Incab

FTTH 101

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ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

PURPOSE STATEMENT / COURSE DESCRIPTION

Registered continuing education program

- FTTH 101 will teach you the core differences between ADSS in power zone versus Strand and Lash in the Comm Space.
- We will discuss the cost and install/maintenance implications for each application as well as the difference between ADSS supports and suspensions.
- We will compare ADSS and lashed aerial systems and talk about types of accessories used for each of them.
- Then you will learn about GPON Architecture and pros and cons of Centralized and Distributed Split Architecture.

LEARNING OBJECTIVES

After this class, you will be able to:

1. Explain the core differences between ADSS in power zone versus Strand and Lash in the Comm Space:
   - cost and install/maintenance implications
   - ADSS supports and suspensions
   - dampers and air flow spoilers
   - pros and Cons of a pole mount splice enclosure and a cable mount splice enclosure
2. Evaluate your options with underground cable placement
   - conduit vs direct bury; benefits, grounding
   - pros and cons of above grade level splice enclosures vs below grade splice enclosures
3. Outline the three main types of GPON architecture
   - GPON
   - concept of a centralized, distributed split, and distributed tap architecture
   - pros and cons of each

Incab University “School of Excellence in Fiber Optics”
Agenda

- Introduction and sound check
- Course Description
- Learning Objectives
- Presentation: 60 min
- Q&A (Technical questions only)
- Let’s start!

Aerial systems

Where they can be installed

ADSS in the Supply Region

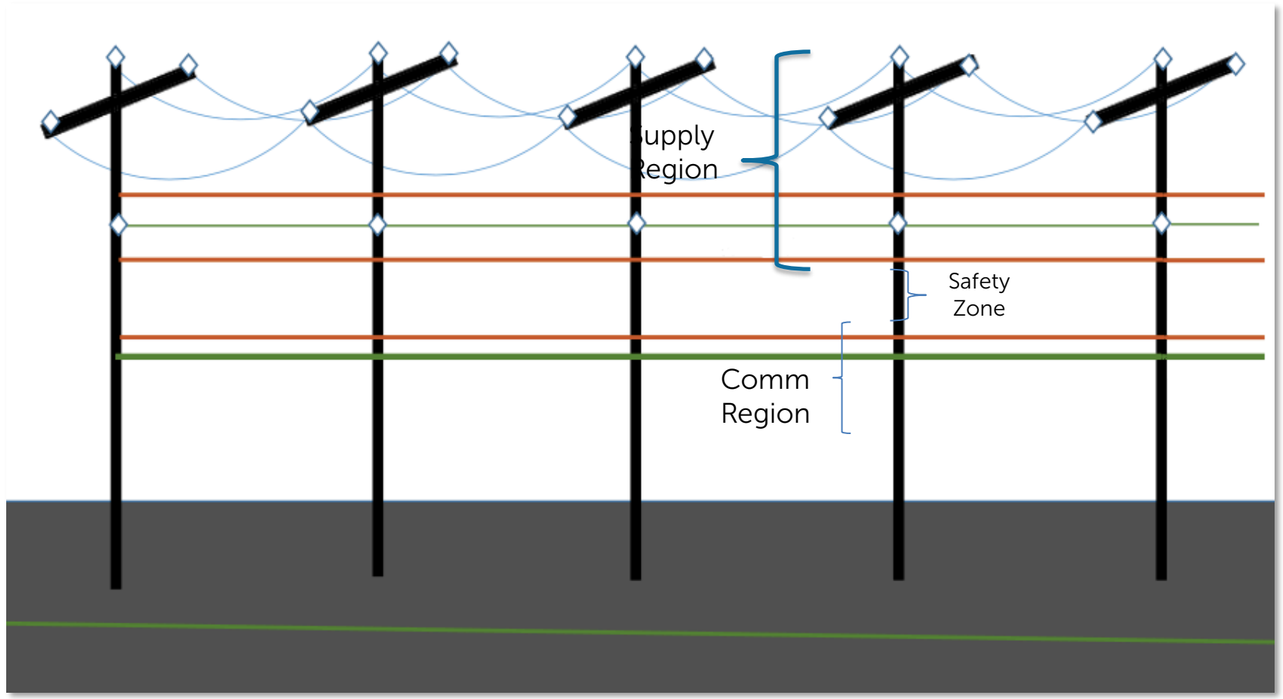
— Attachment must keep within ‘safe working practices’
— Minimum of 30” above top communication cable

ADSS or Lashed in Comm Region

— 12” between comm cables
— ADSS should be top of stack
— Must be 40” below Power Region

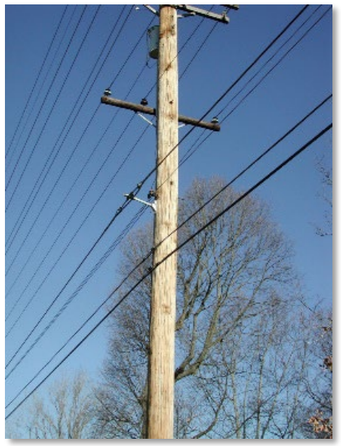
Underground

— Duct cable in conduit
— Armored cable, direct buried



ADSS in distribution supply region

Pros	Cons
Greatly reduced make-ready costs	Power utility crews are required
No Grounding	Vulnerable to shotgun damage and squirrels (Incab does offer rodent-resistant fiber)
No competing against other companies for space (Not in Comm Zone)	Sag due to ice and wind
Very low maintenance after installation	
In most cases, additional guys not needed	
Similar installation to a conductor	



Aerial systems: ADSS

ADSS require hardware designed specifically for your build

Most critical items are:

Dead-ends

Suspensions

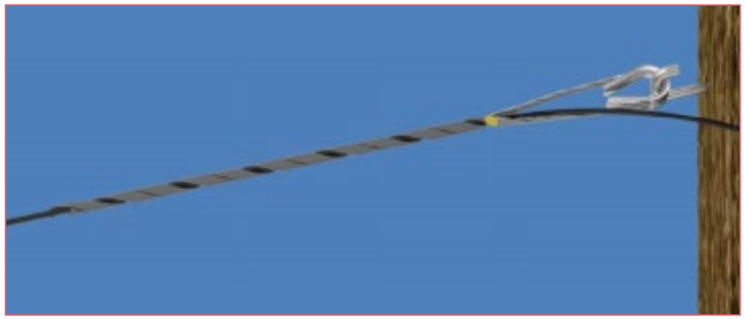
— supports
— suspensions

Motion control

Aerial systems: ADSS
Dead-ends

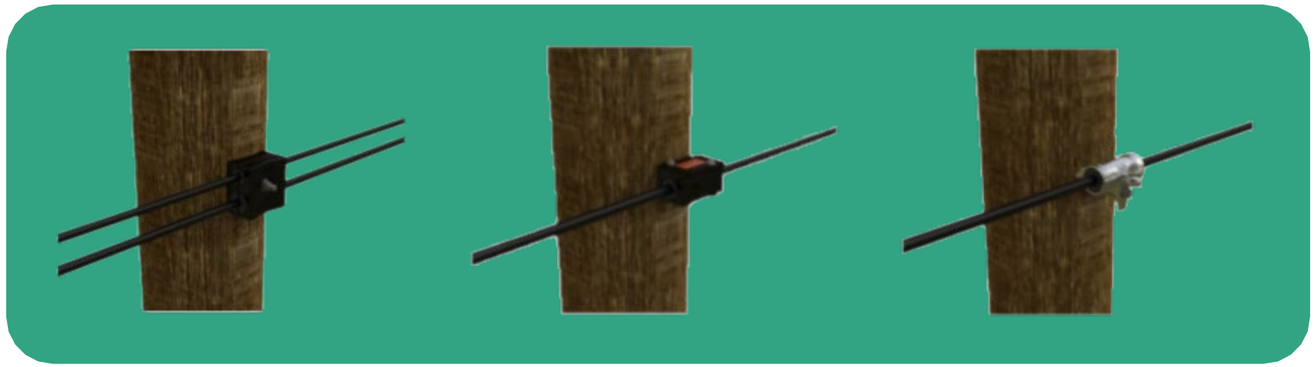
Coordinate the max rated design tension of the cable with dead-end max loaded tension

Dead-end Type	Max Span Length	Max Initial Tension	Max Loaded Tension	For Track Resistant Cables
Lite Tension Dead-end	300 ft	600 lbs	800 lbs	No
Dielectric Dead-end (Limited Tension)	600 ft	1,000 lbs	2,500 lbs	No
Dielectric Dead-end (Medium Tension)	NA	2,000 lbs	4,000 lbs	Yes
Dielectric Dead-end (High Tension)	NA	> 2,000 lbs	> 4,000 lbs	Yes



Aerial systems: ADSS
Supports

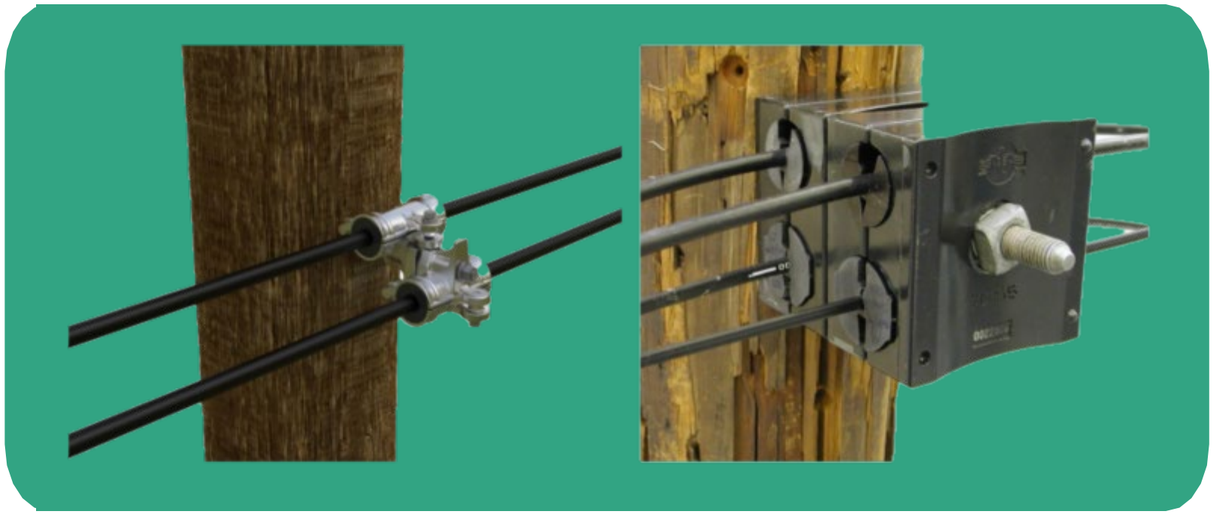
Options are:
- supports
- suspensions



Support Type	Max Span Length	Max Line Angle	Max Vertical Load	For Track Resistant Cables	Use As Stringing Block up to 10°	Multiple Cable Applications
Lite Support	300 ft	20°	1,000 lbs	No	Yes	4 cables max
Dielectric Support	600 ft	20°	1,000 lbs	No	Yes	2 cables max
Aluminum Support	600 ft	20°	1,000 lbs	No	Yes	2 cables max

Aerial systems: ADSS
Supports

- Supports give added benefit of being able to stack, thus allowing for growth



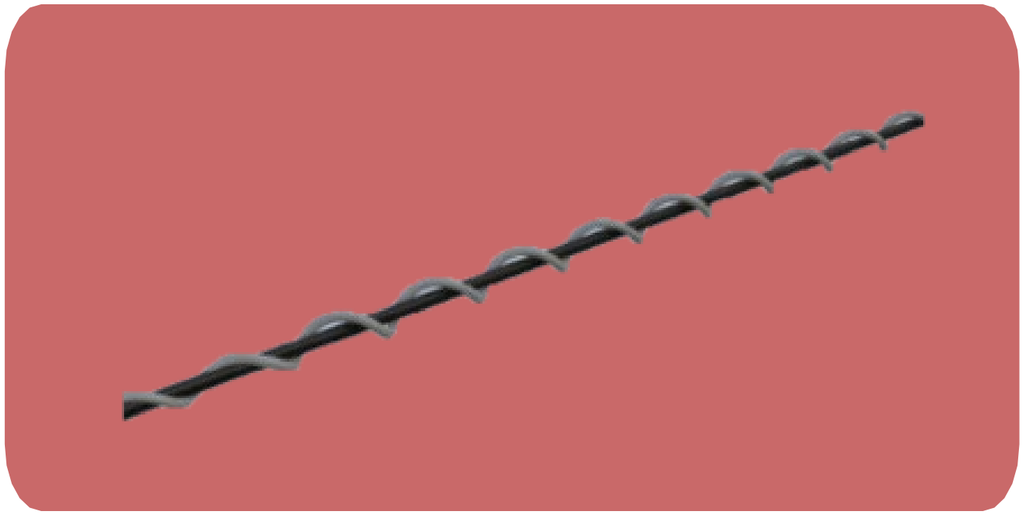
Aerial systems: ADSS
Suspensions

- Incab prefers suspensions because they allow articulation to relieve tension imbalances which can occur as a result of changes in wind and ice loading

Support Type	Max Span Length	Max Line Angle	Max Vertical Load	For Track Resistant Cables	Use As Stringing Block up to 10°	Multiple Cable Applications
Aluminum Suspension	600 ft	30°	7,000 lbs	No	No	No
Aluminum Suspension w/ Structural Reinforcing Rods	1,200 ft	30°	7,000 lbs	Yes	No	No
Dielectric Suspension	N/A	40°	15K – 25K lbs	Yes	No	No

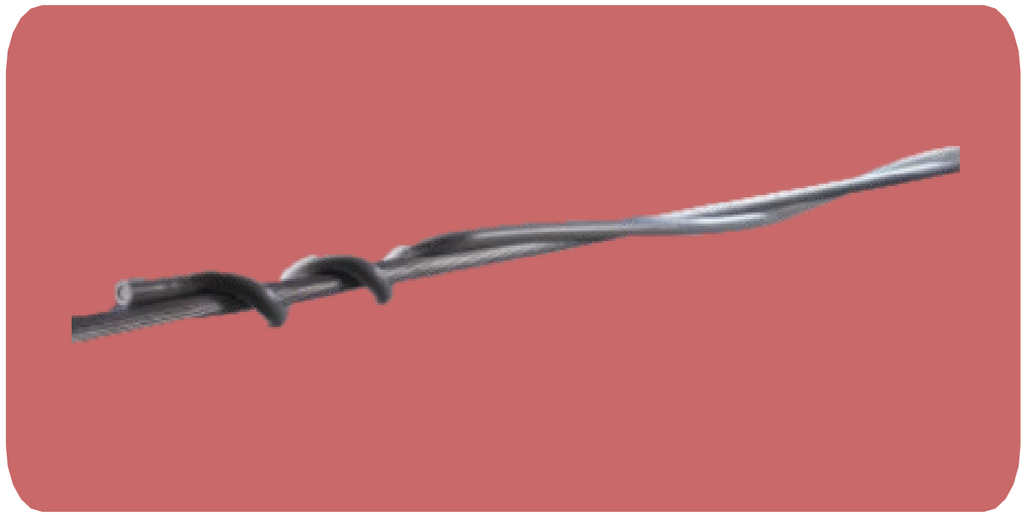
Aerial systems: ADSS
Motion control. Dielectric damper

- Combats the hardware damage caused by aeolian vibration
- Not placement sensitive
- Easy to install
  - wrap on
  - no tools or clamps
- Superior UV treatment
- Economical



Aerial systems: ADSS
Motion control. Air flow spoiler

- Combats the hardware damage caused by galloping (recommended if you have experienced galloping in the past)
- Changes cable profile
- Easy to install
  - wrap on
  - no tools or clamps
- Covers 25% of line
- Selection based on cable diameter



Aerial systems: lashed

Standard hardware for messenger cable + lashing wire

Pros	Cons
Ability to use armored cable to help with shotgun and squirrel damage	Potentially very high make-ready costs, could be $75,000/mile
Can over-lash when additional cable is needed	Higher install cost and maintenance cost
Use of Telco installation crews instead of power crews	Two step installation: messenger, then cable
	Messenger needs to be bonded to ground
	Competition for space with other Telcos
	Broken lashing, constant maintenance

Aerial systems: ADSS and lashed
Splice enclosures – pole mount

- ADSS enclosures can be pole mounted and can be paired with a slack storage bracket

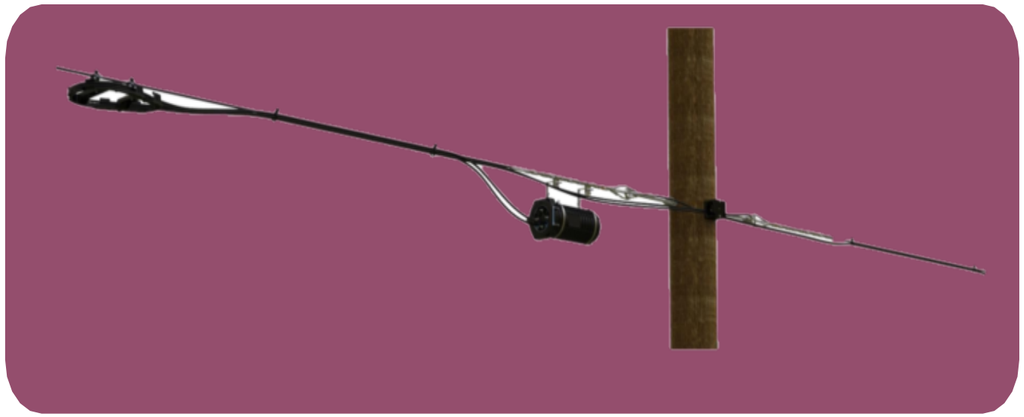
- Pole mounted cable storage:
  - Brings enclosure down below power and comm zone
  - Easy access for telco crews
  - Cable and enclosure can be dropped into a splice trailer
  - Can create an obstacle for power crew trying to climb pole

Aerial systems: ADSS and lashed
Splice enclosures — cable mount

Options:

- Butt splice enclosure
- In-line enclosure (Strand and lash)

Pros	Cons
Does not take up pole space	Use of horseshoe can make removal of cable slack difficult
	Adds a weight load onto the cable (ADSS)



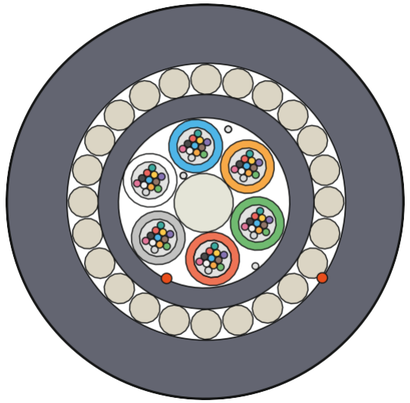
Aerial cables: damage

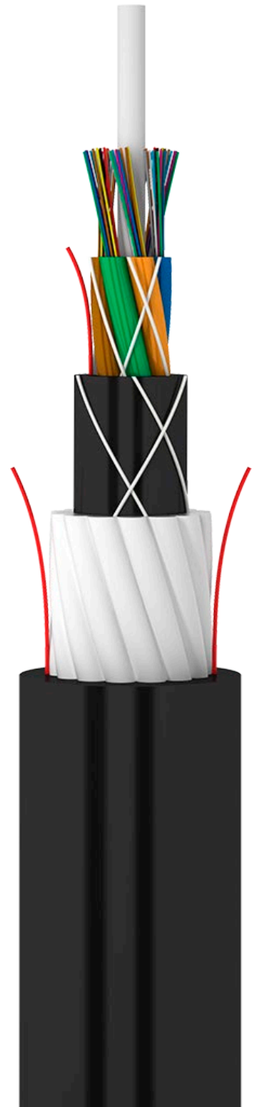
Squirrels and gunshot damage lead the way! Lightning and fire not far behind.

InAir ADSS MT FRP Defender

Multi-Tube (MT) FiberGlass Rods (FRP) Defender

- Anti-rodent additive in the outer jacket for first-line protection
- Superior protection from mechanical damage - FRP rods provide strength and second-line protection
- Completely protected from water ingress
- Designed for aerial applications of 138 kV or less where damage from squirrels/rodents is apparent

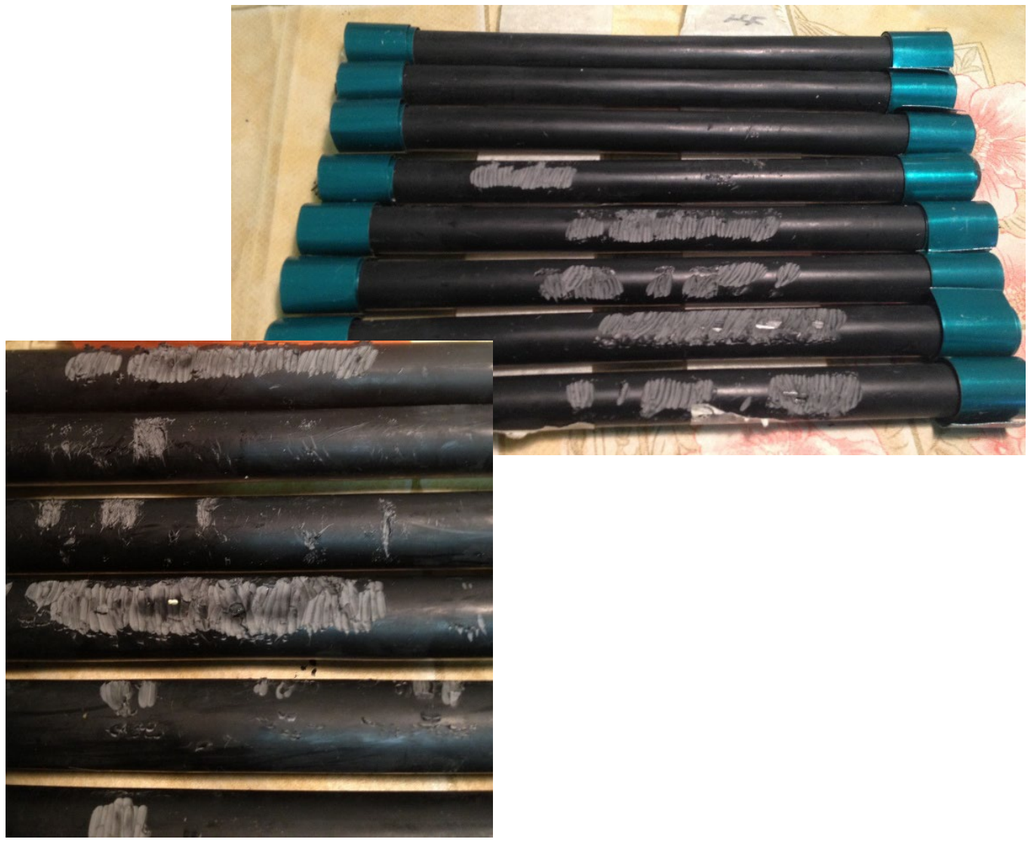




InAir ADSS MT FRP Defender

FRP rods are the best option:

Incab laboratory tests:



Underground cables

Pros	Cons
Protected from harsh weather	Shorter cut lengths, typically less than 3,000 ft (more splicing = more money)
Can joint trench in new construction	There are more backhoes than tornados!
Cleaner aesthetics	Underground damage can take longer to repair (can be lessened with micro cable/micro duct combo)
Lower chance for rodent damage	ROW easement concerns
	Vaults can fill with water, giving the potential for flooded splice enclosures
	Rocky terrain can greatly increase costs

Direct bury VS conduit

Direct Bury	Conduit
Lower overall cost	Higher overall costs
Multiple options for armor to protect cable	Conduit provides protection for cable
Will need to ground/potential to carry voltage back to electronics	No grounding necessary
Armor can be used to locate cable after install	Can use ADSS cable in duct
	Can install multiple ducts for later expansion or leasing opportunities
	Ability to utilize micro-duct to run multiple micro-cables in same conduit (more opportunity to make $$$)

Underground cables

Use of above grade level enclosure VS underground

- Above ground level enclosures allow for easy visual location in rural settings
- Easy access for technicians, eliminates possibility of getting water inside enclosure
- More susceptible to damage from machinery (or bored kids with a baseball bat)
- Pedestal price and install is typically lower cost than vault/enclosure combo

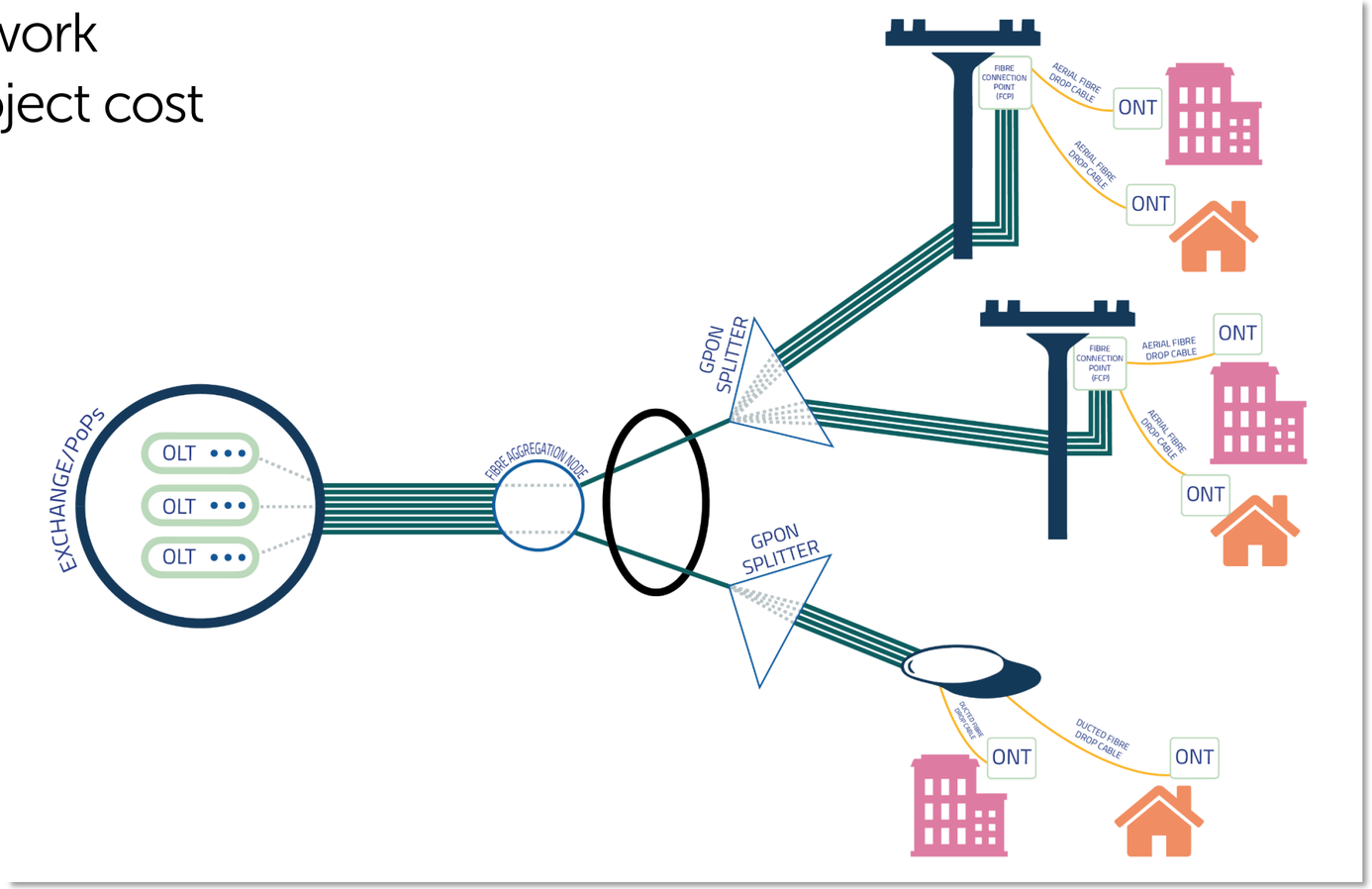
Outside the box solutions

- Round wire armor. Not popular in the US yet.
- Dielectric FRP armor. New, but gaining fans because of versatility and not having to worry about induced voltages and current.
- Some go “belt and suspenders” by putting armored cable into conduits. Be careful with induced voltages and currents. Just grounding isn’t always enough.
- Use of“Optical neutral” or “optical ground,” but these have not been popular to date. Could be a potential solution for permitting issues

GPON architecture selection

GPON: Gigabit Passive Optical Network
Its affect on cable selection and project cost

- Utilizes passive optical splitters.
- Common split ratios are 1x16 and 1x32
- Most common GPON architectures include Centralized Split and Distributed Split



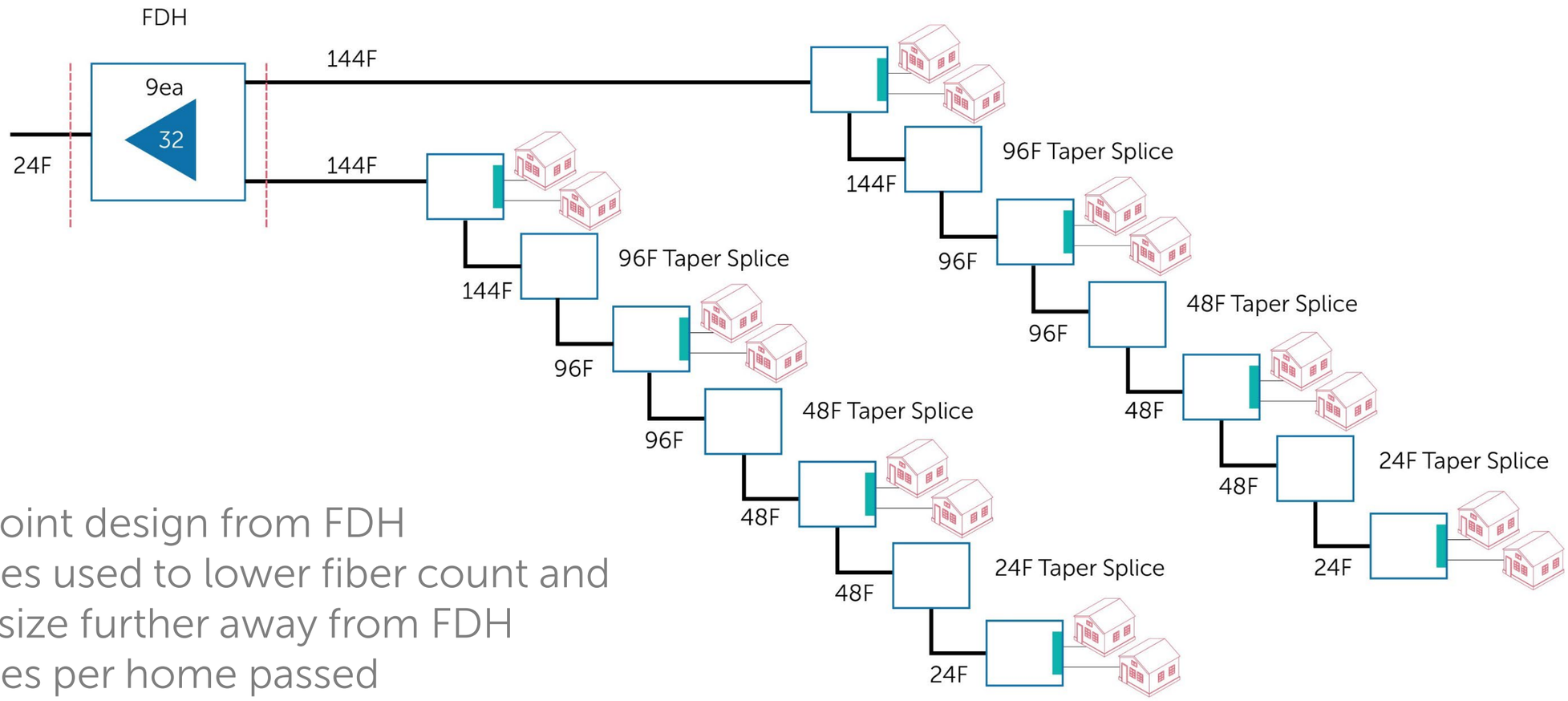
Centralized split architecture
The Basics

- Multiple splitters placed in a single location
- FDH is typically fed with a 24F. The number for FDH cabinet designates how many customers can be served via GPON
- Typical FDH sizes include 96, 144, 288, 432, 576
- Splitters are installed and connected as customer base grows
- High cost associated with use of FDH in both material and splicing $20k or more in a single FDH location

288 – FDH Cabinet

Centralized Split Architecture

The Design



- 288 FDH
- Point-to-point design from FDH
- Taper splices used to lower fiber count and enclosure size further away from FDH
- 3.25~ splices per home passed

Distributed Split Architecture
The Basics

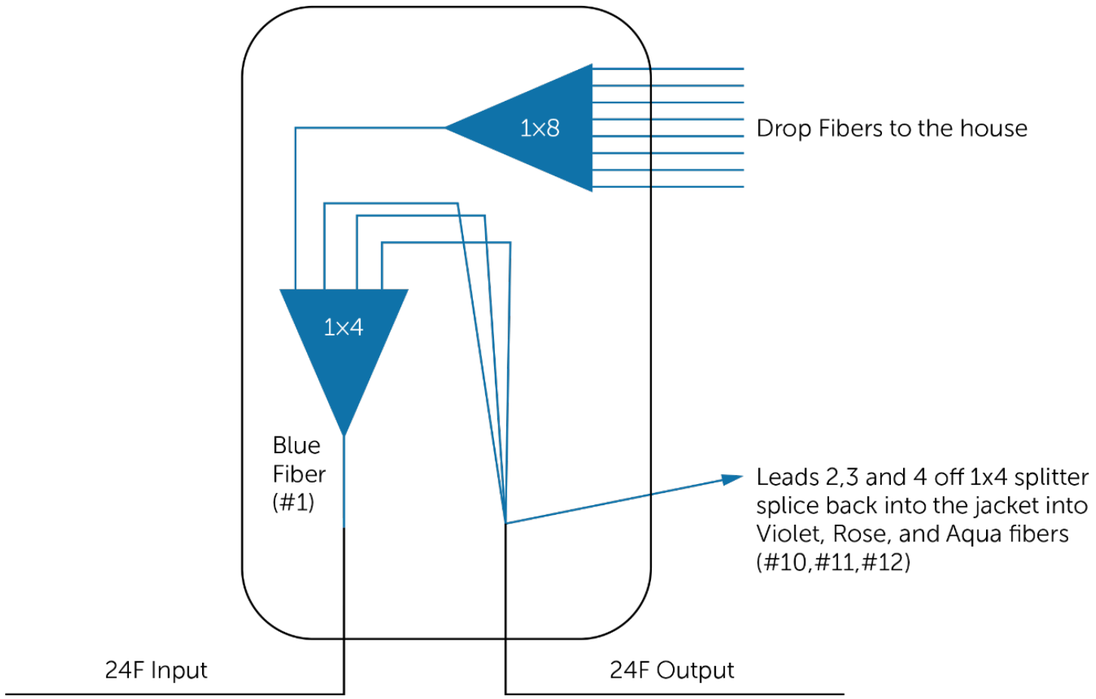
- Moves splitters away from a centralized location and into splice cases throughout the field in different combinations
- Multiple splitter combinations
- “Feeder cable” in centralized split becomes distribution cable
- Splitters are purchased and installed during initial construction
- Can reduce splicing by as much as 3 splices per home passed

Strand mount enclosure with splitter

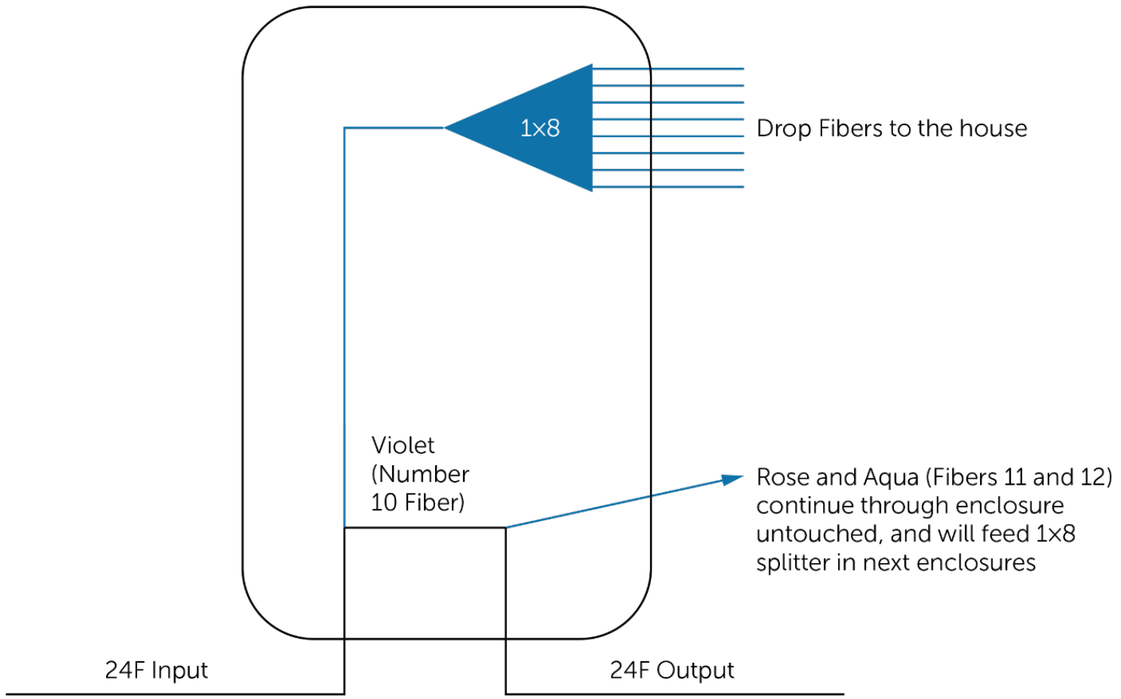
Fiber re-use for distributed split

- Reusing “dead” fibers to continue already split fibers to next enclosure allows us to reduce fiber count while still allowing for growth

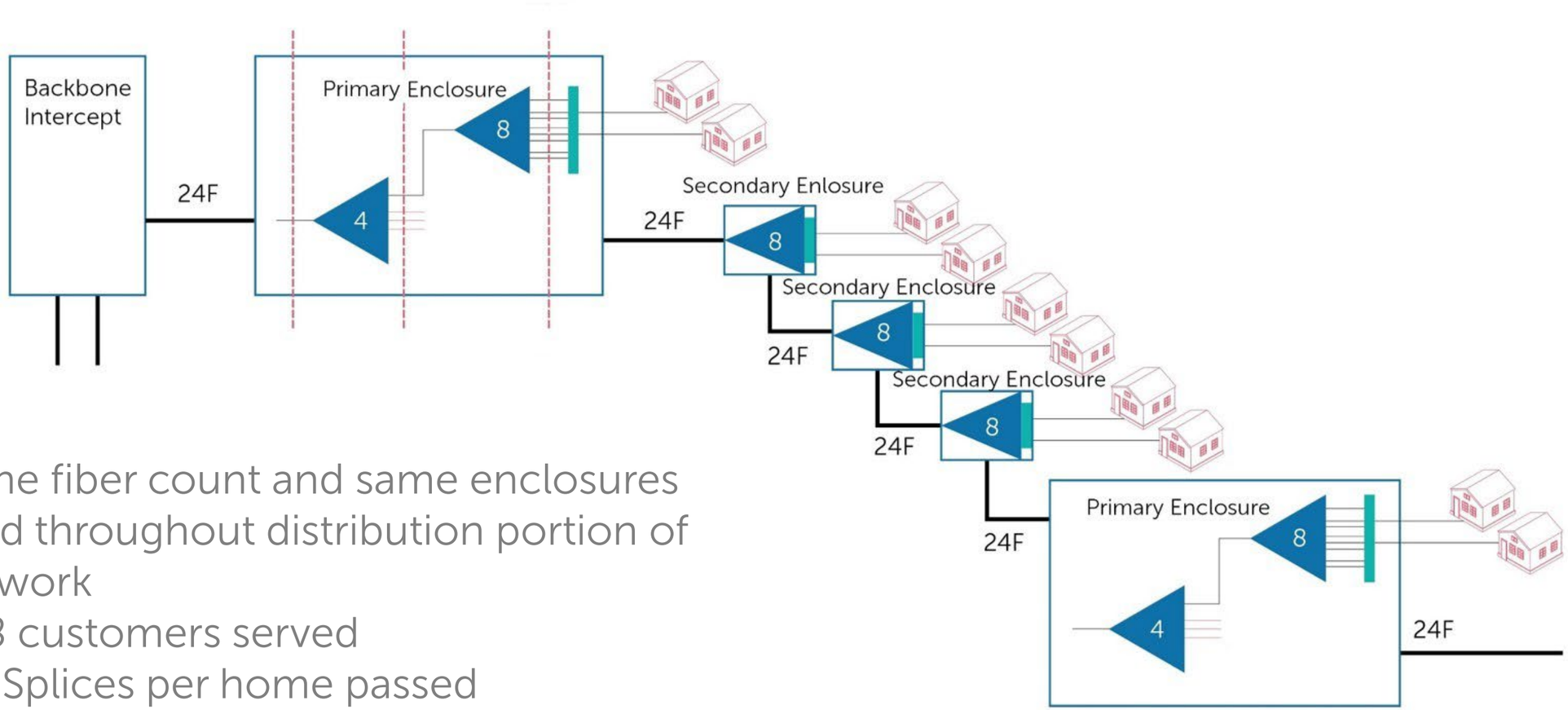
Primary Splice Enclosure



Secondary Splice Enclosure



Distributed split architecture



- Same fiber count and same enclosures used throughout distribution portion of network
- 288 customers served
- .3~ Splices per home passed

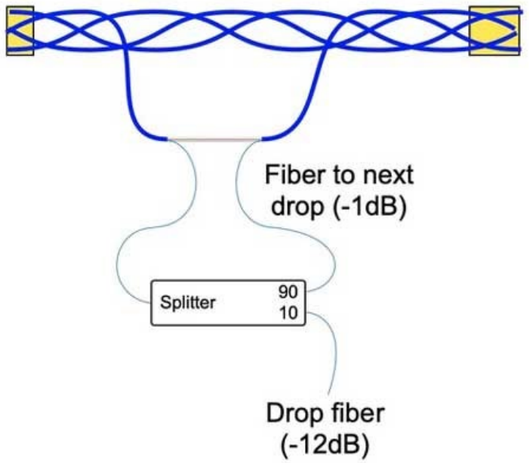
Centralized vs Distributed Split

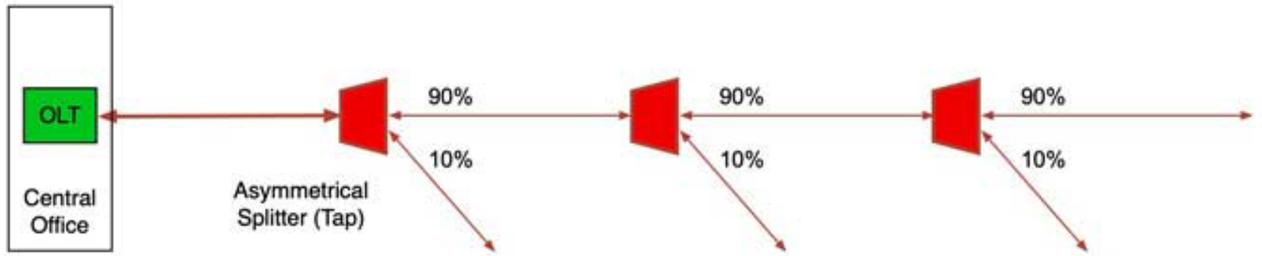
Centralized Split	Distributed Split
Requires higher fiber counts	Allows for more standardization on smaller fiber counts and smaller splice enclosures
Material cost is more expensive	Significantly reduces amount of splicing required
A lot more splicing, therefore higher cost	Requires good mapping program/record keeping
More material to inventory	Not as easy to design as centralized split
Easier to design	Must buy more splitters and OLT line cards up front
Buy splitters and OLT line cards as you go	

Distributed Tap Architecture

- Distributed tap has become more popular in rural broadband deployments, especially with use in rural electric cooperatives due to its low up-front cost.

- Instead of using symmetrical splitters, Tap architecture uses asymmetrical “taps” that bleed off a percentage of light at each tap





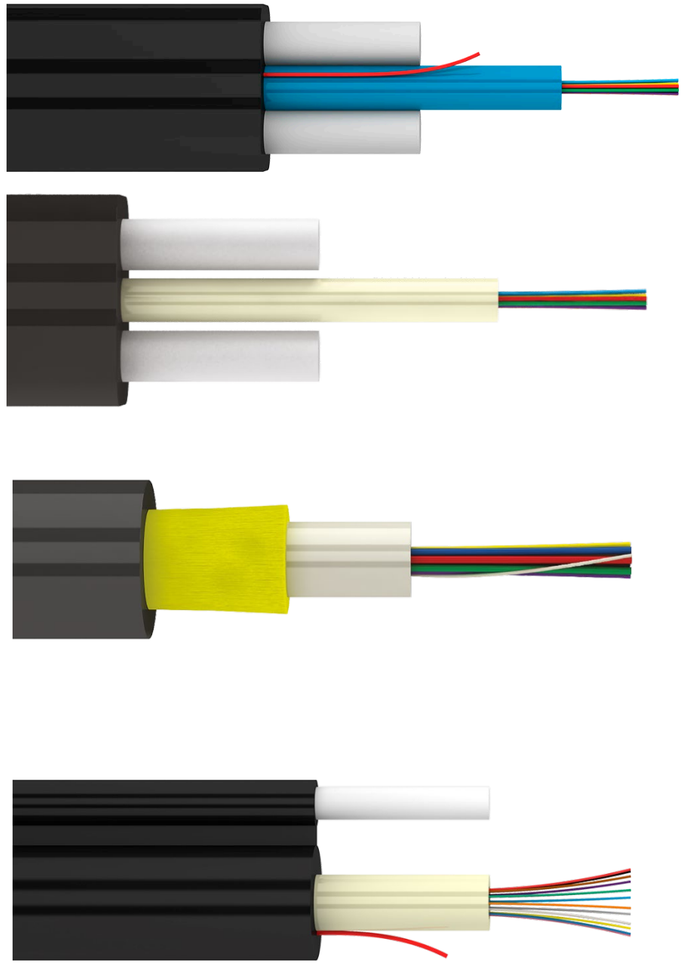
- The benefit to this design is it allows for smaller fiber counts, as each tap allows you to drop off fibers to customers and then continue down line on that same fiber, utilizing different tap percentages until you run out of light budget.

GPON Architecture Selection

	Centralized Split	Distributed Split	Distributed Tap
Cost to Deploy	High	Lower	Lowest
Fiber Density	High	Low	Lowest
Design	Simple	More Complex	Most Complex
Speed to Deploy	Moderate	Fast	Fast
Troubleshooting	Straightforward	Moderately Complex	Most Complex
Expansion	Basic	Complex	Complex
Material Management	Low amount of SKUs	Moderate SKUs	Most SKUs
OLT Port Usage	Efficient	Less Efficient	Least efficient

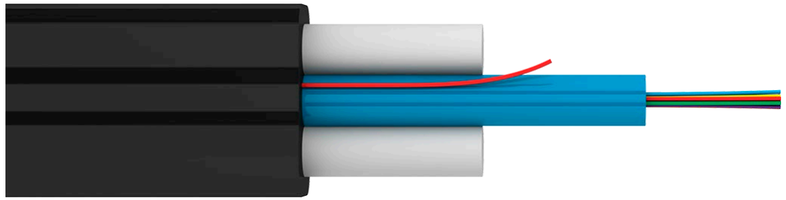
Service Drop Cables Options

- **Flat or “butterfly” drop cables** — newer design. Popular because of high strength. Aerial or UG (If aerial, what loading conditions, and how much sag?)
- **Round drop cables.** Can be armored for added protection
- **Figure 8 cables.** Great for long aerial spans. Much more rugged than a standard flat drop, and can cover up to 400ft more spans while remaining dielectric

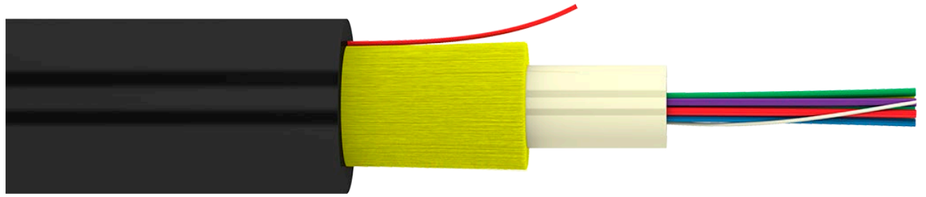


Splice On Drop or Pre-Connectorized?

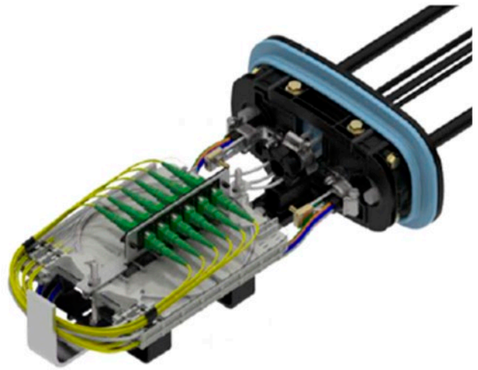
- Flat or “butterfly” drop cables — newer design
  Popular because of high strength. Aerial or UG (If aerial, what loading conditions, and how much sag?)



- Round drop cables
  Can be armored for added protection



- Hardened drop terminals and pre-connectorized drop cables
  Add substantial material cost and adds 10+ different SKU’s to inventory and manage. Consider using SCAPC adapter array in a splice enclosure



Fiber cable for FTTH: Final Thoughts

- There is no “one size fits all” approach to building fiber to the home
- Do everything you can to educate yourself on your network make sure your consultant can explain “why”
- Don’t let a consulting firm push you to a solution that you may regret in 4 years after the project is completed
- Stay away from proprietary, outside plant material
- Reach out to other utilities that have deployed fiber to the home. Many are willing to share their experiences and advice
- **Feel free to use us as a resource! We’re happy to help and make introductions!**

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Thank you!

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