

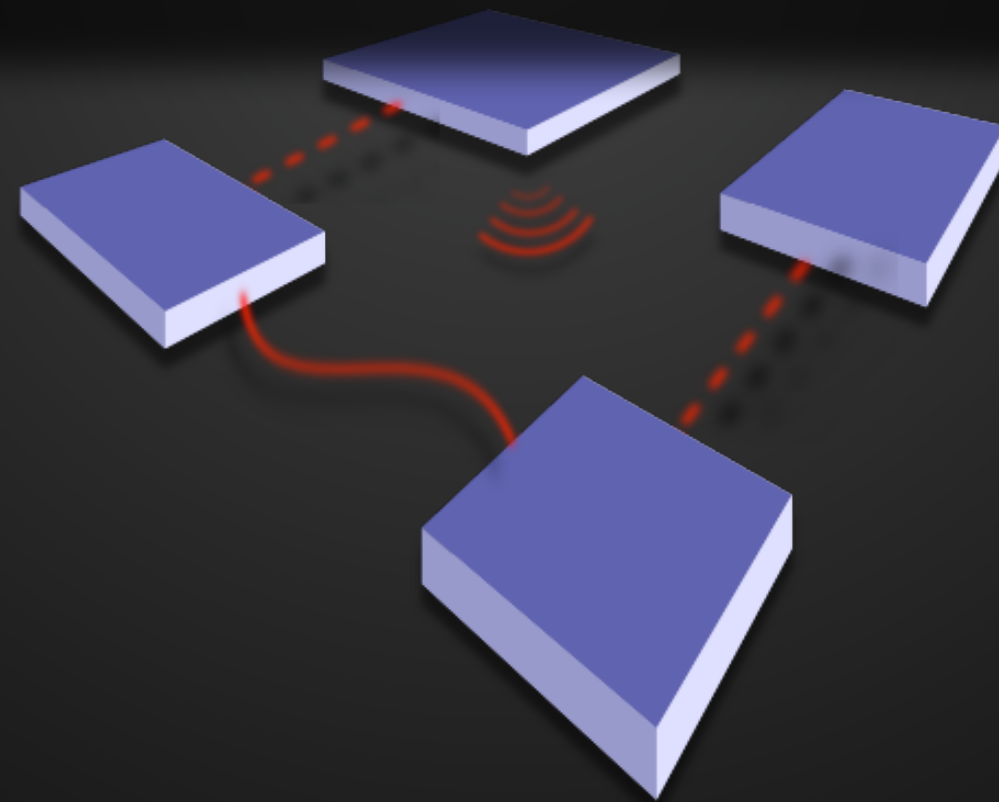
CS-435

spring semester 2025

Network Technology & Programming Laboratory

University of Crete
Computer Science Department

Stefanos Papadakis



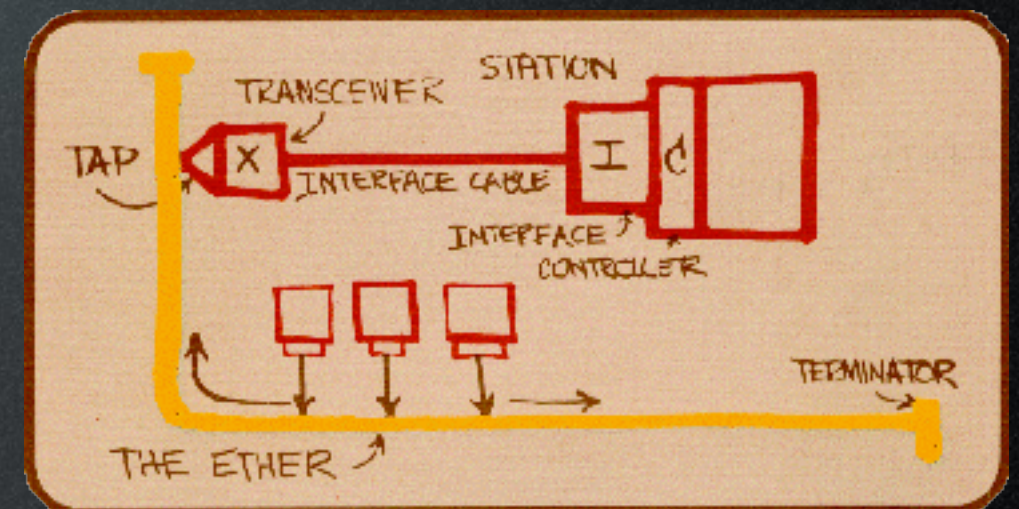
CS-435

Lecture #7 preview

- Ethernet physical media
- Structured Cabling
- Installations

Ethernet

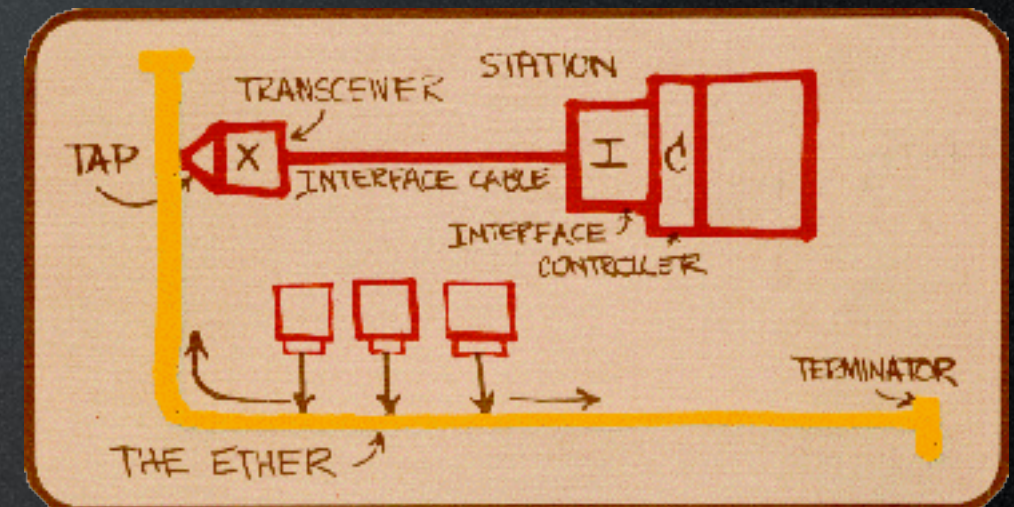
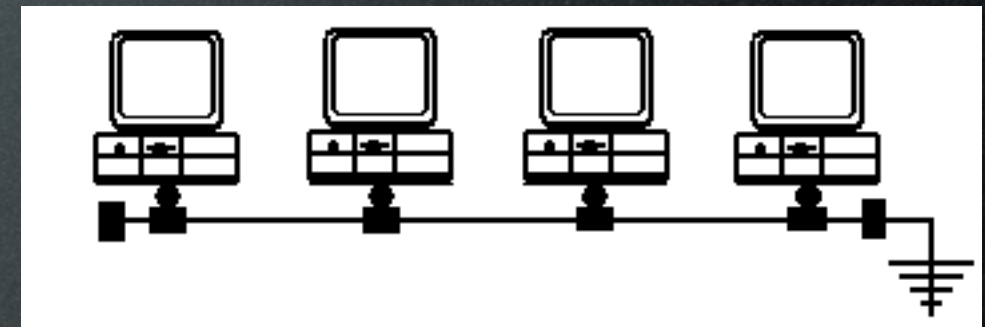
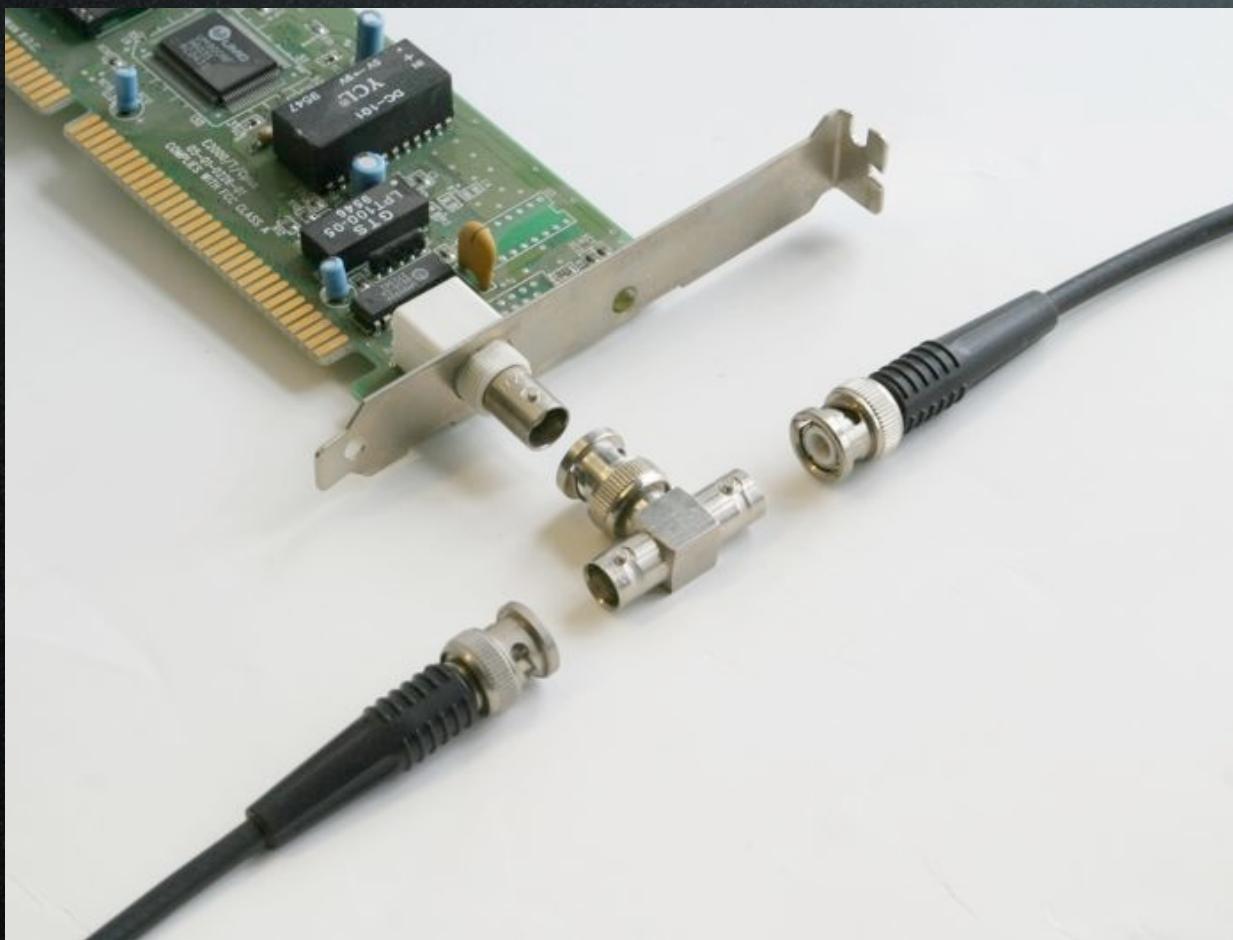
- Ethernet: the first drawing



Ethernet: major milestones

IEEE	year	TIA	data rate	medium
802.3a	1985	10BASE2	10Mbps	COAX
802.3i	1990	10BASE-T	10Mbps	UTP
802.3u	1995	100BASE-TX	100Mbps	UTP
802.3z	1998	1000BASE-X	1Gbps	FIBER
802.3ab	1999	1000BASE-T	1Gbps	UTP
802.3ae	2003	10GBASE-SR	10Gbps	FIBER
802.3an	2006	10GBASE-T	10Gbps	UTP
802.3ba	2010	100GBASE-LR4	100Gbps	FIBER
802.3bz	2016	2.5 / 5GBASE-T	2.5/5Gbps	UTP
802.3by	2016	25GBASE-SR	25Gbps	FIBER
802.3cd	2018	50GBASE-SR	50Gbps	FIBER

Ethernet: the early years



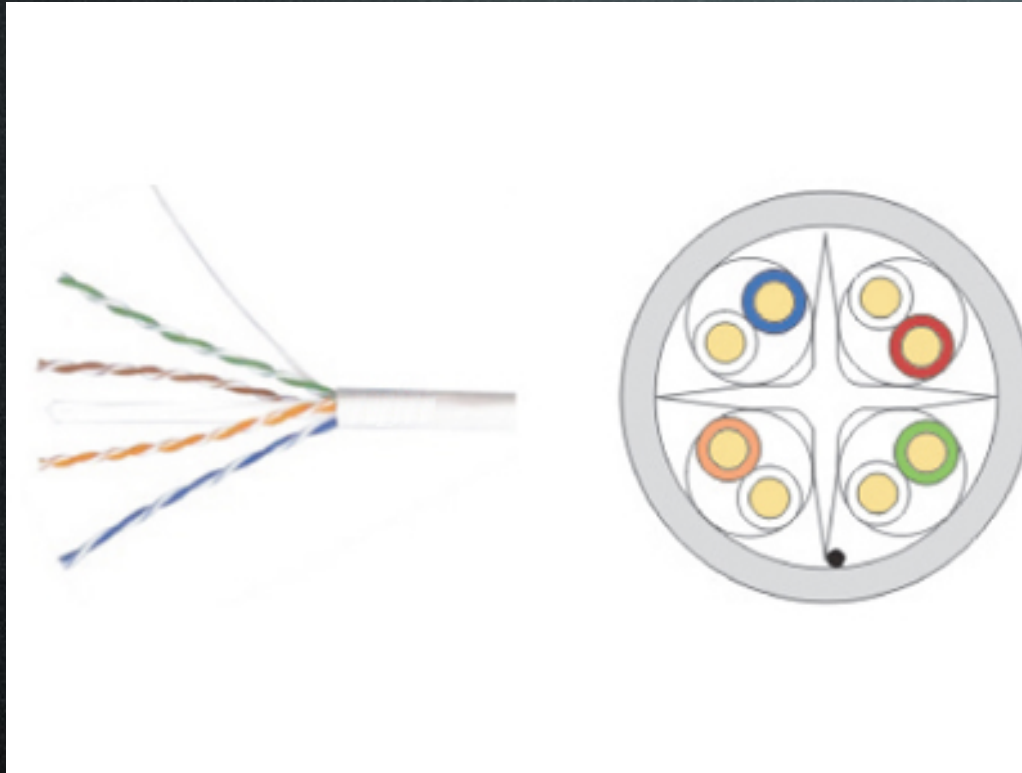
Twisted Pair Cables

Types

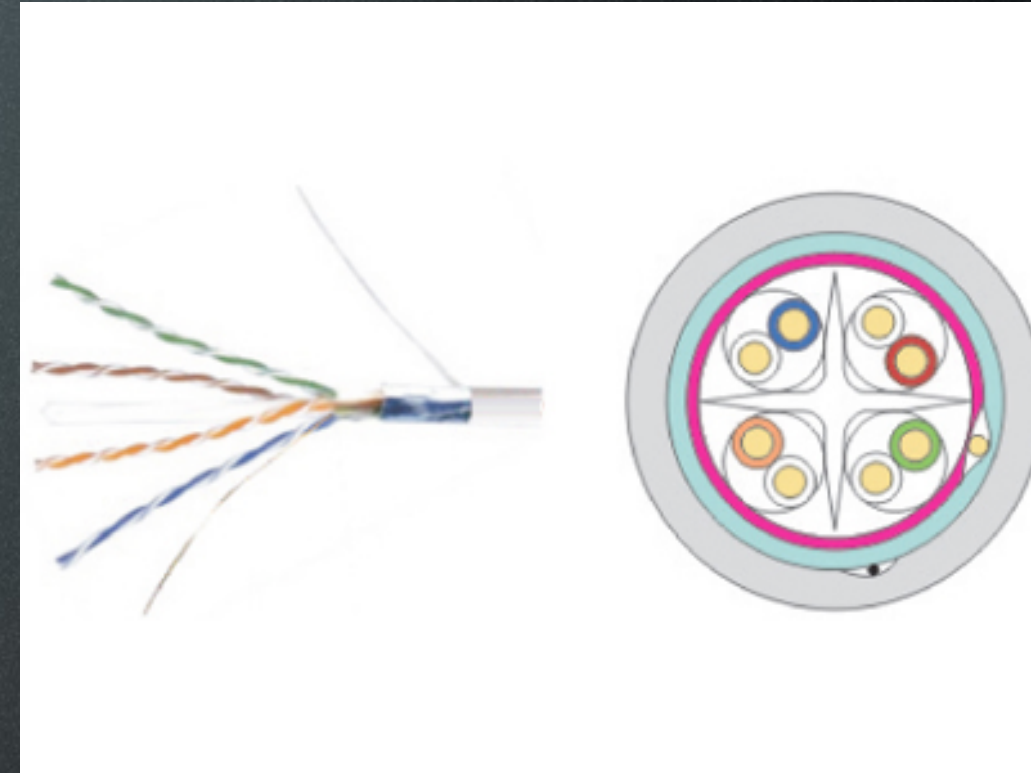
old name	new name	cable screening	pair shielding
UTP	U/UTP	-	-
FTP	F/UTP	foil	-
STP	U/FTP	-	foil
S-FTP	SF/UTP	foil + braiding	-
S-STP	S/FTP	braiding	foil

Twisted Pair Cables

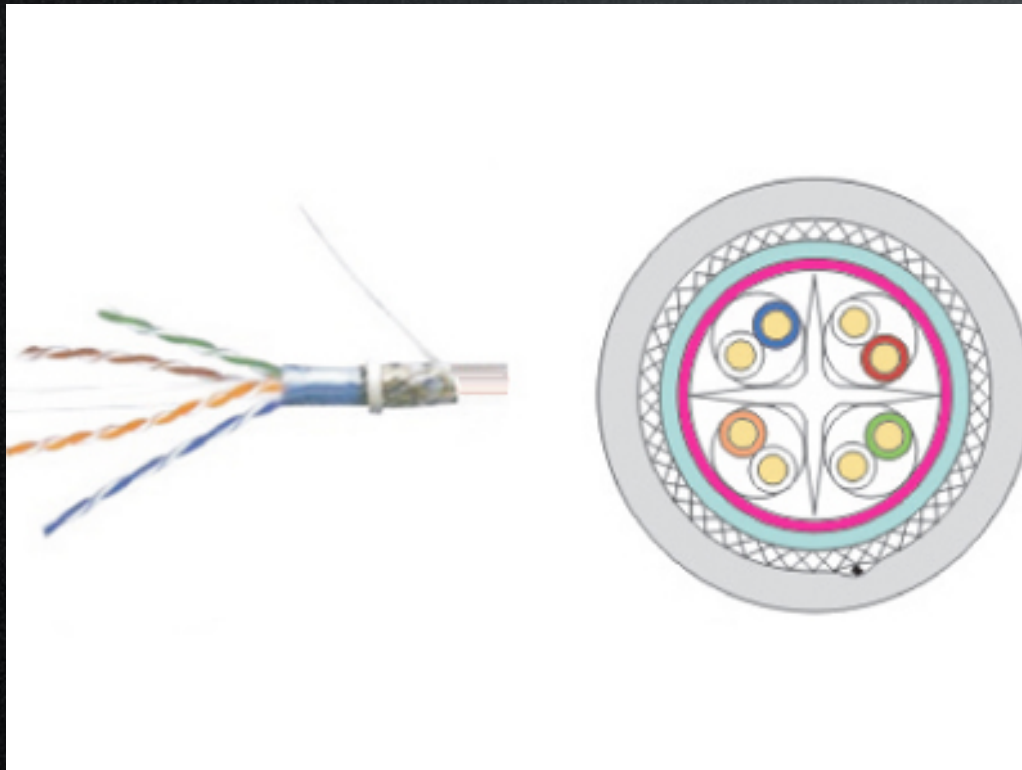
U/UTP



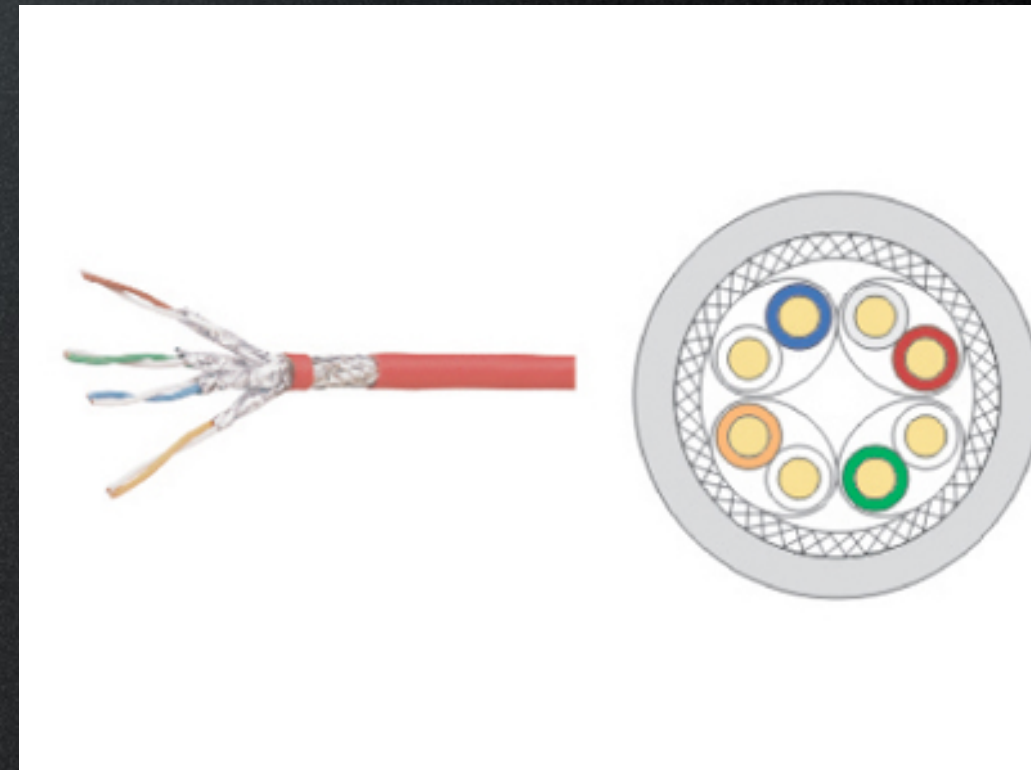
F/UTP



SF/UTP

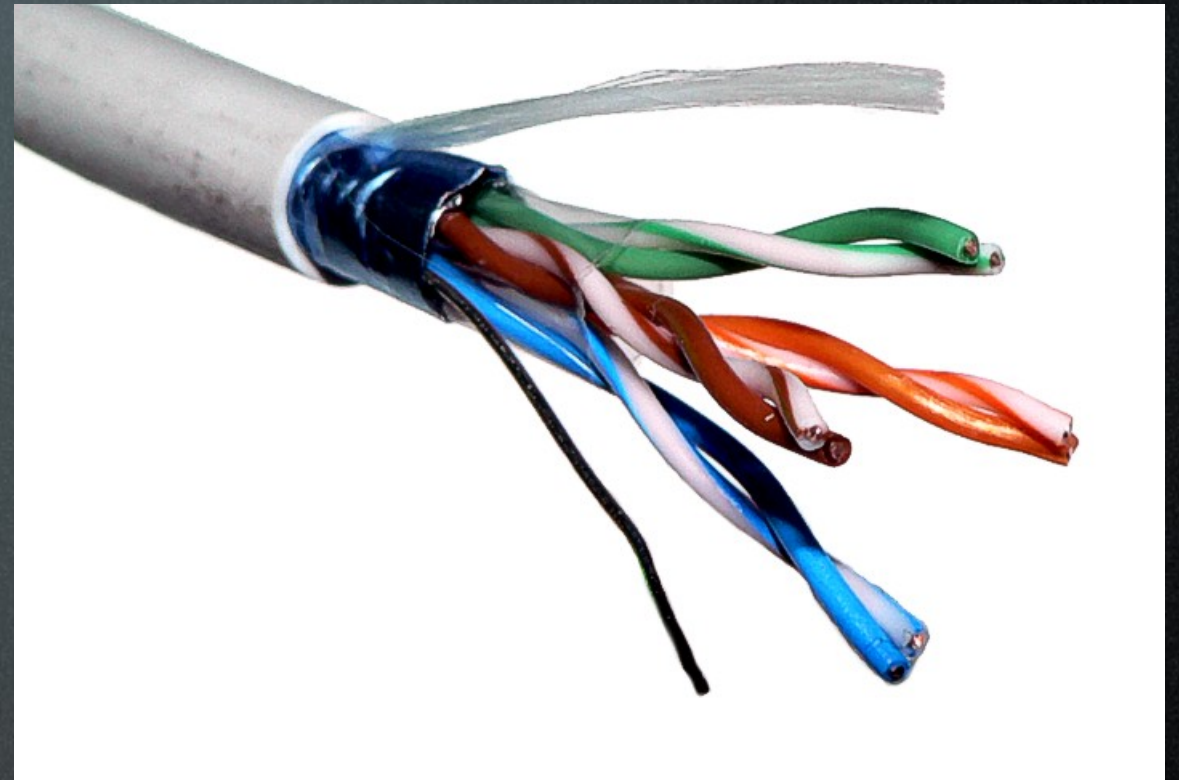


S/FTP



Twisted Pair Cables

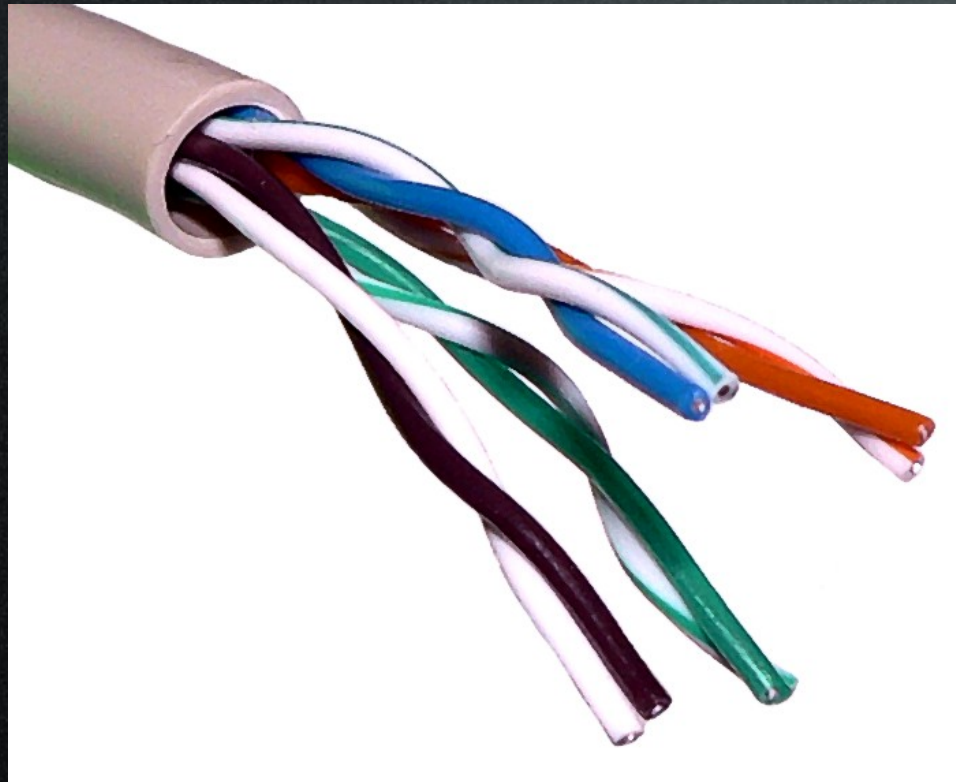
F/UTP



S/FTP



U/UTP



Twisted Pair Cables

Categories

- CAT5: 100MHz (up to 1Gbps at 100m)
- CAT5e: >100MHz
- CAT6: 250MHz (up to 10Gbps at 55m)
- CAT6a: 500MHz (up to 10Gbps at 100m)
- CAT7: 600MHz (U/FTP)
- CAT7a: 1000MHz (S/FTP)(up to 40Gbps/100Gbps at 50/15m)

ANSI/TIA/EIA-568-B

Commercial building cabling for telecom products and services

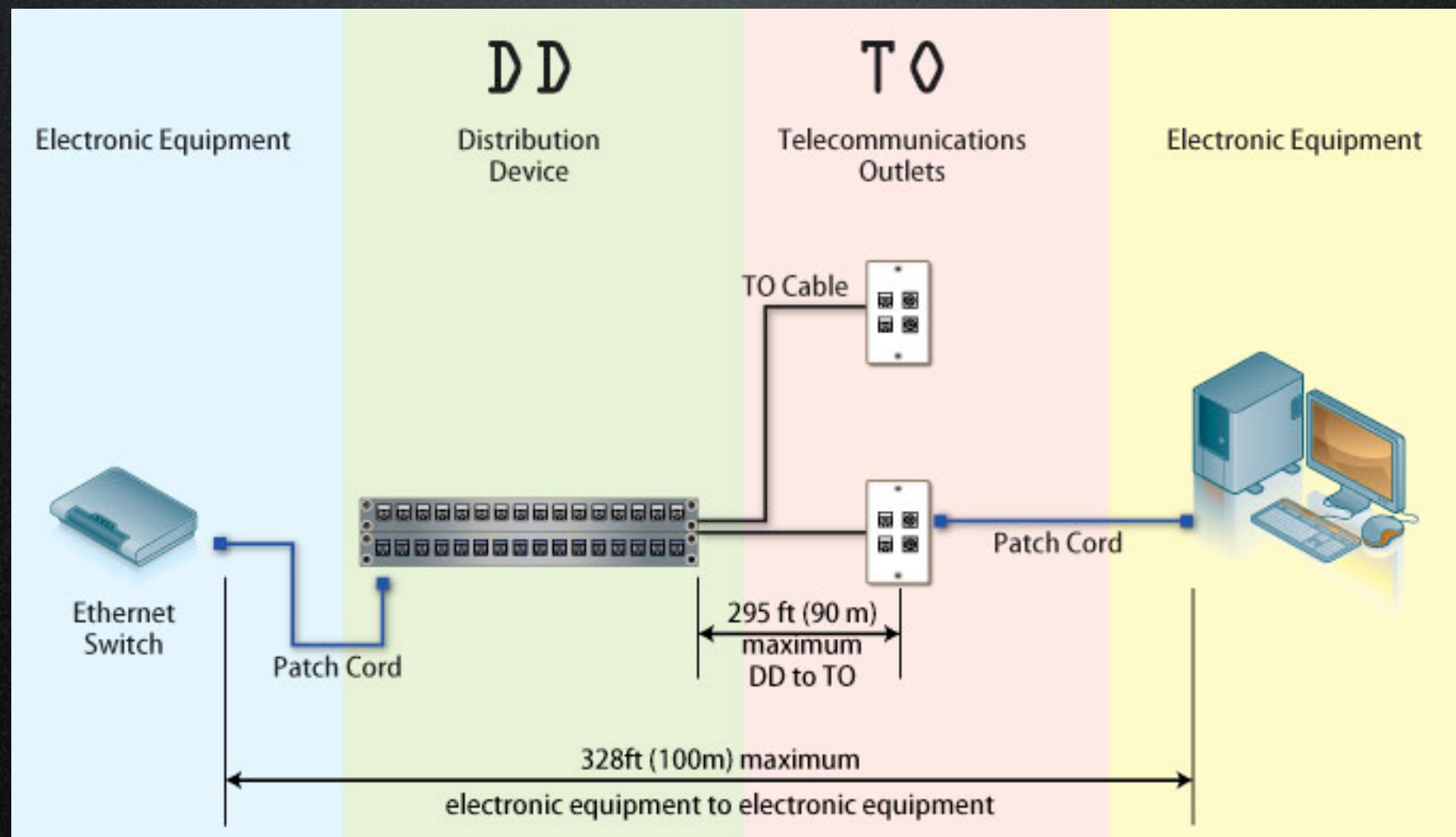
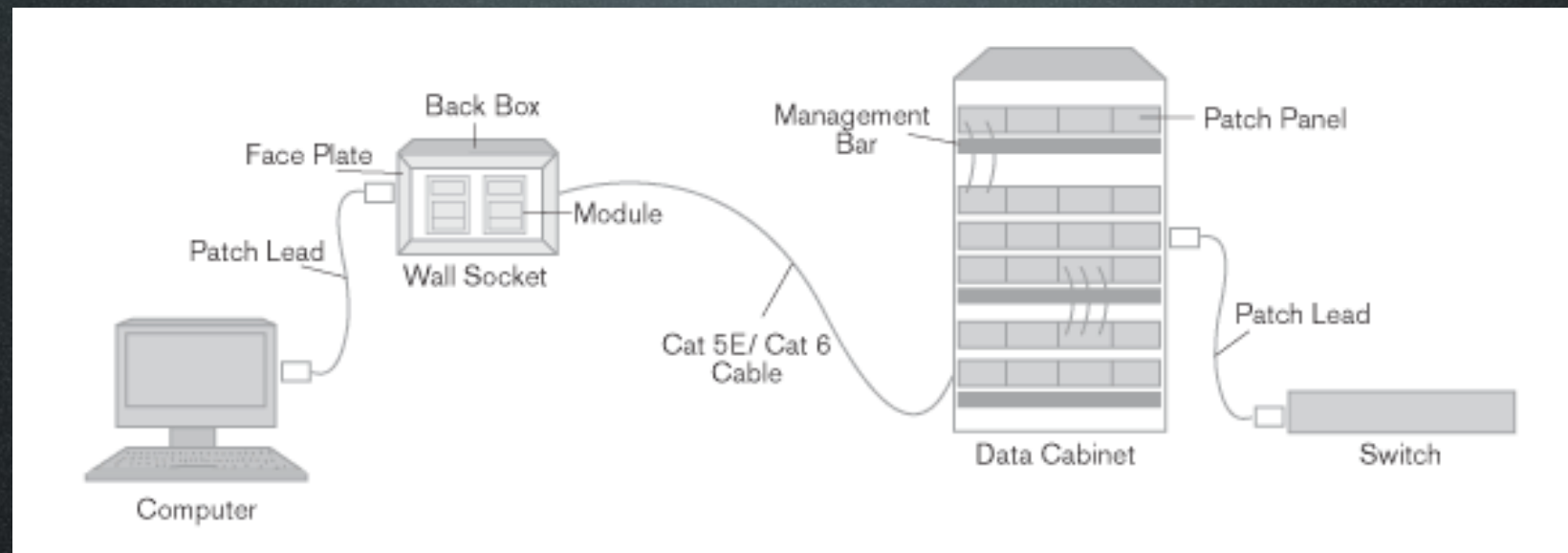
Set of structured cabling standards:

- cable types
- distances
- connectors
- architectures
- terminations
- performance

do not confuse with T568A / T568B (that describe only termination)

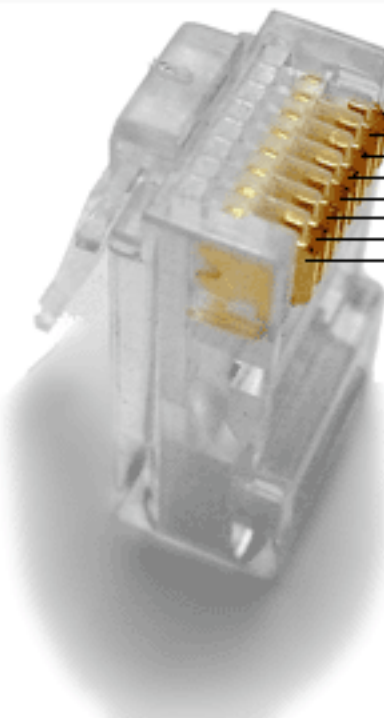
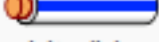
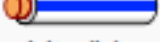
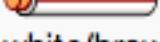
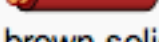
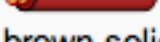
*ANSI/TIA-568-D 2015, TIA/EIA-568-C 2009, TIA/EIA-568-B 2001, TIA/EIA-568-A 1995, TIA/EIA-568 1991

ANSI/TIA/EIA-568-B



T568A & T568B

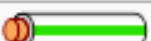
8P8C - RJ45

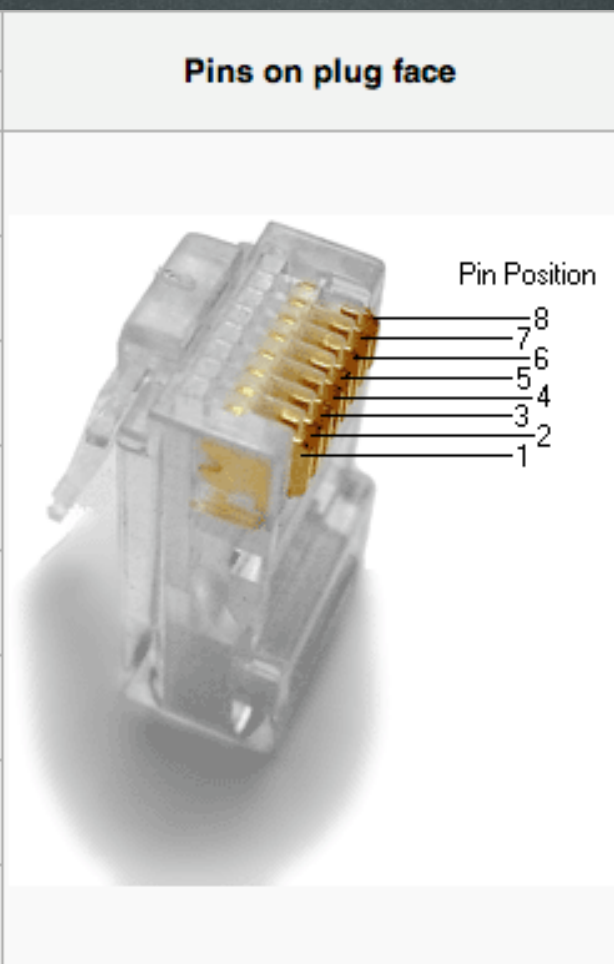
Pin	T568A Pair	T568B Pair	Wire	T568A Color	T568B Color	Pins on plug face (socket is reversed)
1	3	2	tip	 white/green stripe	 white/orange stripe	 Pin Position 8 7 6 5 4 3 2 1
2	3	2	ring	 green solid	 orange solid	
3	2	3	tip	 white/orange stripe	 white/green stripe	
4	1	1	ring	 blue solid	 blue solid	
5	1	1	tip	 white/blue stripe	 white/blue stripe	
6	2	3	ring	 orange solid	 green solid	
7	4	4	tip	 white/brown stripe	 white/brown stripe	
8	4	4	ring	 brown solid	 brown solid	

Ethernet crossover cable

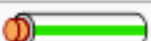
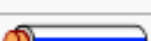
MDI-X

10Base-T/100Base-TX

Pin	Connection 1: T568A			Connection 2: T568B		
	signal	pair	color	signal	pair	color
1	BI_DA+	3		BI_DB+	2	
2	BI_DA-	3		BI_DB-	2	
3	BI_DB+	2		BI_DA+	3	
4		1			1	
5		1			1	
6	BI_DB-	2		BI_DA-	3	
7		4			4	
8		4			4	



1000Base-T

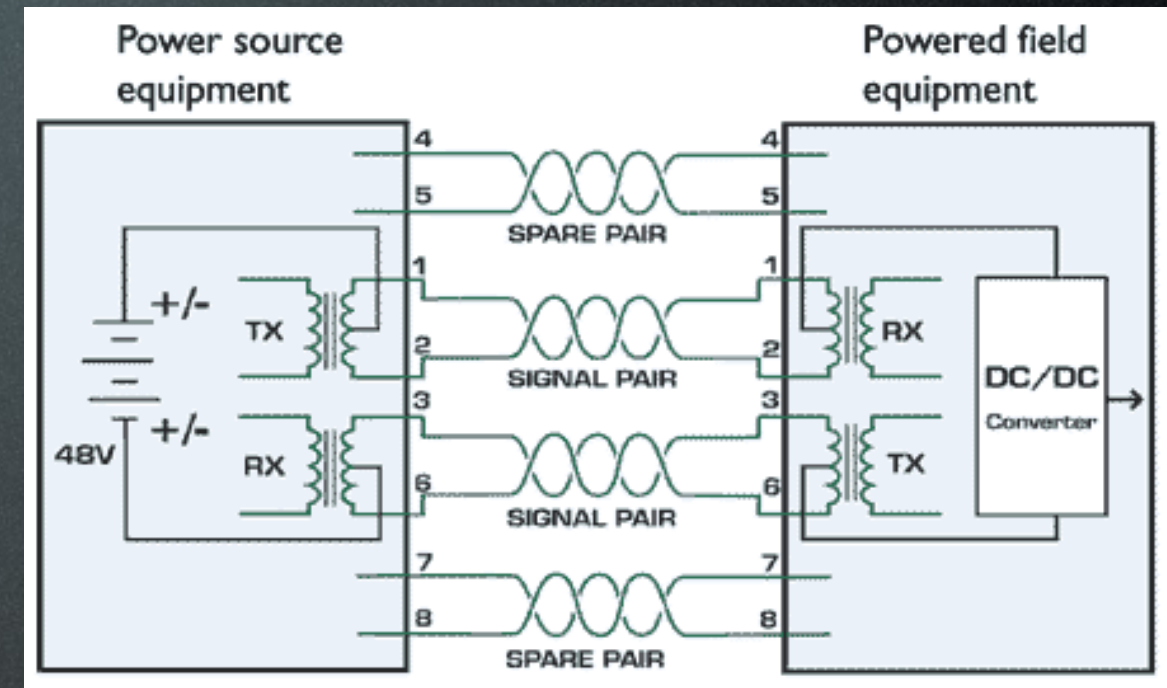
Pin	Connection 1: T568A			Connection 2: T568A Crossed		
	signal	pair	color	signal	pair	color
1	BI_DA+	3		BI_DB+	2	
2	BI_DA-	3		BI_DB-	2	
3	BI_DB+	2		BI_DA+	3	
4	BI_DC+	1		BI_DD+	4	
5	BI_DC-	1		BI_DD-	4	
6	BI_DB-	2		BI_DA-	3	
7	BI_DD+	4		BI_DC+	1	
8	BI_DD-	4		BI_DC-	1	

note: Auto MDI-X devices do not need crossover cables

Power over Ethernet

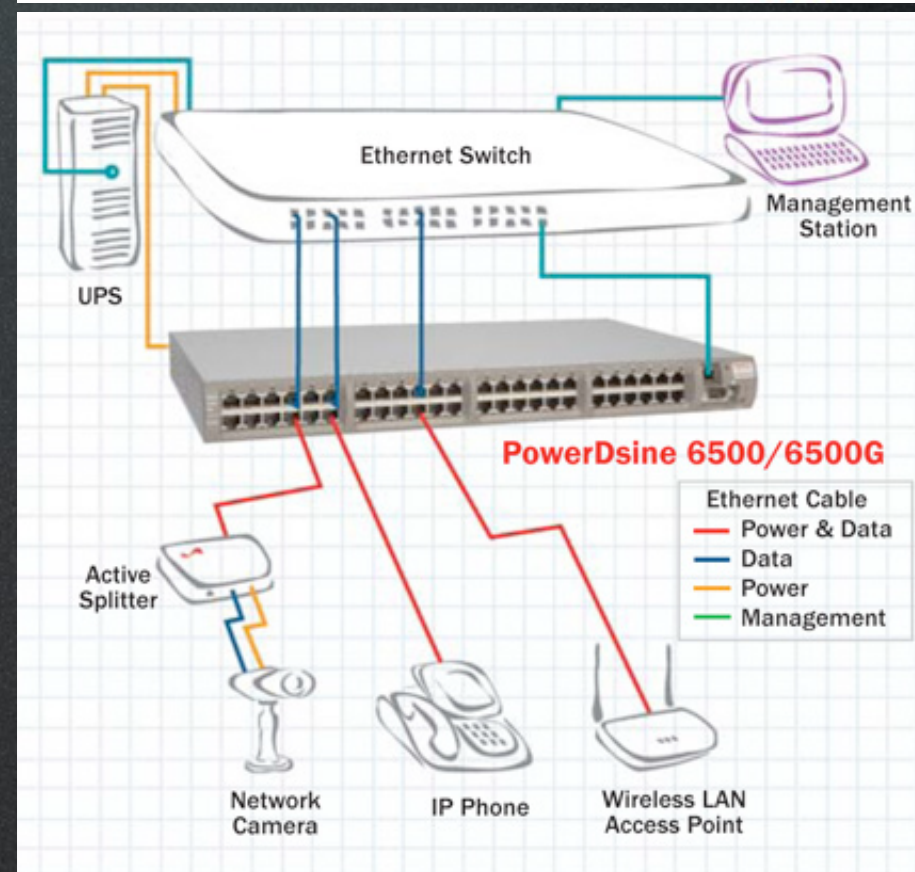
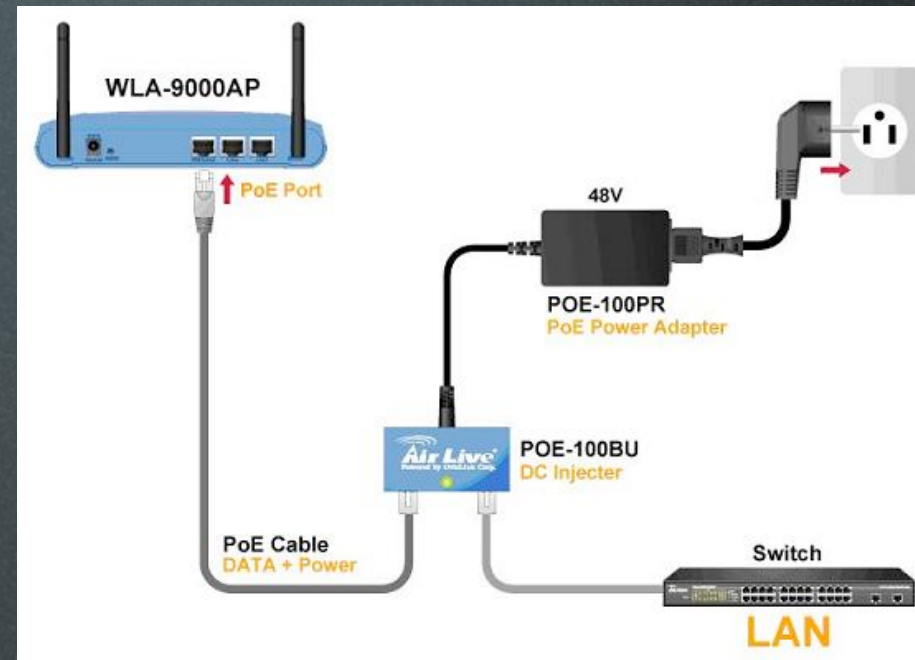
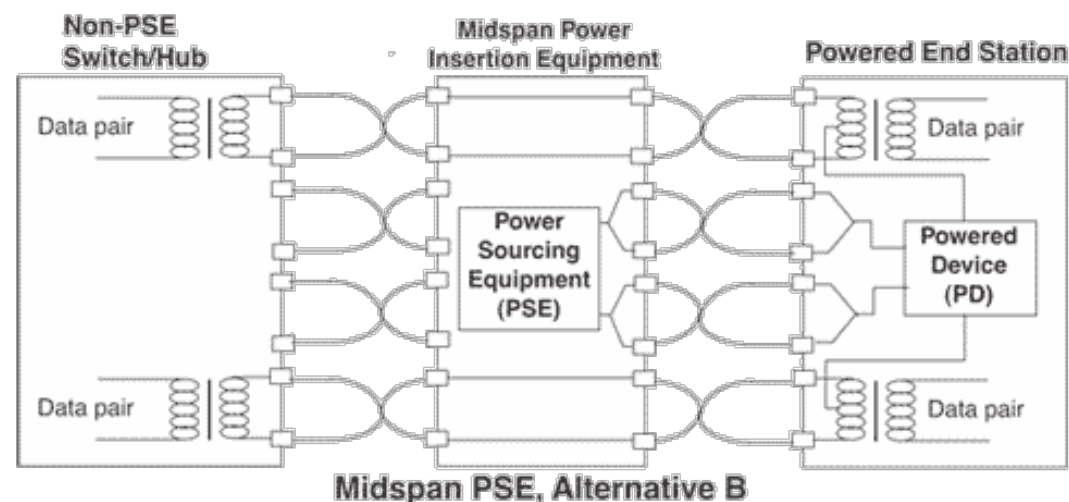
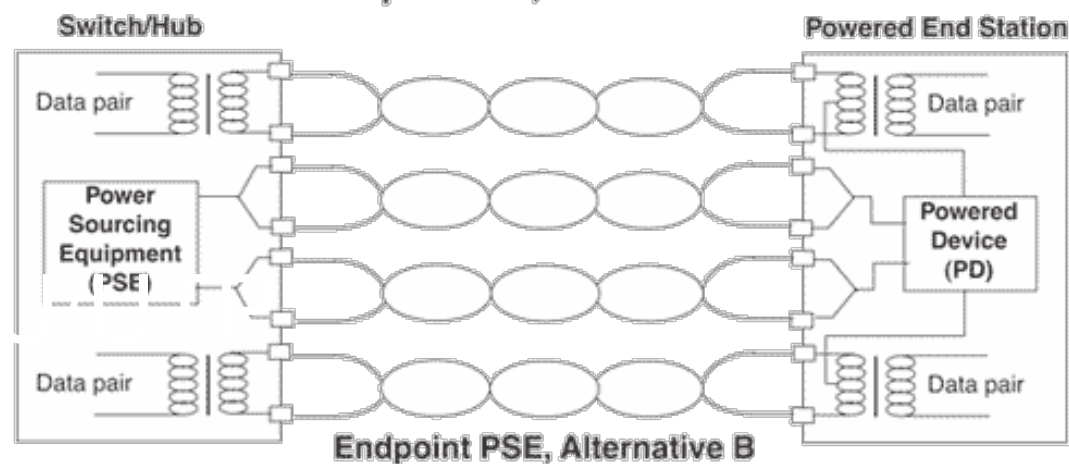
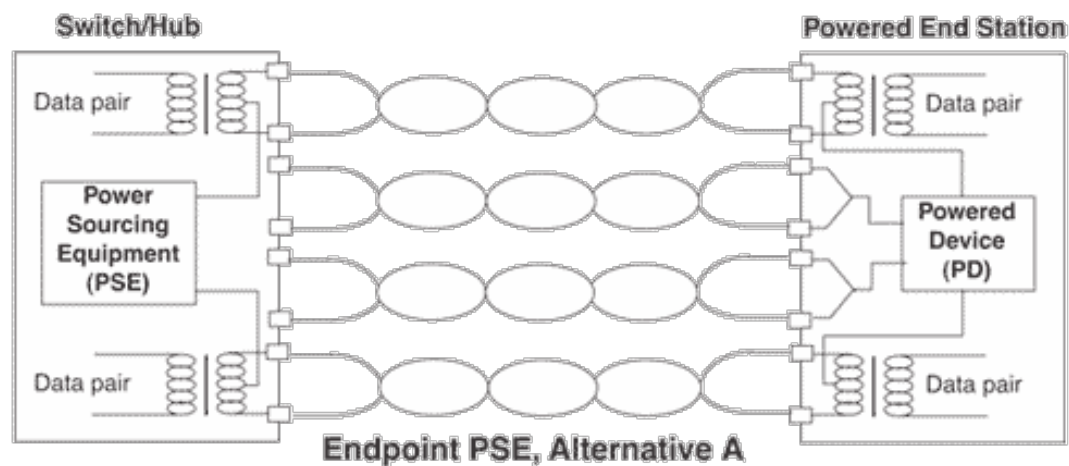
Three standards of PoE:

- IEEE 802.3af-2003 (PoE) 12.9W
- IEEE 802.3at-2009 (PoE+) 25.5W
- IEEE 802.3bt-2018 (PoE++) 71.3W



PINS on Switch	10/100 DC on Spares (mode B)	10/100 Mixed DC & Data (mode A)	1000 (1 Gigabit) DC & Bi-Data (mode B)	1000 (1 Gigabit) DC & Bi-Data (mode A)
Pin 1	Rx +	Rx + DC +	TxRx A +	TxRx A + DC +
Pin 2	Rx -	Rx - DC +	TxRx A -	TxRx A - DC +
Pin 3	Tx +	Tx + DC -	TxRx B +	TxRx B + DC -
Pin 4	DC +	unused	TxRx C + DC +	TxRx C +
Pin 5	DC +	unused	TxRx C - DC +	TxRx C -
Pin 6	Tx -	Tx - DC -	TxRx B -	TxRx B - DC -
Pin 7	DC -	unused	TxRx D + DC -	TxRx D +
Pin 8	DC -	unused	TxRx D - DC -	TxRx D -

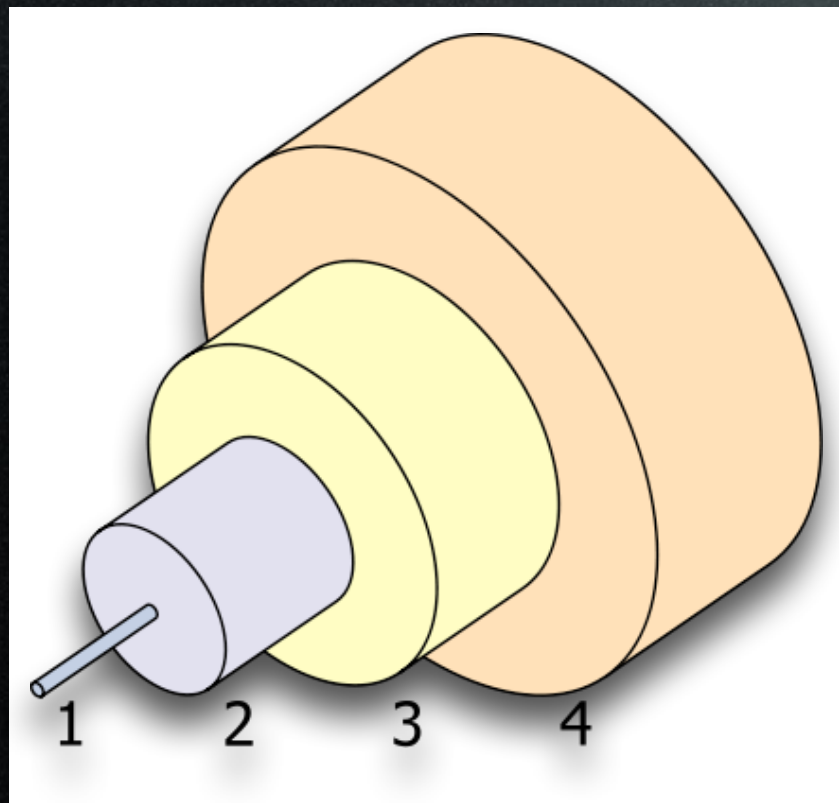
Power Over Ethernet



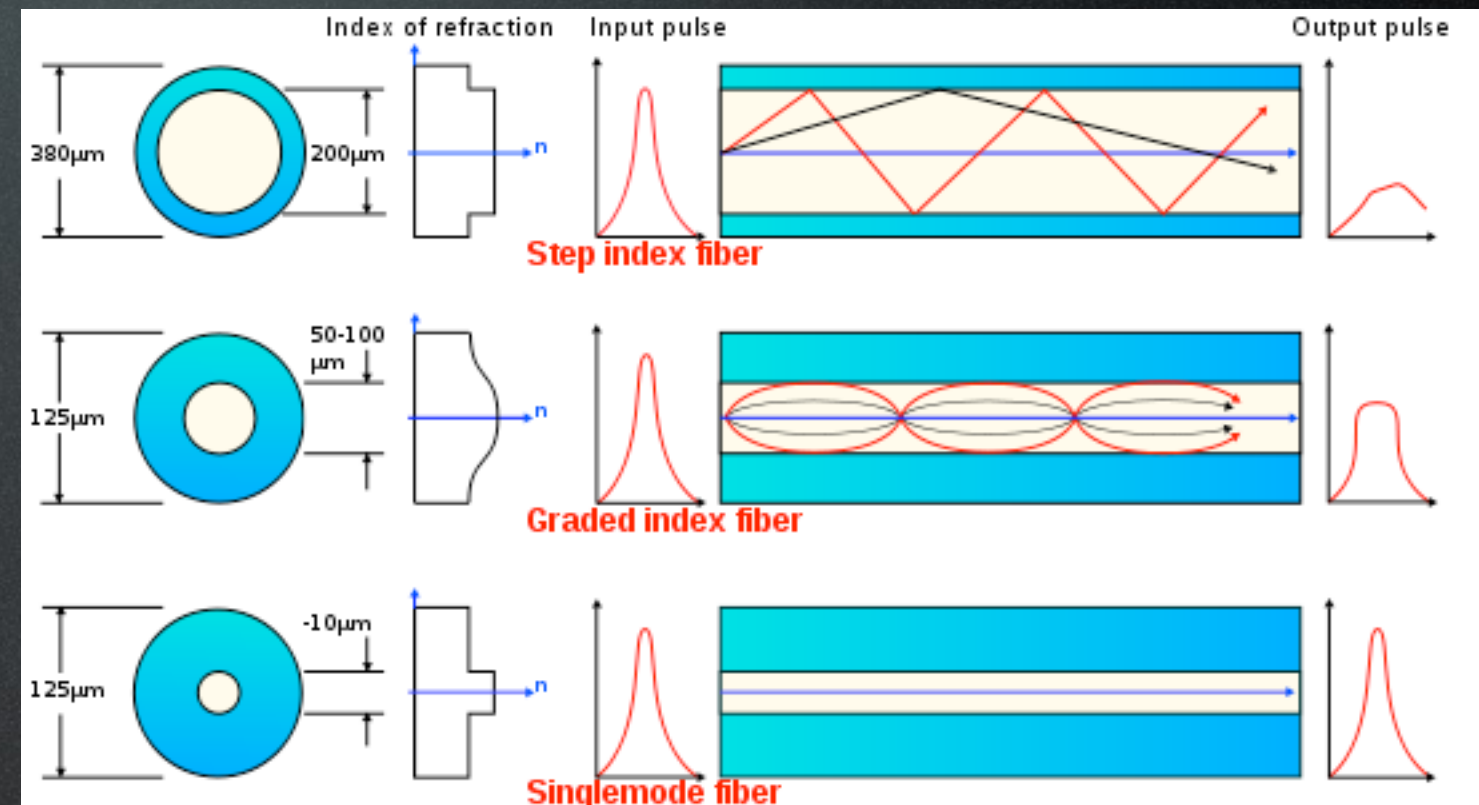
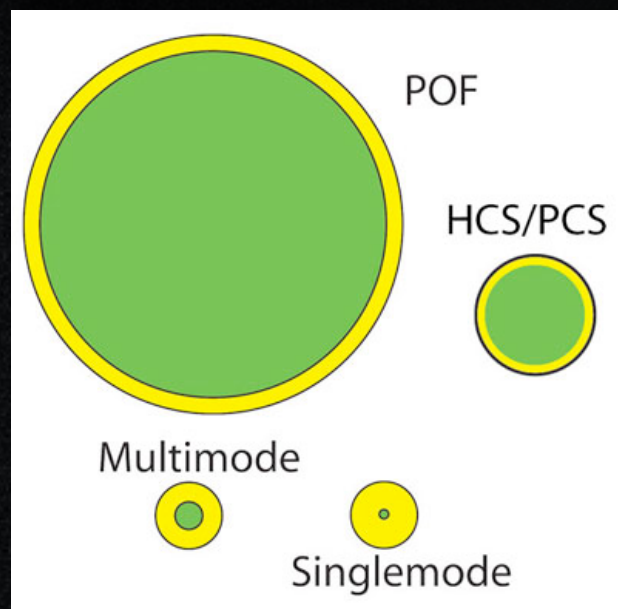
simple
POE
injector

24 ports
POE
midspan

Fiber Optic Cables



1. core
2. cladding
3. buffer
4. jacket



note: POF is used mainly in SPDIF/Toslink

Fiber Optic Cables

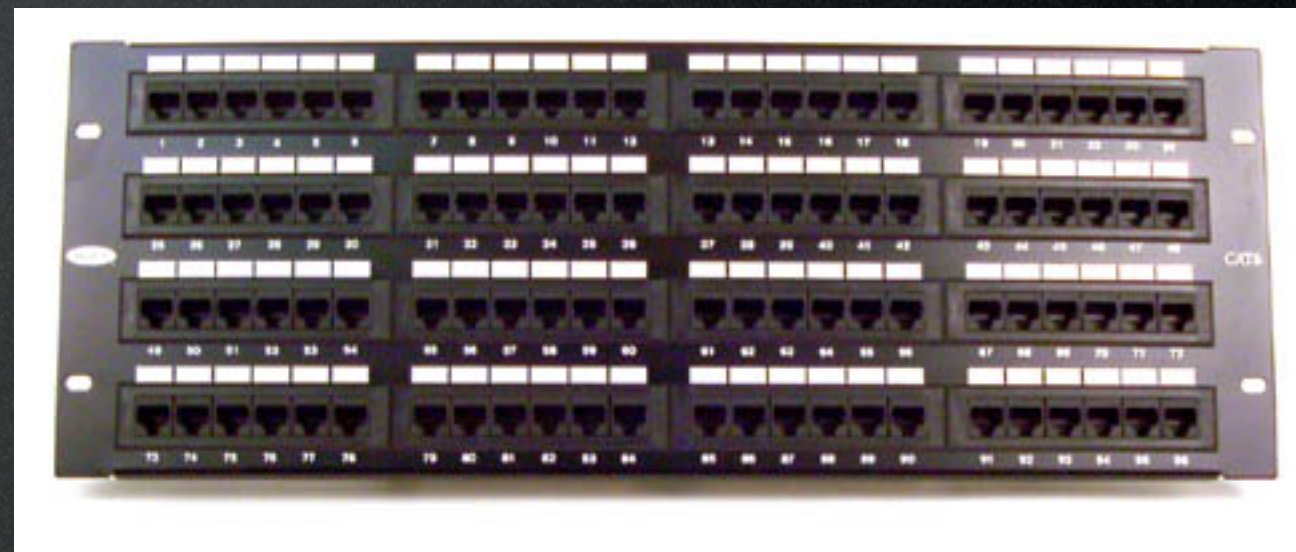
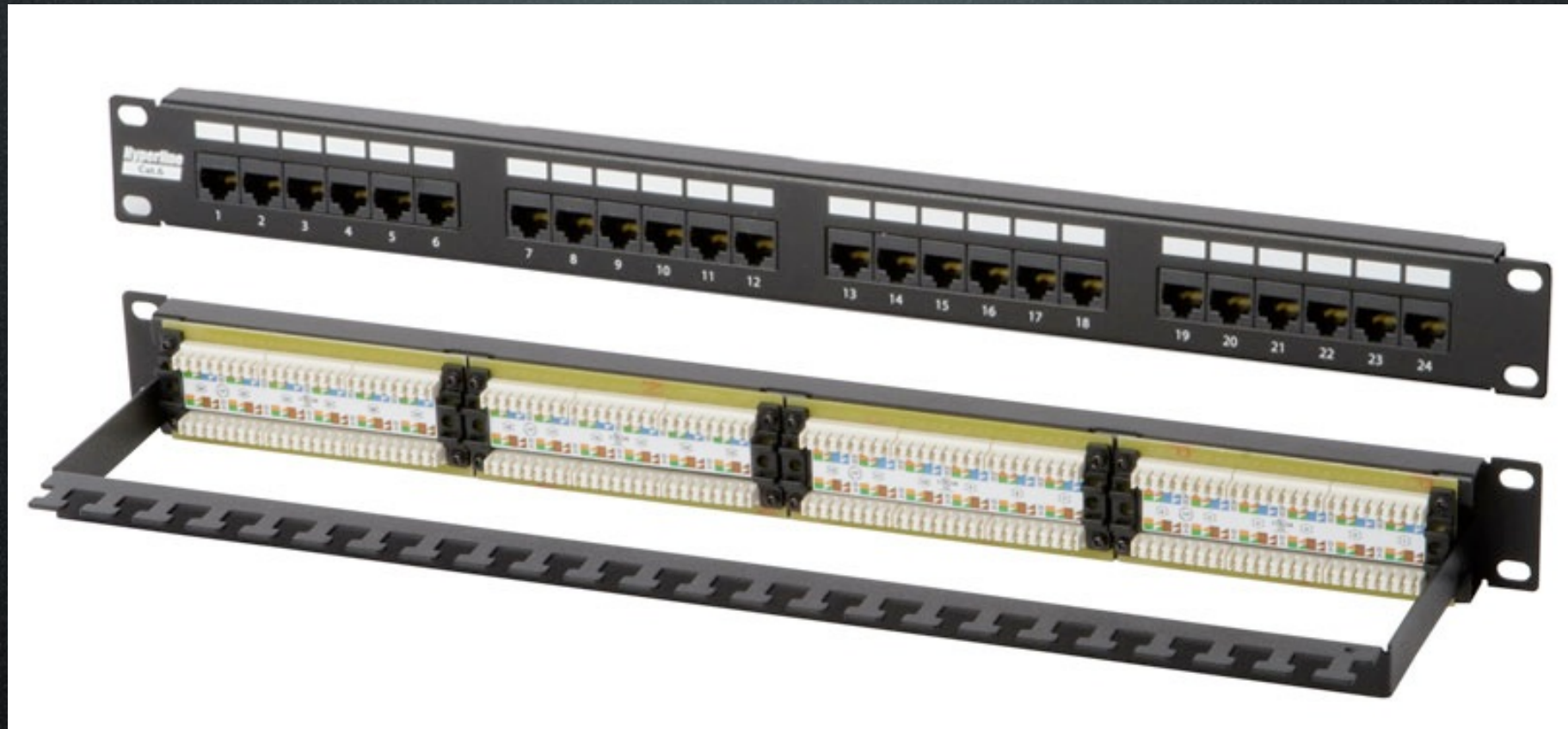
- MultiMode (MM) (LED/VCSEL)
 - OM1: 62.5/125 μm
 - OM2: 50/125 μm
 - OM3: 50/125 μm (10G - 300m, 100G - 100m)
 - OM4/5: 50/125 μm (10G - 400m, 100G - 150m)
 - 3.5 - 1.5 dB/km attenuation
- SingleMode (SM)
 - OS1/2: 8-10/125 μm (10G - 80km)
 - OS1: 1 dB/km & OS2: 0.4 dB/km max attenuation



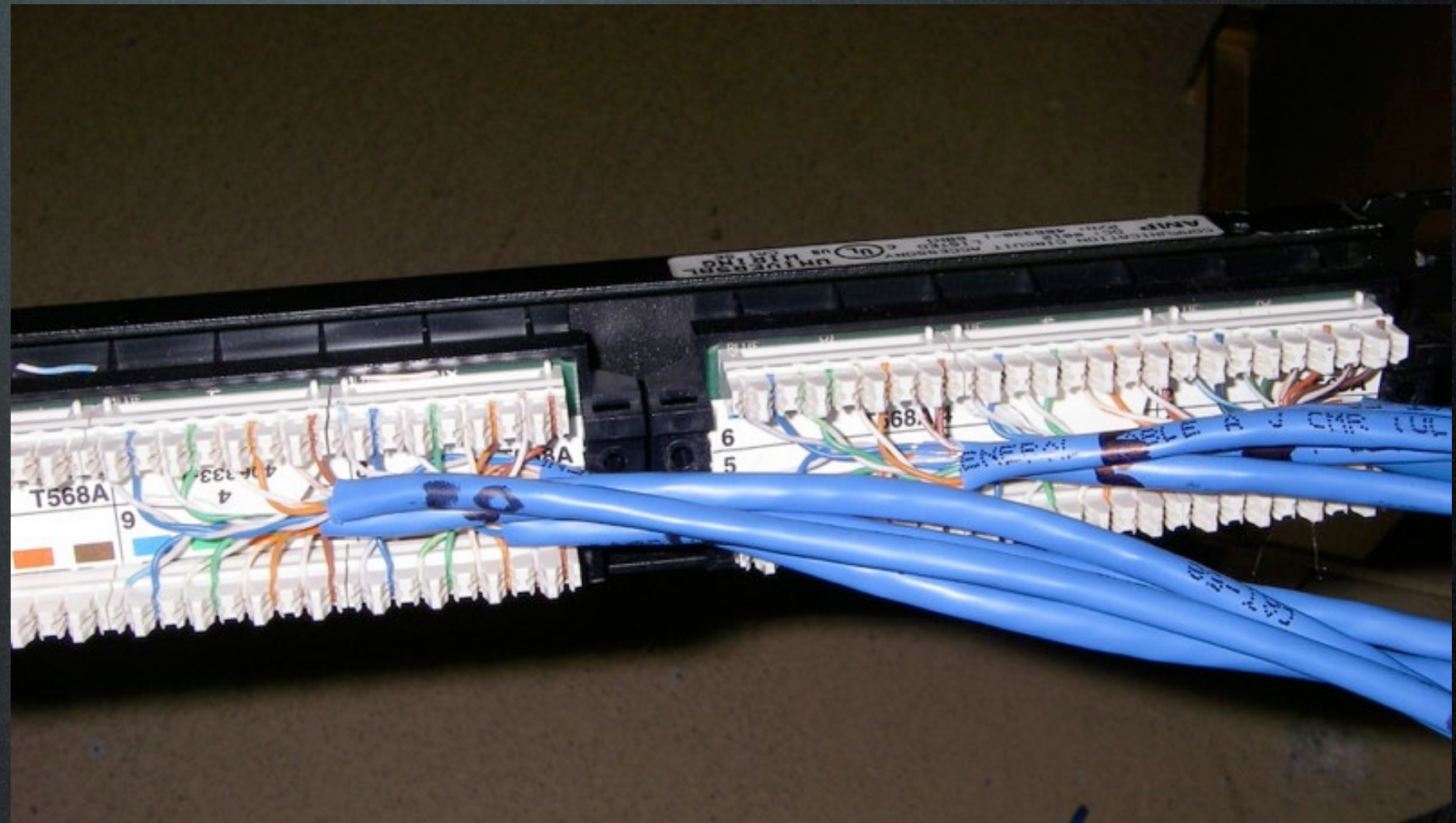
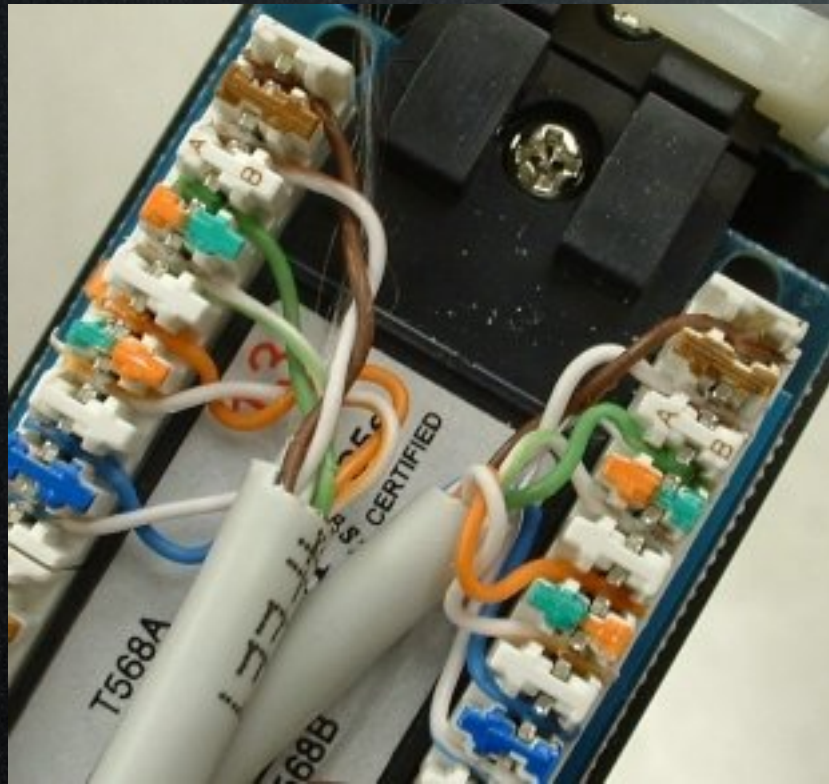
Fiber Optic Connectors



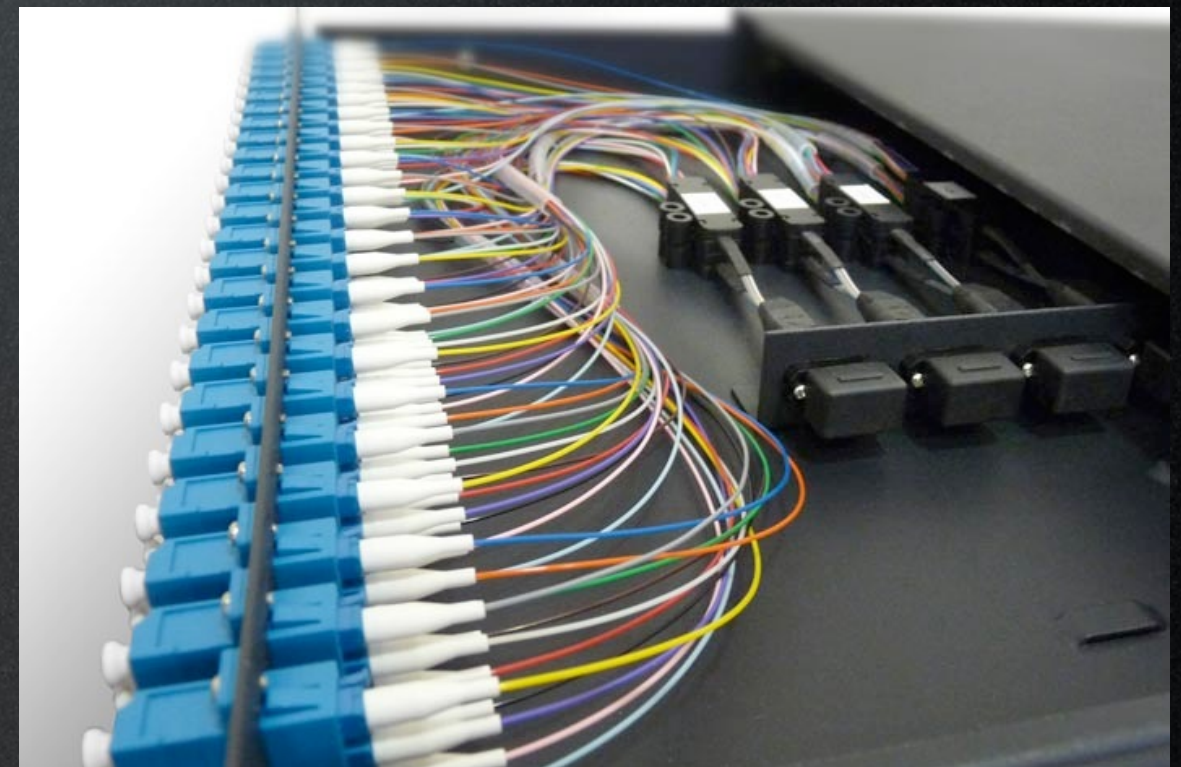
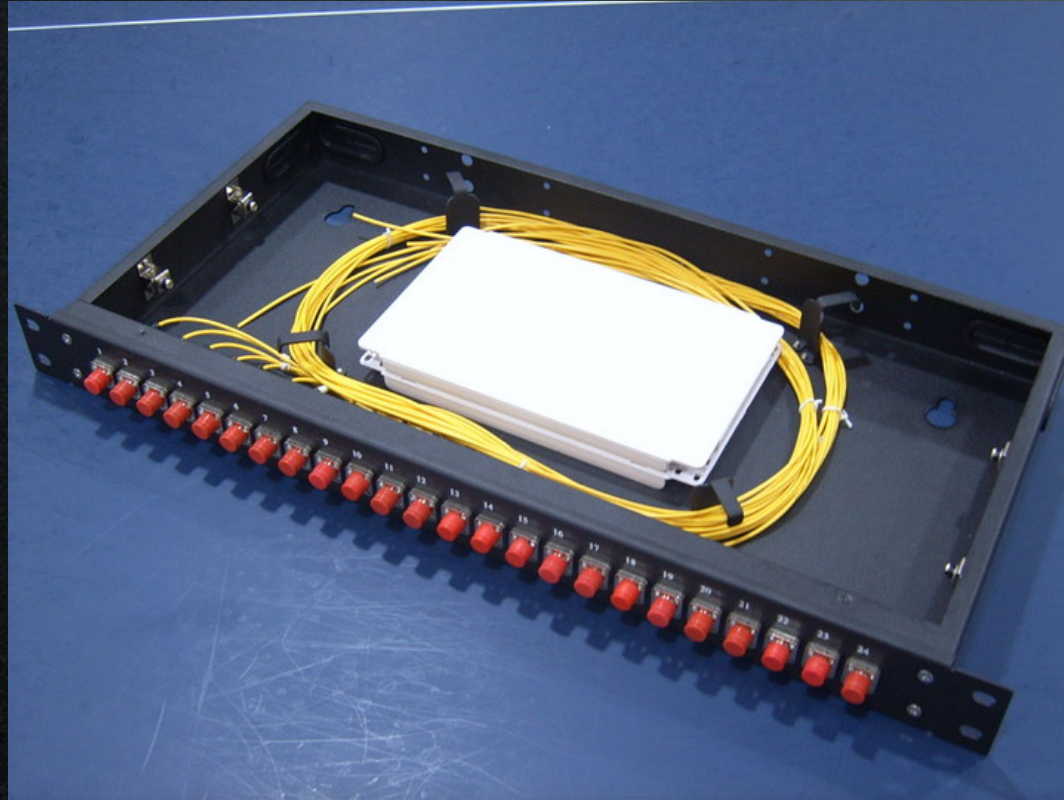
Patch Panels



Patch Panels



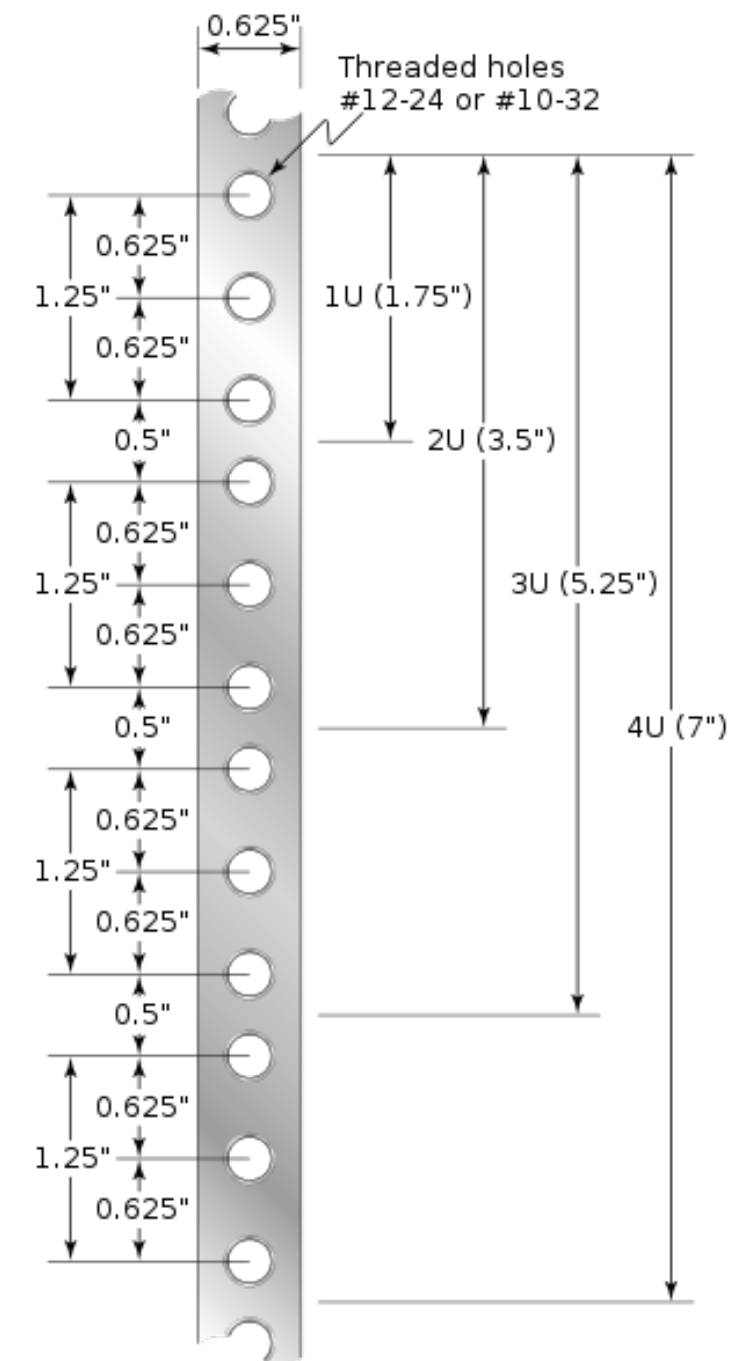
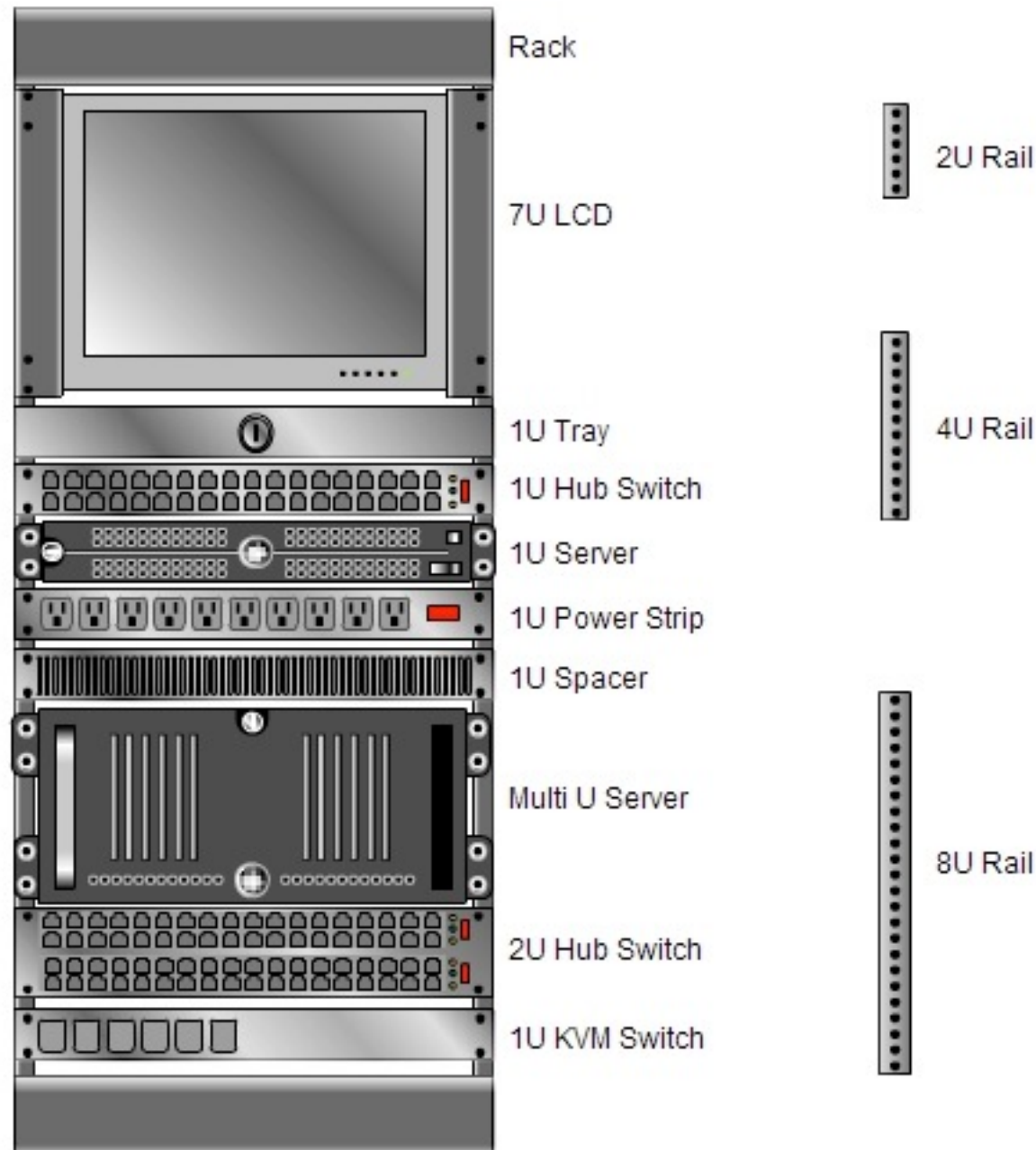
Patch Panels (optical)



Racks



19" Rack Standard



Costs (copper)

- UTP(FTP)
 - CAT 5: 1(+0.5) €/m
 - CAT 6: 1.1(+0.5) €/m
 - CAT 7: 1.8(+0.5) €/m
- Patchpanel 24 (CAT 5e)
 - 70 €
- Patch Cord (UTP)
 - 1m: 1 €
- Termination (UTP)
 - 6 €/2ends

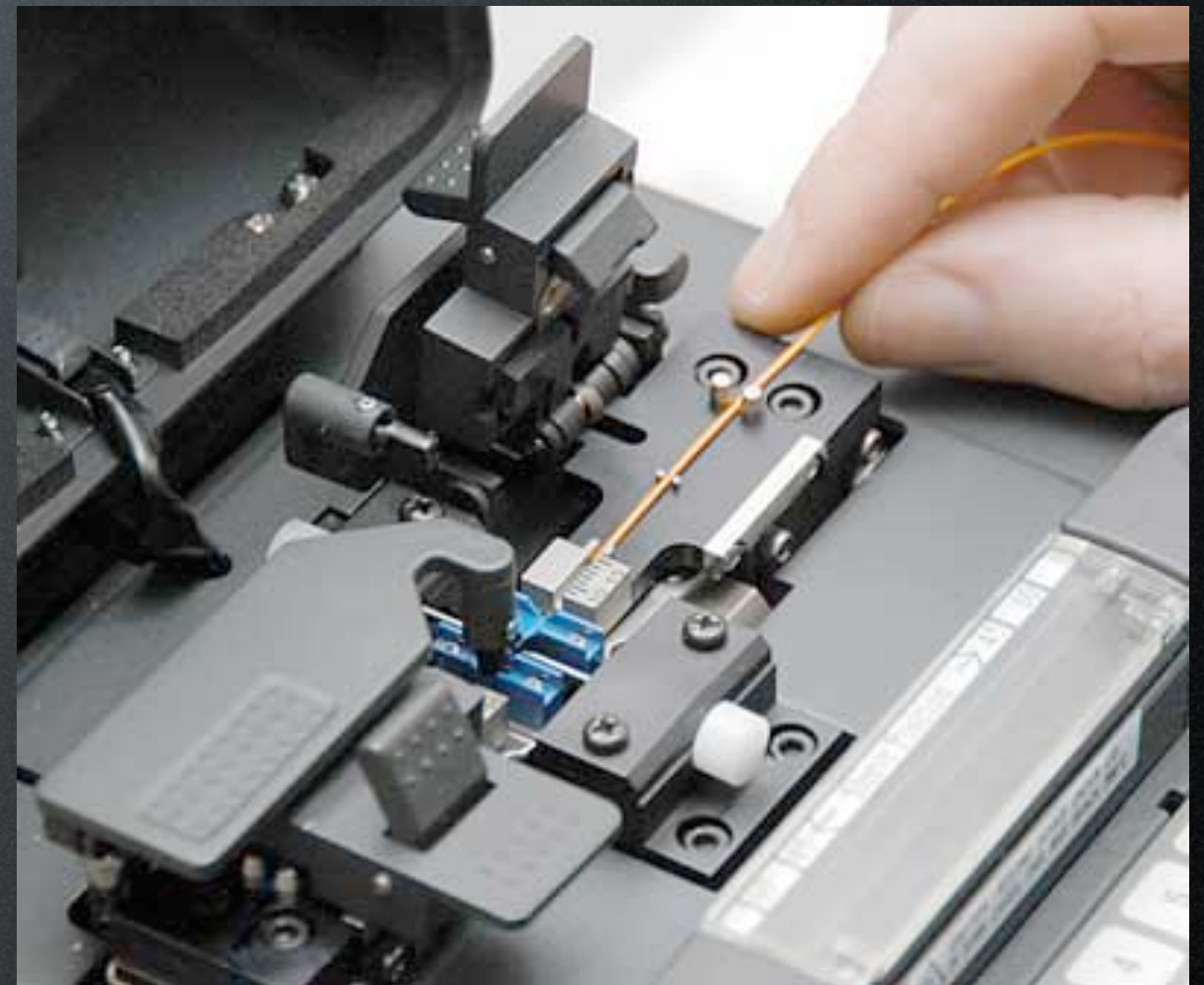
Costs (fiber)

- MM/SM fiber
 - 0.5 €/m
- Patchpanel 24 (LC)
 - 400 €
- Patch Cord (LC)
 - 1m: 7 €
 - 25m: 25 €
- Termination
 - 10 €/end

Termination (copper)



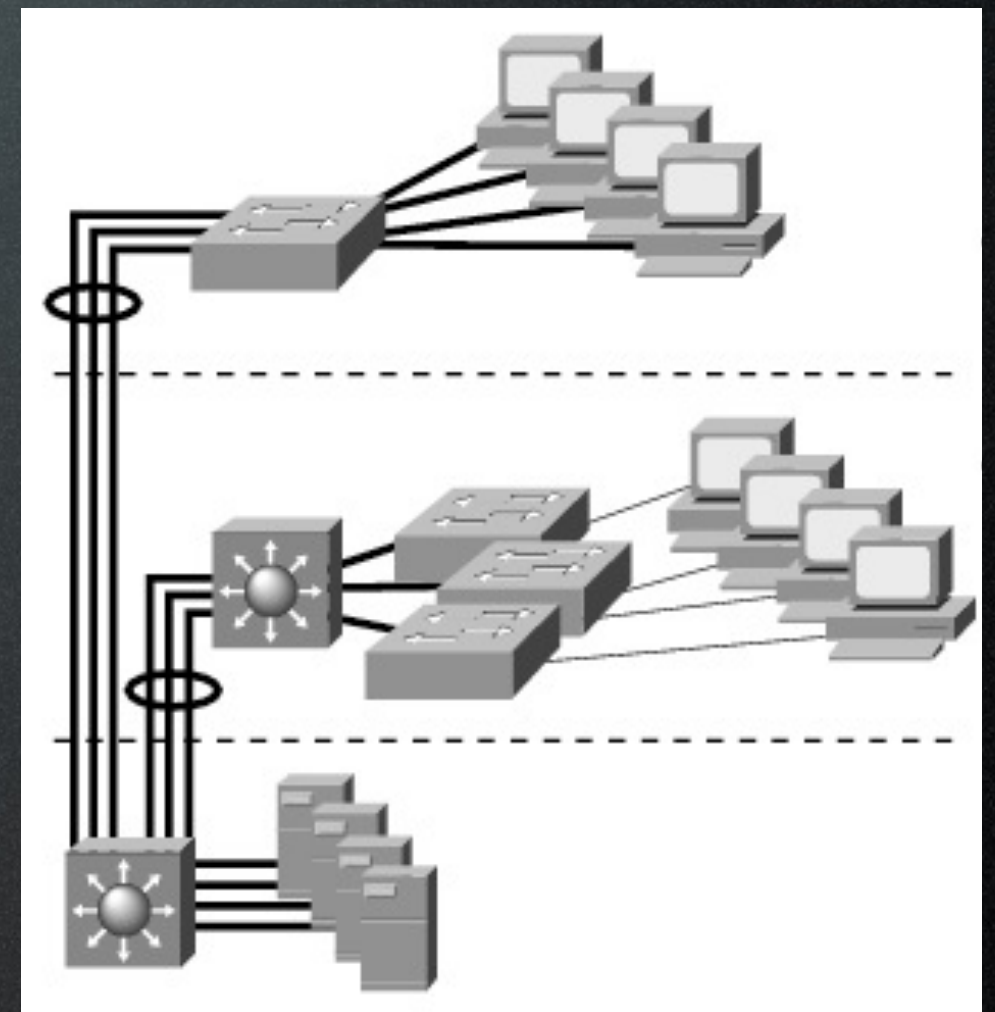
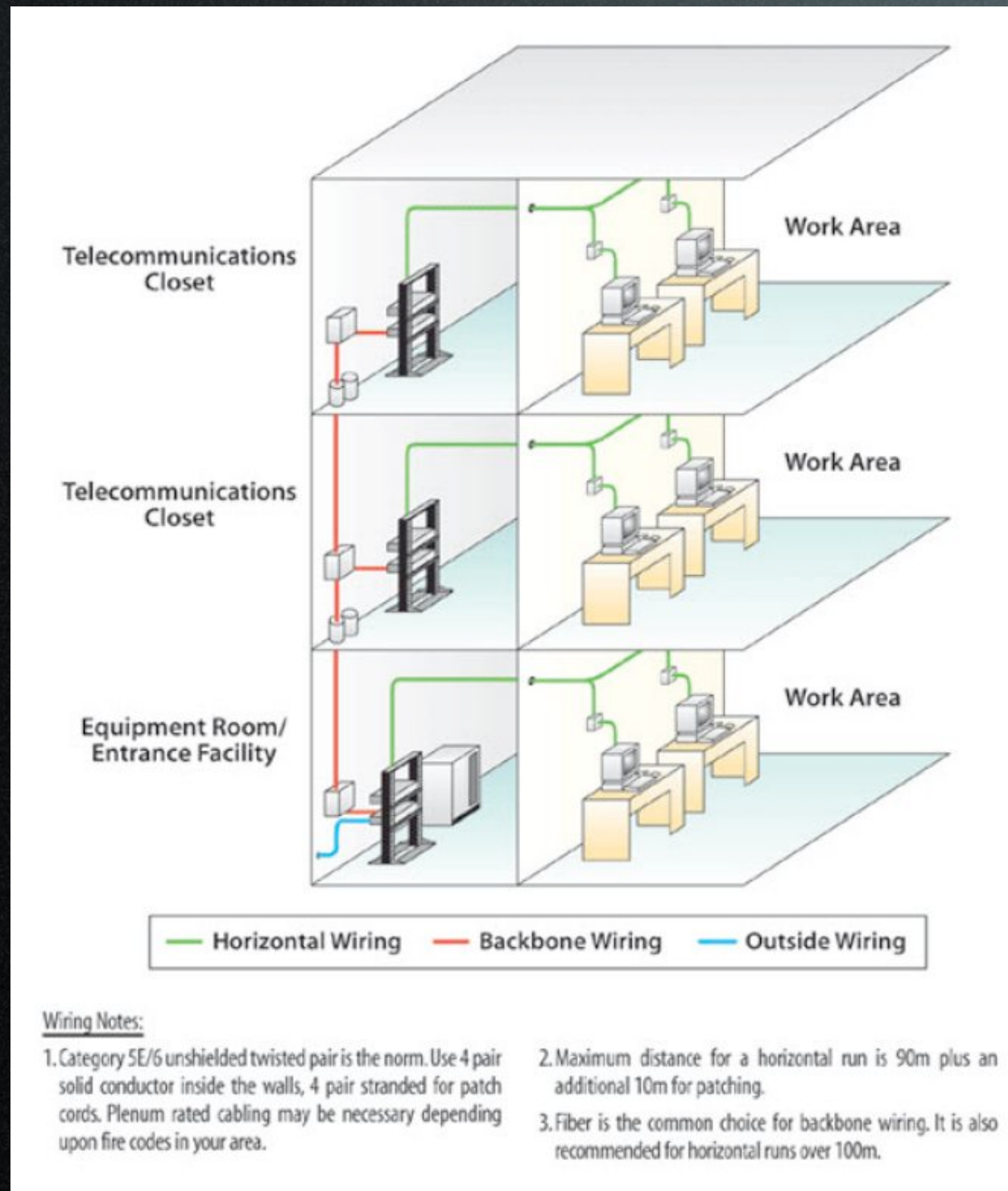
Termination (fiber)



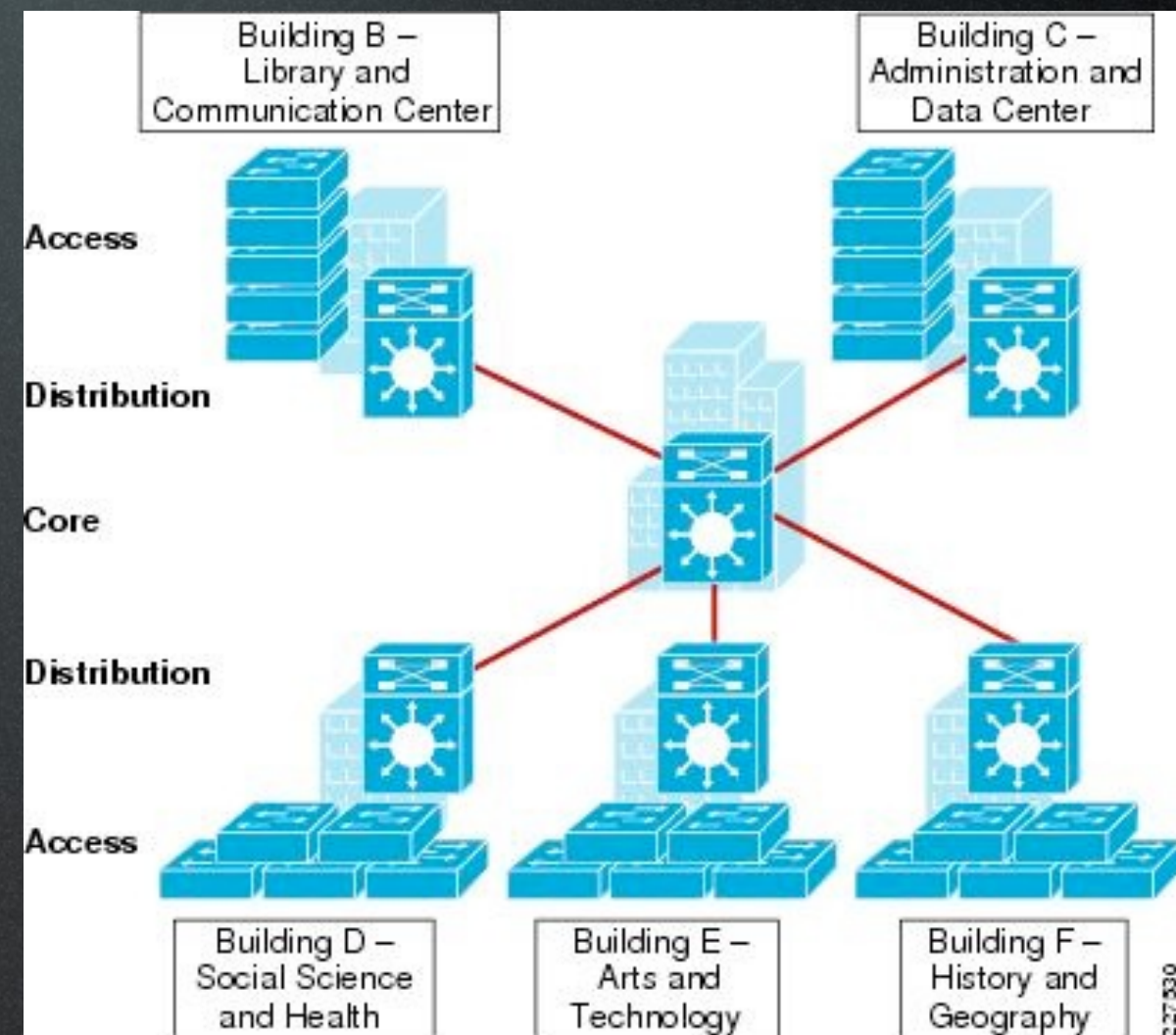
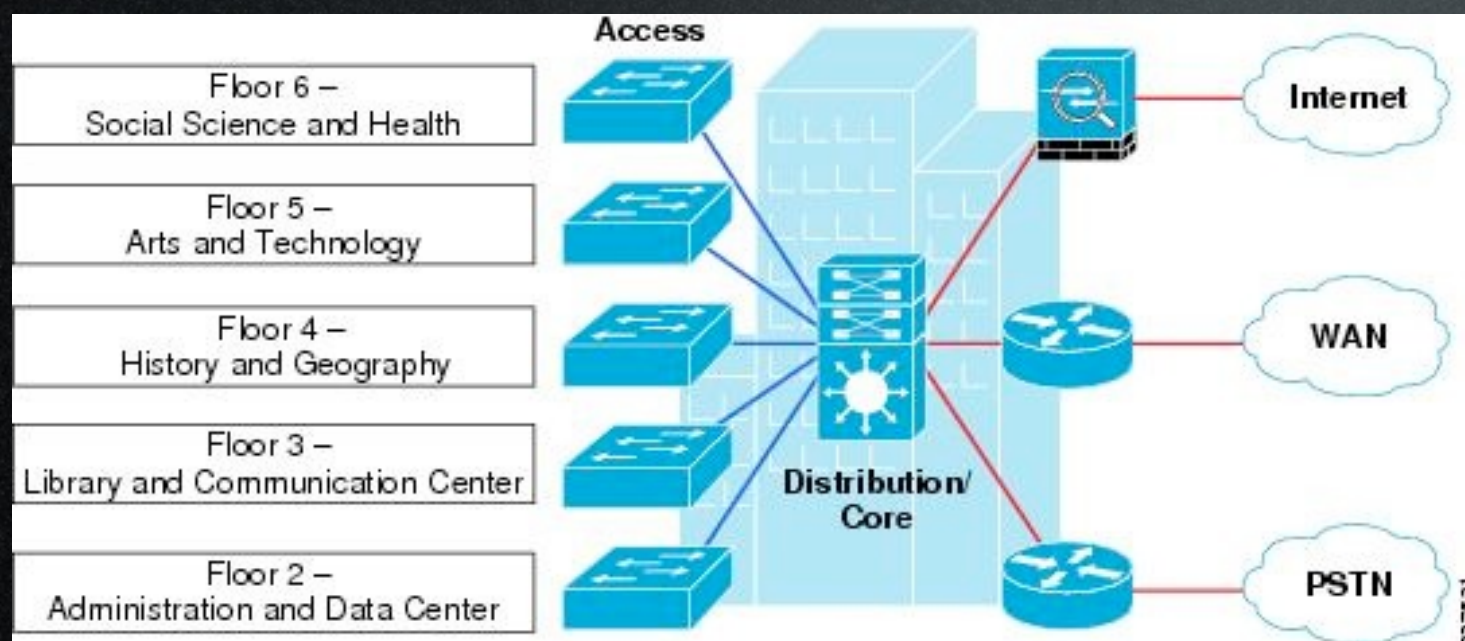
Testing/Certification



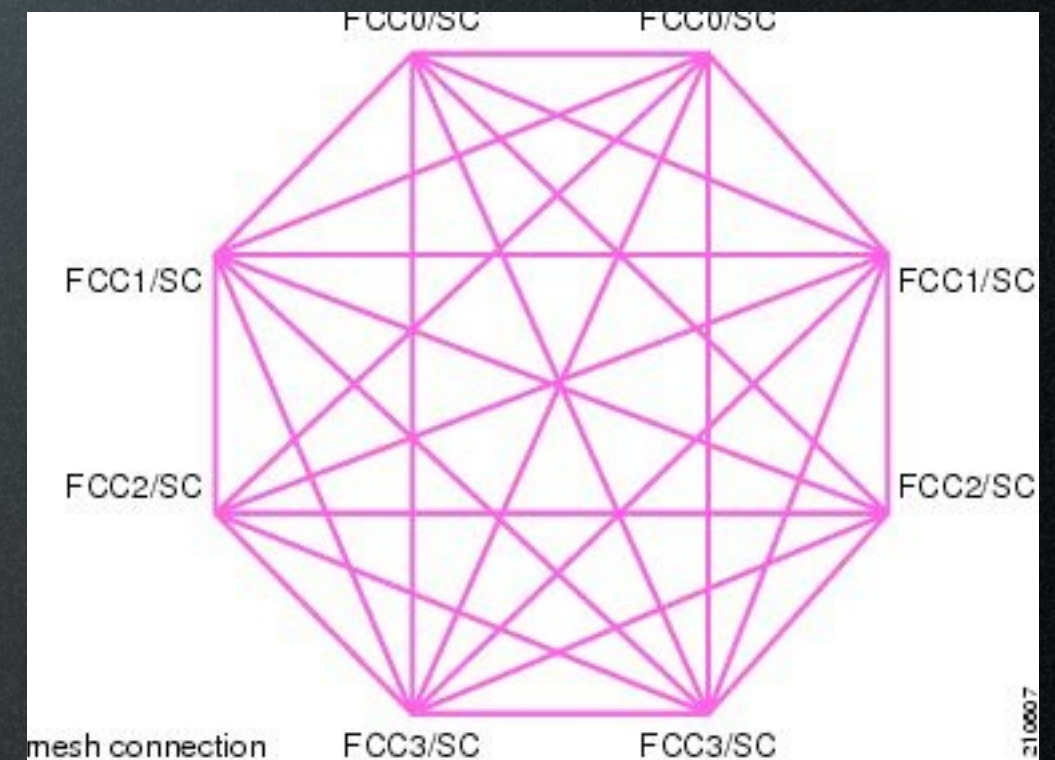
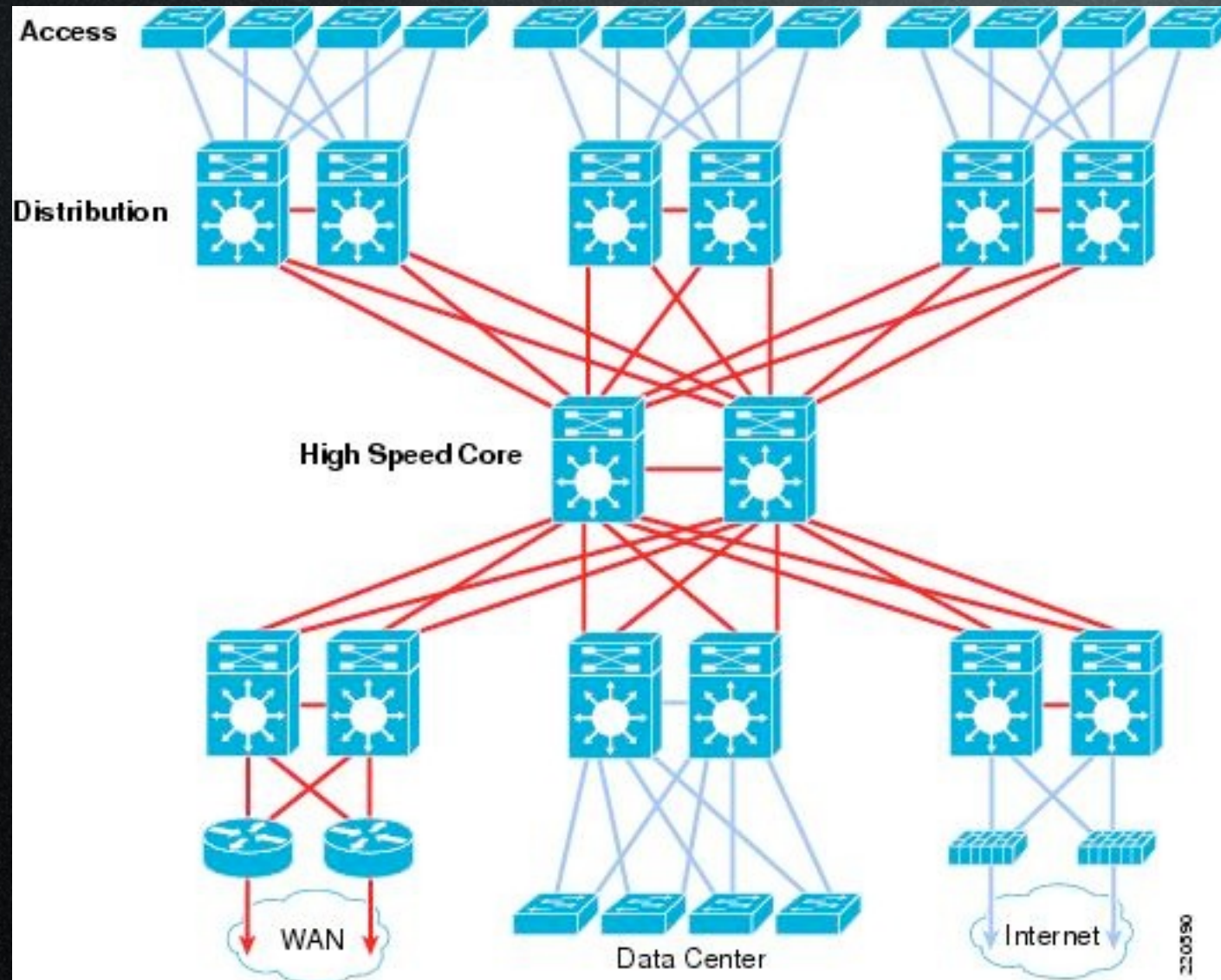
Vertical, Horizontal, Backbone cabling



Vertical, Horizontal, Backbone cabling



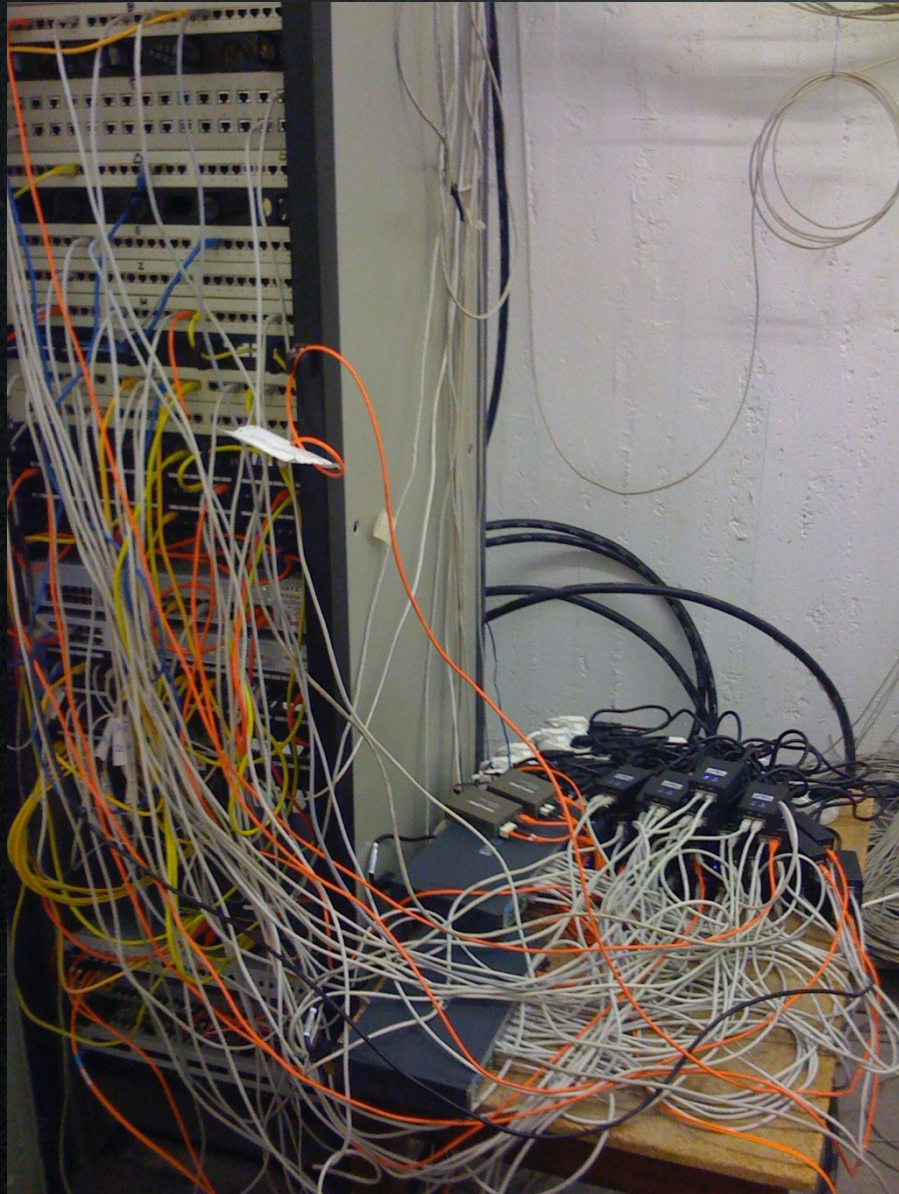
Redundancy: multiple paths/devices



Rapid Deployment Example

switches

fiber to UTP
bridges

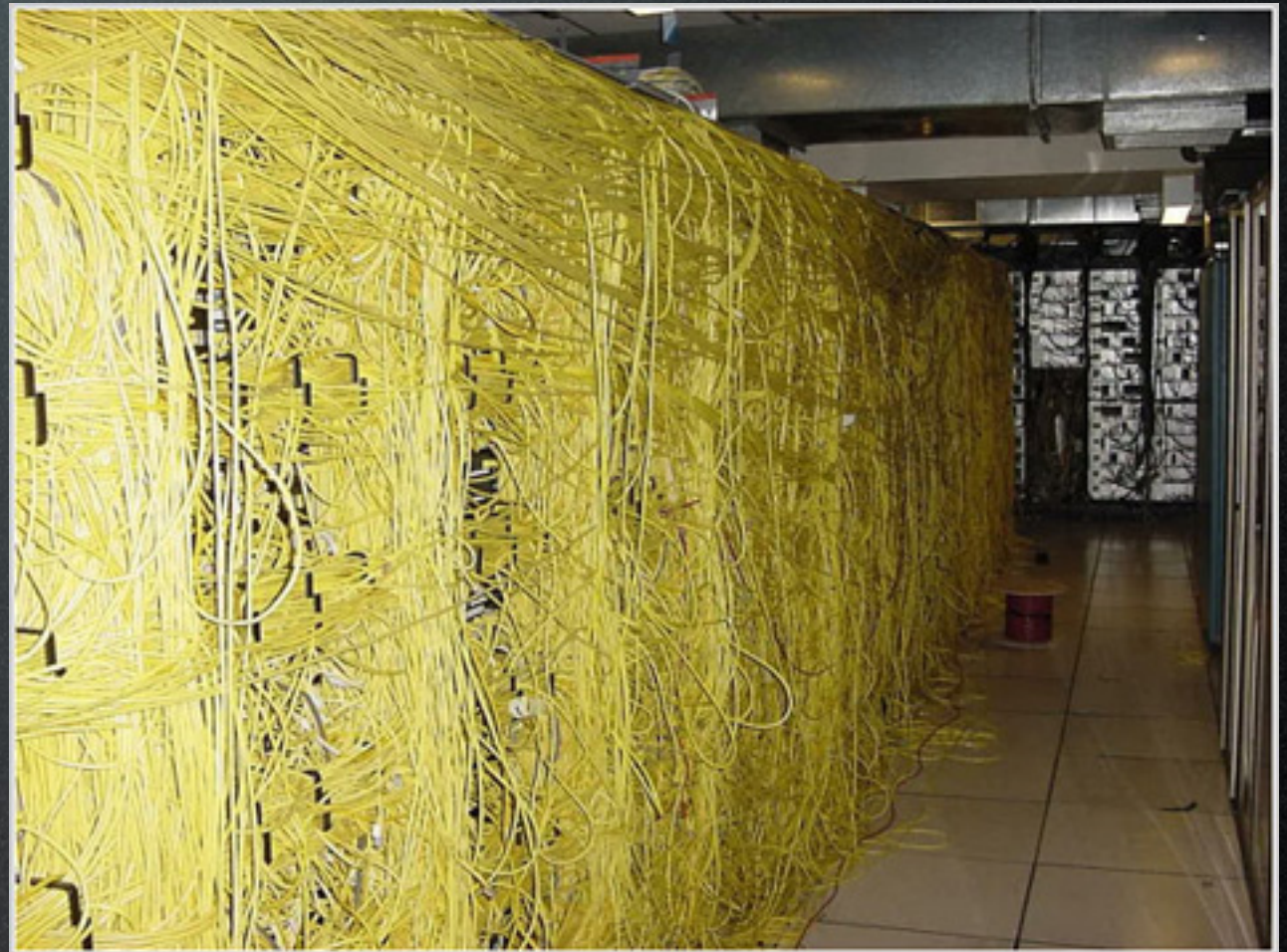
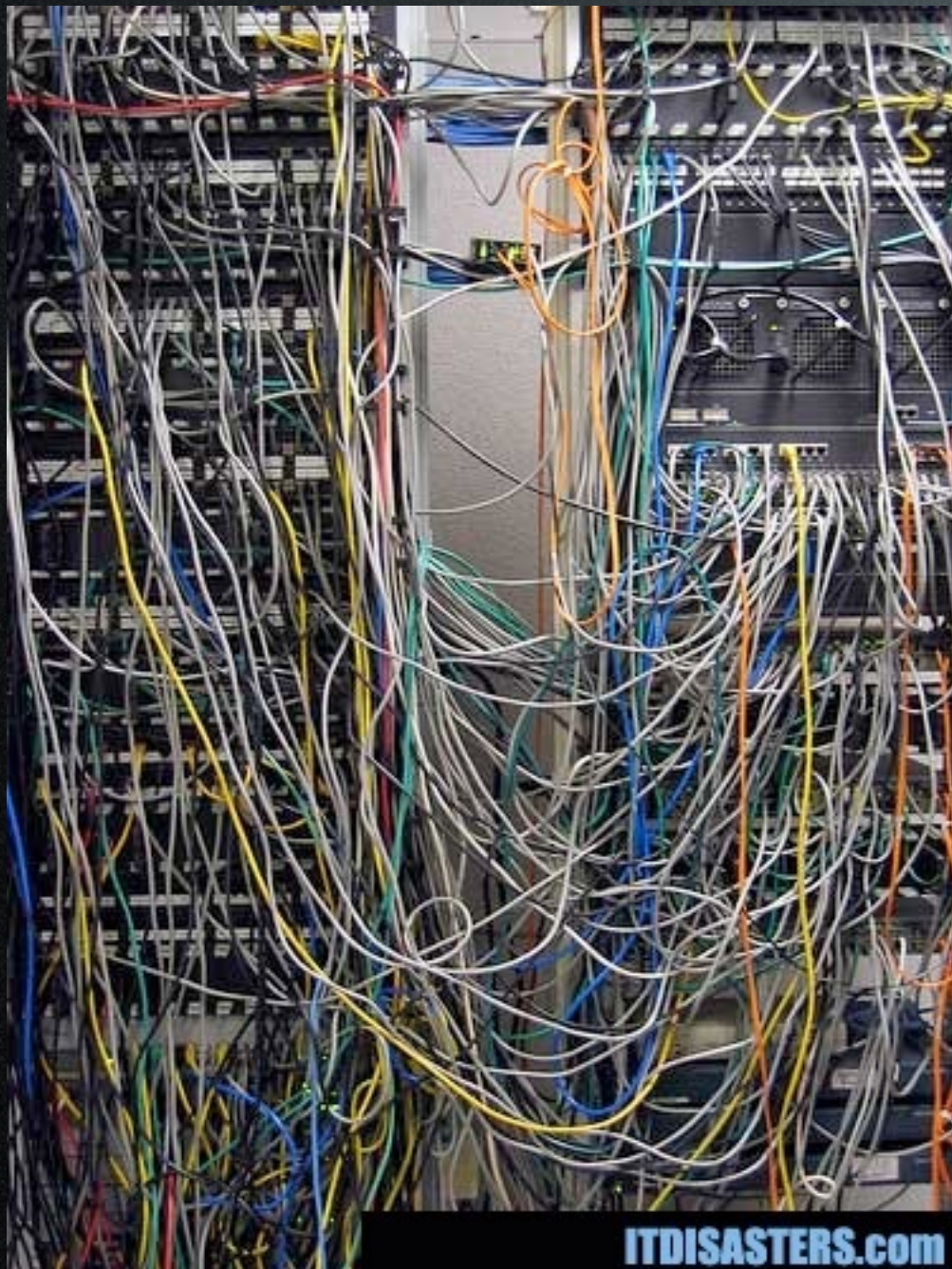


POE
injectors

Good Examples



Bad Examples



UoC

- Τηλεφωνία
 - 1.817 τηλεφωνικές συσκευές, 220 Voicemail, 120 Εφαρμογές Αυτόματης Τηλεφωνικής Γραμματείας
- Ενσύρματη Πρόσβαση
 - 2 Δακτύλιοι Οπτικών Ινών (Γάλλος – Βούτες), 100 κατανεμητές δικτύου, 185 Δικτυακές Συσκευές, 7.000 ενεργές παροχές (πρίζες) δικτύου
- Ασύρματη Πρόσβαση
 - 6 Controllers κεντρικής διαχείρισης, 370 Access Points, 2 Βασικά δίκτυα & adhoc δίκτυα για ειδικές χρήσεις