Network Design Workshop

Cable Installation Tips

Cabling Installa, on Hints

- UTP Copper Installa,on
- Outdoor Conduit Planning/Installa,on
- Fiber Op,c Cabling Installa,on
- Network Racks

Unshielded Twisted Pair

- Cable Construc, on
 - 24 AWG, 4-Pair cable
 - Be aware: counterfeit/fake cable is common
- Installa, on Mistakes
 - 90 Meters maximum installed cable distance
 - No more than 1cm unsheathed cable at termina, ons
 - Termina, on should be in jacks, not RJ45 plugs
 - Labeling should include both ends of wire run

https://en.wikipedia.org/wiki/American_wire_gauge

Various types of UTP Jacks





Beware of Poorly Done Termina, ons

• Remember, only 1cm of unsheathed cable



Patch (or Jack) Panels





Patch Panels with cable in racks



Unshielded Twisted Pair Cable (UTP)

- Always terminate in Jack Panel
- Labeling is a key to reduce work later
- Pull more than one cable





Underground Conduit

- OXen used to route cabling between buildings
- Not simple to design and very easy to make mistakes which make conduits hard to use
- Common mistakes
 - Not enough conduit
 - Conduit too small
 - Too many bends between places you can pull

UG Conduit Rules

- No more than 200m between pull points
- Reduce distance by 50m for every 90 degrees of bend
- Do not exceed 270 degrees without a pull point
- Survey the site, do the layout, place hand holes

UG Conduit Hints

- Bigger conduit be\er than li\le conduit
 - Recommended installa, on: at least one 10cm or two 5cm conduits to each building
- Conduit for fiber op,c cable is different than water pipe.
- Always install a pull rope in all conduits, including empty ones
- Label the Conduits

Planning Underground Conduit

- Get a map of your campus (can use google earth if you don't have a map)
- Layout conduit paths
- Plan for vaults
- Don't forget to think about future expansion

A Simple Campus



A Simple Campus



Conduits on Small Campus



Conduits on Small Campus



But What about Vaults?

- Things to Consider
 - The conduit distance and number of bends
 - Vaults (Hand Holes) provide a pull point, so they reset the 200M rule.
 - How do you come out of building? Do you have a 90 degree bend at the transi,on?
 - Places where you might branch and go different direc,ons
 - Future loca, ons

Suggested Vault Placement



Conduit versus Water Pipe



Gecng Conduit out of Building





Examples of correct conduit connec,ons

Don't Bend Fiber Too Tight

- Fiber has bend radius issues
- Keep bends $\geq 10x$ cable diameter





Buried Conduit Trench



NOTE: For further details see Clause 4.28.

Conduit Fill

- USA Na, onal Electric Code recommends only 40% of the volume of a conduit can be filled
- For low voltage cabling this is important for installing extra cables.
- If the conduit is too full you can damage exis, ng cables by pulling cable past others.
- Pay a\en,on to how full conduits are to help avoid damaging cables.

Labeling Conduit and Cables







Plug Conduits

- Conduit plugs prevent water from using conduits as a pipe
- They also prevent rodents from using the conduits as a pathway



Indoor versus Outdoor Fiber

- Always use outdoor rated cable outside of buildings
 - It must be warranted for outdoor use by the manufacturer
- Loose tube versus ,ght buffer
 - Loose tube is typically cheaper, ,ght buffer is easier to terminate
- Armor versus all dialectric
 - Armor protects against rodent damage
 - Armor requires grounding

Indoor Fiber Packages



Outdoor Loose Tube Armored Cable



96 Fiber Loose Tube Outdoor Non-Armored



Loose Tube vs. Tight Buffer



• Loose Tube: several fibers 250 micron in a buffer tube, gel filling, more compact, fragile, outdoor, very water resistant.



• Tight Buffer: one fiber in a 0.9mm buffer, no gel, bigger, sturdier, in/outdoor.

Break Out Kits (Furca, on)

• These are used on loose tube fiber when doing direct termina, on (not splicing)



Labeling Fiber Cabling

- Iden,fying Fiber
 - Label at each end, strand count, type and des,na,on
 - Label slack loops, Where from? Where to?

Fiber Slack Loops

- You need to install fiber with extra lengths stored along the path
 - These are called slack loops
 - 10m slack every 100m of distance
 - 20m slack at each end

Slack Loops in the USA





Small Vault Slack Loop



Slack Loops in Thailand

How Do You Repair a Fiber Cut?



Easy, If you Have Slack



Fiber Op, c Connectors

- Standardize Connectors
 - Mul, mode: ST or SC (epoxy or hot melt)
 - Single mode: SC or LC (fusion Splice factory UPC pigtail)
- Choose connectors to differen, ate fiber types
 - ST connectors are suitable for MM
 - SC connectors are suitable for SM
 - LC are suitable for both types

Fiber Op, c Connectors

- Color of connector bodies
 - Blue denotes Single Mode
 - Tan or Beige denotes Mul,-Mode
 - Metallic Connectors can be either Single Mode or Mul,-Mode. Check cable color or packaging.



LC Connector



Duplex LC Connector



Connector tip

- Flat: air between surfaces, back reflection -14dB
- Physical contact: slanted end, no air, back reflection -40dB
- Ultra Polish Connector: more polishing, back reflection
 -55dB
- Angled Polish Connector: back reflection -70dB, analog signal



- OM1 62.5µ Mul,-Mode are generally Orange in color (Possibly other colors as well)
- OM2, OM3, OM4 50μ Mul,-Mode are typically Aqua (blue)
- OS2 (single mode) cords are always yellow
- Lengths from .5m to 30m



Single Mode SC to SC and ST to SC



 50μ Mul,-Mode ST to ST



62.5µ Mul,-Mode ST to LC

Fiber Patch Panel



Fiber Patch Panel



Network Racks

- There are a number of different types of network racks
 - Free standing or wall mount
 - Enclosed or not enclosed
 - In US and Europe, network racks tend to be in rooms dedicated for that func,on
 - Buildings with concrete walls makes it be\er to use more and smaller (wall mount) network racks

Wall Mount Network Rack





Free Standing Network Racks



Instructions to Contractors

- Please refer to the web site for this workshop to retrieve a document that gives complete instruc,ons to contractors for
 - Category 5e cabling
 - Fiber op,c cabling
 - Installa, on of underground conduit and vaults
- Download and edit this document to meet your needs

Questions?