

Fiber Network Design Considerations for BEAD Funded Deployments

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OFS

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> Fiber Network Design Considerations for BEAD Deployments

OFS Introduction

BEAD overview and BABA requirements.

Fiber Network design options and comparison

Designing for Future Readiness

Fiber Cabling Options

> OFS Designs, Develops, Manufactures Optical Fiber Solutions



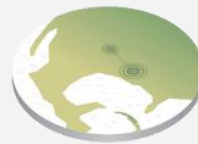
- \$1.8B Communications Solutions Business
- Supplier to leading Communication Service Providers US and Worldwide
- 600 Million KM of Fiber Manufactured since the 1970s
- Original inventor of fiber, fiber optic cable, connectivity
- Made in U.S.A solutions meet BABA – BEAD requirements



Transoceanic



Transcontinental/
Long Haul



Regional



Metro



Fiber to the
Subscriber (FTTx)

> OFS – Bell Labs Heritage – An original inventor of fiber



1958

Bell Labs patents its invention of the laser, creating the first light source powerful enough to transmit light.



1974

Bell Labs invents the modified chemical vapor deposition (MCVD) process for fabricating silica optical fibers, a major advance in optical fiber manufacture.



1975

Bell Labs invents the Biconic connector, the first optical fiber connector.

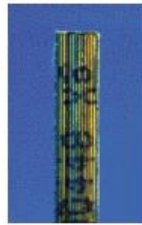


1976

Bell Labs researchers at the Atlanta facility conduct the first fiber optic telecommunications system experiment, for voice and data.

1975

Bell Labs invents ribbon fiber optic cable systems, including 12-fiber ribbon cable and the 12-fiber mechanical splice for rapid installation of high fiber counts.



1977

In Chicago, Illinois, AT&T conducts the first field trial of a lightwave system carrying voice, data, and video traffic.



1983

AT&T begins commercialized production of single-mode optical fiber.



1998-2000

Lucent introduces and patents AllWave® Optical Fiber - the world's first full spectrum fiber, enabling a 30% increase in fiber capacity.



1995

Bell Labs invents the LC Connector, a high performance, intuitive to use optical connector 1/2 the size of the SC connector.



2002-2003

OFS launches First Fully Dry Gel-Free OSP Cables meeting the Telcordia GR-20 standard, saving hours per cable end in preparation or restoration.



2008-2009

OFS introduces EZ-Bend® Optical Fiber - the first ultra bend insensitive solid-fiber and cable.



2010

OFS introduces first gel-free ADSS cable, PowerGuide® DT Cable.



2012

OFS introduces InvisiLight® Optical Solution - Living Unit Invisible Fiber Installation.



2014

Furukawa Electric launches FITEL® NINJA - handheld fusion splicer, first splicer with removable V-grooves, reducing maintenance time from days to minutes.



2015

OFS introduces the InvisiLight® MDU Hallway Solution, a virtually invisible fiber system for existing multiple dwelling/tenant units.



2016

OFS receives Emmy® Award for the "Pioneering Invention and Deployment of Fiber Optic Cable."



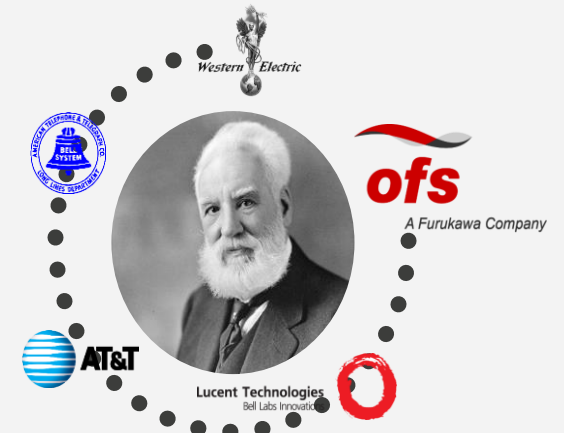
2017

OFS optical cable product lines expanded to include new Rollable Ribbon technology, doubling fiber density.



2019

OFS launches InvisiLight® ILU 600 Solution, world's first 0.6 mm surface mount fiber system.



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> U.S Govt Funding ~\$80B for Broadband and Middle Mile

Program and Federal Agency	Administrator	Funding	Timeframe
Capital Projects Fund (CPF), State and Local Fiscal Recovery Fund (SLFRF) Dept of Treasury	States and U.S. territories	\$10B CPF \$8B SLFRF	21 – 26
Rural Digital Opportunity Fund (RDOF) FCC	Federal (FCC)	\$9.2B (\$3B in default). \$11.2B phase 2?	21 – 28
Enhanced A-CAM Fund FCC	Federal (FCC)	\$13.5B over 10 years	24 - 33
ReConnect USDA	Federal (USDA)	~\$700M/yr	Ongoing
Tribal Broadband Connectivity NTIA	Federal (NTIA)	\$3B	22 - 27
Middle Mile Grant NTIA	Federal (NTIA)	\$1B+\$700M match (awarded May 2023)	23 - 27
Broadband Equity Accessibility and Deployment (BEAD) NTIA	States and U.S. territories	\$42.45B +25% match (~\$61B estimated with over-match)	25 - 30

Source: <https://www.cartesian.com/bead-program-framework/>

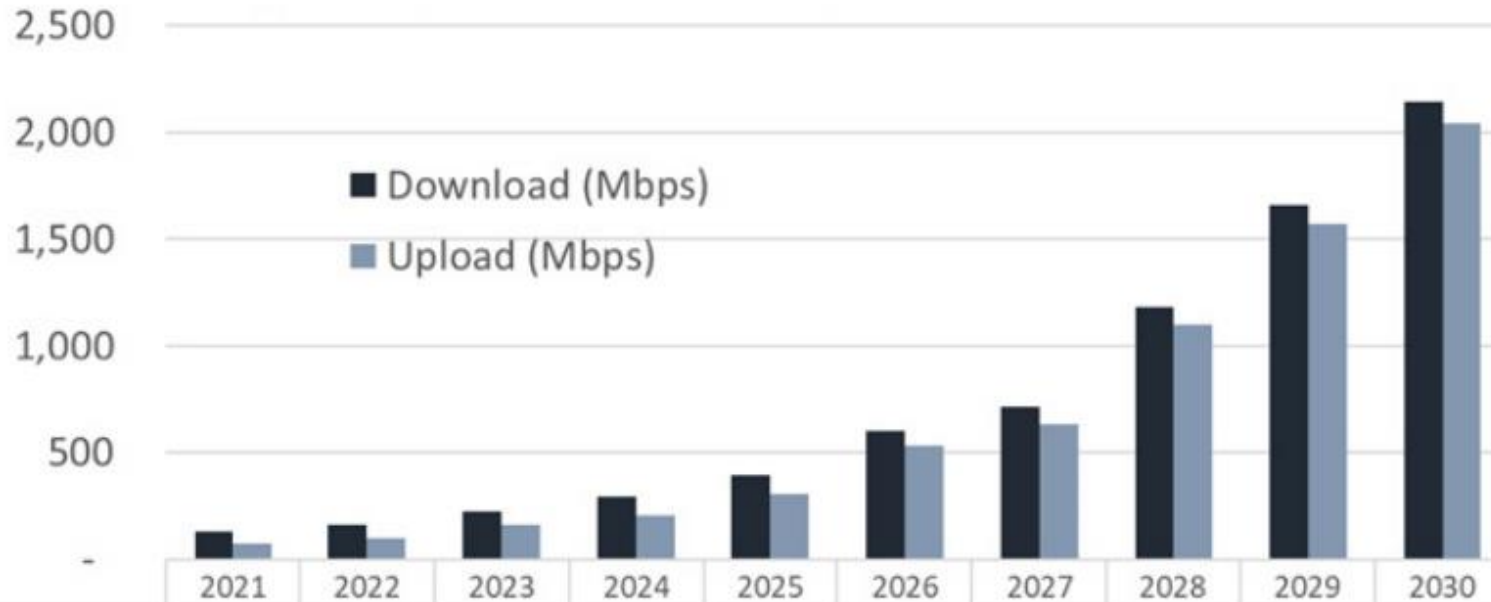
> BEAD Program

- \$42.45B to bring high speed internet to ~7M unserved/underserved homes and institutions.
 - Requires at least 25% matching funds
 - Design, engineering, broadband equipment, fiber cabling/duct/hardware, labor.
 - *Not eligible: Operating Expenses*
- All 50 states + 6 U.S. territories
- Fiber to the Home preferred, other technologies eligible
- Must meet the Build America Buy America requirements for the BEAD program

Consult NTIA and Each States Notice of Funding Opportunity for more Information

➤ Why Fiber? Demand Heading Toward Multi-gig Symmetrical

PROJECTED PEAK BANDWIDTH REQUIREMENTS - HOUSEHOLD OF 4



■ Download (Mbps)	131	158	222	293	396	601	709	1,182	1,658	2,141
■ Upload (Mbps)	73	98	160	203	302	529	633	1,100	1,570	2,044

- Does not include Robotics
 - Early adopters, Radiologists, Power Users/Gamers, others may require much more

Source: Fiber Broadband Association Technology Committee

FBA TECHNOLOGY COMMITTEE BANDWIDTH DEMAND FORECAST

2040		
15%	23%	30%
8,660	16,966	29,510
8,223	16,198	28,174

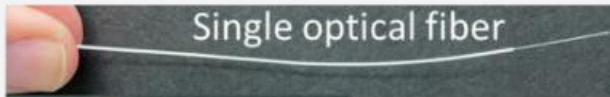
> Fiber Offers Unmatched Capacity and Lowest Latency

Speeds - bits per second

How much information per second

Video/AR/VR/MR/3D

- 600 Tbps (600,000 Gbps) capacity on one fiber
 - Full Spectrum
 - Capacity known today, may increase
- 60,000 times today's widely deployed 10 Gb/s
- 20,000 times what might be needed in 2040
- >1000 times any other technology

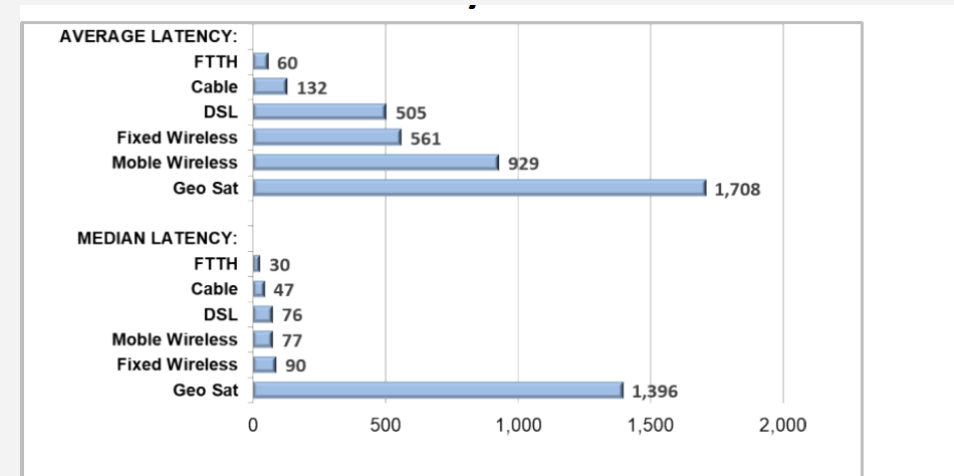


Latency - milliseconds

Reaction time

Gaming/AR/MR

- 2 times faster than HFC/Cable
- 3 – 9 times faster than Wireless



Source: RVA Inc 2023

[Source: Fiber Broadband Scalability and Longevity white paper](#)

fiberbroadband.org/research-and-resources.

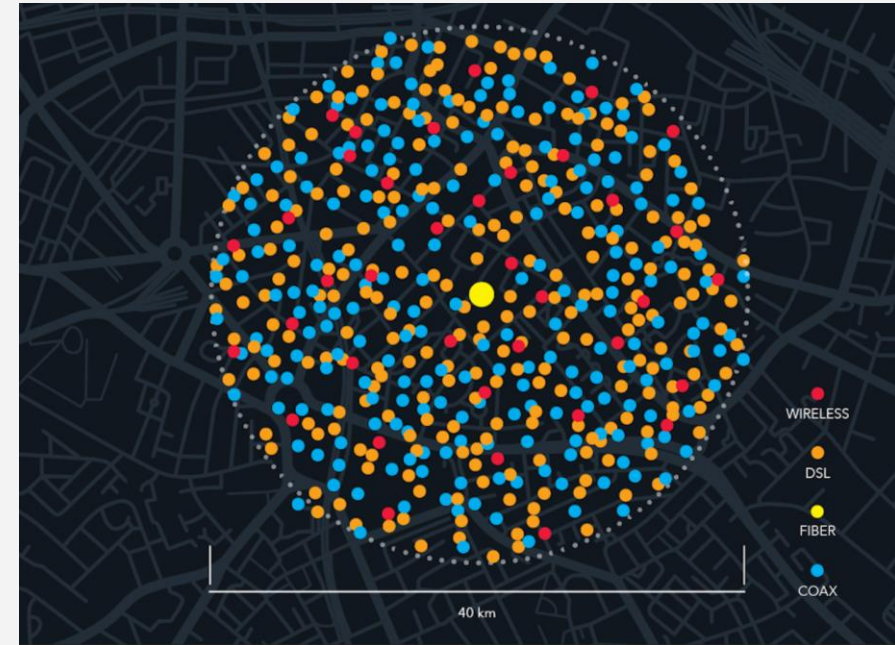
> Fiber is Scalable With no Outdoor Changes

Fiber

- 40 KM area covered from one point (central office)
- Upgrades in the central office and at the subscriber
- Lower Opex through fully passive outdoor infrastructure
- Capacity of 600,000 Gb/s per fiber

Other Technologies

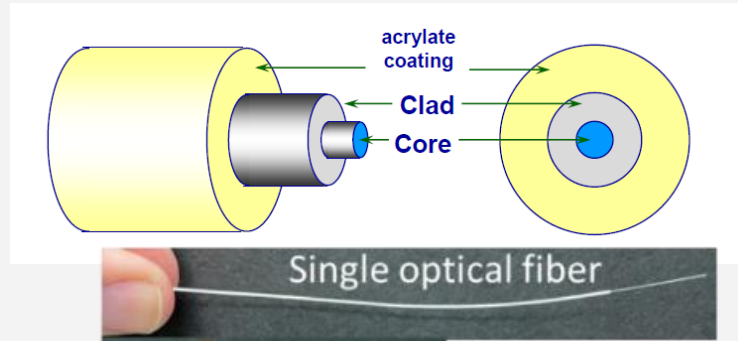
- ~0.2 – 2 KM covered by each outdoor powered node
- Upgrades in CO, at the subscriber, **and at many points in the outdoor infrastructure.**
- Higher OPEX, greater power required, less resilient.



[Source: FBA Access-Network-OpEx-Analysis-White-Paper.pdf](#)

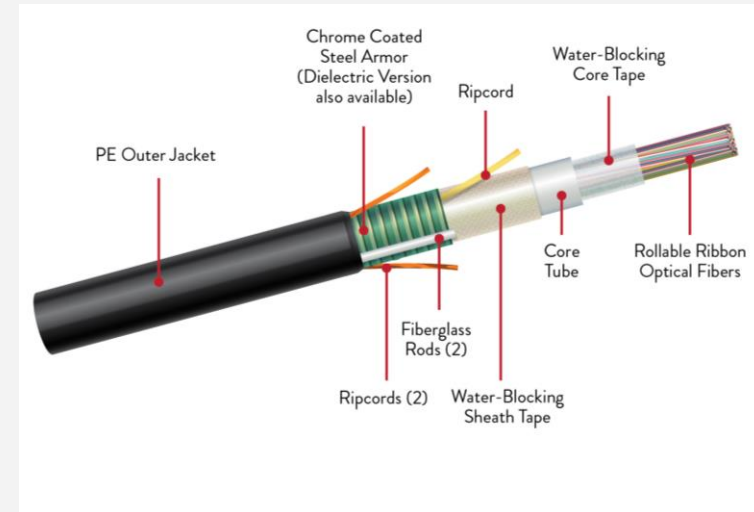
[Source: Fiber Broadband Scalability and Longevity white paper](#)
fiberbroadband.org/research-and-resources.

> Fiber is Built to Last With No Known Expiration Date



Fiber

- Super pure glass 10X stronger than steel
- Core is “doped” to carry the optical signal
- Coatings protect the glass from damage
- 50 years of technology development



Fiber Optic Cable

- Fiber housed in protective elements
- Made to withstand installation and environment
- Below grade and aerial
- PE outer protective jacket material 100-year history

Fiber Proven Across Oceans, Continents, and to Homes Since the 1980s

➤ BEAD Funding Subject to Domestic Procurement Preference

What is subject by the BABA for BEAD Rules?*

Construction Materials and Manufactured Products permanently incorporated into the Broadband Network Infrastructure.

FTTH example:

Active FTTH Equipment

- OLT and ONT

All infrastructure between the OLT and ONT

- Fiber optic cable including the optical fiber inside the cable, with or without connectors added.
- Enclosures, Cabinets, Terminals, Handholes
- Strand and Lash materials and other cable attachments.
- Etc.

* Please see the full ruleset here:

[National Telecommunications and Information Administration Limited General Applicability Nonavailability Waiver of the Buy America Domestic Content Procurement Preference as Applied to Recipients of Broadband Equity, Access, and Deployment Program](#)

[BEAD Waiver FAQs](#)

Demonstrating Compliance NTIA BABA for BEAD

NTIA's framework for BABA self-certification and compliance is broken down into two main components:

- 1. Self-Certification:** Manufacturers, at the risk of federal penalty, can choose to certify that certain equipment they produce meets the domestic manufacturing requirements described in the BEAD BABA waiver. The Department of Commerce (DOC) will host a BEAD BABA Self-Certification page listing manufacturers that have completed the certification process. Instructions for how to add your company's BABA-compliant equipment to the list can be found under the ["Approved Waiver" section on the DOC BABA page.](#)
 - Manufacturers are not required to self-certify. The Self-Certification list is a voluntary mechanism to limit fraudulent claims of BABA compliance.
 - In the coming weeks, NTIA will release the first version of the Self-Certification list. This list will be updated on a regular basis.
- 2. Compliance:**
 - [Manufacturer's BABA certification letter:](#) Manufacturers are required to provide a BABA certification letter to a subgrantee for equipment that requires domestic production in the BEAD BABA waiver. Subgrantees are required to maintain this certification letter in the event of an audit. More information about the manufacturer certification letter can be found at the [BBUSA BABA Compliance and Self Certification page.](#)
 - [Waiver Reporting:](#) Subgrantees will be required to report certain information on finished waived electronics used in BEAD deployments. This information will be used to better understand the electronics used in domestic broadband deployments, including the specific types of equipment, their ubiquity, and their country of origin.
 - Information on the specific reporting requirements that NTIA will require subgrantees to track for finished waived electronics can be found at the [BBUSA BABA Compliance and Self Certification page.](#)

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[Demonstrating Compliance](#)
[NTIA BABA for BEAD](#)

> BEAD Vendors Must Self Certify BABA Compliance

NTIA Website

https://www.commerce.gov/sites/default/files/2024-07/BABA_Self_Certification_List.PDF

Companies that have certified specific equipment they make complies with the Buy America requirement for the BEAD Program:

OFS Fitel

<https://www.ofsoptics.com/babaa-for-bead-compliant-products/>

OFS is a Vertically Integrated Manufacturer of Optical Fiber, Fiber Optic Cable, and Connectivity

<https://www.ofsoptics.com/babaa-for-bead-compliant-products/>

The following listed products are available in BEAD compliant versions upon request. [Contact OFS](#) directly to order a compliant version.

Categories

- Optical Fiber**
Single-Mode & Multimode Fiber
- Fiber Optic Cable**
OSP, Premises Cordage Cable, Connectorized & Jumpers
- Enclosures**
Wall Units, POE & Accessories

Manufacturing Locations Legend

- Norcross, GA: Optical Fiber
- Carrollton, GA: Fiber Optic Cable, Enclosures
- Canover, NC: Enclosures
- Sturbridge, MA: Optical Fiber
- Brownwood, TX: Fiber Optic Cable

Searching for a compliant product? Look here!

Product Family	Long Description	Material / Comcode	Material Description	Availability	Manufacturing Locations
Central core fiber optic cable	AccuRoll - fiber: SM AllWave+ ZWP [G.657.A1]	C00-001-232-B285-B	AT-3GE8Y3X-288	Available	Norcross, GA Carrollton, GA
Central core fiber optic cable	AccuRoll - fiber: SM AllWave+ ZWP [G.657.A1]	C00-001-325-B285-B	AT-3GE8Y3X-360	Available	Norcross, GA Carrollton, GA
Central core fiber optic cable	AccuRoll - fiber: SM AllWave+ ZWP [G.657.A1]	C00-001-233-B285-B	AT-3GE8Y3X-432	Available	Norcross, GA Carrollton, GA
Central core fiber optic cable	AccuRoll - fiber: SM AllWave+ ZWP [G.657.A1]	C00-001-323-B285-B	AT-3GE8Y3X-576	Available	Norcross, GA Carrollton, GA
Central core fiber optic cable	AccuRoll - fiber: SM AllWave+ ZWP [G.657.A1]	C00-001-308-B285-B	AT-3GE8Y3X-720	Available	Norcross, GA Carrollton, GA
Central core fiber optic cable	AccuRoll - fiber: SM AllWave+ ZWP	C00-001-289-B285-B	AT-3GE8Y3X-864	Available	Norcross, GA

> BEAD Program Status (as of 1/9/25)

Funding obligated to all 50 states + 6 Territories

23 states have issued RFPs to date, 3 have announced awards

Louisiana

- \$748M, 95% to FTTH, 23 service providers

Nevada

- \$553M, 80% to FTTH, 19 service providers

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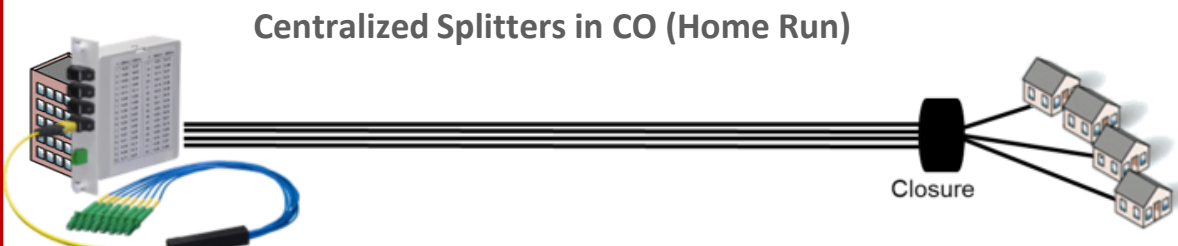
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Fiber Cabling Options

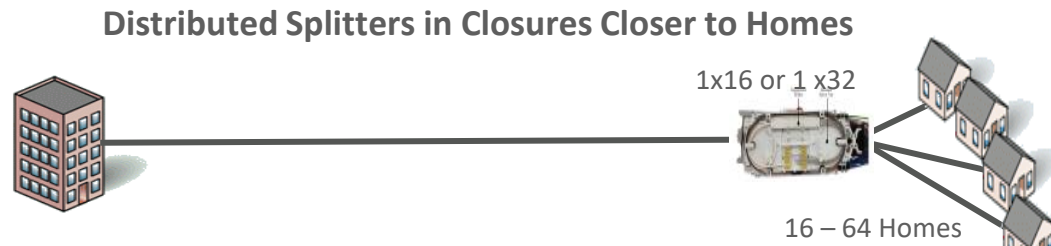
> Design Impacts to Consider

Centralized Splitters in CO (Home Run)



- Homes <1km (3-4kft) from the CO
- Higher total cost with longer distances and high take rates

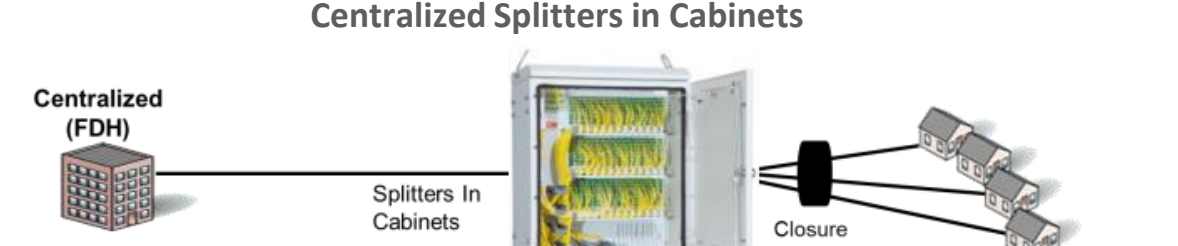
Distributed Splitters in Closures Closer to Homes



- Lower cabling costs
- Higher OLT cost with low take rates
- Lower total cost for most areas


Lower Complexity

Centralized Splitters in Cabinets



- Lower OLT costs with low take rates
- Cabinet cost and distribution cabling cost
- Higher total cost for low density areas

Distributed Cascaded Splitters Closer to Homes



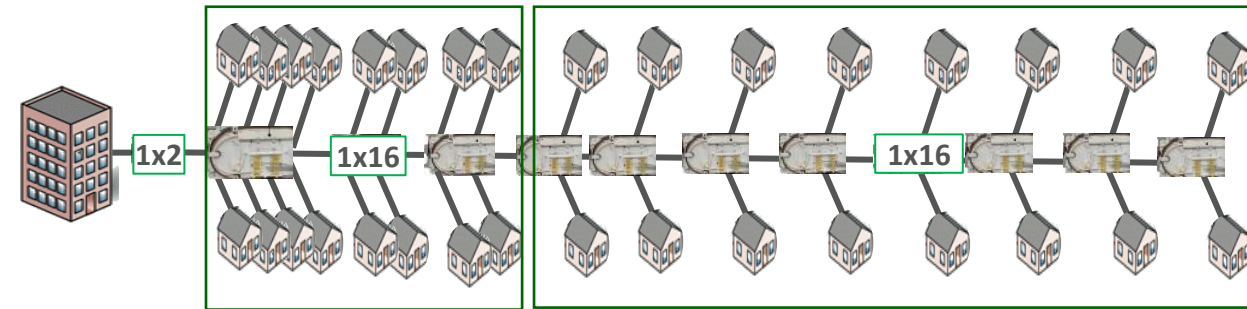
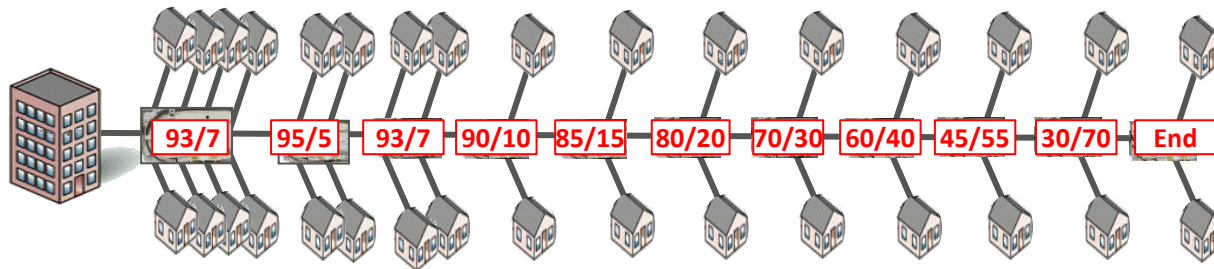
- Lower cabling costs
- Higher OLT cost with low take rates
- Lower total cost for low density areas

All above utilize balanced splitters, which are widely available

➤ Balanced Splitter Design Uses 1 or 2 Splitter Part Numbers vs. 11 for Unbalanced Splitter Design

Un-balanced Splitters – different power from each leg
i.e. Distributed Tap

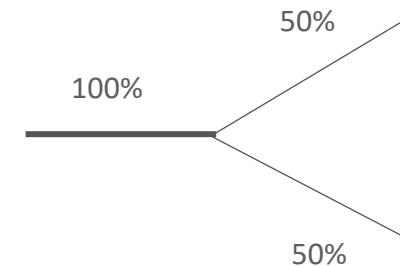
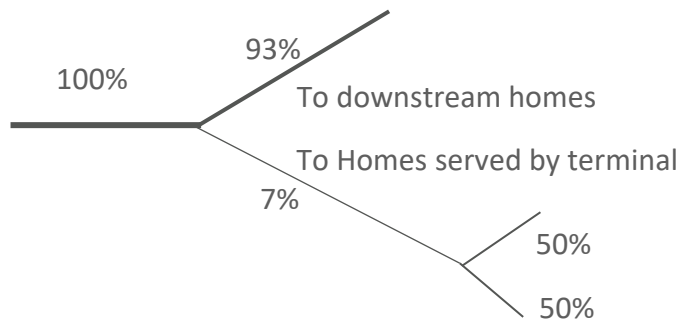
Balanced Splitters – same power from each leg



Unbalanced splitter ratio

(10 different unbalanced splitter terminals this example + 1 end terminal)

Lower complexity, lower cost



> Balanced Splitter Design Can Save \$30 to \$80 per Home Passed

Unbalanced Split (Tap) Design typically more expensive

Larger, more expensive closures

Splitters themselves are more expensive

Sweet spot – 1x2 and 1x16

Smaller number of splitters

Balanced vs. specialized unbalanced splitters

Can use re-use 12 fiber cables

12 fibers can support up to 384 homes passed

Other split ratios

1x32 – Can be less expensive in more densely populated areas

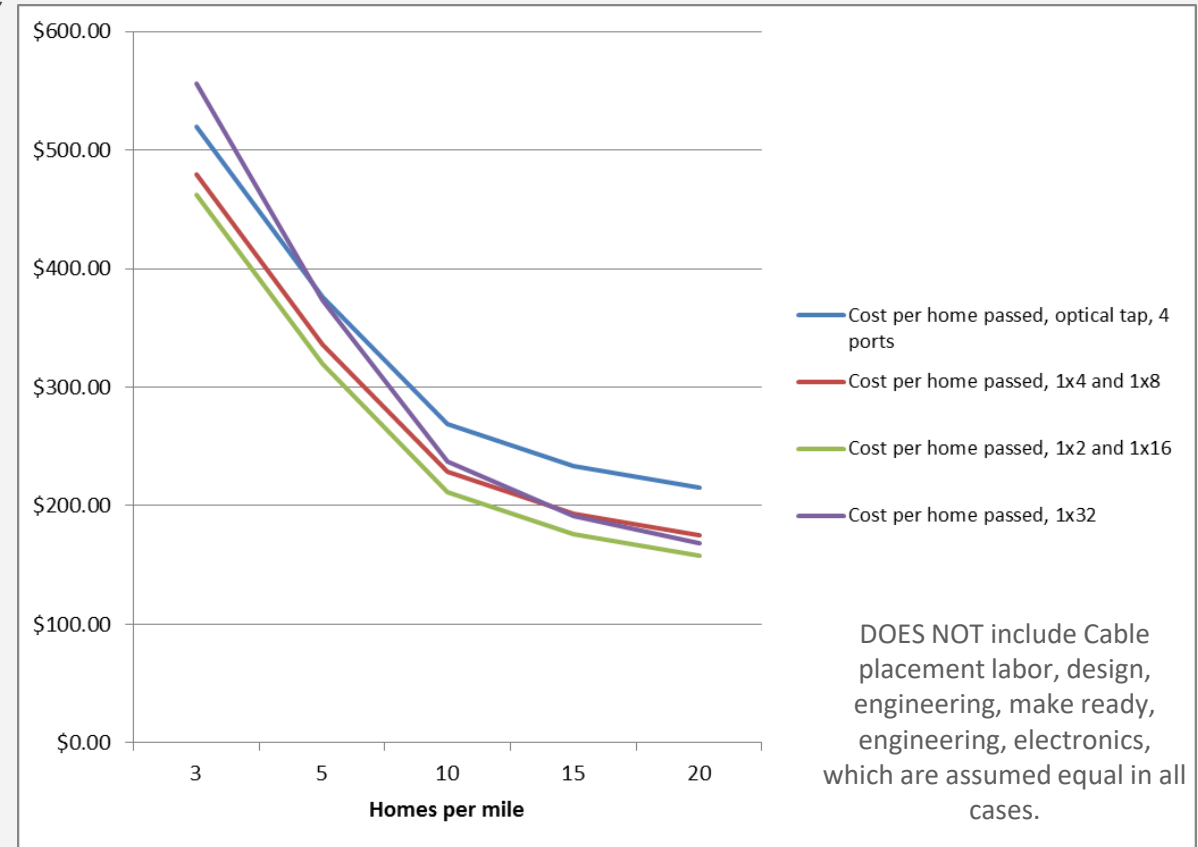
Partially offset by need for 24 fiber cable to reuse fibers

1x4/1x8 (and vice versa)

Can re-use 12 fiber cables

Increases splitter number, which increases cost

Cost per Home Passed for Cable, Splicing, Splitters, Closures



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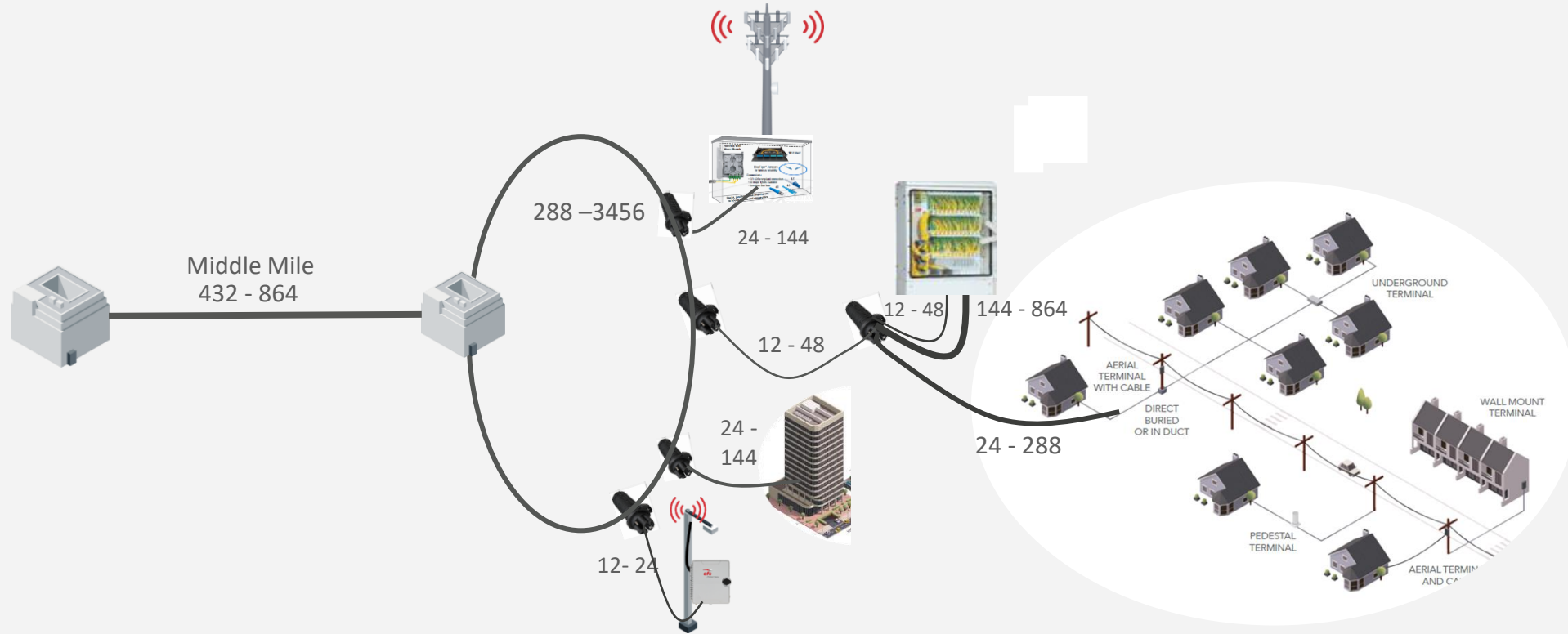
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> Fiber Counts Increasing – Design for the Future

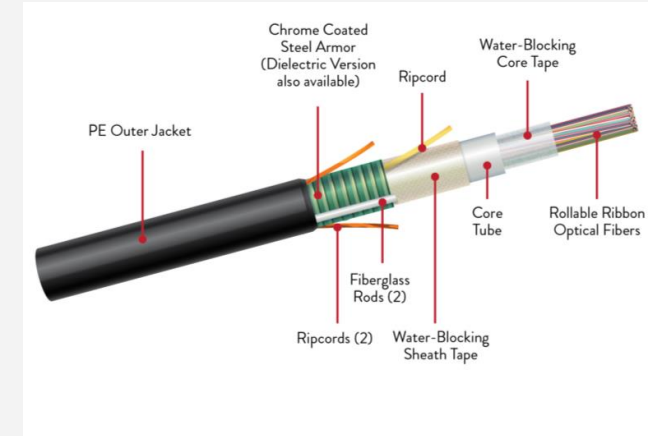


Increasing Bandwidth Demand

Artificial Intelligence

➤ Upsize Fiber to be Future Ready – And Reduce Fiber Counts/Complexity

Application	Count
Core internal backbone	2-12
FTTH backbone	2-12
Sensors, switches, cameras, etc.	1-2/each
Community needs?	36-48 or more
Leasing/Dark Fiber	??
Mobility	Up to 12 per small cell per 750 ft
FTTH distribution	12 - 24 – distributed splits, higher for centralized splits
Spare	36-48?



- Fiber itself is inexpensive
- \$1000s/Home Passed to engineer/install cable
- Middle Mile 432 - 864
- Many Rural Providers Standardize on 144 or 288
- OFS can help size fiber counts for your needs

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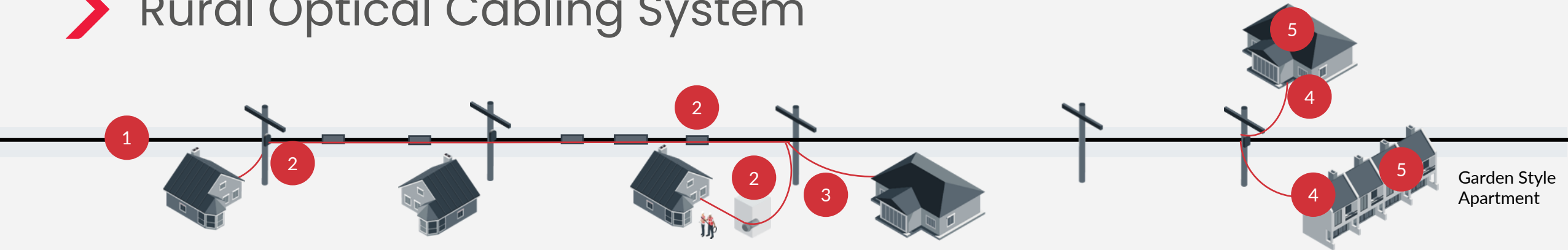
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Rural Optical Cabling System



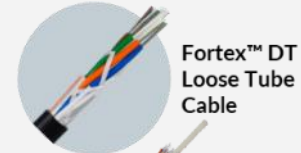
1 Trunk and distribution cables



PowerGuide® ADSS Cable



AccuRoll® Rollable Ribbon Cable



Fortex™ DT Loose Tube Cable



PowerGuide® AccuTube+® RR ADSS Cable

2 Drop terminal Systems



SlimBox® Terminal with Tail



Sherpa CMS® Cable Management System



Ribbon and Single Fiber Splice Machines

3 Drop cables and Field Termination



Mini LT Flat Drop



EZ-Bend® Drop and House Wrap



EZ!Connector

EZ!Fuse Connector

4 Demarcation and Point of Entry



SlimBox CSP Enclosure

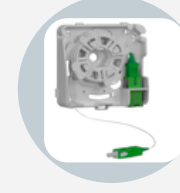


SlimBox Enclosures

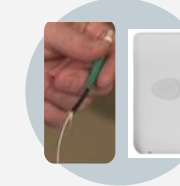


SlimBox Facade Enclosure

5 In-home and apartment




InvisiLight® Solution



EZ-Bend and InvisiLight Drop Solution

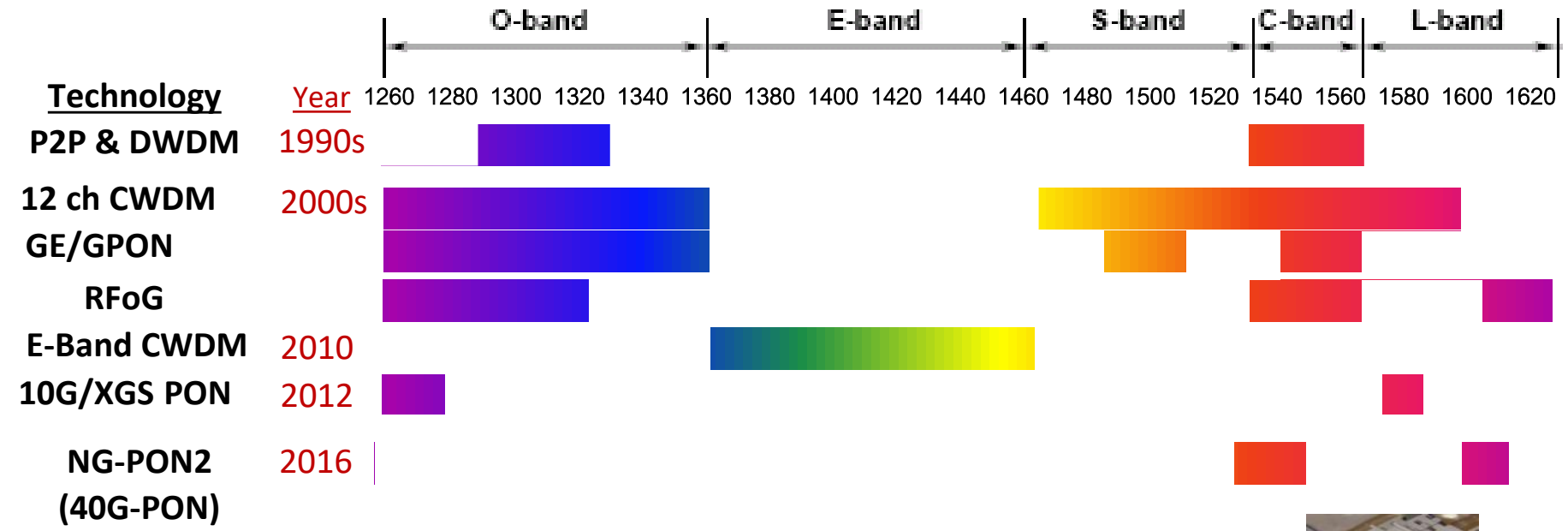
Garden Style Apartment

> OFS Fiber Offering for BEAD and Middle Mile

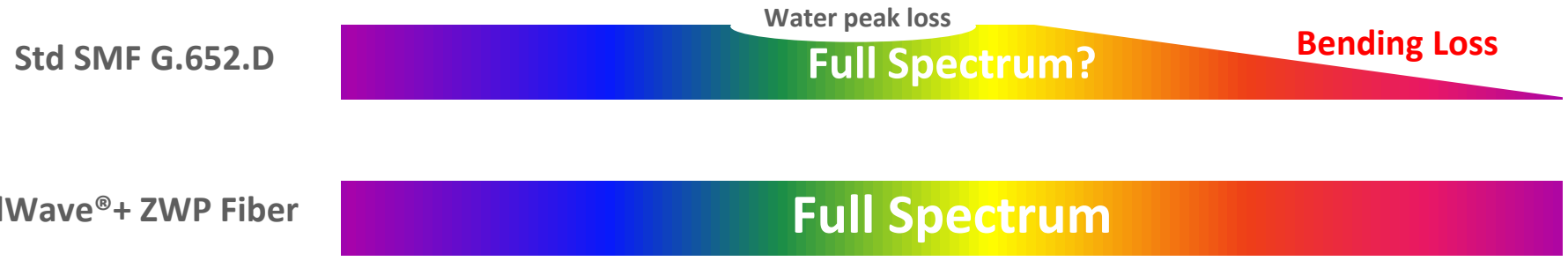
Primary Application ITU compliance		OFS Fiber	Attenuation Max (fiber) 1310/1383/1490/1550/1625 0.XX dB/KM	Bend radius min. Loss/turn max 1550 nm
OSP Cable FTTx/Middle Mile G.652.D and G.657.A1.	  		34 / 31 / 24 / 21 / 24	10 mm  0.75 dB
OSP Cable FTTx/Middle Mile FTTx/Metro/BH/LH G.652.D and G.657.A1.	  		33 / 31 / 21 / 18 / 20 15% lower loss for up to 15% longer reach.	10 mm  0.5 dB
Premises/CO/DC better bend. HD OSP cables where bend needed. G.652.D and G.657.A2	 		35 / 31 / 24 / 21 / 24	7.5 mm  0.5 dB
Drop Cables, In-building/residence extreme bend G.657.B3+	 EZ-Bend 3 mm cord 0.006 dB 		35 / 35 / 24 / 21 / 23	2.5 mm  0.20 dB

> Right Fiber Can Enable More Services over Many Decades

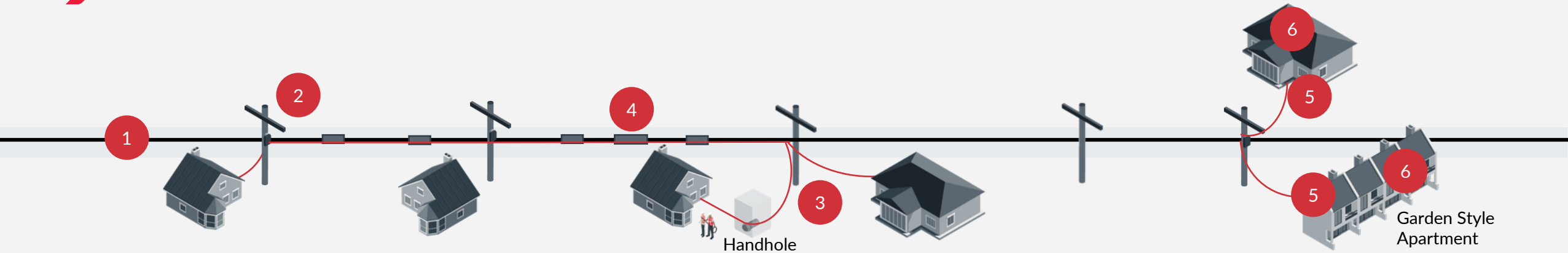
ITU-T Wavelength Bands (nm) – G.694.2



FTTx and 5G will use all of these!

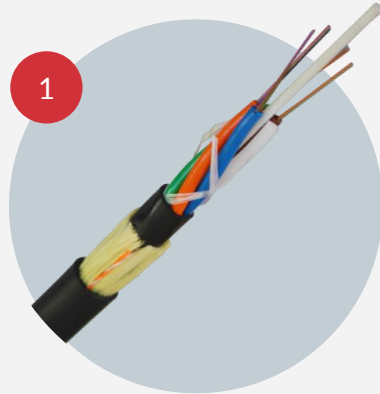


> Examples of FTTx and Middle Mile OSP Cables



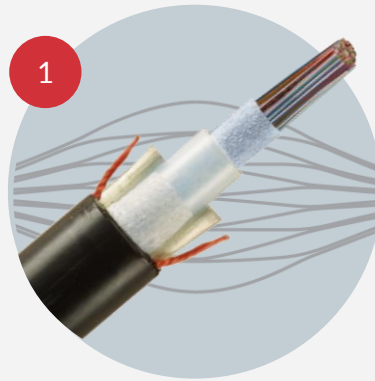
PowerGuide® AccuTube+ RR ADSS Cable

First and Only Fully Dry Rollable
Ribbon Construction. Faster Splicing,
Light Weight, Higher Density



PowerGuide® ADSS Cable

First Fully Dry Construction;
30 years of reliable service



AccuRoll® Rollable Ribbon (RR) Cable

Double density with Ribbon splice
efficiency and Easy Fiber Breakout



Fortex™ DT Loose Tube Cable

Reliable Fully Dry
Construction in Service
for 15 years.



All Standard with
AllWave®+ ZWP Bend-
Insensitive Optical Fiber

Fully Dry ADSS

> Aerial Dielectric Self Supporting Cable (ADSS) Installs, faster, easier, with lower cost



- Cable is self supporting – no strand required.
- Up to 30% lower installed cost, 30% faster vs. lashing
 - *Make ready cost and time savings*
- Gel-free ADSS Cable
 - *1 hr. time savings per terminal – no gel to clean*
- Popular with Power Utilities (Fully Dielectric)



**PowerGuide® AccuTube+
RR ADSS Cable**
Fully Dry Rollable Ribbon
Construction. Faster Splicing, Light
Weight, Higher Density



**PowerGuide®
ADSS Cable**
Fully Dry Construction; 30
years of reliable service

> ADSS and Lashed Cables

ADSS installation is typically significantly faster

Install 1 cable versus 2

Fewer trips up the pole

Lower tensions – possibly less guying

No maintenance, bonding or grounding

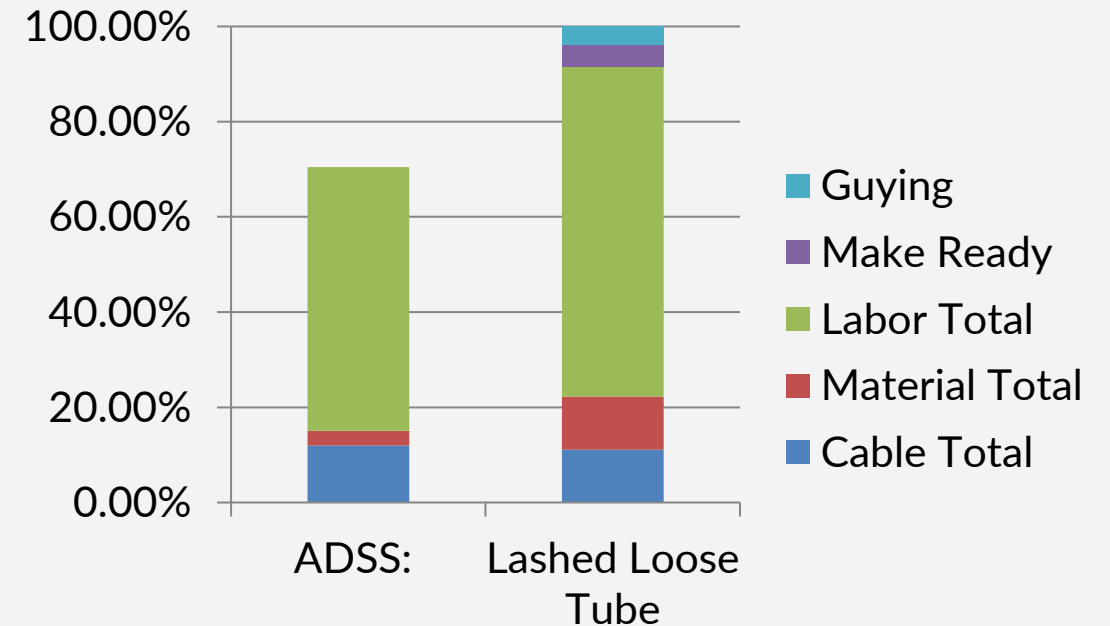
Can place in supply zone

Reduces make-ready significantly

Drop management can be challenging

Often best aerial choice for FTTH when building to new areas

Cable and Installation Costs for Typical Network



*OFS designs for similar long-term reliability for either cable type.
Solutions can be mixed and matched as needed.*

> OSP Cable Designs Converging to Rollable Ribbon



Loose tube and micro



Flat ribbon

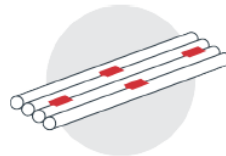
WHY ROLLABLE RIBBON?



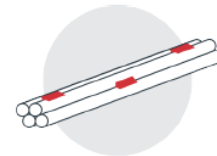
Fewer Smaller
Ducts



Cheaper
Shipping
Faster
Installation



Faster
installation (mass
fusion splicing)



Less space in
cabinets and
trays

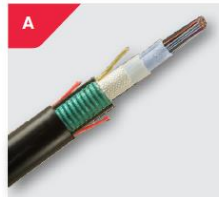


Faster time
to Market

Complete Ecosystem for Rollable Ribbon Cables

Fiber Cables Splicing Training

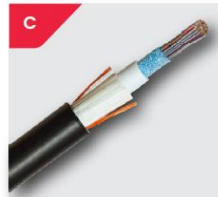
Outside Plant Cable Options



AccuRoll® Rollable Ribbon Cable
(Dielectric and Armored Versions)



AccuTube®+ Rollable Ribbon Cable
(Dielectric and Armored Versions)



DuctSaver® Rollable Ribbon Cable
(Dielectric and Armored Versions)



PowerGuide® AccuTube®+ Rollable Ribbon ADSS Cable



RollR® Rollable Ribbon Microcable

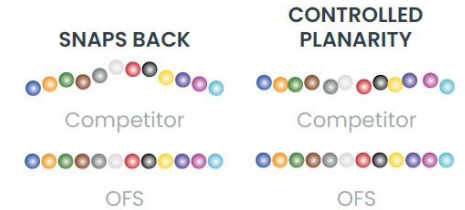
Why OFS Optical Fiber?

AllWave®+ Zero Water Peak Optical Fiber is included in most cables.

- **Zero Water Peak:** Low loss through the optical spectrum
- **Bend Insensitivity:** Lower loss at longer wavelengths with tighter bends
- **Seamless Splicing**
- **Excellent Mechanical Reliability and Coating Performance**

Why OFS Rollable Ribbon?

- **Excellent Spliceability**



- **Long-term Performance:** Fiber attachment locations in our rollable ribbon are formed by adding adhesive, versus cutting away.



Splicing Rollable Ribbons



➤ Rollable vs Flat Ribbon Coil comparison

Flat Ribbon
AccuRibbon
32"

Rollable Ribbon
Accuroll
18"



Smaller Cable Diameters deliver:

1. Smaller coils which lead to smaller Handholes. Smaller hand holes are less expensive to purchase and install.



Tools required

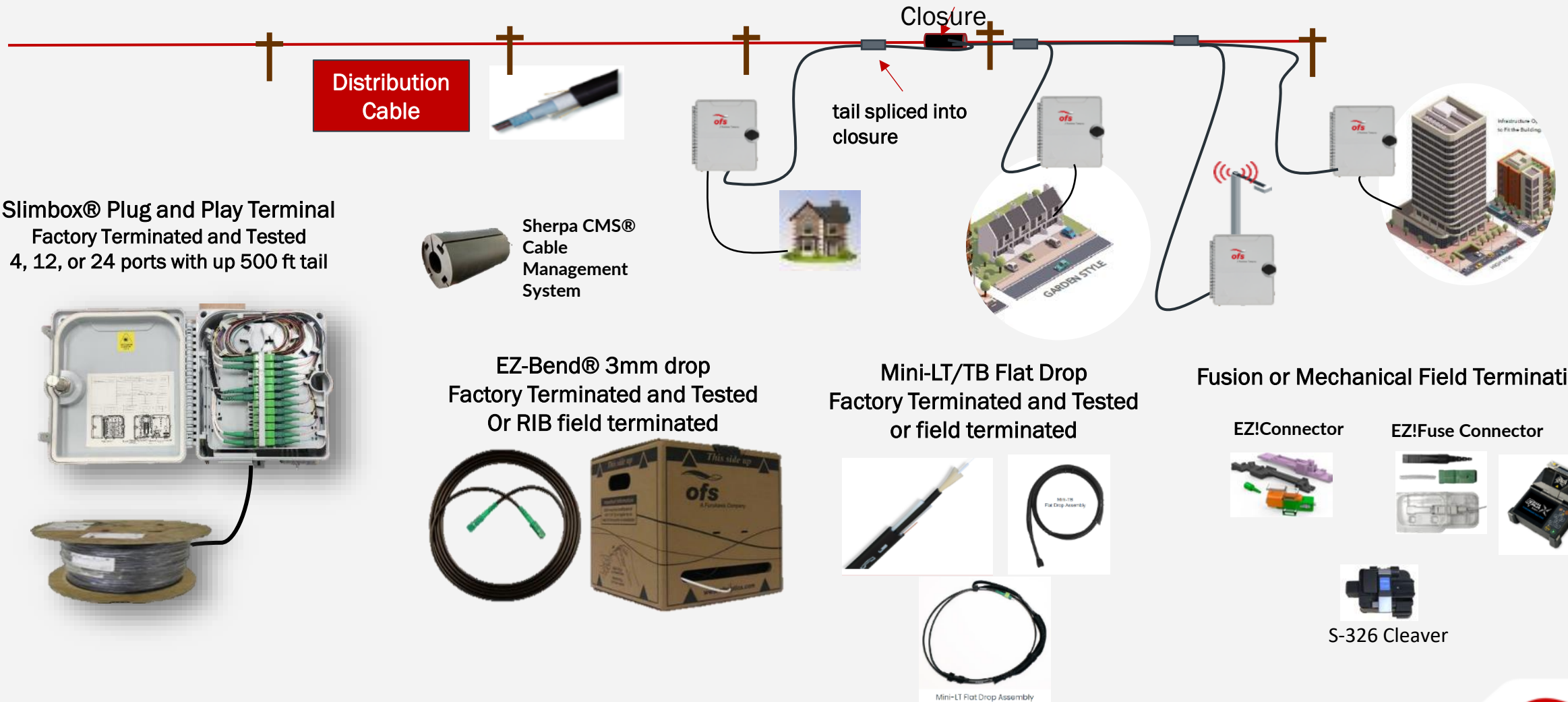


Tools required

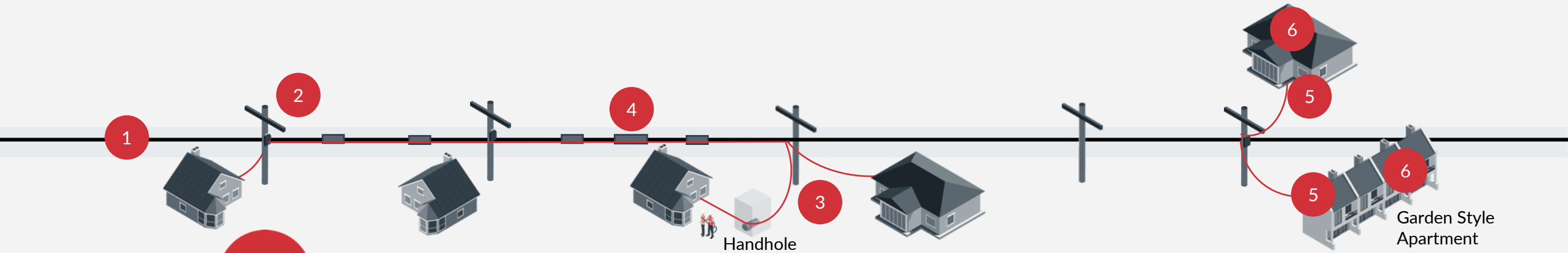


Terminal and Drop Cable System

Compact, Low Labor Installation Using Standard Connectors. Factory or Field Terminated



> Cable Management for ADSS and Drop Cables



Sherpa CMS
Cable
Management
System



A New Solution to an Old Problem

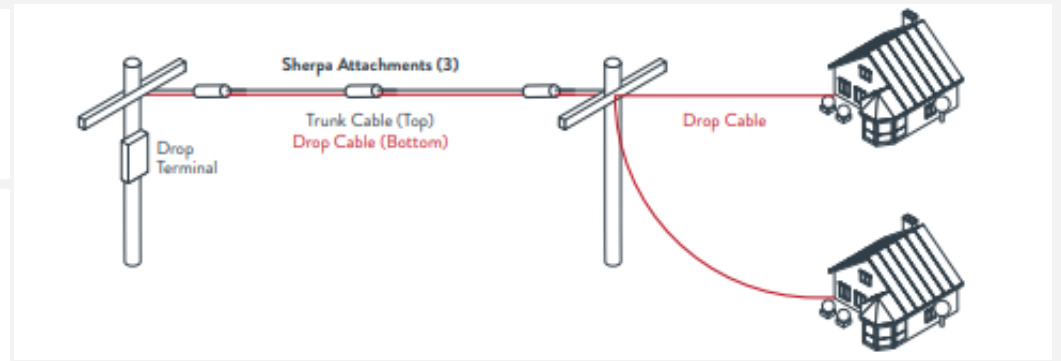
Faster Deployment with Fewer Pole Attachments

- Attach multiple drop cables to an ADSS or strand and lash cable
- Compact managed appearance along the pole line vs. separate drops
- Preserve valuable pole attachment real estate
- Fully Dielectric

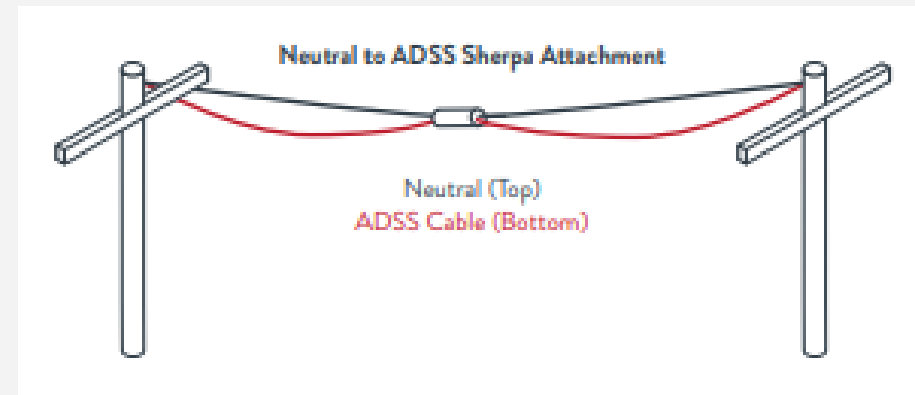
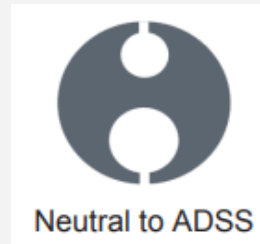


> Sherpa Cable Management for ADSS and Drop Cables

- Two versions
 - Attach drops (flat or round) to an ADSS or lashed trunk/distribution cable



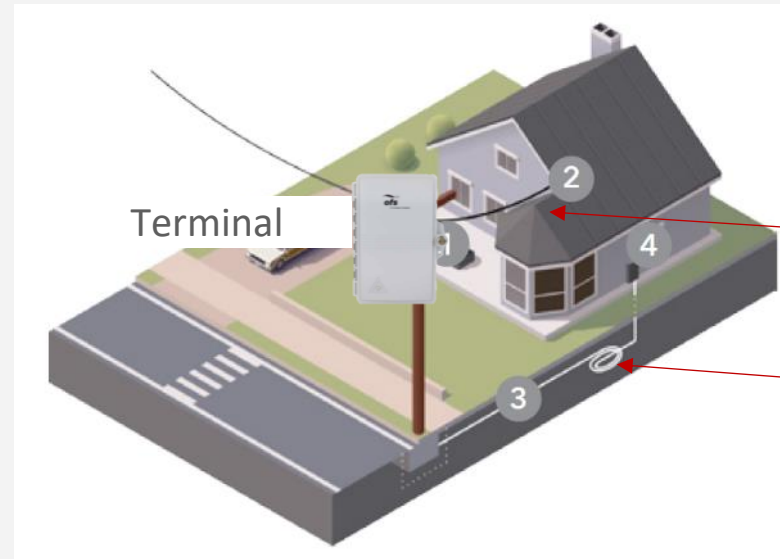
- Attach ADSS trunk to a neutral



> Connectorized vs. Spliced Cabling: Choice Depends on Service Provider Needs/Capabilities

Connectorized

- Faster installation
- Lower skill requirements preferred
- No existing splice machines or splicing very expensive.
- Capable to manage inventory and slack

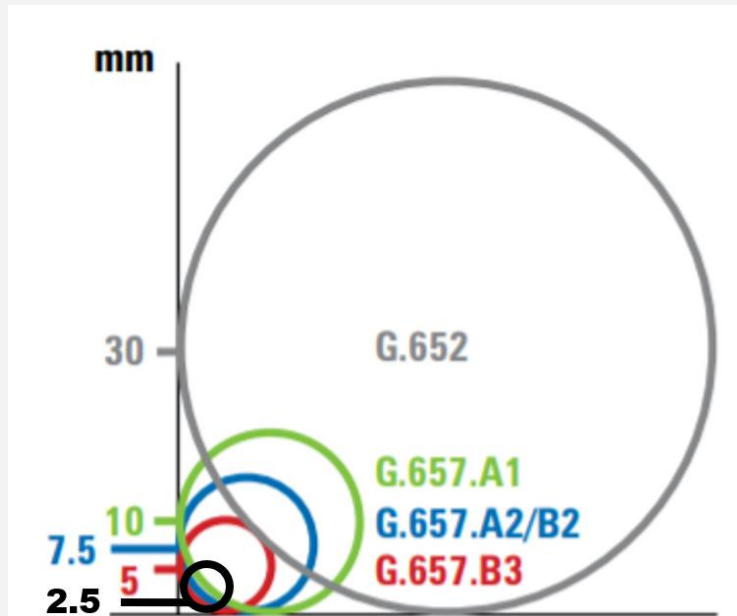


Spliced or Field Terminated

- Lower material cost (~\$20 per subscriber)
- Reduce connector pairs/ lower loss
- Splice reliability desired
- Easy/less inventory desired
- Splice machines/competence available

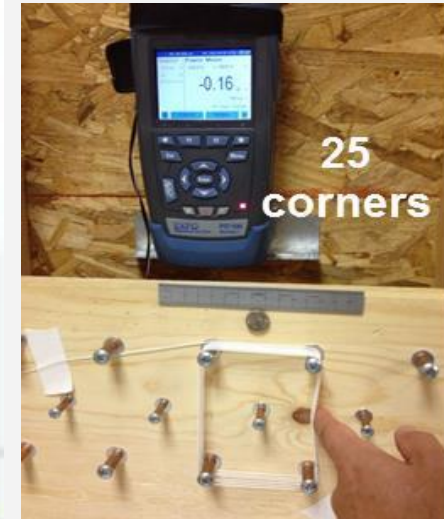
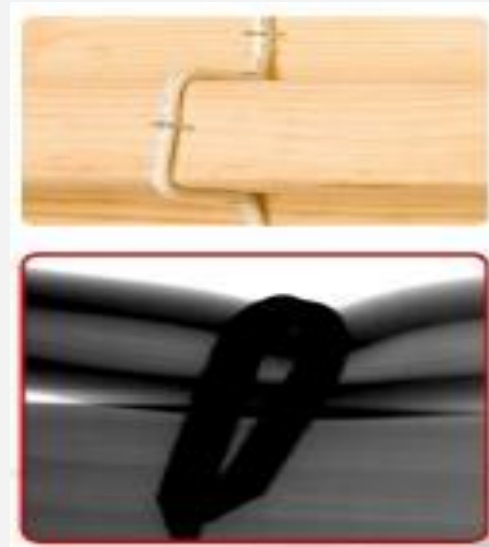


➤ Optical Fiber with 2.5 mm Bend Radius Enables in Home Installation



EZ-Bend Enhanced G.657.B3

ITU T Fiber
Recommendation
vs. Bend Radius



> Advanced Technologies Enable Fiber Inside Homes and MDUs

In Living Units



In Hallways or Breezeways



On Buildings



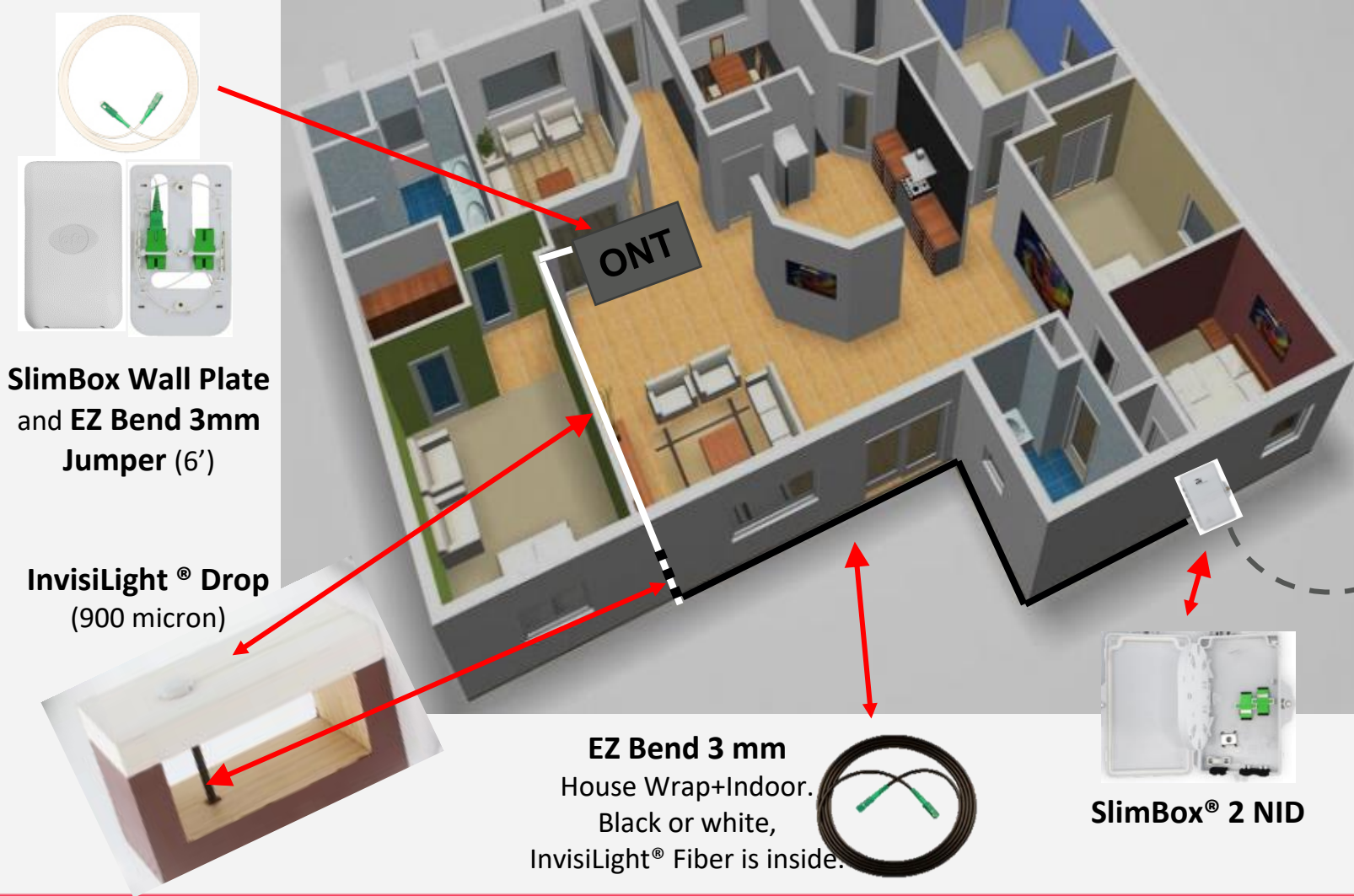
.....and around corners
2.5 mm bend radius fiber



<https://www.ofsoptics.com/invisilight-products/>

> Center the ONT to Improve Wi-Fi and Customer Experience

For Homes or Small MDU Buildings



Retain Customers

Reduce Trouble Calls

Avoid risky attic/wall fish installations

**Virtually invisible option:
Convert to InvisiLight for only
a couple of bucks**

> EZ-Bend® Fast Wrap Solution Helps Center the ONT Faster With Less Inventory

Replace a One NID plus 6 jumper lengths up to 150 ft

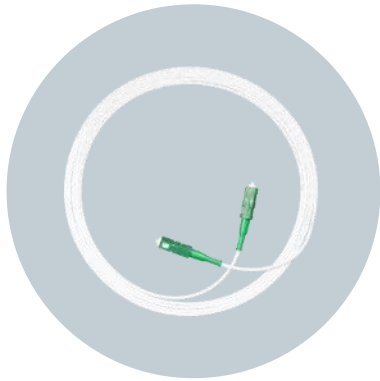


Save 15 min, Reduce Part Numbers by 85% with one part number

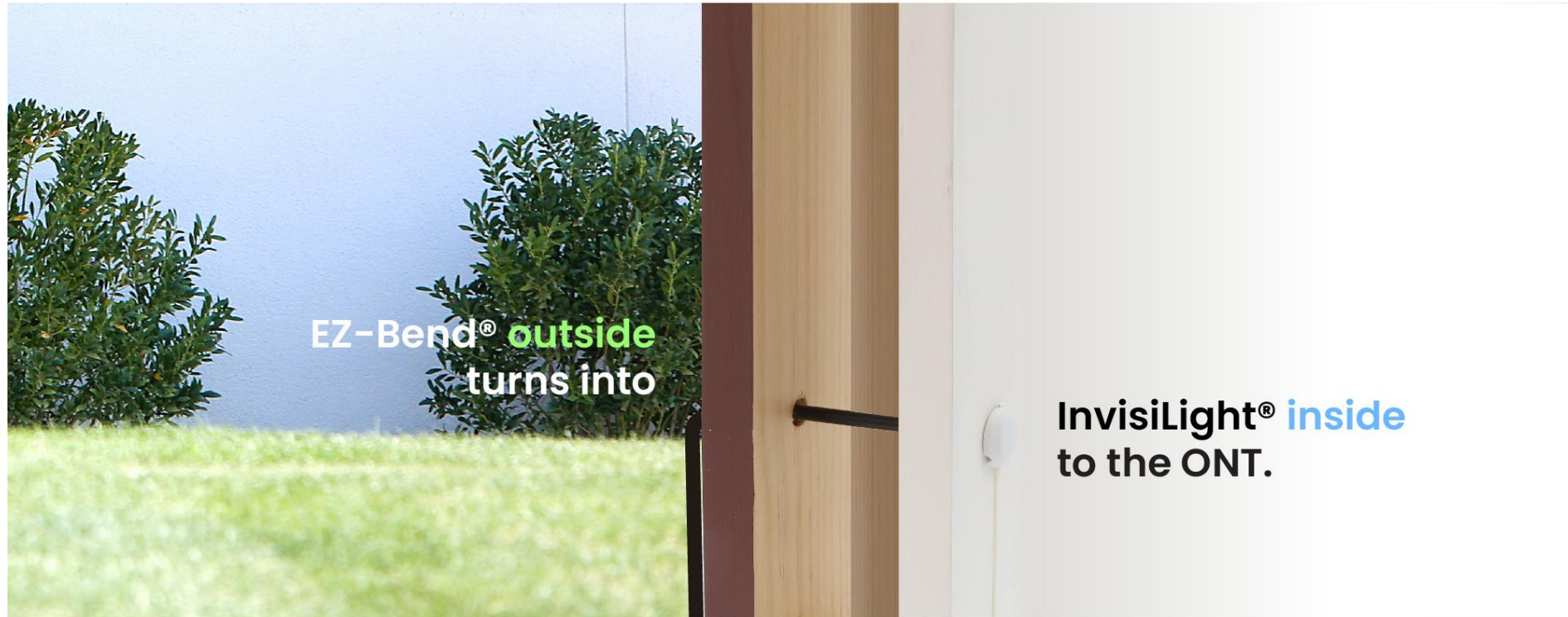


> EZ Bend® Cords and Jumpers

Turns into InvisiLight® inside the home

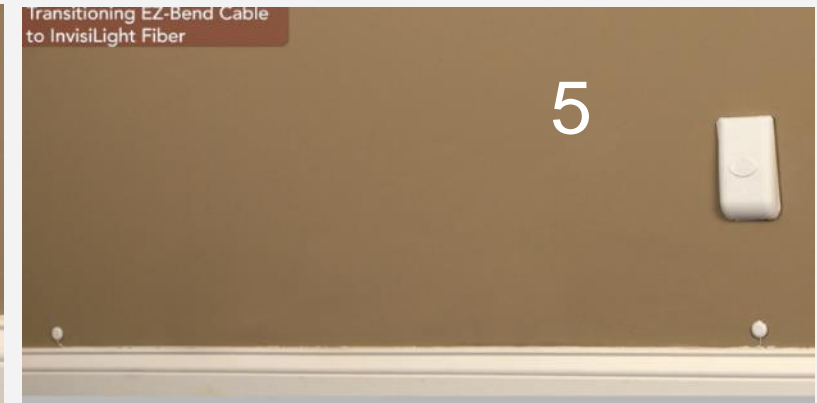


EZ-Bend® Drop
and House
Wrap



Bendable to 2.5 mm
radius, terminated your
way – in the field or in
the factory

> EZ-Bend® cables can be Easily Converted to InvisiLight® to Extend to the ONT



[InvisiLight\(r\) Drop Solution video](#)

1

> Fiber Network Design Considerations for BEAD Deployments

Fiber will be the Primary Technology Deployed for BEAD Funded Projects

BEAD Investment of \$61B requires BABA for BEAD compliant infrastructure

Design Simple, Scalable, and Easy to Maintain and Restore Architectures

Design for the Future by Upsizing Fiber Count

Cost Effective, Future Ready BEAD Compliant Fiber Cabling Available from the OLT to ONT

<https://www.ofsoptics.com/babaa-for-bead-compliant-products/>

Design, Fiber Cabling, Consulting, and Training Available

Thank You

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