Campus Network Best Practices: Structured Cabling

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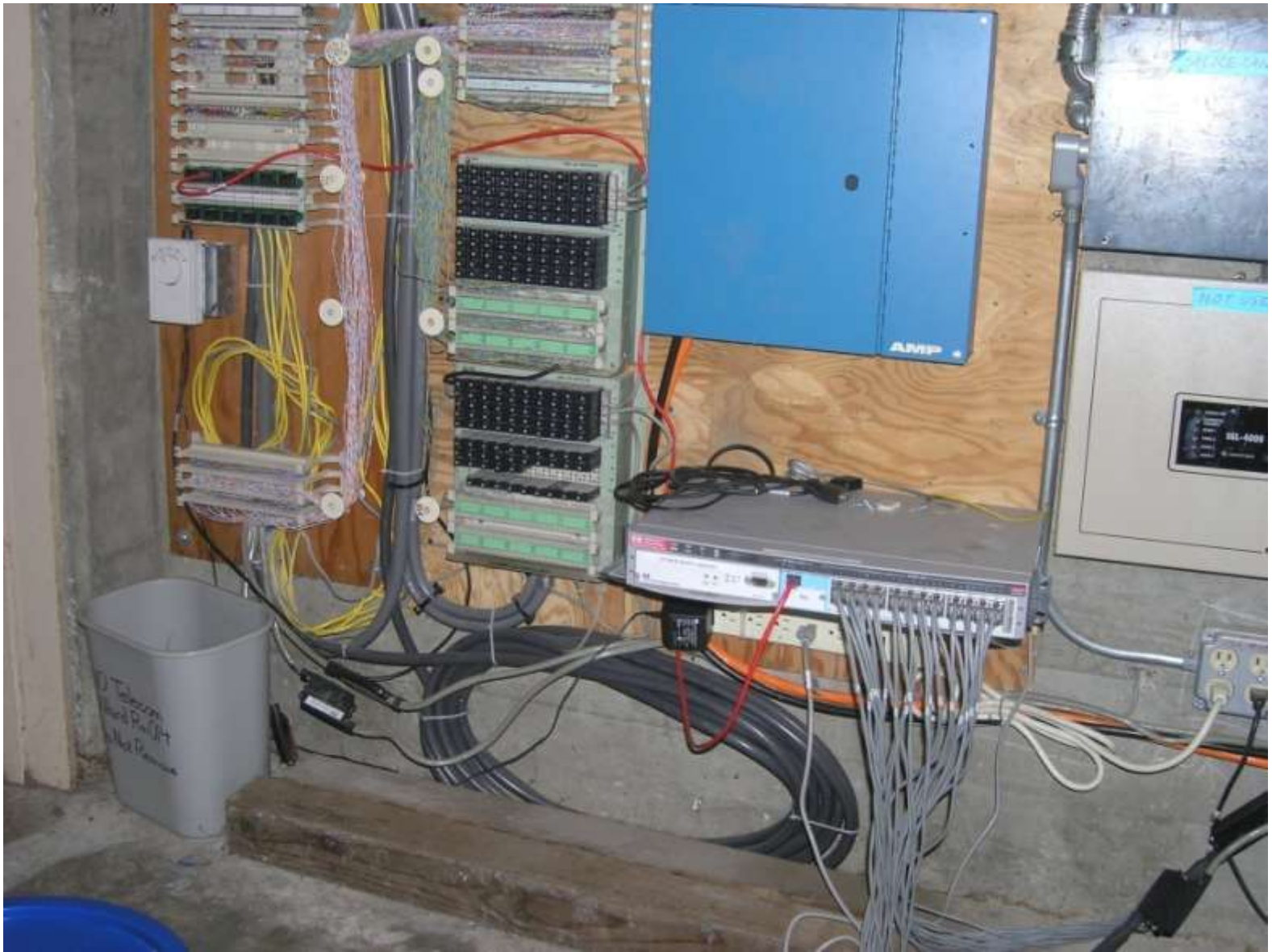
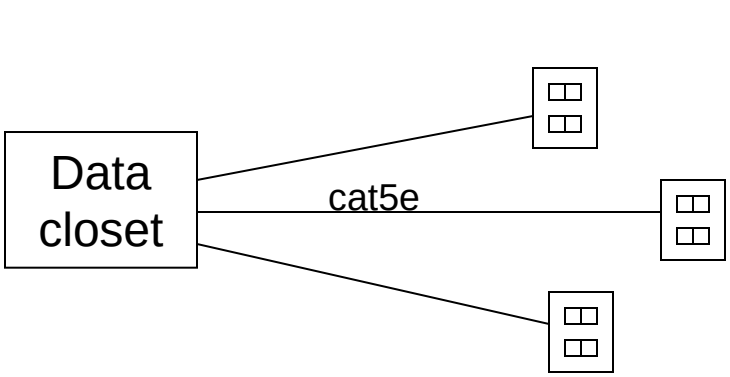
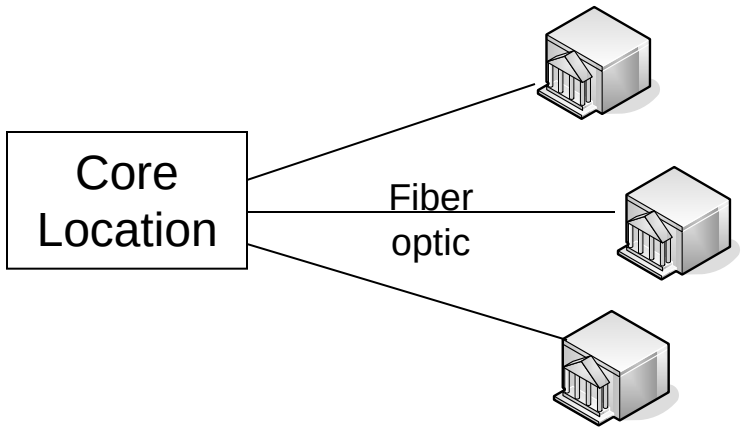
We all have some ugly wiring



Structured Cabling Systems

- Only two types of cabling:
  - Unshielded twisted pair copper – provides service to individual computers and between network closets
  - Fiber optic cabling – provides service to buildings and between network closets
- Everything is run in a star configuration





Unshielded Twisted Pair Cable

- Run in star configuration from network rack location to individual outlets in offices or labs.
- Run at least 2 cables to every outlet – I recommend 4 if you can afford it.
- Run 4 to 6 cables between network racks if the distance is less than 90 meters
- Question: what type of cable to run? Cat5, cat5e, Cat6, ???

What type of UTP

- What speed does each type support?

Cable Type	Max Speed	Max Distance	Cost Factor
Category 5	100Mbs	100m	1x
Category 5e	1000Mbs	100m	1x
Category 6	1000Mbs	100m	1.5x
Category 6	10,000Mbs	57m	1.5x
Category 6a	10,000Mbs	100m	3x

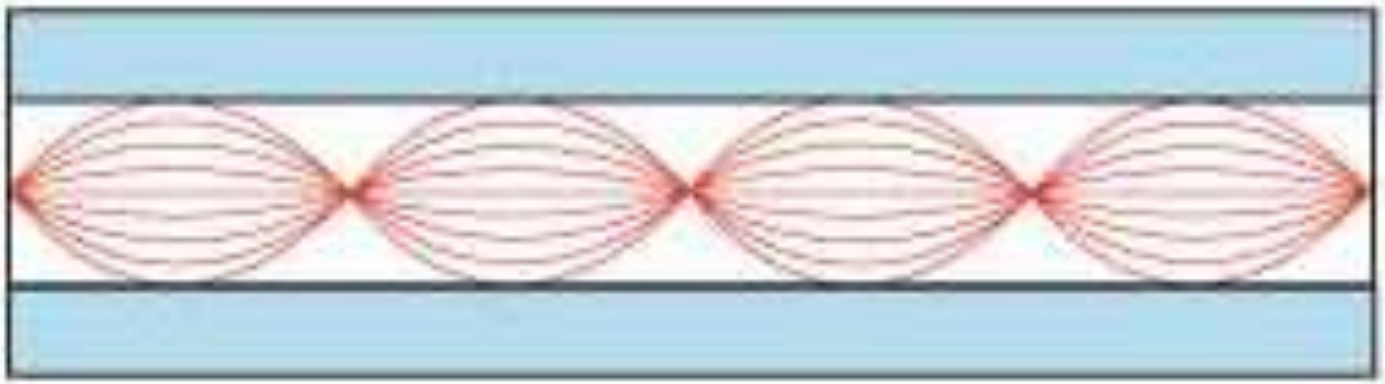
- Strongly recommend category 5e cabling.

Unshielded Twisted Pair Cable

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

Fiber Optic Cabling

- Two basic types of fiber
  - Multi Mode



  - Single Mode

Multi Mode Fiber

- Two basic types:
  - 62.5 micron core. Legacy, older style
  - 50 micron core. Newer
- A number of standards to be aware
  - G.651 – 50 micron
  - OSI/IEC 11801 OM1 – 62.5
  - OSI/IEC 11801 OM2 – 50 micron
  - OSI/IEC 11801 OM3 – 50 micron laser optimized
  - OSI/IEC 11801 OM4 – 50 micron higher bw

Single Mode Fiber

- All have core between 8 and 10 micron
- Standard types:
  - OS1 and OS2 (OSI/IEC 11801 types)
  - ITU G.652 (A, B, C, D)
  - ITU G.653 – 1310/1550 with EDFA amps
  - ITU G.654 – 1550 only
  - ITU G.655 – 1550/1625 for long haul DWDM
  - ITU G.656 – 1460/1625 for long haul DWDM
- You want G.652.D or OS2 single mode

Types of Optical Interfaces

Standard	Speed	Fiber Type
100baseFX	100Mbs	MM
1000baseSX	1Gbs	MM
1000baseLX/LH	1Gbs	MM or SM
10GbaseSR	10Gbs	MM
10GbaseLRM	10Gbs	MM
10GbaseLR	10Gbs	SM
10GbaseER	10Gbs	SM

Optical Interfaces: Cost & Distance

Standard	Cost	OM1	OM2	OM3	OM4	G.652.D
100baseFX	$250	2km	2km	2km	2km	No
1000baseSX	$500	275m	550m	1km	1.1km	No
1000baseLX/LH	$1000	500m	500m	?	?	10km
10GbaseSR	$1500	33m	82m	300m	550m	No
10GbaseLRM	$1300	220m	220m	220m	?	No
10GbaseLR	$4000	No	No	No	No	10km
10GbaseER	$10000	No	No	No	No	40km

Unfortunately, Not Simple

- Various types of fiber make this confusing
- Different equipment vendors claim different numbers
- From Cisco web site:

  "On average, customers will experience much longer transmission reaches than reported in the IEEE specifications, given better than worst-case optics and better than worst-case multimode fiber characteristics. "

Fiber Price Comparison

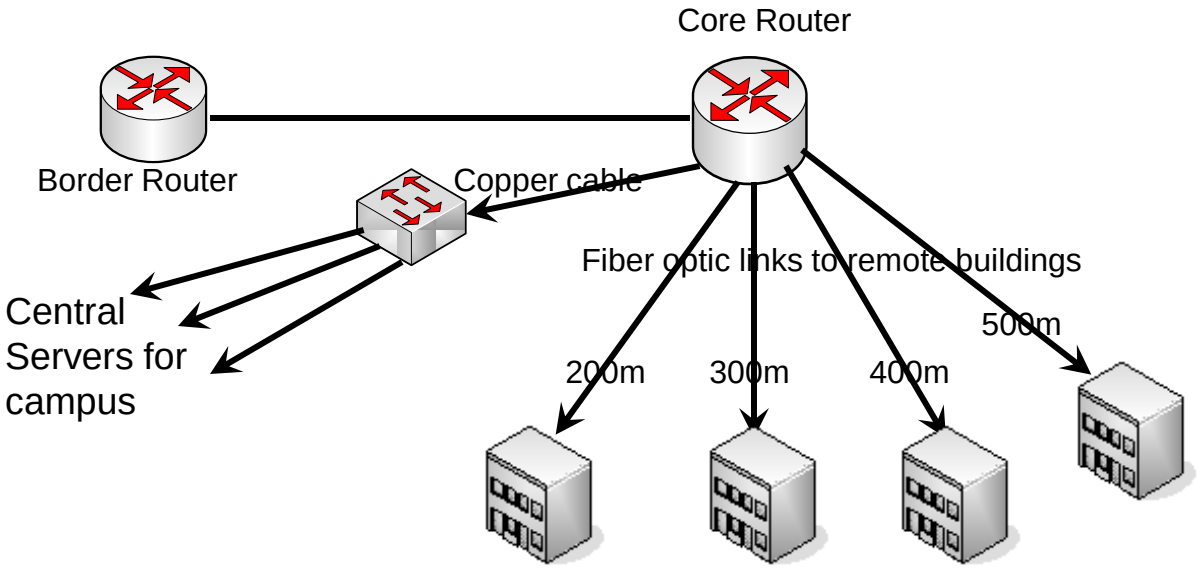
- Single mode fiber cabling is cheaper
- Multi mode optical interfaces are cheaper
- What makes sense for your campus?

Fiber Type	Cost per km	Cost 1Gbs	Cost 10Gbs
OM1 (62.5 legacy)	$4,884	$500/1000	$1300/$1500
OM2 (50 legacy)	$4,054	$500/1000	$1300/$1500
OM3 (50 laser optimized)	$10,151	$500/1000	$1300/$1500
OM4 (new std)	$19,959	$500/1000	$1300/$1500
G.652.D (single mode)	$1,185	$1000	$4000

Pricing based on 12-fiber outdoor cable, Corning 012TU4-T41xxD20

Simple Fiber Pricing Example

- Consider the simple network below
  - Total fiber length 1400m
  - 8 optical interfaces



Pricing Example – 1Gig Links

- Use cheapest optical interface possible, but note that cheap interface is distance limited based on fiber type

Fiber Type	Fiber Cost	Optics	Optics Cost	Total Cost
OM1	$6,837	2x1000baseSX 6x1000baseLX	$7,000	$13,837
OM2	$5,675	8x1000baseSX	$4,000	$9,675
OM3	$14,211	8x1000baseSX	$4,000	$18,211
OM4	$27,942	8x1000baseSX	$4,000	$31,942
G.652.D	$1,659	8x1000baseLX	$8,000	$9,659

Pricing Example – 10Gig Links

- Note that some fiber types won't support 10Gig over the required distances

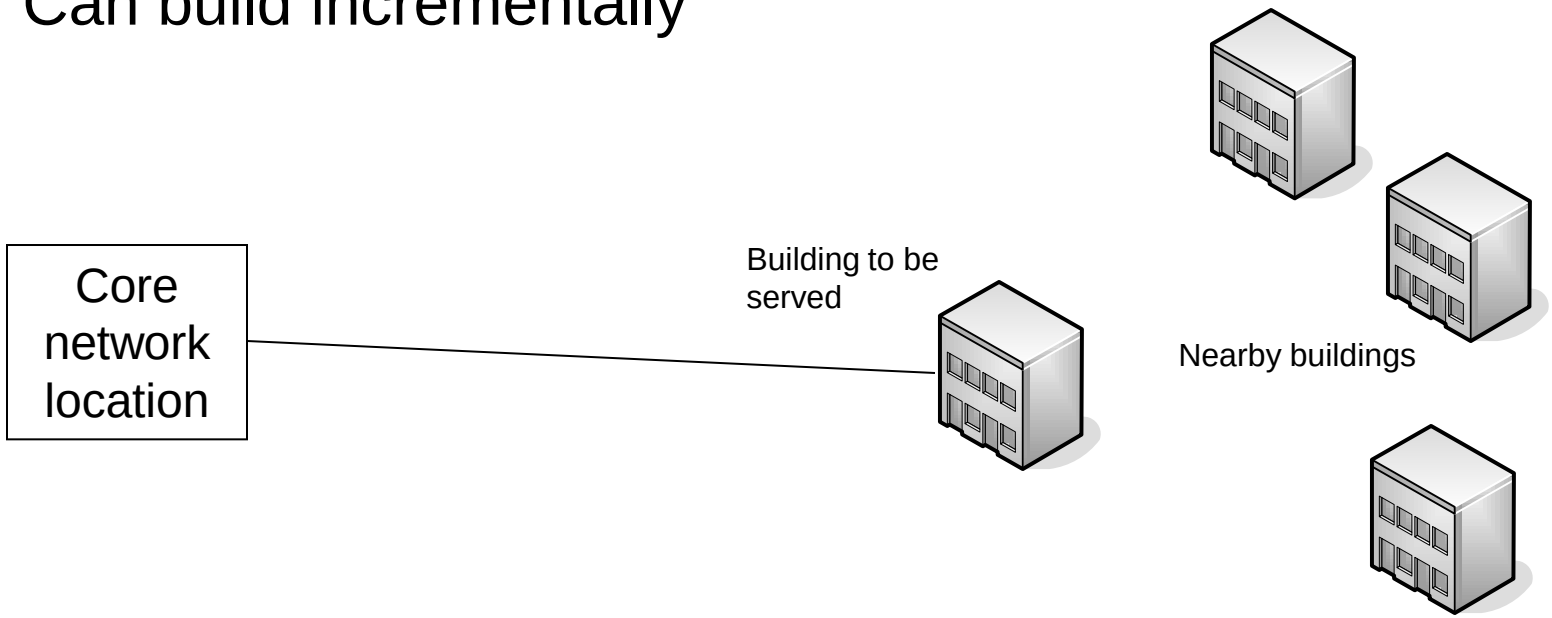
Fiber Type	Fiber Cost	Optics	Optics Cost	Total Cost
OM1	$6,837	Not supported		No
OM2	$5,675	Not supported		No
OM3	$14,211	Not supported		No
OM4	$27,942	8x10GbaseSR	$10,400	$38,342
G.652.D	$1,659	8x10GbaseLR	$32,000	$33,659

Fiber Optic Recommendations

- Only install Multi Mode OM2 if distances are short
- Don’t do OM1, OM3 or OM4 anywhere
- Install Single mode everywhere
- Run in star configuration from core network location to individual buildings
- Run in star configuration inside of buildings from main network closet to other closets
- To reduce costs, can run large fiber cable from core to some remote location, then smaller cables from there to surrounding buildings

Star Configuration

- Plan for future -- Install enough fiber
  - Between Buildings: 6 single mode from core to each building (multi mode OK if distances are short)
  - Inside of buildings: 6 single mode and 6 multi mode between network racks
  - Can build incrementally



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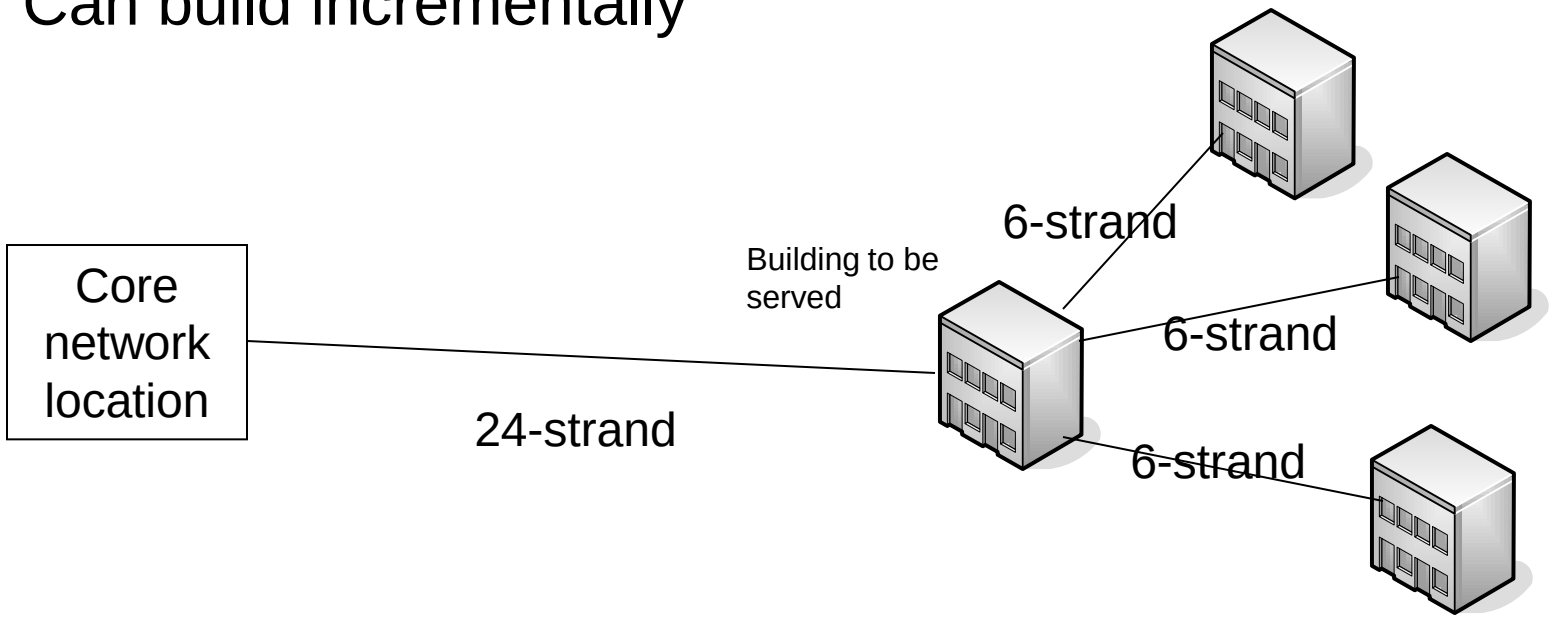
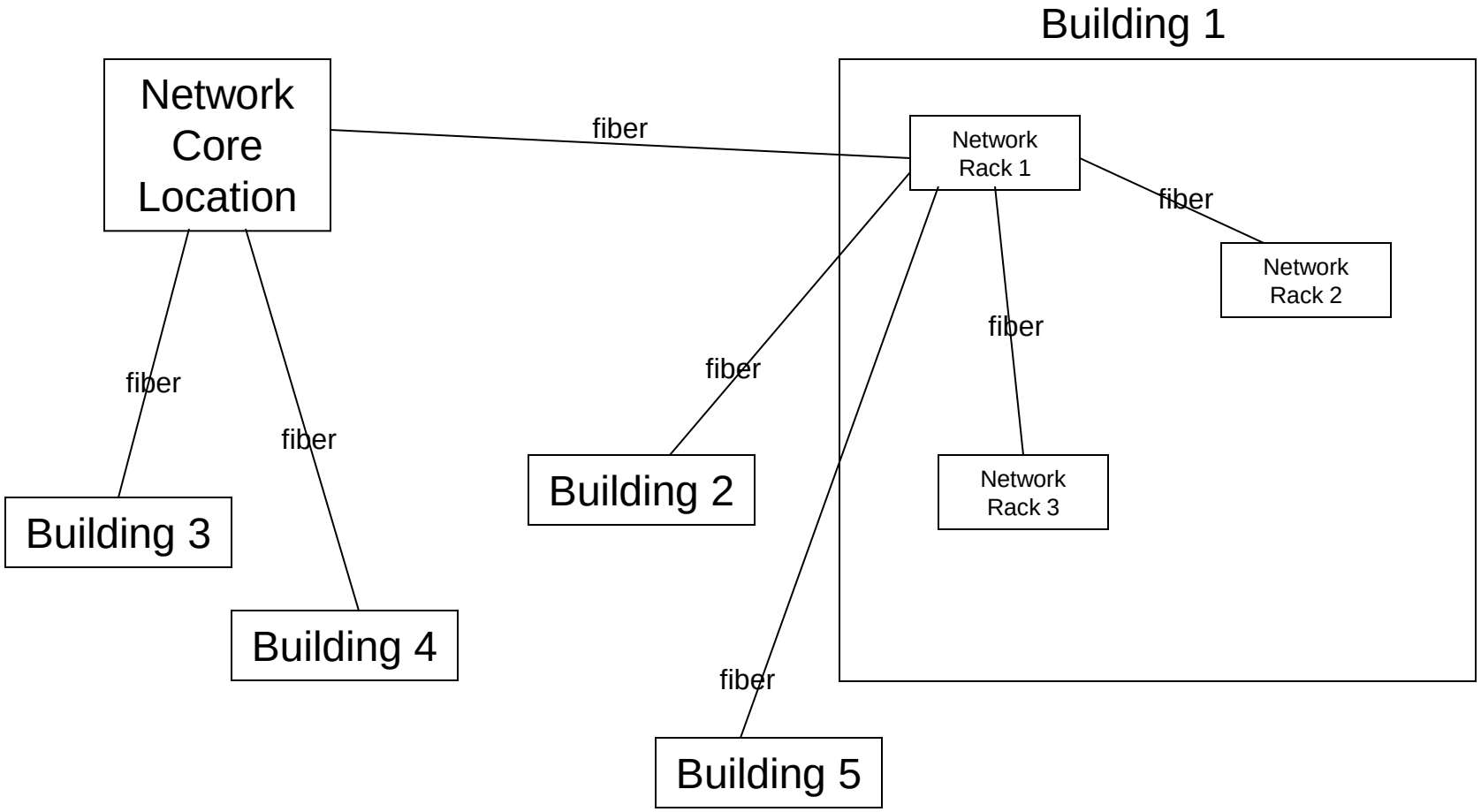
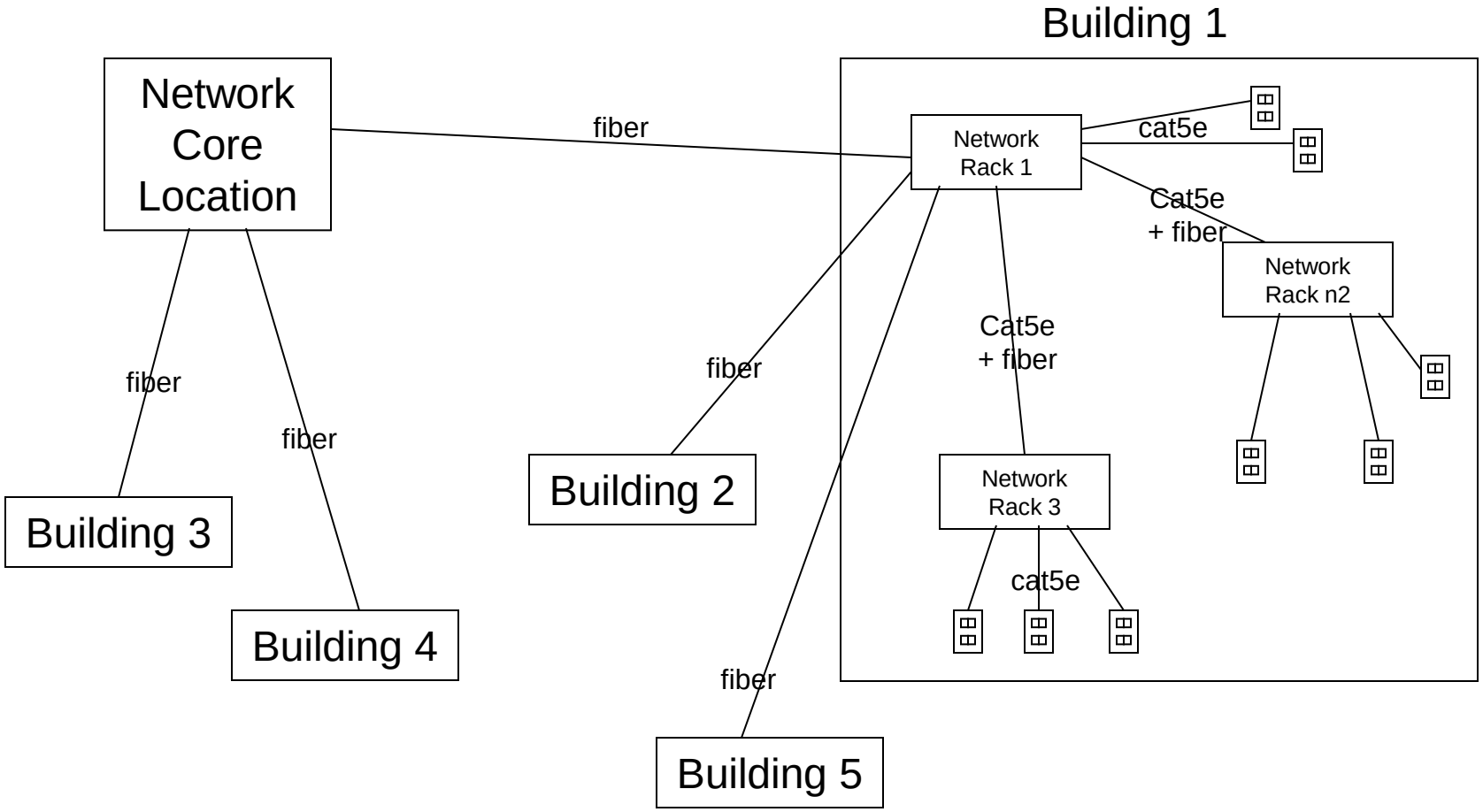


Fiber Optic Topology



Putting it all Together



Questions?