



MILLENNIUM
GEOSPATIAL

Millennium Geospatial FTTx Design Guide

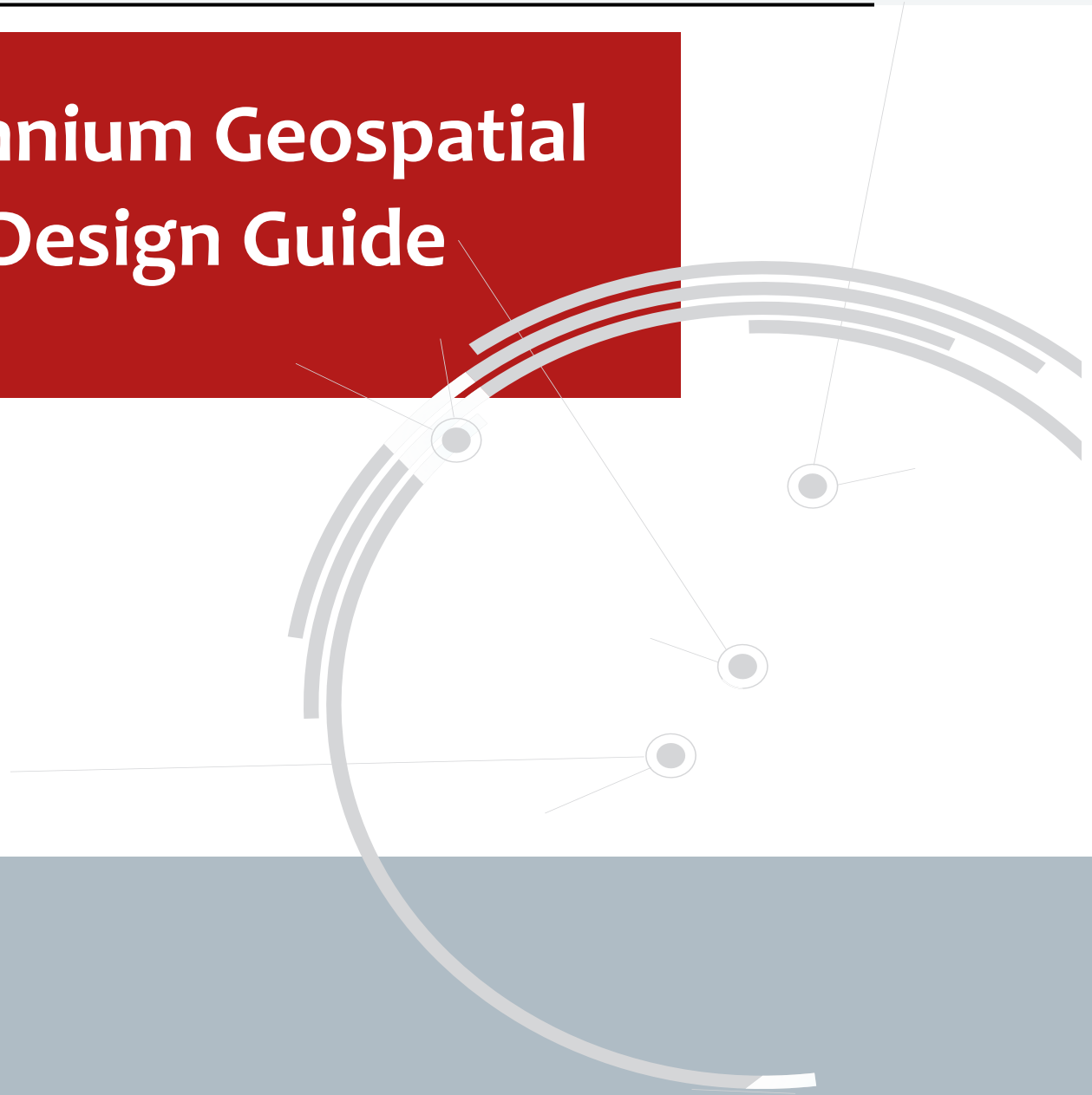


Table of Contents

Cable Sizing and Routing.....	3
Slack Loops.....	5
Conduit and Underground Structures	6
Strand and Aerial Placement	8
Splicing and Fiber Assignments.....	9
Multipoint Service Terminal (MST).....	11
Aerial Drops.....	13
Underground Drops	14
Fiber Distribution Hub (Passive Cabinet)	15
Optical Line Terminal (Active Cabinet)	16
Naming Conventions.....	17
Appendix A.....	18
Glossary	18
Revisions	19

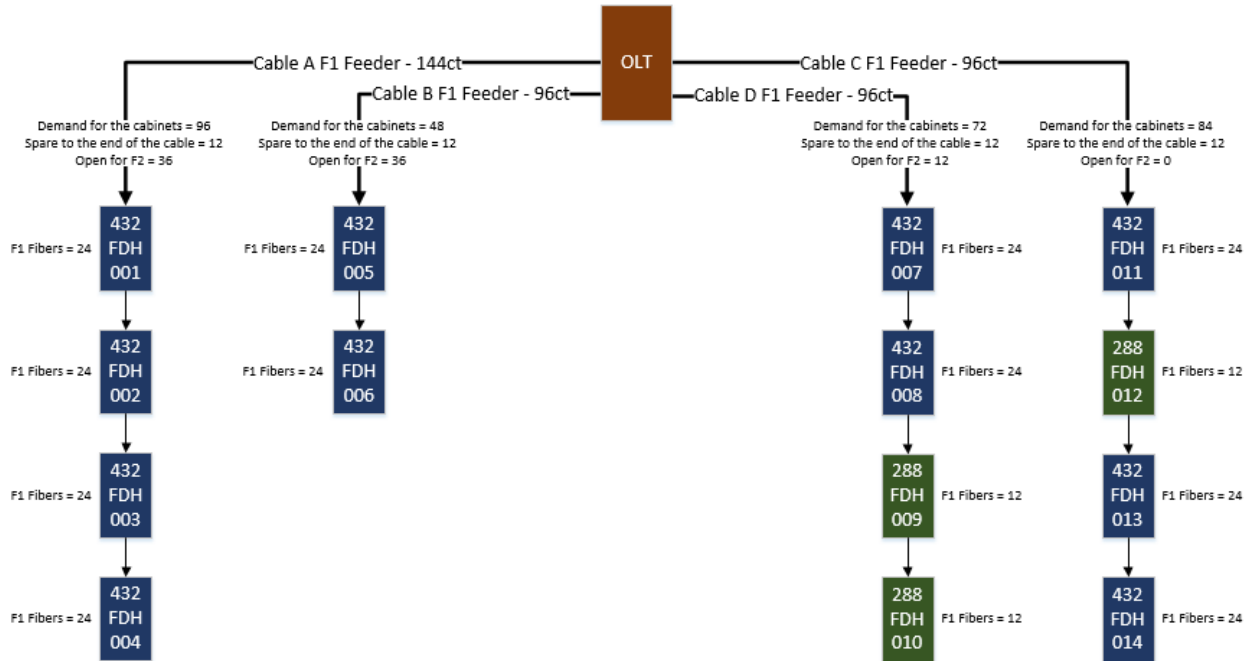
Cable Sizing and Routing

1. Cable sizes available for Transport (F0) is 288.
2. Cable sizes available for Feeder (F1) are 48, 96, 144 and 288.
3. Cable sizes available for Distribution (F2) are 24, 48, 96,144.
 - a. The exception being when F1 and F2 share a sheath.

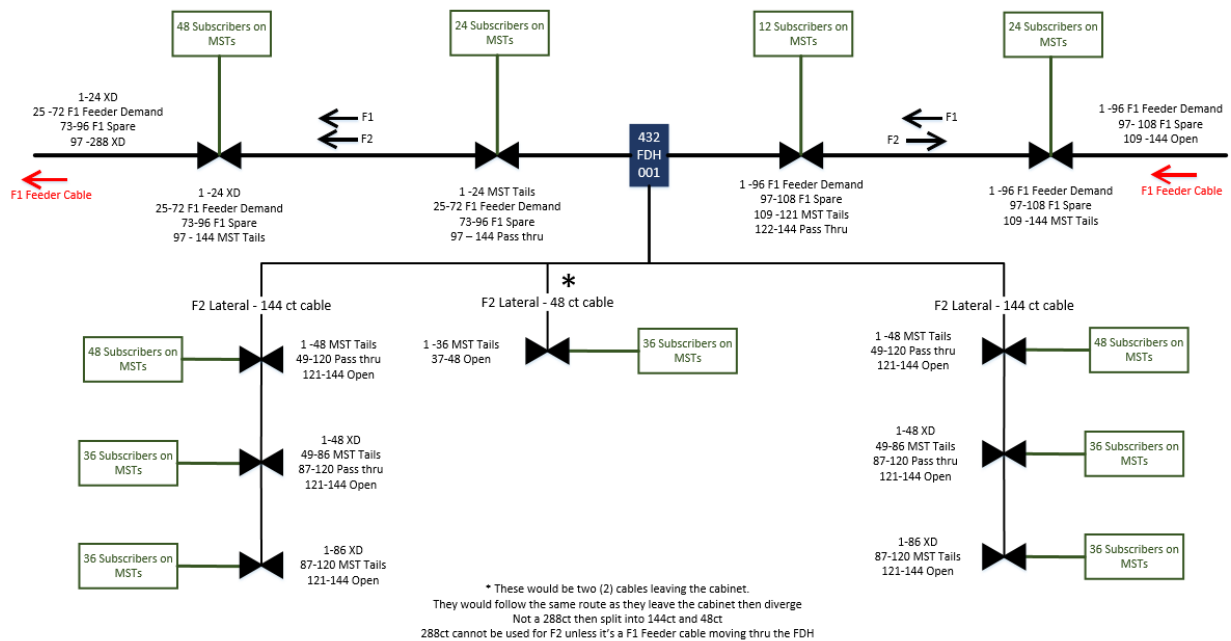
Cable size and type	Outside Diameter
Commscope Fiber Optic Cable, armored, 24-fiber, SM, OS2, loose tube, gel-filled, 1000 m	0.453 in
Commscope Fiber Optic Cable, armored, 48-fiber, SM, OS2, loose tube, gel-filled, 1000 m	0.453 in
Commscope Fiber Optic Cable, armored, 96-fiber, SM, OS2, loose tube, gel-filled, 1000 m	0.528 in
Commscope Fiber Optic Cable, armored, 144-fiber, SM, OS2, loose tube, gel-filled, 1000 m	0.673 in
Commscope Fiber Optic Cable, armored, 288-fiber, SM, OS2, loose tube, gel-filled, 1000 m	0.772 in

4. Transport (F0) Fiber will not share sheath with any Feeder (F1) or Distribution (F2) fibers.
5. Transport (F0) may share a route with Feeder (F1) or Distribution (F2) where required for cost effective design. This situation should be avoided where possible.
6. Transport (F0) route will be one (1) 288ct diverse physical ring.
7. Feeder (F1) and Distribution (F2) may be inside the same sheath.
8. Feeder (F1) routes should be designed with a minimum of one (1) 12ct tube continuous spare from the Active Cabinet (OLT) to the last Passive Cabinet(FDH) on the lateral. (See figure below)
 - a. Two (2) 12ct tubes are preferred when it does not require the cable to be upsized.
 - b. Number of fibers needed for F2 can be taken into consideration when determining to leave 12 or 24 fibers for spare.
9. Feeder (F1) Laterals should be sized to 4 Passive Cabinets (FDH) per leg where possible.
 - a. 5 cabinets require internal CHR Project Management Approval.
 - b. If a Feeder leg requires 6 Passive Cabinets, customer approval would be required. There is a maximum of 6 Passive Cabinets per leg.
10. Distribution (F2) routes should be designed with one (1) 12ct tube continuous spare capacity per lateral cable from Fiber Distribution Hub (FDH) to the final splice case on each lateral cable. (See figure below)
 - a. If providing one (1) 12ct tube of spare will require the fiber to be sized greater than 144ct then another shorter route should be proposed to serve the demand closest to the cabinet.

OLT Feeder (F1) Cable Demand with Spare



FDH Distribution (F2) Cable Demand with Spare

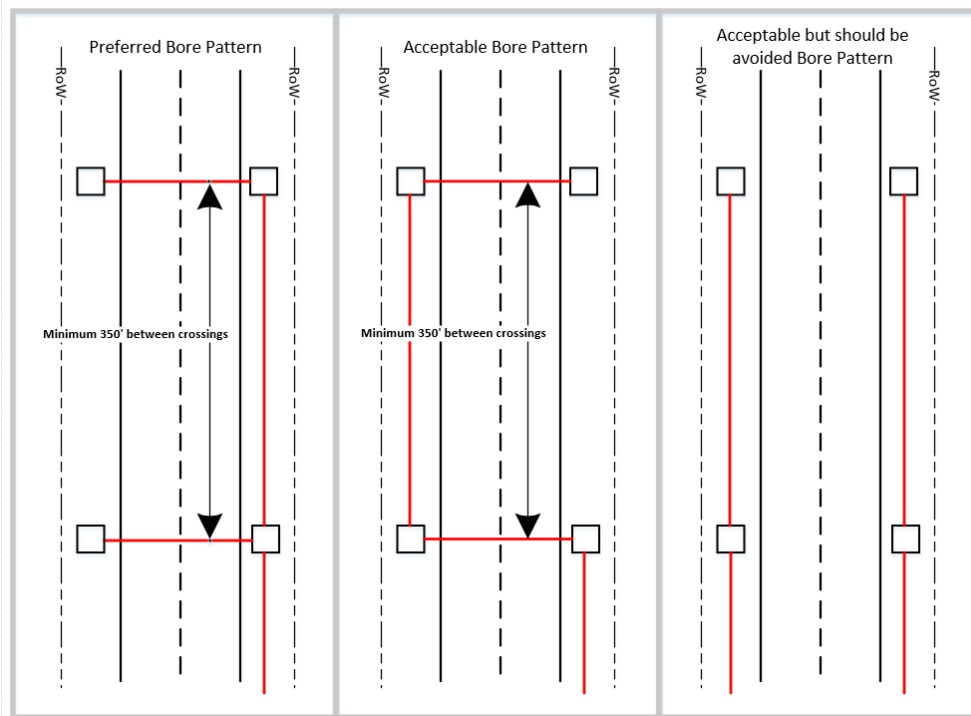


Slack Loops

1. Place a 100' coil for Maintenance Slack every 750' to 1000' of cable path.
 - a. Cable path should be considered the accumulation of aerial and underground placement along a single path.
 - b. Where possible, the maintenance slack should be placed aerial.
 - c. For long underground routes, you may need to add additional handholes to place maintenance slack in.
 - d. The operational slack placed for splicinglosures should not be counted towards the 100' of coil. Reminder to count riser footage into the total path length.
2. Place 50' of coil for each fiber optic cable entering any splicinglosure.
 - a. Please note if a cable is passing through a handhole with a splicinglosure in it but is not being pulled into the enclosure, it should not receive a 50' coil.
3. The Aerial/Underground placement of coil should be placed the same as the splicinglosure.
4. Place 25' of coil for each fiber optic cable entering a Pedestal.
 - a. Do not show a coil for MST tails entering a Pedestal.
5. Aerial slack will be placed in aerial snow shoe (PM93)
6. Slack loops will be called out as the BFO or CO unit. It will not be grouped with the conduit or strand, BFOxxI or COxx(6M).
7. Place a 100' coil or a Reelend within 200' of any railroad or interstate crossing.

Conduit and Underground Structures

1. All conduit should be proposed within the Right-of-Way.
2. Proposing conduit parallel to each other on both sides of a road should be avoided when possible.
 - a. Preferred placement is conduit on one side of the road with road crossing to T off MST tails or fiber optic cable taps. See figure below.



3. There should be a minimum of 350' between road crossings.
4. All conduit proposed will be 1.25" HDPE.
 - a. Exception being railroad crossing, we will propose 4" steel duct.
5. Fiber optic cable and MST tails will not be proposed in the same conduit.
 - a. Where cable and tails share the same route, a separate conduit should be proposed for cable and for tails. See the sizing chart below to determine how many ducts would be needed for each cable run.
6. Road bores should be proposed perpendicular to the road then turn to meet structure.
7. Avoid more than 2 – 90° turns in a conduit path with no handhole or pedestal between the turns.

- 8. Conduit should be proposed at a 80% fill rate. (see chart below)
 - a. 1.25" HDPE Conduit has inside diameter of 1.13, max fill capacity is 0.91"

		Number of Parallel Fibers				
		24	48	96	144	288
Count First Fiber	24	1	1	0	0	0
	48	1	1	0	0	0
	96	0	0	0	0	0
	144	0	0	0	0	0
	288	0	0	0	0	0

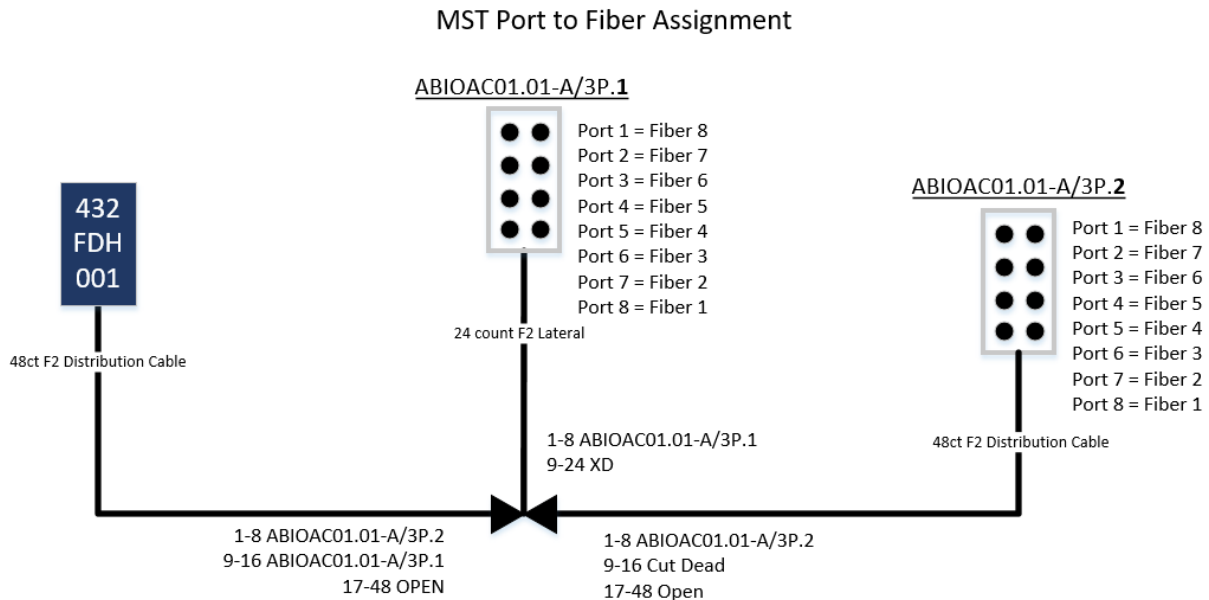
- 9. F1 and F2 cable may be proposed in the same conduit where the fill ratio allows.

Strand and Aerial Placement

1. Aerial Make Ready
 - a. The general rule for placing cable in the city will be place using the lowest cost model. All cable will be placed using aerial placement where possible unless there is a pole that needs extensive make ready. At those poles, we will drop underground for three spans and come back up to aerial. It is cheaper to place 3 spans of buried then to replace a pole and three spans of aerial. Three spans of buried is an AEP requirement.

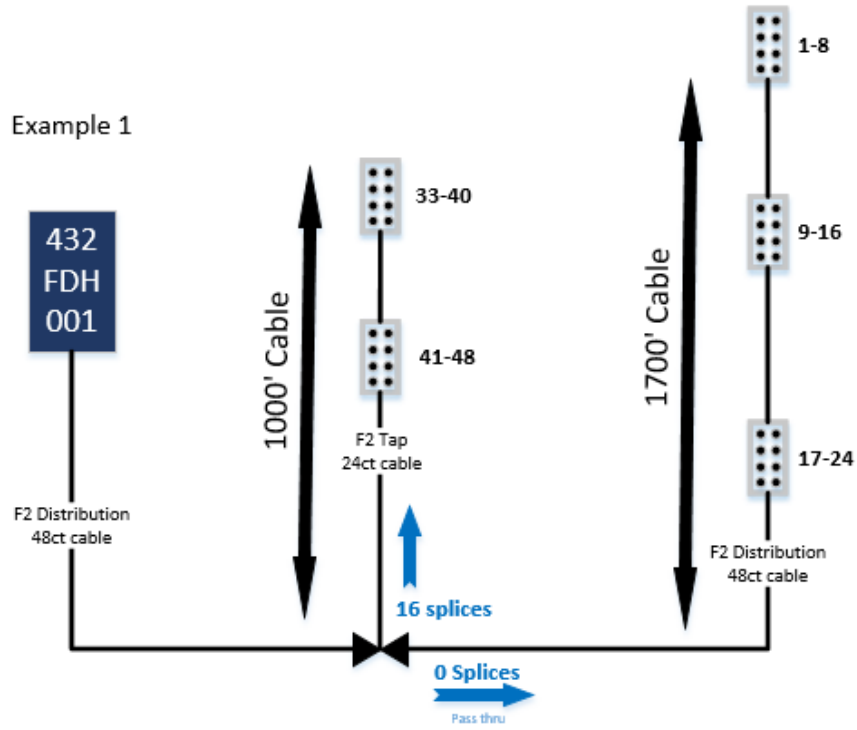
Splicing and Fiber Assignments

2. MST Ports not allocated to subscriber address will not be spliced at splice closures and will not be assigned ports at the cabinet.
 - a. Example: MST with a demand of 9 subscribers, a 12p MST should be proposed. But only 9 of the ports would be spliced and assigned at the cabinet.
3. F2 Distribution cables leaving the passive cabinet will have their fibers assigned with the first (fiber 1 – blue/blue) fiber on that lateral cable to the furthest subscriber on that F2 Cable. (see example below)
 - a. The F2 Laterals (Taps) branching from the main cable will assign the first (fiber 1 blue/blue) from that lateral, splicing to the main F2 cable picking up the lowest count available on the Main F2 cable at that splice. (see example below)

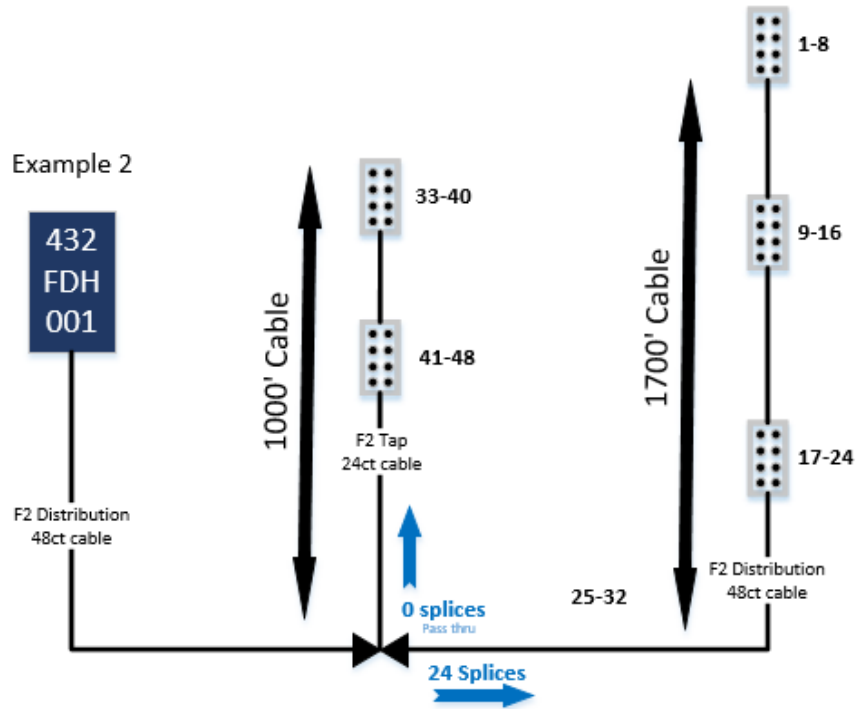


4. Aerial splice case locations should not be rear easement where possible. Splice cases must be accessible with a bucket truck for placement and operations.
5. The F2 Distribution cable leaving the cabinet should continue to the furthest MST on that lateral, this will reduce the number of splices in the lateral. Compare example 1 and 2 in the figure below
 - a. Exception is when the additional distance of high count cable exceeds the total cost of splices by greater than 10%. See Chart attached for lateral cost calculation.

Example 1



Example 2



Multiport Service Terminal (MST)

1. MST Port Sizes will be standardized to a 2, 4, 6, 8 and 12 port MST
 - a. When subscribers are greater than 8 use a 12 port MST. Do not use combinations of 2, 4 or 6 to reduce the amount of unused ports. A single 12 port is more cost effective than 2-3 MSTs placed with no unused ports.
2. MST tail footages available to design are 50', 100, 250', 500', 750', 1000', 1500', 2000.
3. Preferred MST location would be central to the drops it is serving , whether the drops are aerial or buried. See the *"Drops"* section of the guide for more information.
4. As noted in the *"Conduit and Underground Structures"* section, buried MSTs require their own conduit when placed. MST tails and sheathed fiber optic cable cannot be placed in the same duct.
5. To account for the additional footage that may be required when splicing MST Tails, the following chart should be used to determine the correct tail length for the designed route footage.

Design Route Length*†	MST Tail Length To Call Out
MST in same location as splice**	50'
50' to 74'	100'
75' to 224'	250'
225' to 474'	500'
475' to 724'	750'
725' to 974'	1000'
975' to 1474'	1500'
1475 to 1975'	2000'

*Remember to include riser footage when calculating the route distance the MST tail will travel.

**When MST is placed in the same handhole as a splice closure or MST placed aerial next to an aerial splice closure.

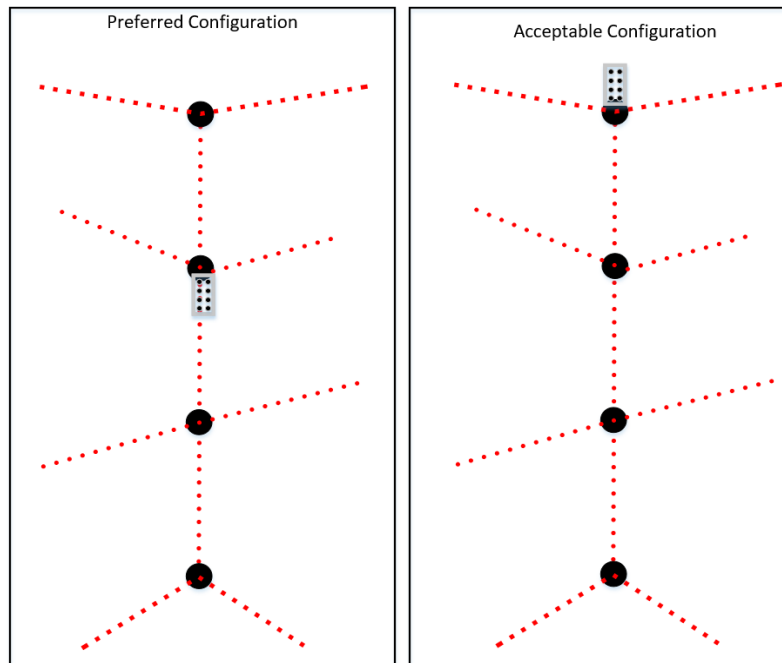
† 50' slack loop at all street crossings where the MST continues on the other side of street. This does not apply to alleys.

6. Buried MSTs should be placed inside a Pedestal (RUS unit BDO5) or Handhole locations.

7. Number of MSTs that can be pulled back to a splice closure is based on the below chart.

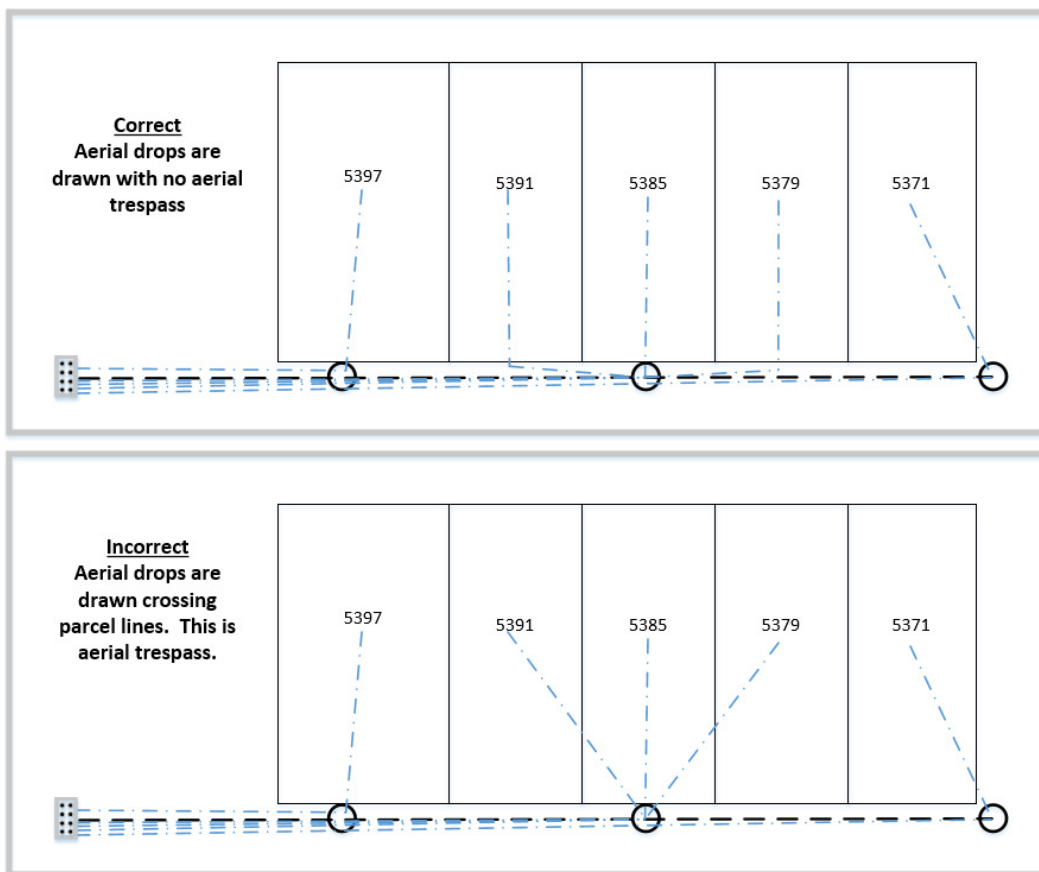
RUS Unit	Manufacturer /Model	Number of Ports	Splices per Tray	Number of Trays	Total Number of Splices	Number of Tails per port
HACO(S)	FOSC 450 A4	4	24	3	72	4
HACO(M)	FOSC 450 B6	6	24	6	144	4
HACO(L)	FOSC 450 D6	6	72	6	576	4
HBFO(S)	FOSC 450 A4	4	24	3	72	4
HBFO(M)	FOSC 450 B6	6	24	6	144	4
HBFO(L)	FOSC 450 D6	6	72	6	576	4

8. 2 MSTs may be placed at a single pole location but should be avoided where possible.
 - a. Label must be on design - 2=Double Nap
9. Aerial MSTs should be placed central to the drops it feeds. (see figure below)
 - a. In some geographies it may require a MST placed at the end of drops, this is acceptable but should be avoided where possible.



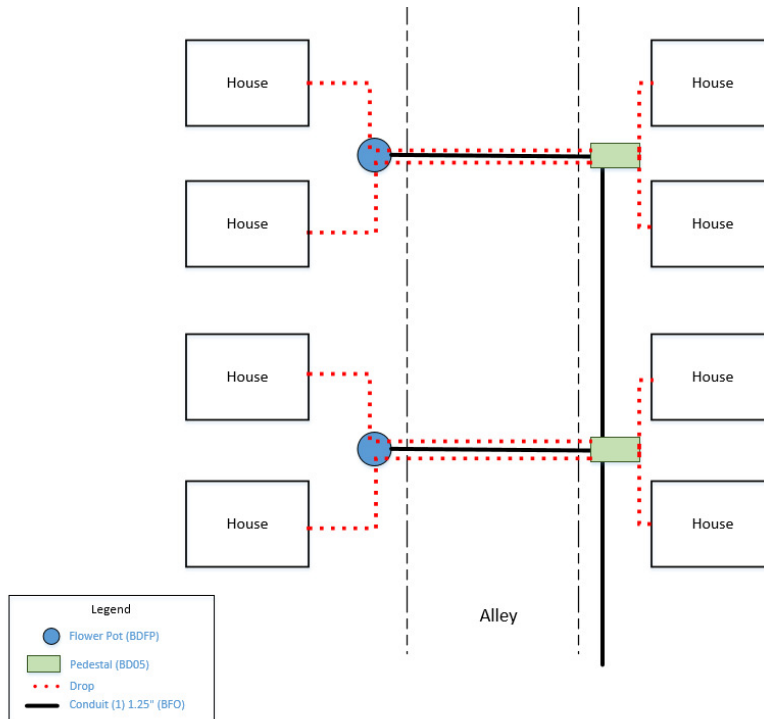
Aerial Drops

1. Aerial drops should be proposed based on existing communications or service power connectivity from pole to structure.
 - a. Aerial drops should not be proposed with aerial trespass. (see figure below)
2. If aerial drops are proposed to cross a property line, need to check for existing connectivity from pole to structure. This is to ensure there is an existing utility easement that allows for trespass.
3. Aerial drops that cross streets greater than 2 lanes should be avoided and will require customer approval.
4. Aerial drops should never be proposed to cross multiple streets.
5. Drops should not cross more than 2 pole spans in either direction.
 - a. Drop poles are not included in the 3 span total.
 - b. Exception on pole lines only feeding 1 direction when MST is placed on the end of a drop run. There are accessibly reasons a MST would be proposed at the end but should be avoided.



Underground Drops

1. Underground drop placement needs to have alleys bored to access passings on the other side of the alley which share an access point. See figure below.
 - a. Drops that cross the alley should be proposed starting at the Pedestal with the MST then crossing the alley to a flowerpot then to the structure. See figure below.



Fiber Distribution Hub (Passive Cabinet)

1. Cabinet should be proposed in public right-of-way.
2. Cabinet sizes should be proposed at approximately 90% fill, with a minimum of 75% fill.
 - a. 432 should serve 380 to 432 subscribers, with no less than 320 subscribers.
 - b. 288 should serve 255 to 288 subscribers, with no less than 215 subscribers.
3. Cabinet size availability 432 (24 F1s) or 288 (12 F1's)
 - a. 432 cabinet preferred.
 - b. 288 where it makes sense.
4. Distribution (F2) Cabinet stubs
 - a. 288= 2-144 stubs (1-144) + (145-288).
 - b. 432= 3-144 stubs (1-144) + (145-288) + (289-432).
5. FDH Cabinets shall be placed on top of a vaults (RUS unit BHF36x60x36). These locations will have a fiber marker w/test station (RUS unit BM55F) called out for locate purposes.
6. Cabinets should be proposed with the following criteria in mind.
 - a. Safety from road traffic for people placing and servicing the cabinet.
 - b. Does not obstruct the view of traffic for vehicles. At either road intersection or driveways.
 - c. Does not obstruct the view of signage.
 - d. Where possible place cabinets in general area where there are already visible utilities.
 - e. Do not propose cabinets on dirt roads.
7. In cases where there is an Interstate, body of water or multi-track railroad crossing that splits an FDH boundary, the cabinet should be proposed on the side with the largest number of subscribers. The reason being the number of F2 fibers consumed when crossing should be the least possible. Special crossings should provide the most open fibers possible for future use.

Optical Line Terminal (Active Cabinet)

1. Placement of cabinet should be proposed in public right-of-way.
2. Placement selected provides maximum protection available along with room for protection poles.
3. Determine slab size to support active cabinet only or active cabinet plus generator – open item needs to include placement of permanent generator, NTS to provide slab size.
 - a. Natural gas, diesel generator or regular gas– lets discuss
4. Cabinets should be proposed with the following criteria in mind.
 - a. Safety from road traffic for people placing and servicing the cabinet.
 - b. Does not obstruct the view of traffic for vehicles. At either road intersection or driveways.
 - c. Does not obstruct the view of signage.
 - d. Where possible place cabinets in general area where there are already visible utilities.
 - e. Do not propose cabinets on dirt roads.

Naming Conventions

1. Version numbers
 - a. Version (v1,v2, etc.) shall be when CHR sends file to NTS Pending review and any subsequent changes
 - b. FINAL shall be when NTS approves the file and sends it back to CHR
2. Detailed Desktop Design(DDD)
 - a. DWG, KMZs and PDF files
 - i. (Exchange Name)DDD_(Phase)_(Version Number)_(Date)
 1. Example: Colorado CityDDD_Phase 1_v1_1-6-2016
 2. Example: Colorado CityDDD_Phase 1_FINAL_1-10-2016
 - b. BOM
 - i. (Exchange Name)DDD_(Phase)_BOM_(Version Number)_(Date)
 1. Example: Colorado CityDDD_Phase 1_BOM_v1_1-6-2016
 2. Example: Colorado CityDDD_Phase 1_BOM_FINAL_1-10-2016
 - c. Splice Plan
 - i. (Exchange Name)DDD_(Phase)_Splice Plan_(Version Number)_(Date)
 1. Example: Colorado CityDDD_Phase 1_Splice Plan_v1_1-6-2016
 2. Example: Colorado CityDDD_Phase 1_Splice Plan_FINAL_1-10-2016
 - ii.
3. Abilene Overbuild
 - a. DWG, KMZs and PDF files
 - i. (Exchange Name)_(Serving Area)_(Phase)_(Version Number)_(Date)
 1. Example: Abilene_F1_Phase 1_v1_1-6-2016
 2. Example: Abilene_F1_Phase 1_FINAL_1-10-2016
 - b. BOM
 - i. (Exchange Name)_(Serving Area)_(Phase)_BOM_(Version Number)_(Date)
 1. Example: Abilene_F1_Phase 1_BOM_v1_1-6-2016
 2. Example: Abilene_F1_Phase 1_BOM_FINAL_1-10-2016
 - c. Splice Plan
 - i. (Exchange Name)_(Serving Area)_(Phase)_Splice Plan_(Version Number)_(Date)
 1. Example: Abilene_F1_Phase 1_Splice Plan_v1_1-6-2016
 2. Example: Abilene_F1_Phase 1_Splice Plan_FINAL_1-10-2016

