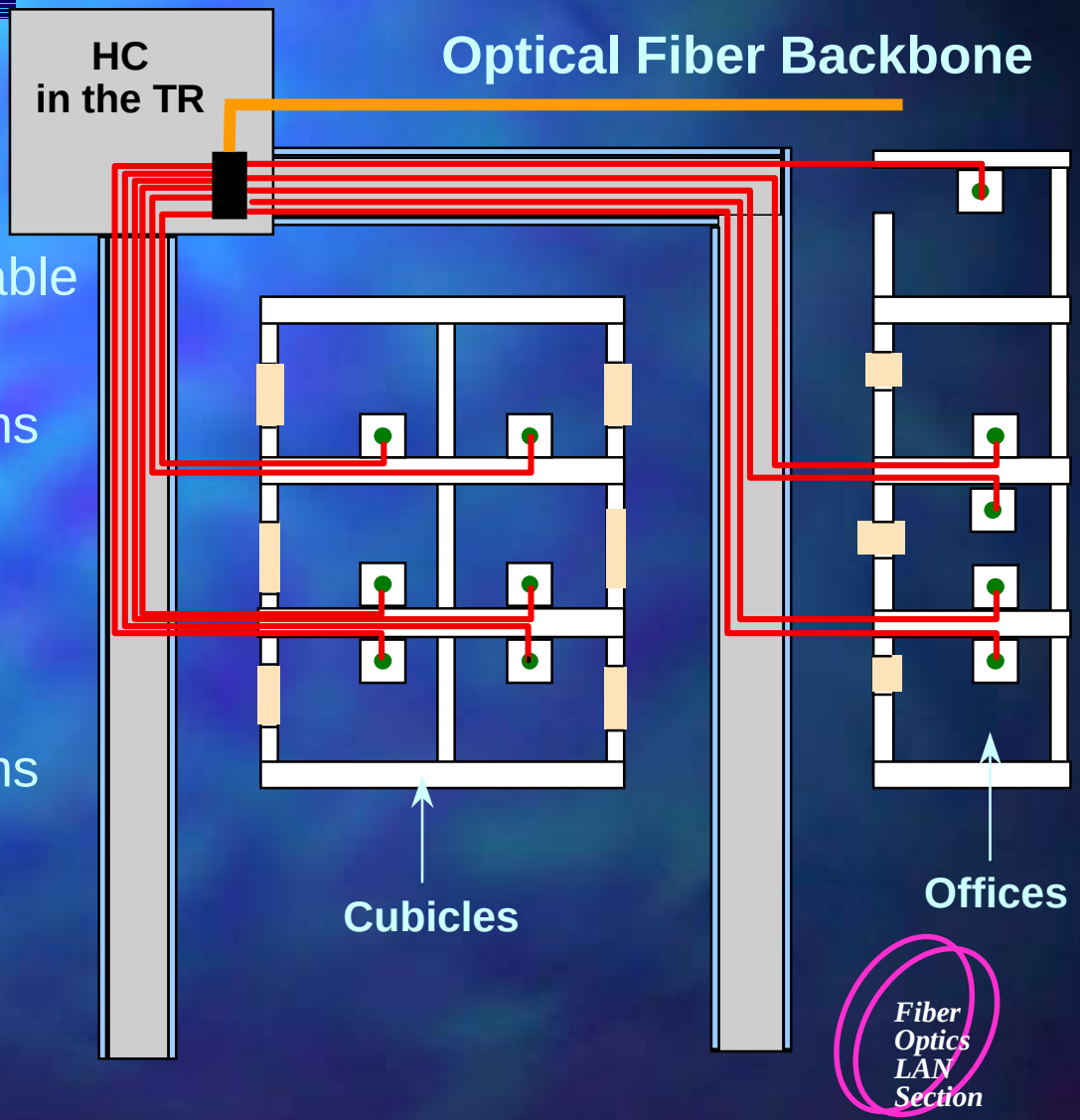
= Horizontal Cable

= Telecommunications Outlet/Connector

= Building Pathways and Spaces

HC = Horizontal Cross-Connect

TR = Telecommunications Room



Zoned Cabling with a Telecomm Enclosure

LEGEND:

= Fiber Backbone Cable

= Horizontal Cable

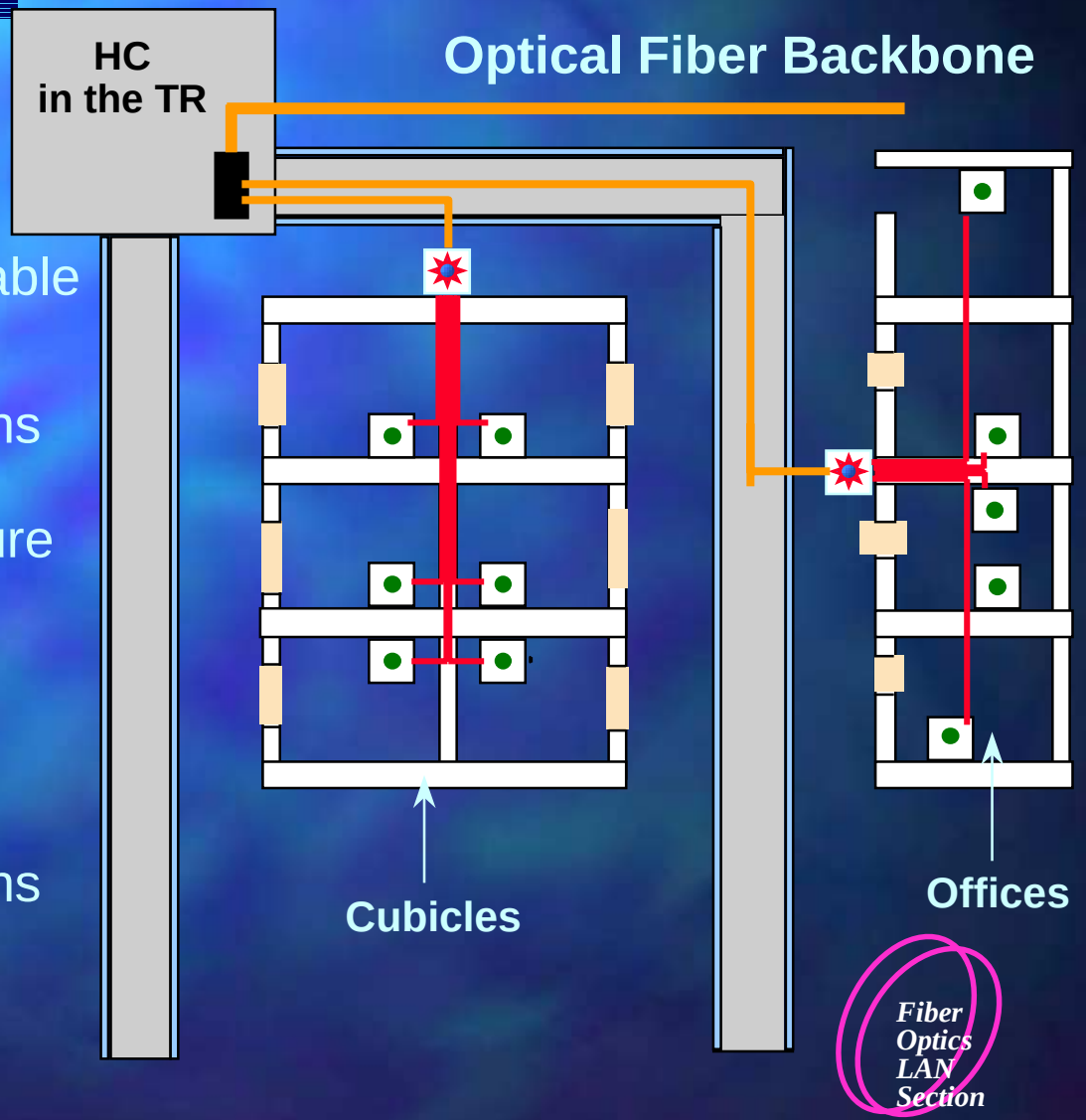
= Telecommunications Outlet/Connector

= Telecomm Enclosure with a switch

= Building Pathways and Spaces

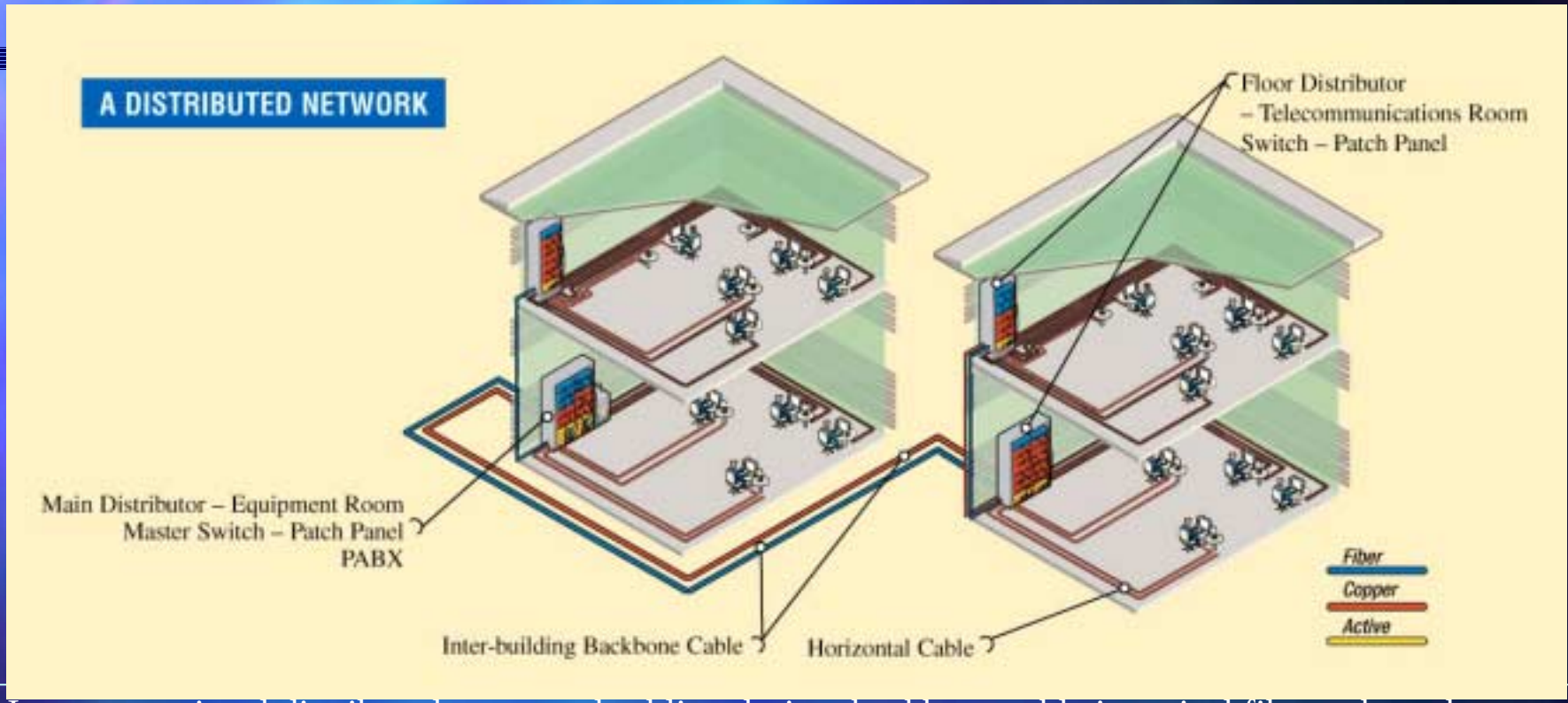
HC = Horizontal Cross-Connect

TR = Telecommunications Room



A Distributed Network

Copper and Fiber



In a conventional distributed structured cabling design, backbone cable is optical fiber, where the horizontal segment of the network typically consists of twisted-pair copper cable or optical fiber cable (depending on distance). Backbone cables in an inter-building network travel from a main cross-connect (distributor) to one or more horizontal cross-connects within the telecommunication rooms on each floor, which includes active electronics equipment such as hubs, concentrators or switches.

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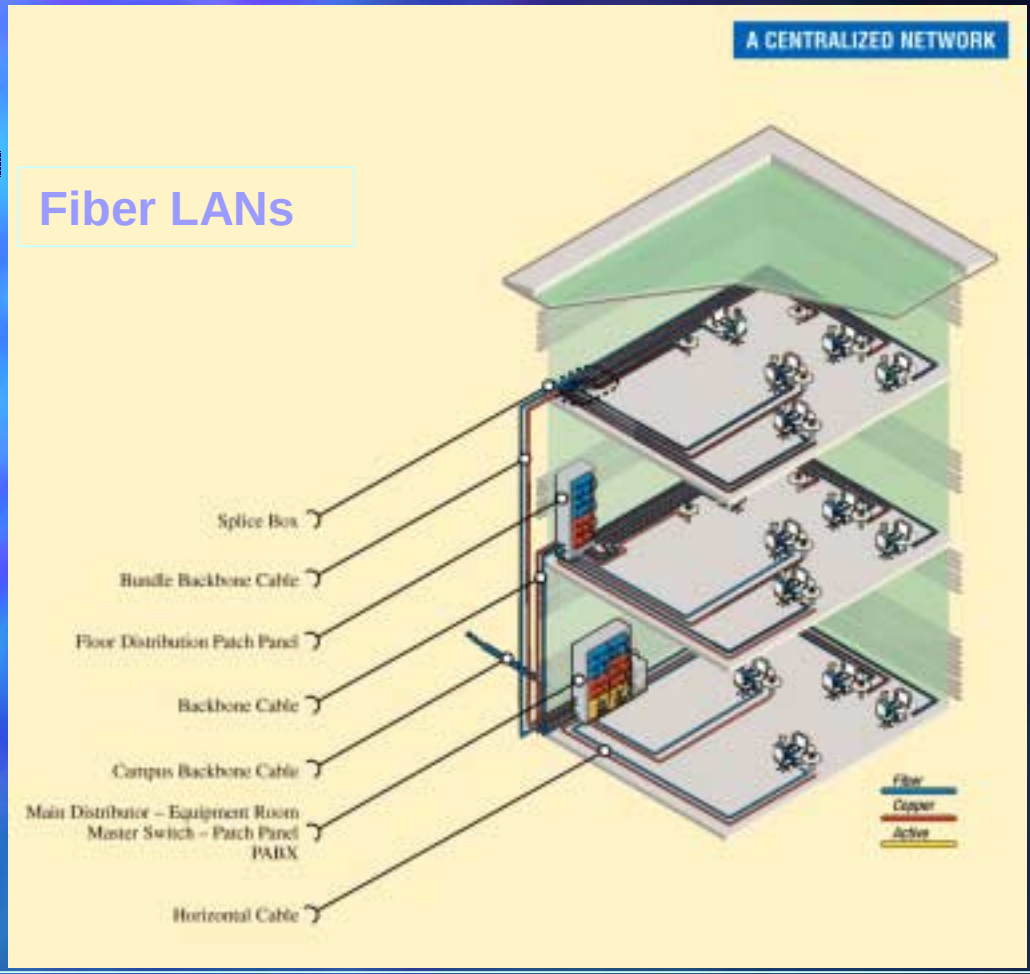
A Centralized Network



Optical fiber's bandwidth and ability to carry data over long distances is best utilized in centralized networks. Centralized networks have more unblocked bandwidth than distributed networks and therefore better suited for combined voice, video and data traffic requiring quality of service implementation. Optical fiber eliminates intermediate closets, thus simplifying network layout and reducing overall system cost. A centralized network is the most efficient and cost-effective way to implement a fiber-centric LAN.

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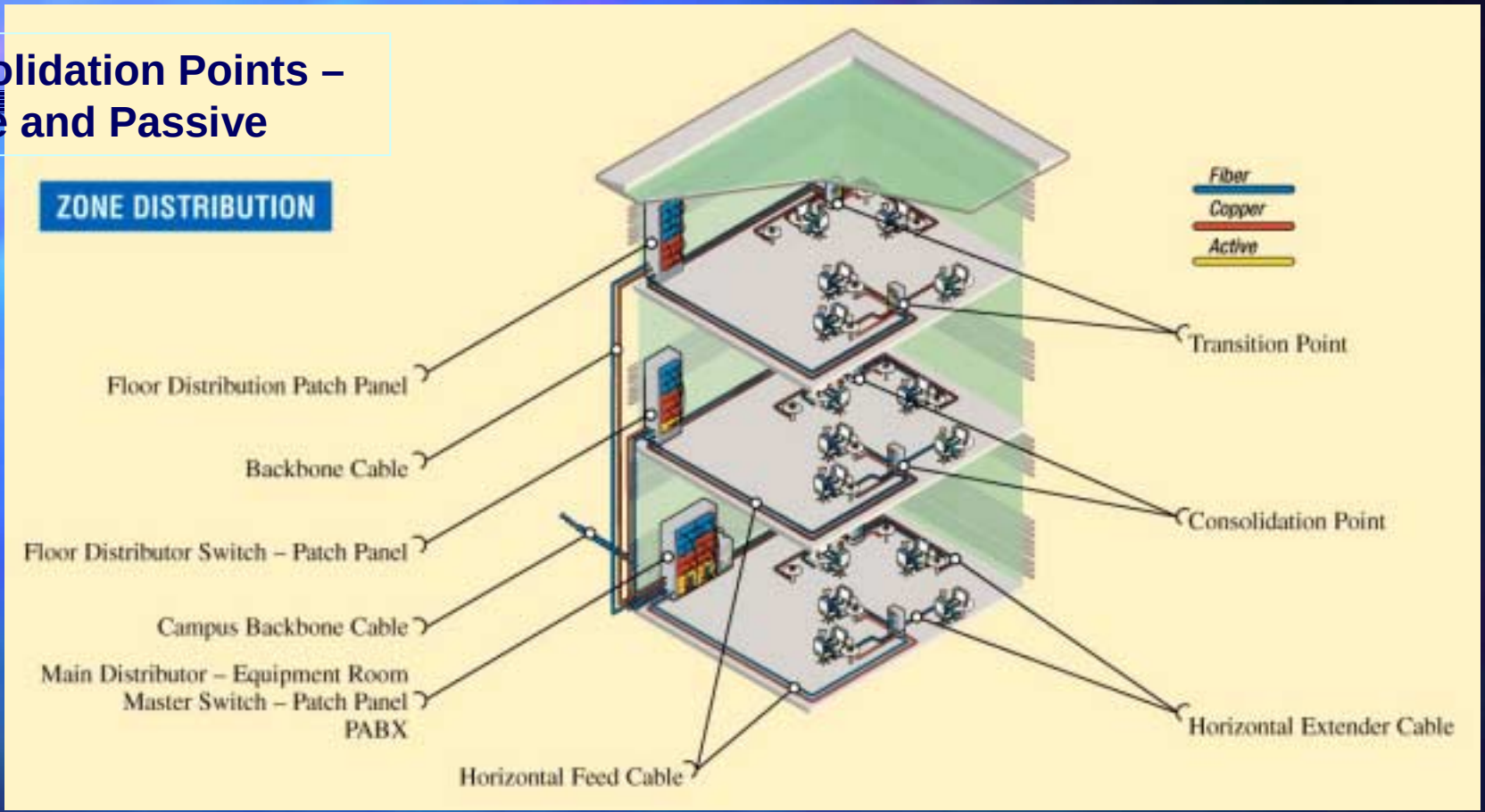
Zone Cabling Architecture

Consolidation Points – Active and Passive



Moves, adds or changes in an open-office environment can be accommodated quickly and efficiently through consolidation points by combining permanent feeder cabling with pre-terminated plug-and-play extender cables associated with the work area. Providing connectivity closer to end-users not only adds flexibility, but also reduces network downtime and re-cabling ends, which can result in significant cost savings.

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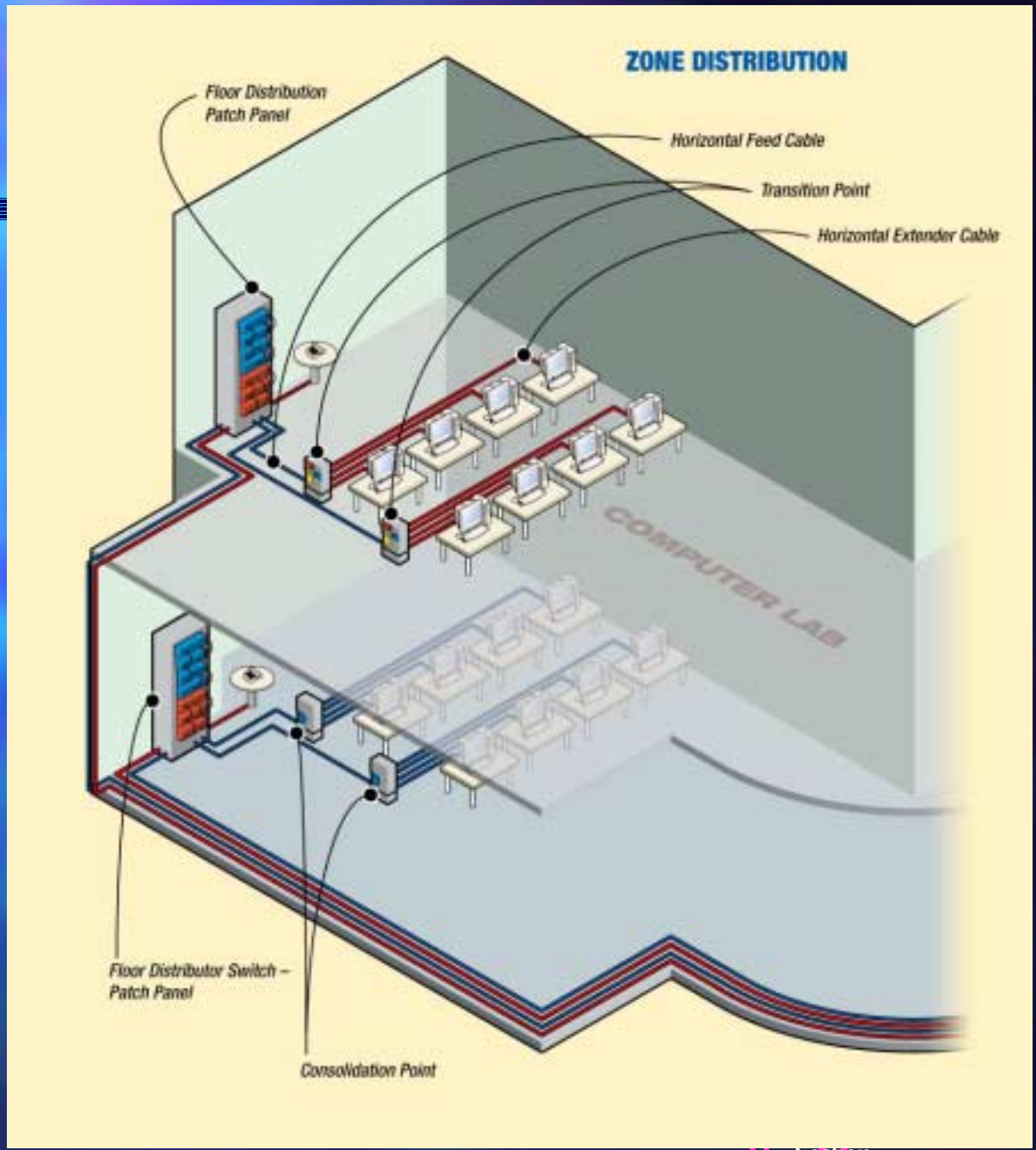
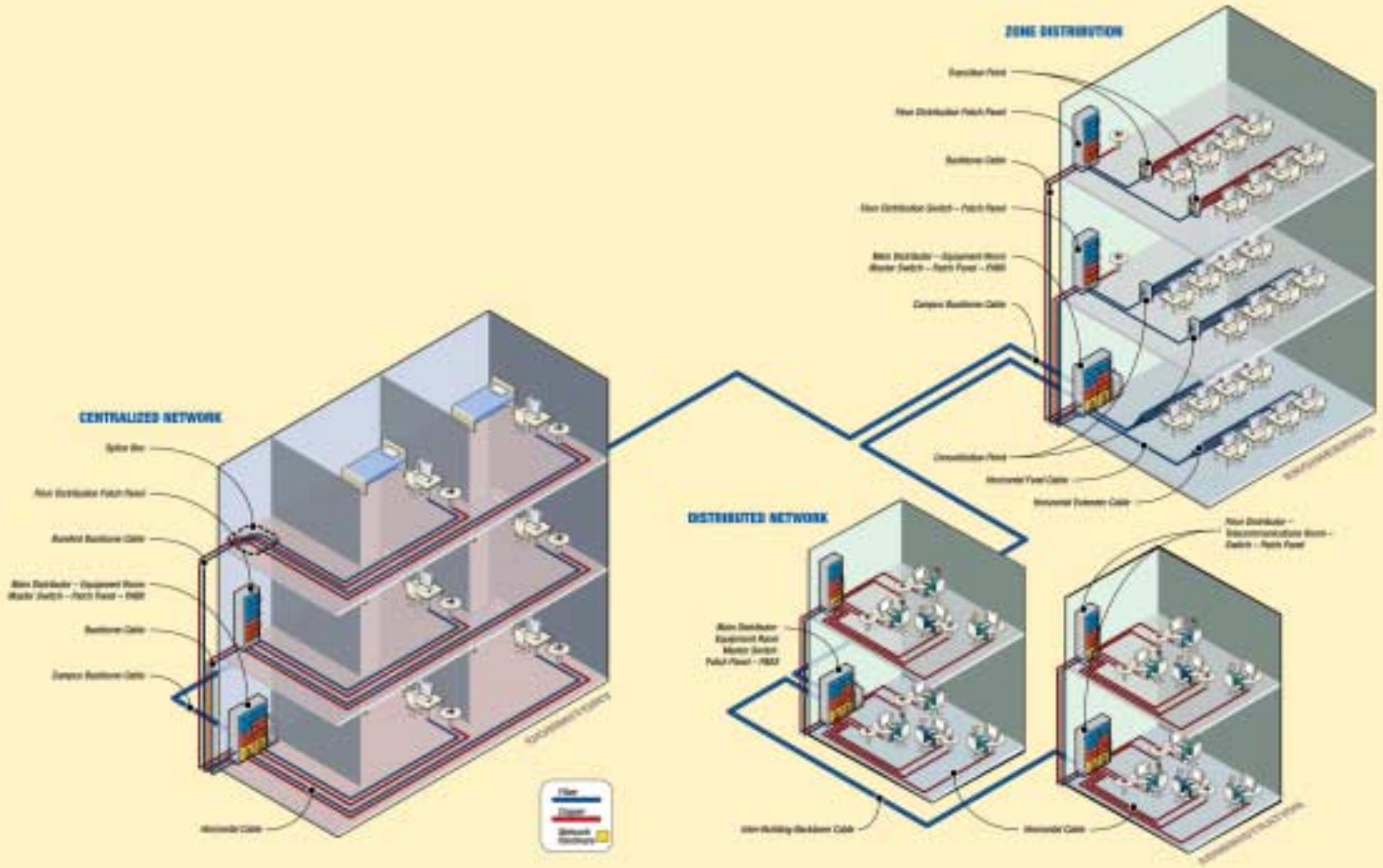
Zone –

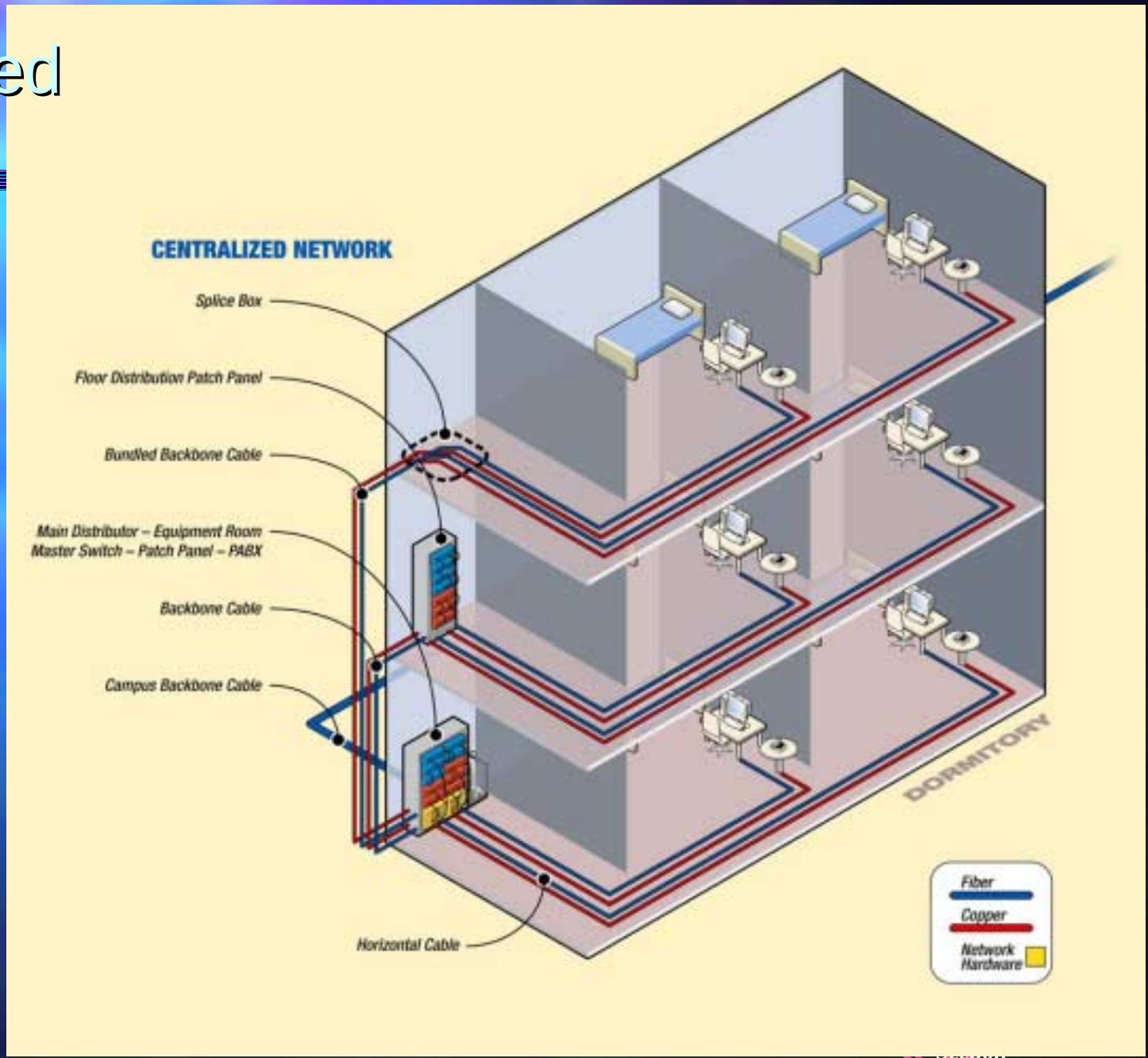
Transition points vs. consolidation points



A Multi-design Campus Network

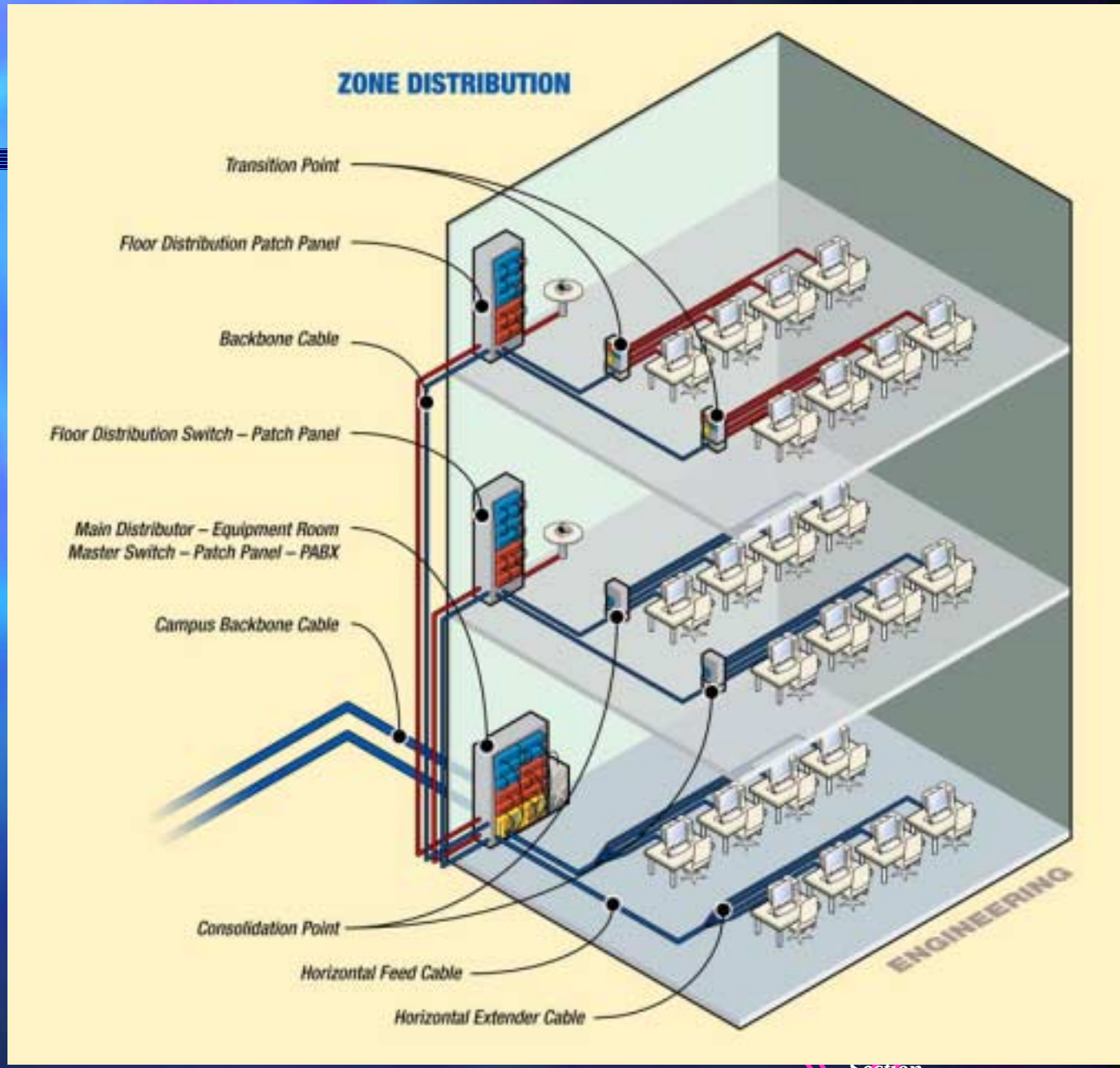


Centralized Designs

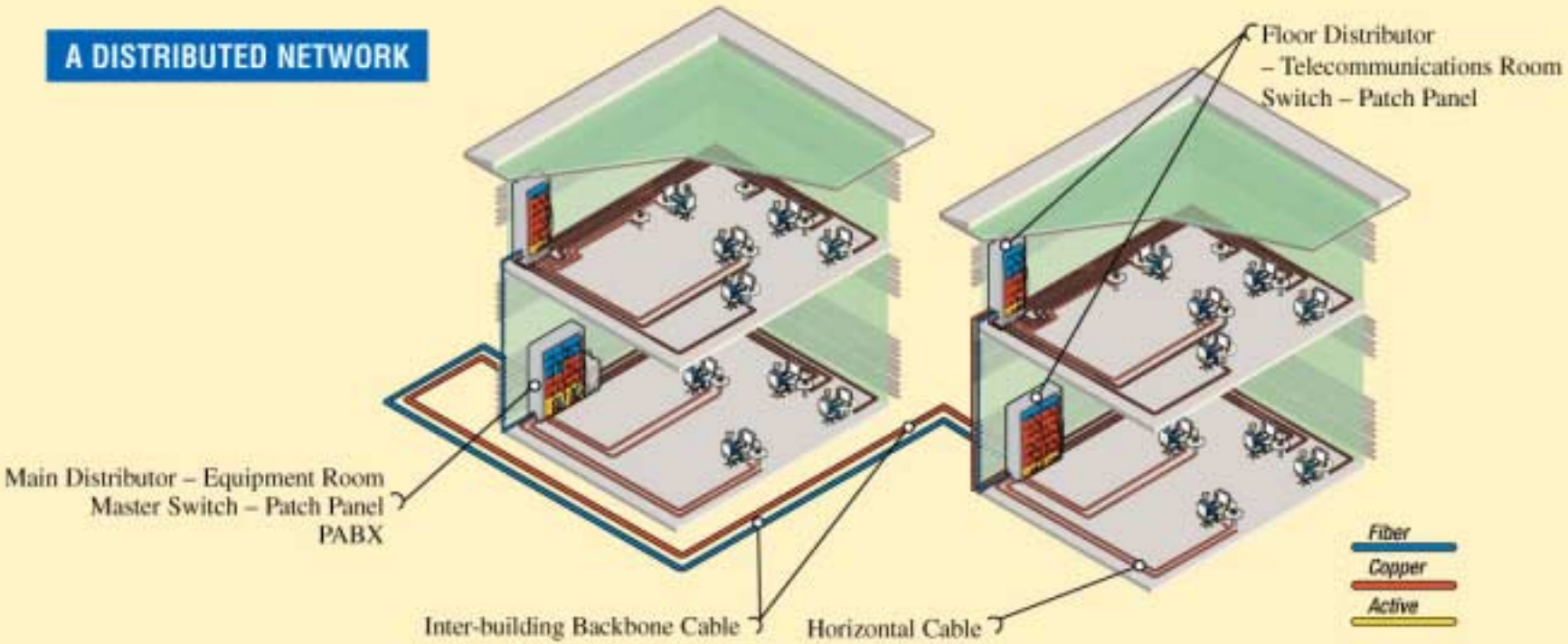


Zone Distribution

Engineering or Other



A DISTRIBUTED NETWORK



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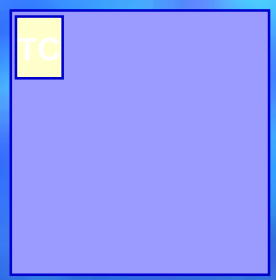
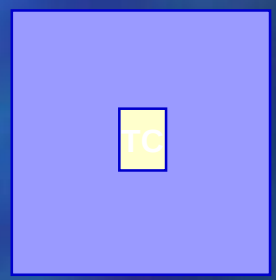
Central or corner located closet?

Floor areas are both 32 x 31 m

Which one uses the most cable?



Corner solution
average length 45 m



Central solution
average length 30 m

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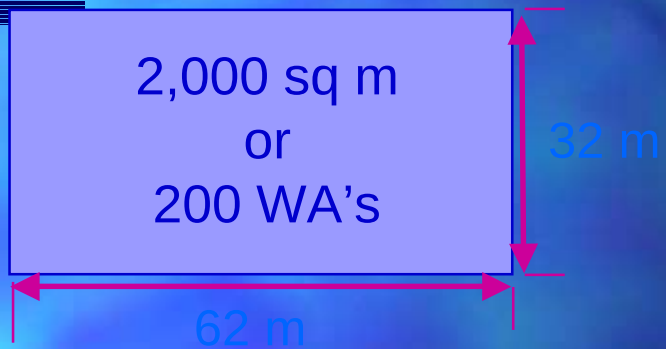
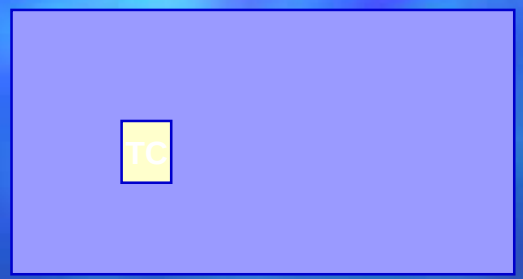
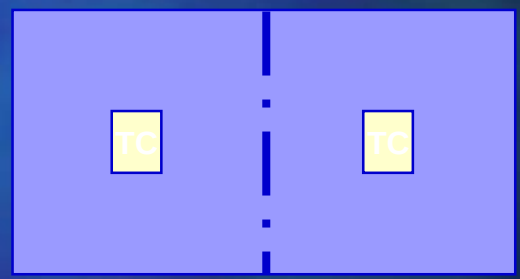
How many closets required in this area?





"90 metre rule" solution
200# WA into TC
average length 55 m



"TIA-569A" solution
100# WA per TC
average length 30 m

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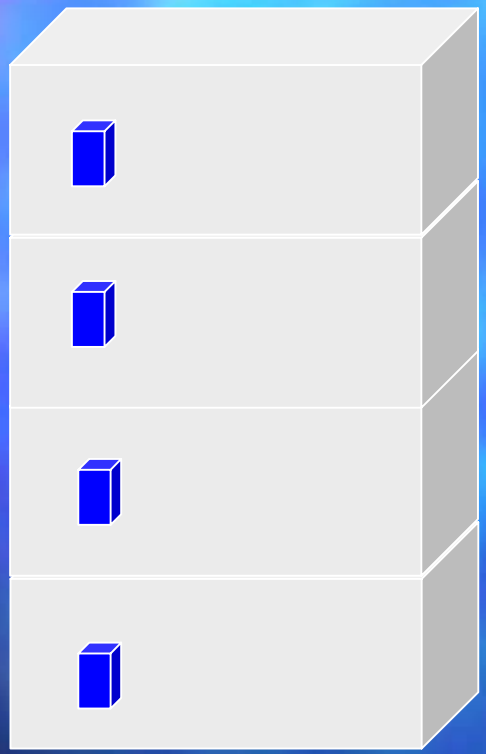
4# Telecomms Outlets per 10 sq m

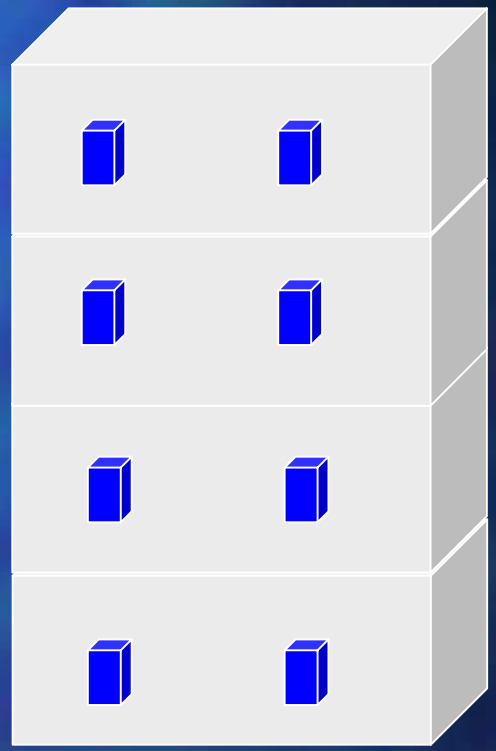


"90 metre rule" option
4# TCs Av 55 m

3,200 x 55 = 176,000 m

Floors 62 x 32 m
Total WA = 800
Total TO = 3,200

78,400 metres
more cable used on
"90m rule option"



"569A" option
8# TCs Av 30 m

3,200 x 30 = 96,000 m

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A note on HVAC in Telecomms Closets?

- is enhanced HVAC required in a 100# WA TR ?
- is enhanced HVAC required in a 200# WA TR ?
- how much does a HVAC wall unit cost ?
- using mini closets with max 100 WA's can remove the need for enhanced HVAC

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The GWU Network Strategic Plan

- Taking advantage of optical fiber
  - Performance across 2000 meters (10 and 100Mb).
    - Continuous run from outlet to hubsite
  - Scalable bandwidth without replacing cable.
    - Evolution to integrated voice, video, and data
    - Change from Ethernet to ATM with move of a patch cord.
  - Reliable with simplified testing and maintenance.
    - No EMI - clean signal transmission with reduced errors.

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The GWU Network Architecture

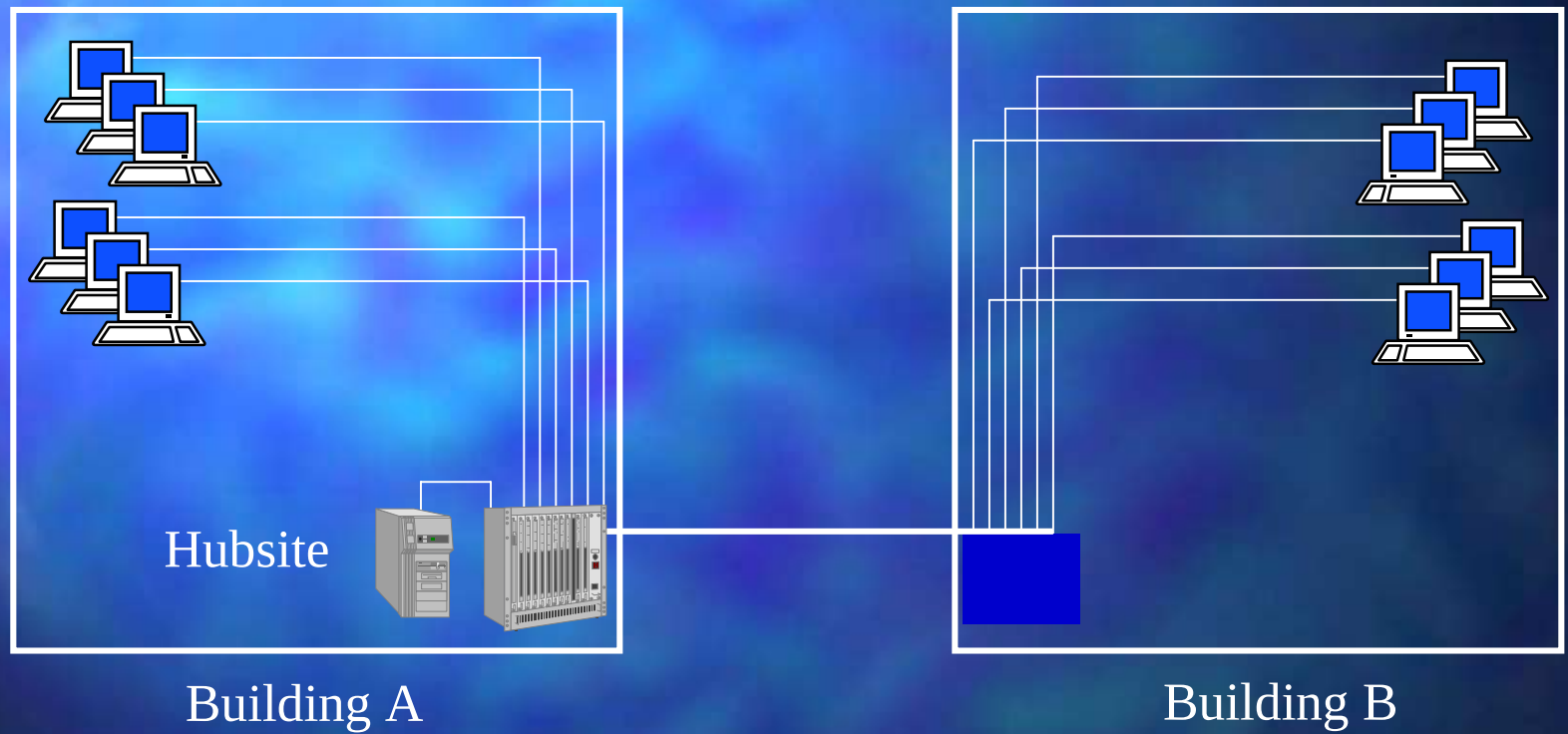
- Eleven (now 19) major hubsites located throughout campus supporting more than 100 buildings.
  - Copper plan required more than 180 closets.
  - Equipment located only in hubsites.
  - Ease of deployment, HVAC, security.
  - Far fewer maintenance people, each much more knowledgeable.
  - LAN management costs contained

One hubsite serves both residence halls

Fiber Optics LAN Section

The GWU Network Strategic Plan

- Continuous run - outlet to 18 hubsites



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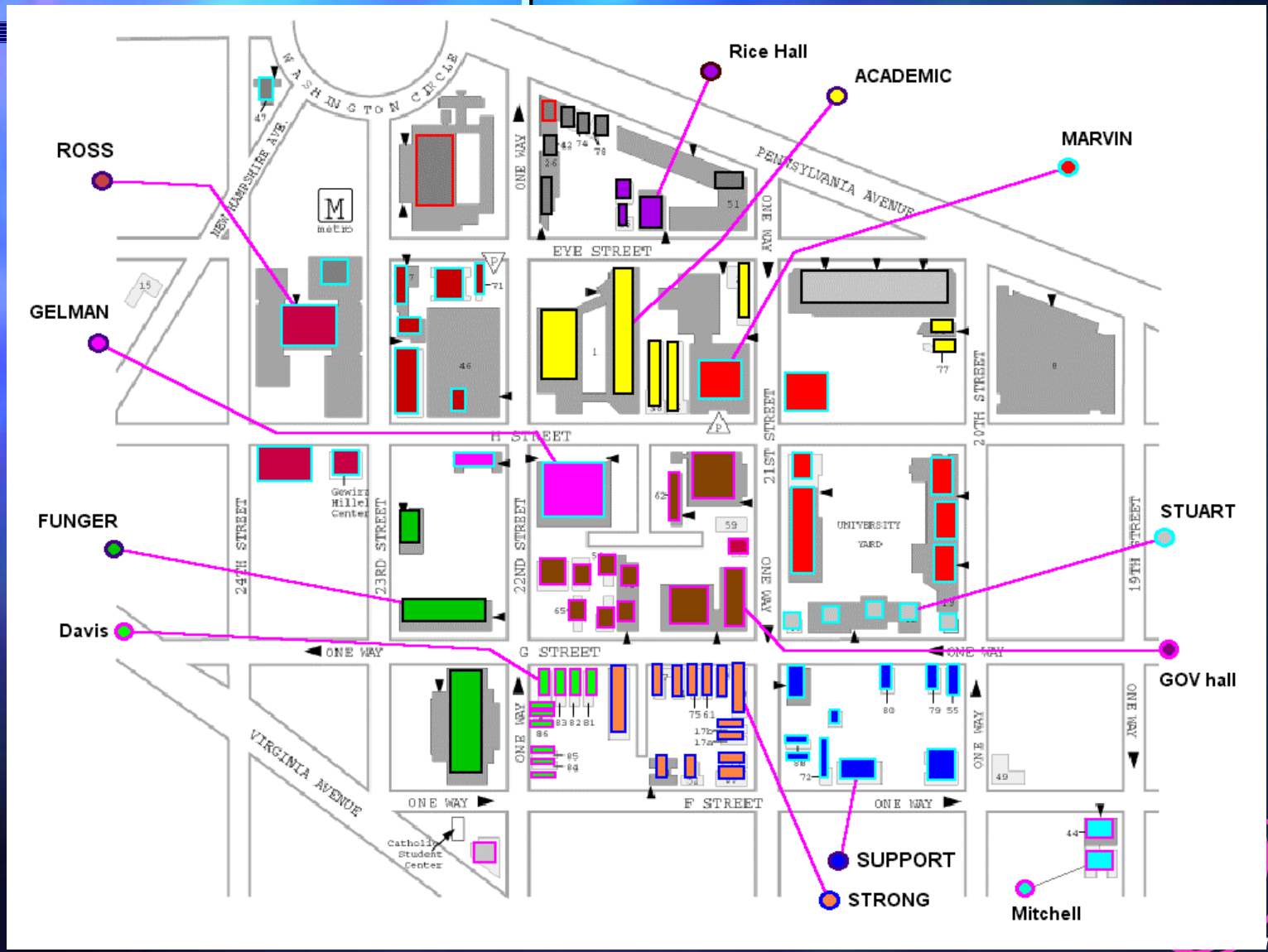
The GWU Campus Hubsites



Cost Model Background

TIA FOLS Fiber-Copper Cost Models

- Hierarchical star UTP vs. centralized fiber
- Building “model”
  - 8 story, 48 ports/floor
  - Costs calculated on “per port” basis
  - Port utilization
    - Copper: 70%
    - Fiber: 90%
- Fiber used in riser subsystem (both models)
- Horizontal subsystem
  - UTP: Cat 5e or Cat6 UTP (depending on model)
  - Fiber: 62.5 or 50 µm multimode fiber
- Telecommunications room
  - Copper TR: $20,000
  - Fiber TR: $4,500

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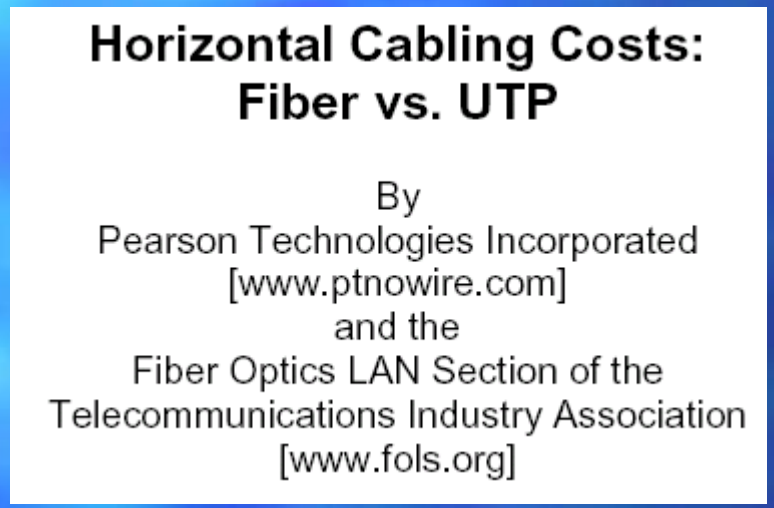
TR Costs

	UTP/Fiber	All Fiber
UPS	1,000	
Temp. Control	10,000	
Closet cost	9,000	4,500
Closet size	6'x10'	3'x5'
Total cost	$20,000	$4,500

Cost Model Assumptions



- Thirteen page document details all parts of the model
- Currently being changed to reflect new model.
- Expect the new model (and assumptions) to be available next month

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Cost Model Assumptions (cont.)

Assumptions

The model compares the cost of a horizontal UTP/vertical fiber network [Figure 1, hereafter referred to as 'UTP'] to the cost of a fiber to the desk network [Figure 2, hereafter, 'FTTD']. The UTP model is presented in the left-hand side of the spreadsheets; the FTTD is on the right.

The "building" used in the model is an eight-story building [cell C5] with 48 ports/floor [cell C3]. Since the cost analysis is calculated on a cost/port basis, this model is deemed realistic and unbiased for or against fiber. In fact, any bias that exists has been implemented slightly against the FTTD because we have not included testing costs or long-term network maintenance.

This analysis applies equally well to multiples of 8 floors or multiples of 48 ports per floor. For port numbers that are less than multiples of 48, the analysis will show FTTD to have a cost lower than that of UTP, since UTP switch port utilization [cell C2] may drop below the 70 % value.

For the purposes of the model we have assumed a total loaded labor rate of $60/hour [cell C1]. This rate is consistent for the largest cities in the US, such as Chicago, New York and Boston, where the installation work force is unionized. For other locations, a total loaded labor rate of $40-45/hour is more realistic. However, the labor cost will not affect the conclusions and comparisons, since the labor cost is only about 10% of the UTP total cost [E61] and about 6% of the FTTD total cost [J61].

Areas filled with yellow on both the left and right sides of the spreadsheet are assumed to be the same cost. No effort has been made to quantify these costs. Even if these costs are not identical, we believe that any differences will not be large enough to invalidate the conclusions drawn from the spreadsheets.

Cost Model Sample

per node	per node	man-hrs		ALL FIBER NETWORK	per node	per node	or cost,$
64.00				fiber NIC	100.00		
9.00				fiber jumper to wall plate	15.00		
2.29				wall plate	3.00		
5.00	9.60	0.16		jack or barrels +plugs	3.00	10.00	0.17
18.00				horizontal fiber cable	45.73		
5.00	0.20	0.16					
5.00	9.60	0.16		2 mechanical splices	16.00	10.00	0.17
5.59	5.00	0.08		wall mounted enclosure	3.00	15.00	0.25
176.93							
8.08	0.00						
2.08	30.00	0.50					
				sub total	185.73	35.00	
300.98	54.40		**A**	**cost/port**	185.73	35.00	
21.95	0.00						
6.67	9.60	0.16					
0.00							
8.00	10.00	0.17					
21.00				vertical riser fiber cable	30.00		
57.62	19.60			**sub total**	30.00	0.00	
1.20	0.41		**B**	**cost/port**	30.00	0.00	

Summary of Results

Where fiber makes sense

Scenario	UTP/ Fiber	Fiber	$	%
SG-Compatible List	822.74	923.53	+ 100.79	+ 12.25
SG-Compatible Street	822.74	797.19	- 25.55	- 3.1
Tier One Electronics Street	753.82	960.99	+ 207.17	+ 21.58%
Tier One Electronics II	822.74	822.99	0	0
Media Conversion A	822.74	806.47	- 16.27	- 8.3
Media Conversion B	804.57	806.47	+ 2.00	0
Media Conversion C	753.82	690.38	- 63.44	- 8.4
100BASE SX	822.58	737.19	- 85.38	- 10.38

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Summary

Is It Cost-Effective Today?

- Evaluate network needs & growth requirements when selecting media
- Alternative architectures offers real savings today
  - Single point of administration
  - Reduced port costs & life-cycle savings
  - Accepted in the standards world-wide
- Fiber LAN electronics costs decreasing
  - 850 nm short wavelength generally less expensive
  - 100BASE-SX offers lower costs, smooth migration
- Fiber LANs can be cost-effective today

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Summary

Where is Fiber Cost Effective?

- New installations where fiber can be designed for centralized or zoned cabling
- Network upgrades where fiber can be designed for centralized or zoned cabling
- Installations that require long cable runs
- Installations where EMI/RFI is an issue
- Installations where bandwidth requirements continue to increase – where are they not?
- Installations where the cabling infrastructure capacity needs to last more than 5 years
- Installations where “future-proofing” is a main concern

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- **For more information on joining the Fiber Optics LAN Section:**
  - **Contact Andy Dryden**
    - **703-907-7702 or adryden@tia.eia.org**
  - **Visit our website at www.fols.org**

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