RFoG Solutions

CommScope

1910 - 2010

One hundred years.   What a difference a century makes!

3 Million Telephones – No National Network
105 Million US Population

Marconi Wins Nobel Prize for Physics
Radio Consisted of "Wireless Telegraphy"

April 1909 Charles Herrold Launched
"San Jose Calling" – later became KCBS

Georges Rignoux and Alain Fournier
First Demonstrated the transmission of
still silhouettes in Paris in 1909

It would not be until 1925 that a demonstration
of live images would occur

Henry Ford sells 10,000 cars

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100 Years of Progress

All Digital Communication

2009 Marked the End of Analog Television

**HDTV
Mobile TV
Digital Telephone**

Fiber Optic Backbones Carry Virtually All Modern Communications Systems

Yet The Last Mile is still Reminiscent of 1910.

Fiber Market Drivers

Why <u>Would</u> Network Operators Want an Entirely Fiber to the Home network?

1- No Sweep & Balance Required – No Frequency Response Errors

2- No Dials Meters or Knobs in the outside plant

3- No System Power Bills or outages due to utility failure

4- No CLI Flyovers or Ride Outs – No Annual Proof of Performance

5- No Return Path ingress problems

6- Extended bandwidth capability

7- Immunity to lightning damage, corrosion, and electrolysis

8- Greater home and community value

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Fiber Market Inhibitors

Why <u>Wouldn't</u> Operators Want an Entirely Fiber to the Home network?

1- Fear of Incompatibility with legacy network components

2- Would obviate back office billing, monitoring, work force management and provisioning systems

3- Require the replacement of head end / central office equipment. CMTS, set top control, VOIP interface to PSTN

4- May require the replacement of all customer premise equipment – DOCSIS modems, set top boxes, telephone eMTAs

5- Service disruption to customers during change over from electrical to optical

6- Complex installs because drops cross streets and property lines

7- Inspire Shareholder fear over recapitalization of network

BrightPath Removes all the Inhibitors

- No disruption or impact on adjacent plant

- All Back Office Systems Remain in Place

- Cable Modem CMTS, Set–Top Controllers, eMTA command and management are unchanged

- No internal customer premise wiring changes for existing customers

- Drop lengths equivalent to coaxial HFC – or long drops as desired

- Drop installation is virtually identical to Hybrid Fiber Coax

- Capex costs may actually be less than HFC

- Operational costs are significantly reduced, pleasing shareholders and credit suppliers

PONs

APON (ATM Passive Optical Network). First Passive optical network standard. It was used for business applications, and based on ATM.

BPON (Broadband PON) is commonly offered at 622 Mbps downstream and 155 Mbps upstream. Its ATM structure and bandwidth limits make it less than ideal for video. Development has stopped on BPON. BPON networks will over time be converted to EPON or GPON. There are approximately 2 million BPON users worldwide.

GE-PON (for Gigabit Ethernet PON) has a higher installed volume than all other PON technologies combined. EPON is found widely in Asia. EPON offers a symmetrical 1.25 Gbps service suitable for data, voice and video.   It is Ethernet based end to end.

Current PON Architecture

GPON - operating at 2.5 Gbps downstream and 1.25 Gbps upstream, is the latest PON standard to emerge. It combines the lessons of service management from BPON with the inherent efficiency of Ethernet based transport. QoS is performed using standard Ethernet and IP methods.

An example is Verizon's F IOS - **Fiber Optic Service**

(**FIOS === Gaelic for Knowledge**)

NEWEST 10 GEPONn - WDM-PON

For CATV operators all PON solutions require new $$$$ CPE equipment.

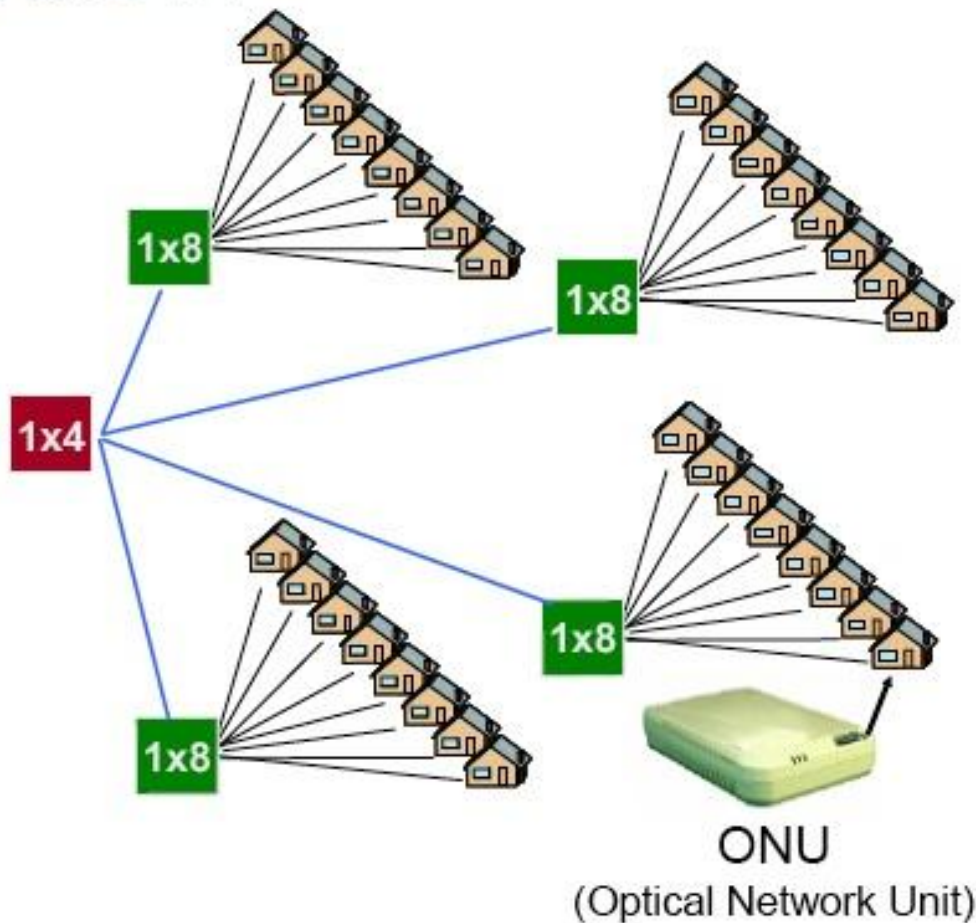**CommScope**

Passive Optical Network

OLT
(Optical Line Terminal)
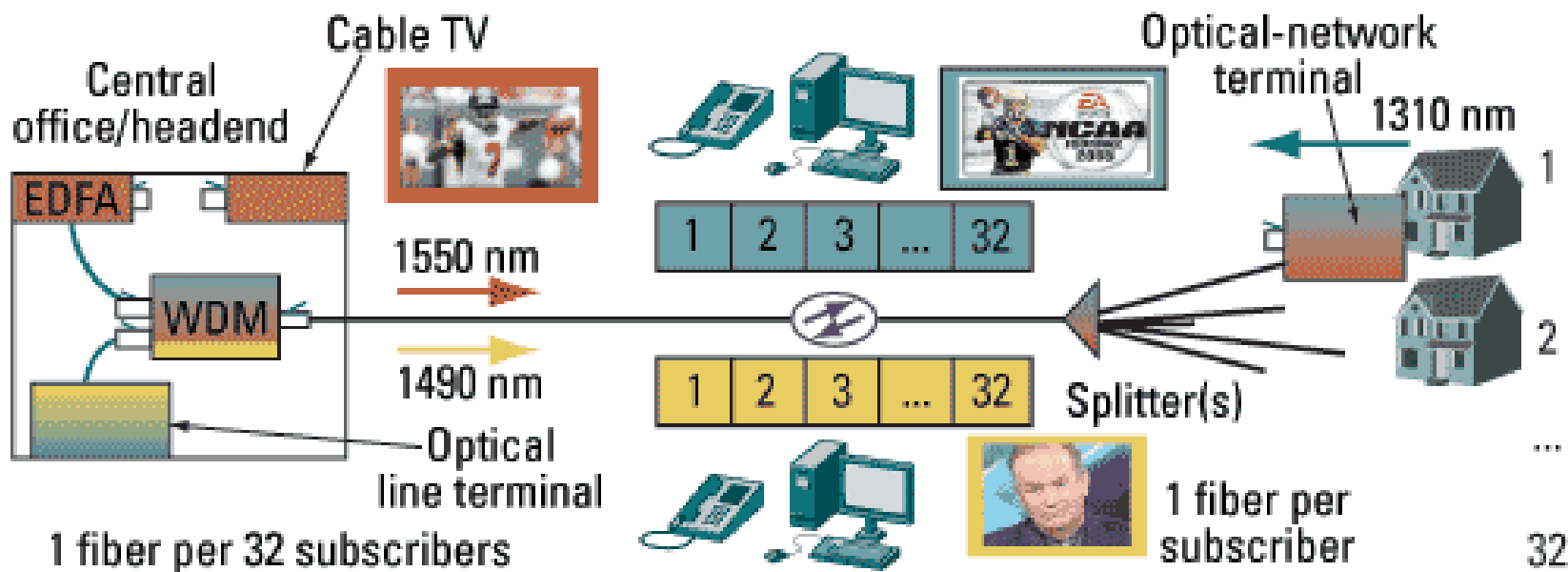
4 PON ports per OLT

1 x 4 Optical Splitter

1x4

1x8

1x8

1x8

1x8

ONU
(Optical Network Unit)

CommScope

BrightPath allows drop lengths equivalent to copper.

PON is the Child of a Non-Competitive World
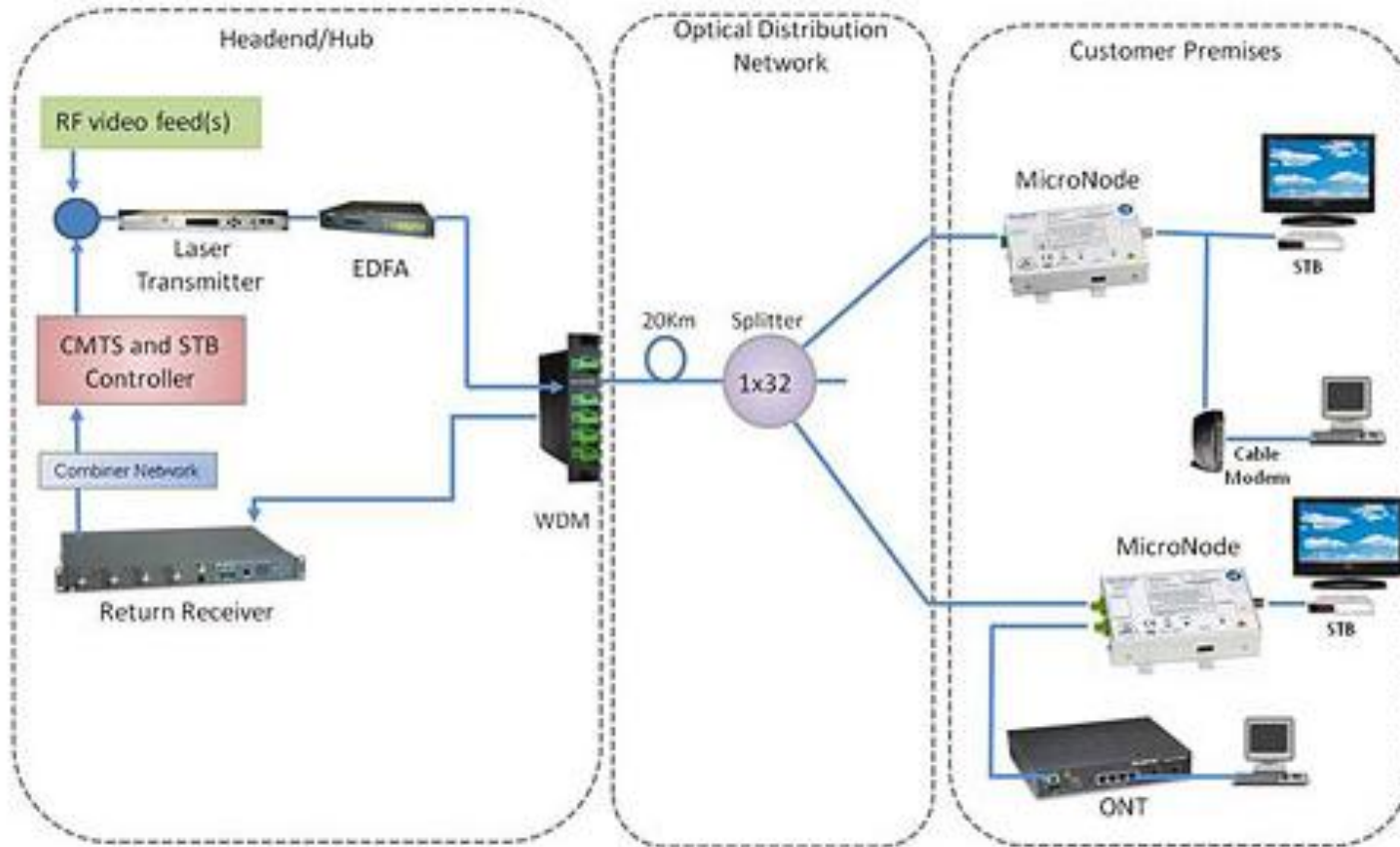## It's Economic Assumption is 100% Take Up

RFoG RF Over Glass

Is Passive
Is Entirely Optical
Is a Network

So Why Isn't it called a PON ?

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RFOG Architecture Sans Taps

CommScope

Tapped RFOG Key Components

- Installed at the customer's premise
- Converts optical signal to RF Signal
- Manages 1550 nm downstream and 1310 nm upstream
- Upstream signal threshold feature squelches noise

Optical Tap

Network Interface Unit

- **Installed in the distribution network**
- **2, 4 and 8 port versions**
- **Superior fiber management**
- **Connectorized Drop ports**
- **Branch Cable capability**

Standards

ITU-T G.983

APON (ATM Passive Optical Network). This was the first Passive optical network standard. It was used primarily for business applications, and was based on ATM.
BPON (Broadband PON) is a standard based on APON. It adds support for WDM, dynamic and higher upstream bandwidth allocation, and survivability. It also created a standard management interface, called OMCI, between the OLT and ONU/ONT, enabling mixed-vendor networks.

ITU-T G.984

GPON (Gigabit PON) is an evolution of the BPON standard. It supports higher rates, enhanced security, and choice of Layer 2 protocol (ATM, GEM, Ethernet). Verizon is in the process of implementing this.

IEEE 802.3ah

EPON or GEPON (Ethernet PON) is an IEEE/EFM standard for using Ethernet for packet data.

IEEE .3AV

10GEPON (10 Gigabit Ethernet PON) is an IEEE Task Force for 10Gbit/s backwards compatible with 802.3ah EPON. 10GigEPON will likely be based on Wave Division Multiplexing (WDM) technology.

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IPS 910 RFoG   (RF over Glass)

**SCTE Interface Practices Subcomittee standard in development for Point to Multipoint (P2MP) operations that has a proposed wavelength plan compatible with data PON solutions including EPON,GEPON and 10G-EPON.**
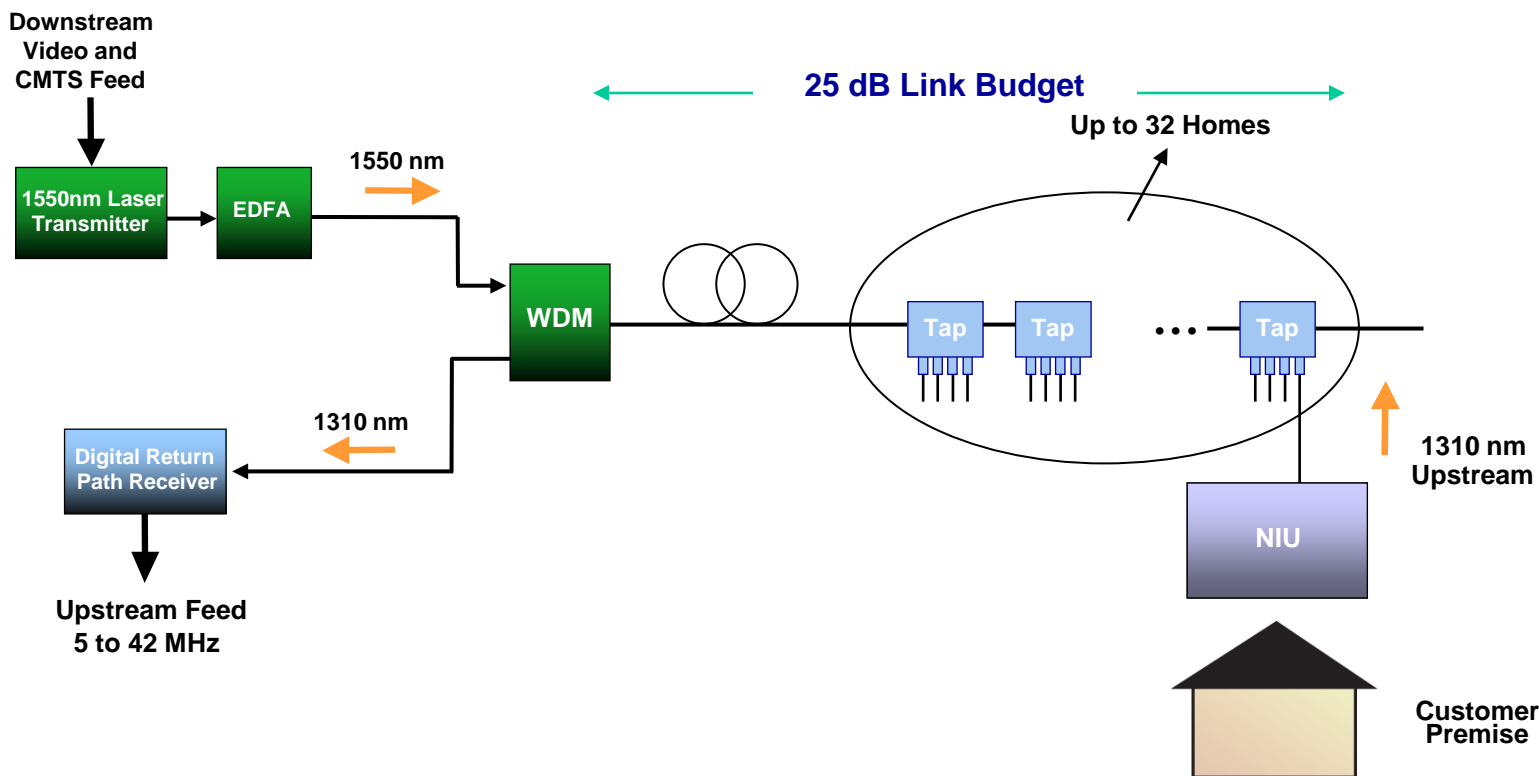**RFoG offers an FTTH PON like architecture for MSOs without having to select or deploy a PON technology.**
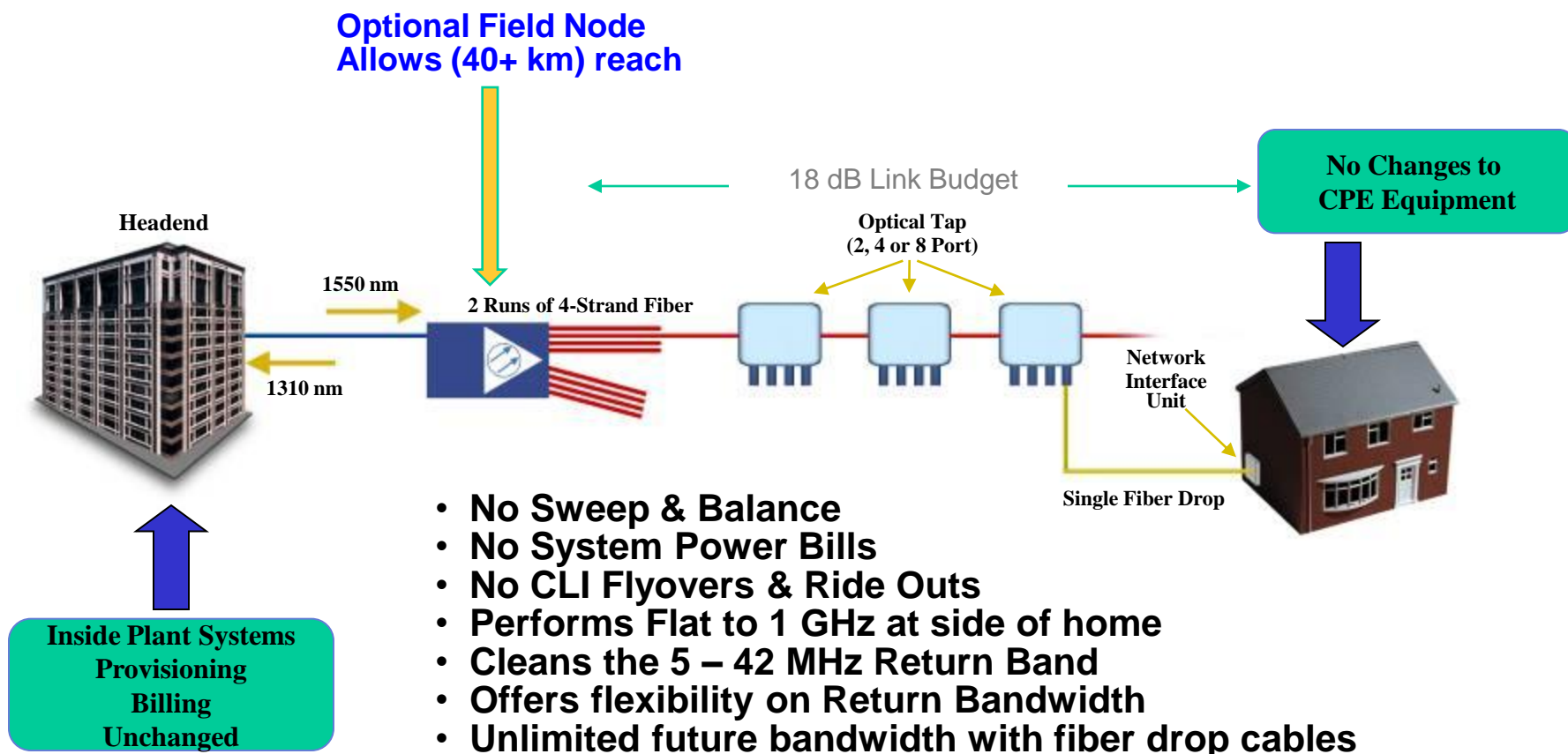
HFC Compatible

FTTH New
Development
*(Service Area
256 Homes)*

Headend
Ring

CommScope
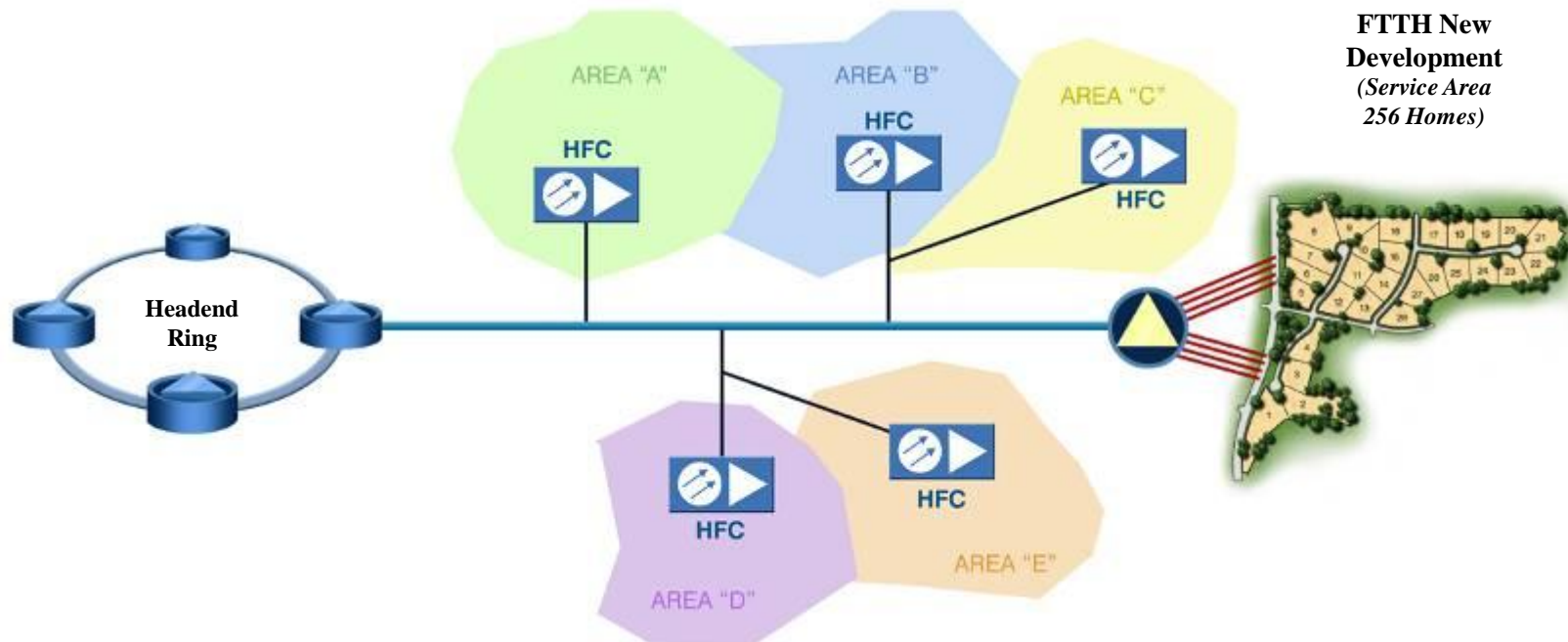
Direct from Headend Architecture

- **Utilizing a direct feed in the BP architecture allows:**
  - 25 dB link budget, consisting of fiber and tap loss (limited by NIU upstream transmitter output).
  - Typically 32 ports per fiber.
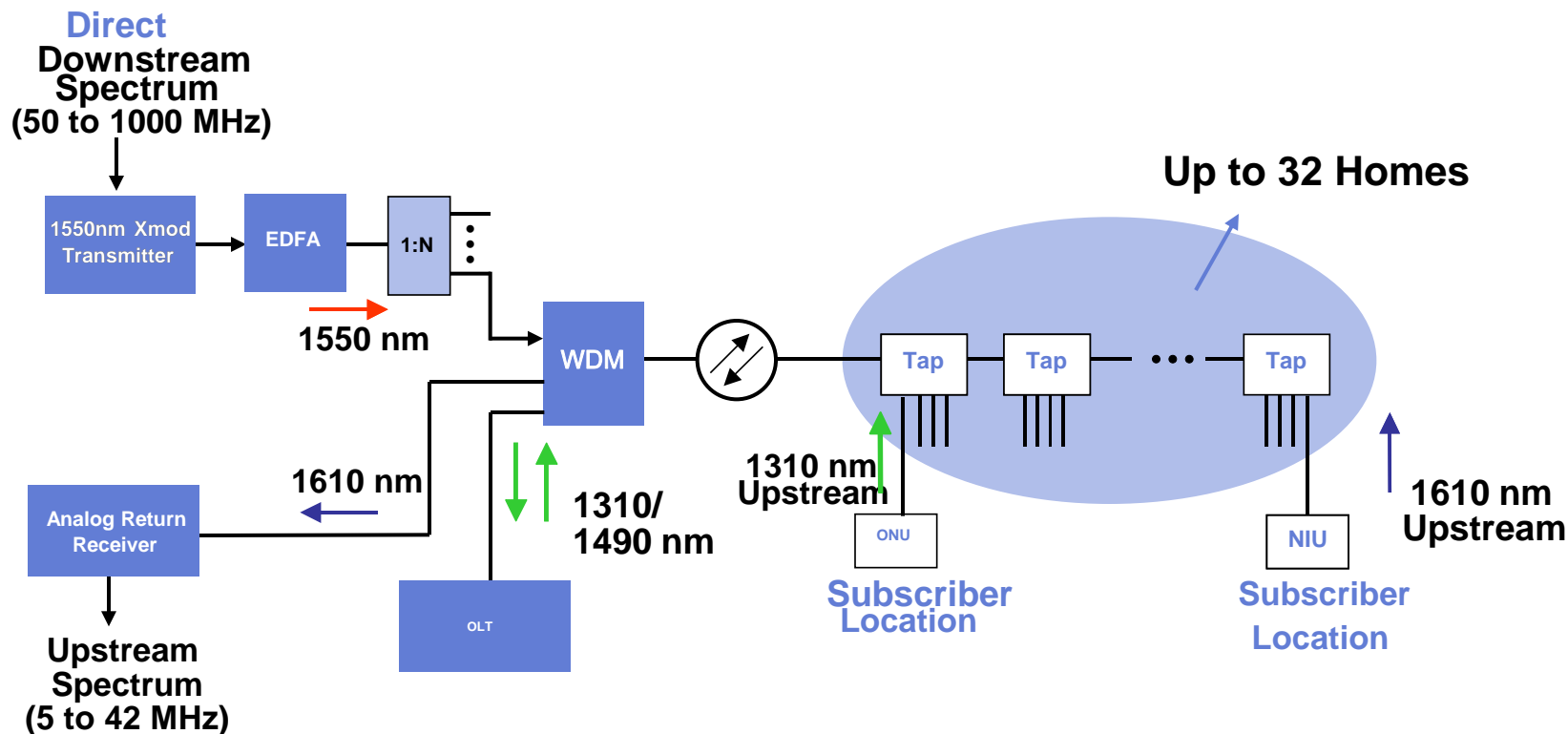- **Link budget to 25 dB.**

Optical Repeaters

Optional Field Node Allows (40+ km) reach

18 dB Link Budget

No Changes to CPE Equipment

Headend

1550 nm

1310 nm

2 Runs of 4-Strand Fiber

Optical Tap (2, 4 or 8 Port)

Network Interface Unit

Single Fiber Drop

Inside Plant Systems Provisioning Billing Unchanged

- **No Sweep & Balance**
- **No System Power Bills**
- **No CLI Flyovers & Ride Outs**
- **Performs Flat to 1 GHz at side of home**
- **Cleans the 5 – 42 MHz Return Band**
- **Offers flexibility on Return Bandwidth**
- **Unlimited future bandwidth with fiber drop cables**

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PON Overlay

- **Moving the NIU wavelength above 1550 nm enables the NIU to coexist with PON equipment on the BrightPath network**
- **A single platform simplifies support of business services and migration to a PON system**
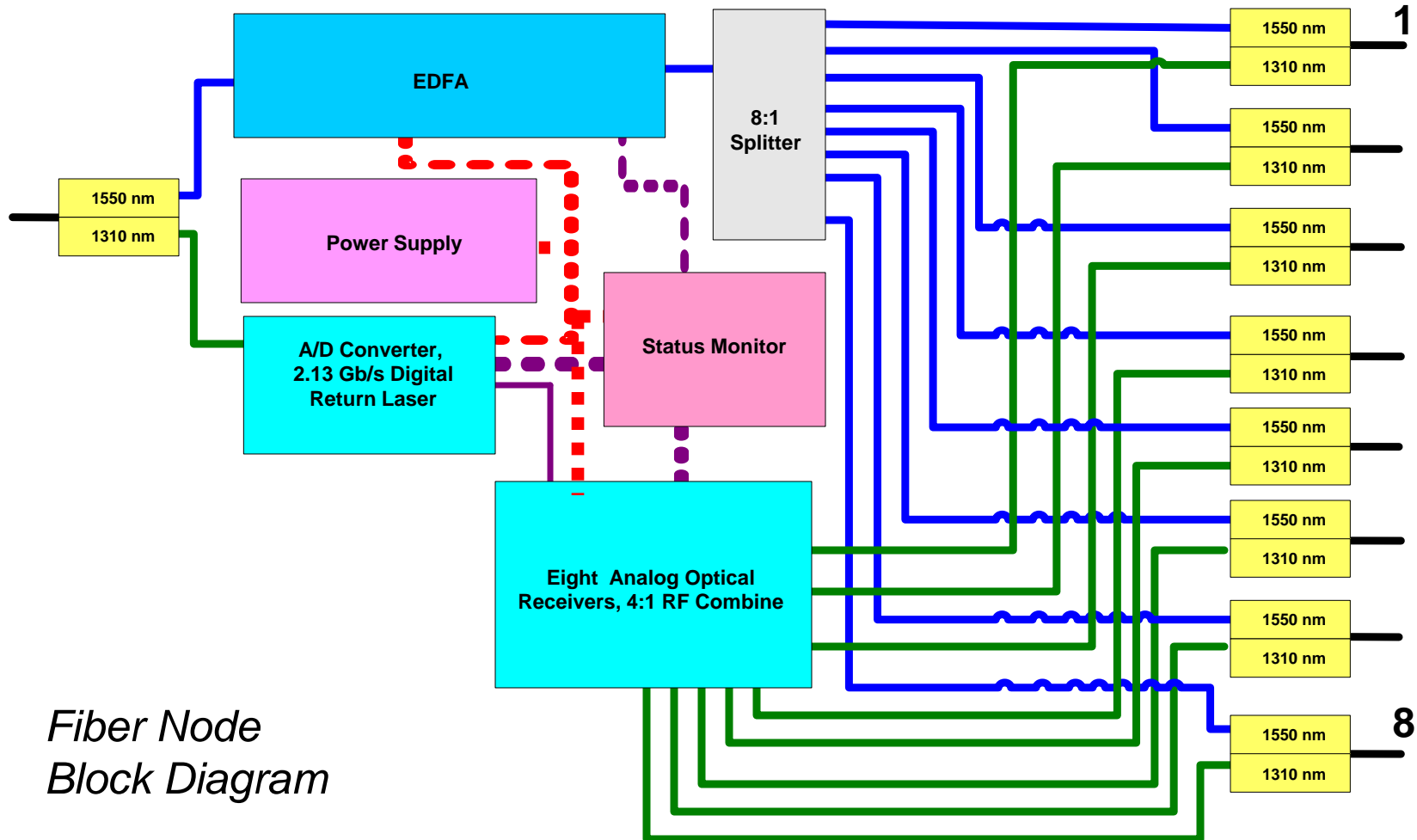
Optical Repeater

Fiber Node
Block Diagram

BrightPath Repeater
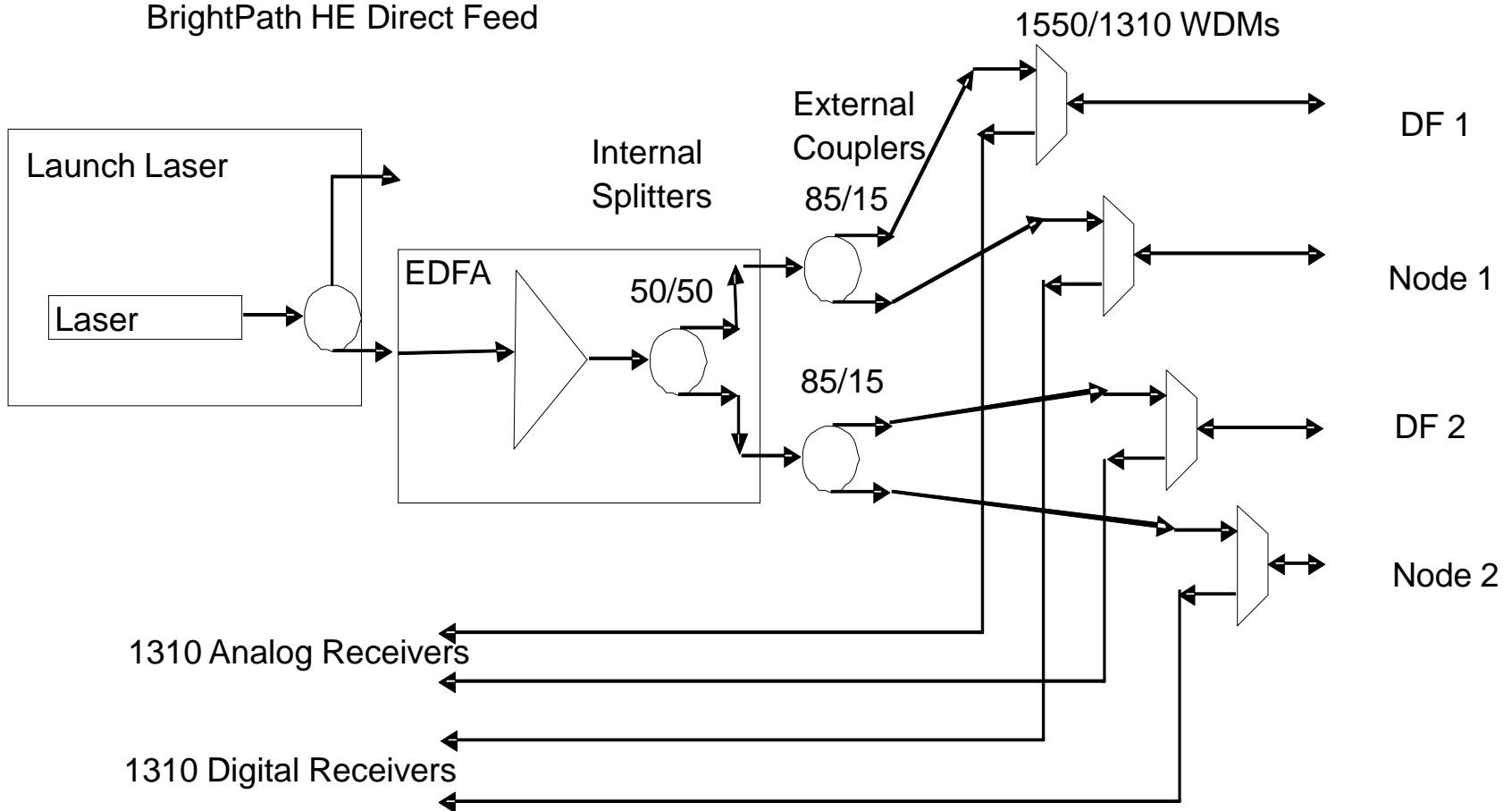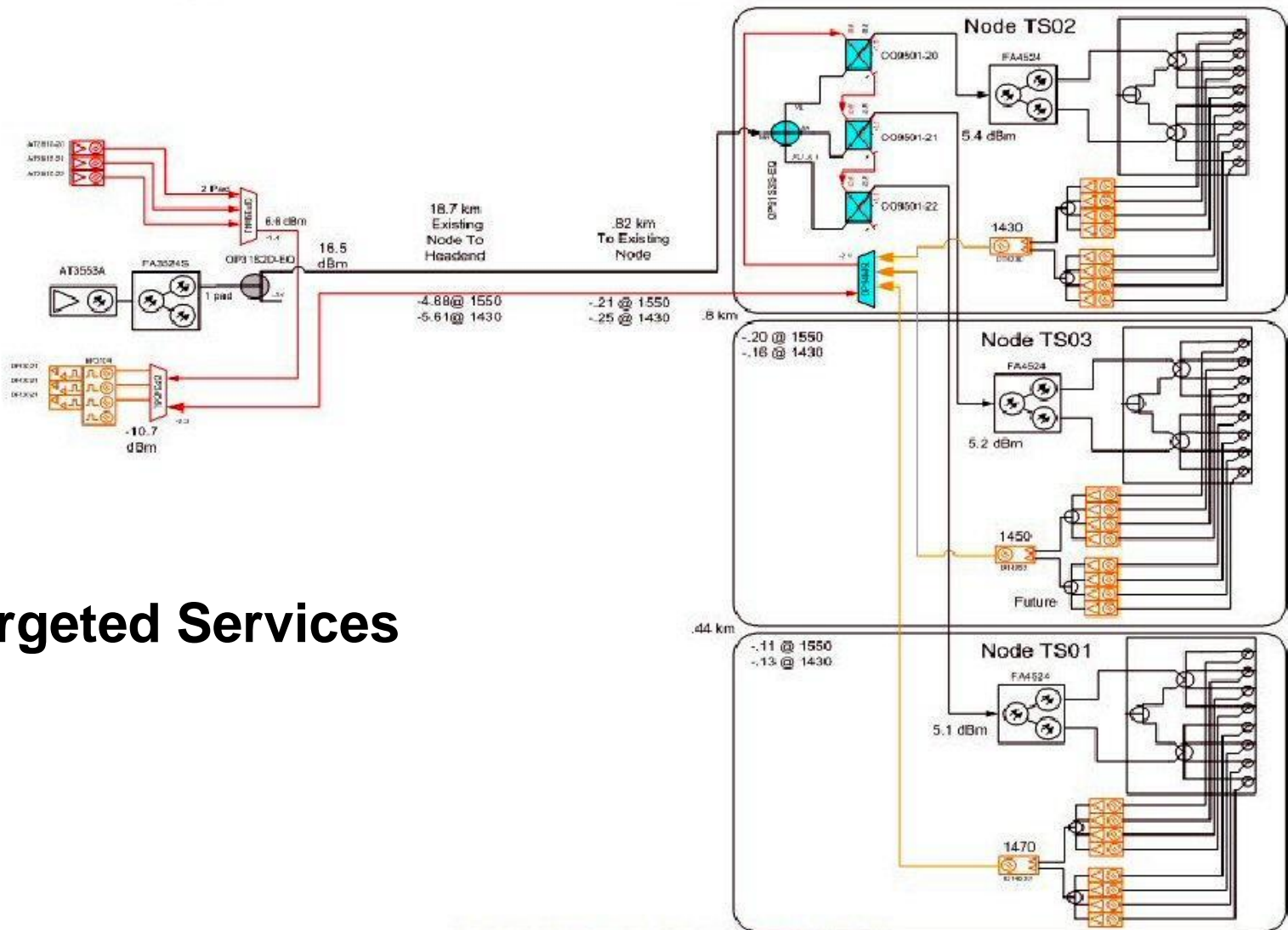## *Based on the Aurora "Virtual Hub"*

- **Installed at the same point as a standard node**

- **256 home capacity**
  - **Each fiber services up to 32 homes**

- **Includes the following added features:**
  - **EDFA**
  - **Analog optical receivers receive optical inputs on upstream path**
  - **Return signal digitized and transmitted to headend**
  - **Multiplexer combines signals onto one fiber for connection between node and headend**

Page 23

Laser & EDFA Outputs

BrightPath HE Direct Feed

1550/1310 WDMs

External Couplers

Launch Laser

Internal Splitters

Laser

EDFA

50/50

85/15

85/15

DF 1

Node 1

DF 2

Node 2

1310 Analog Receivers
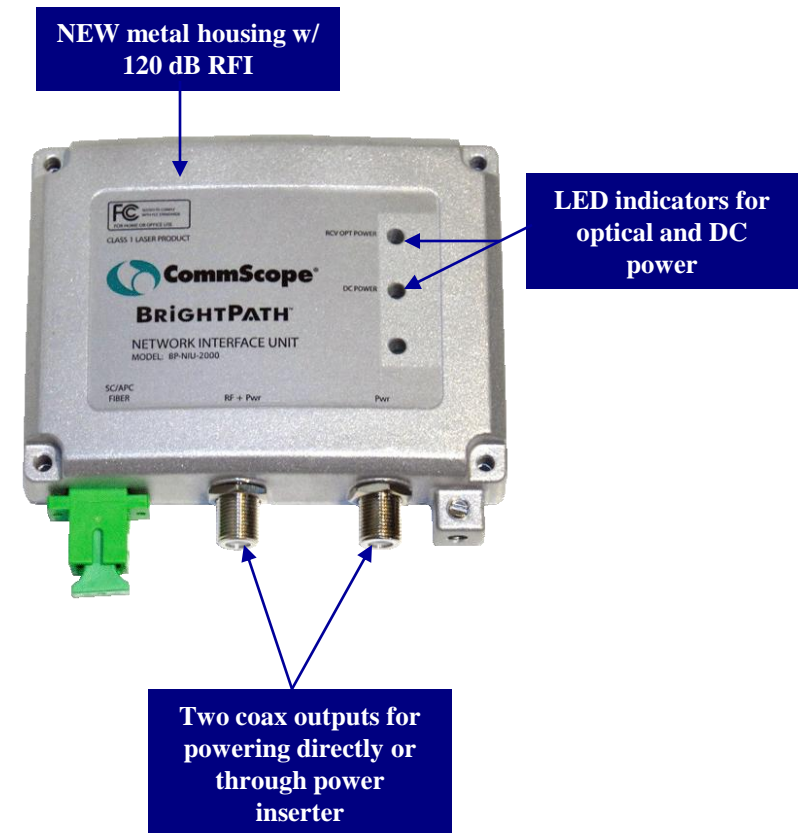
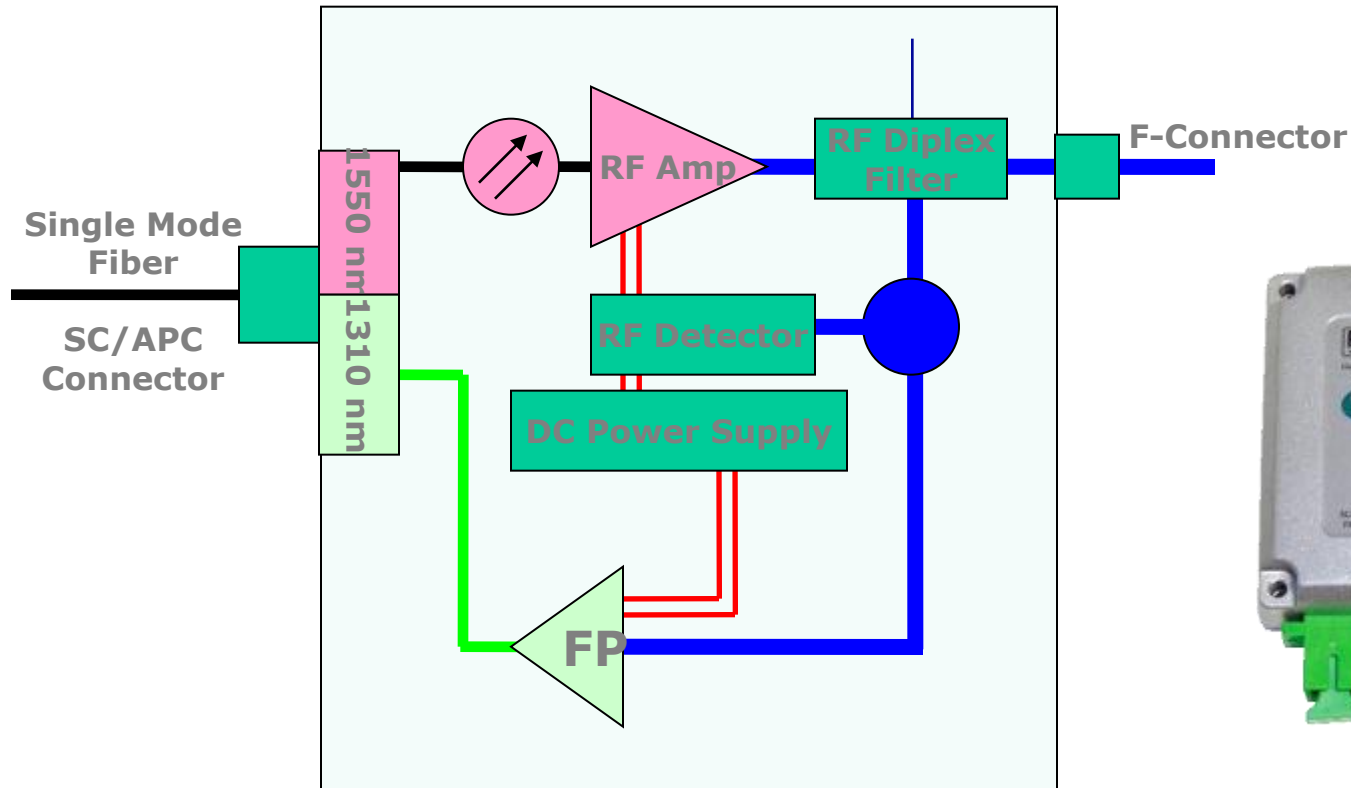1310 Digital Receivers

Targeted Services

Network Interface Unit (NIU) –

- **Installed at the customer's premise**
- **Converts optical signal to RF signal transmitted over coax**
- **Manages 2 wavelengths: 1550 nm downstream and 1310 nm upstream**
- **Analog return signal transmission to node**
- **Upstream signal threshold feature squelches noise**
- **Full transparency for headend equipment and CPE**

NEW metal housing w/ 120 dB RFI

LED indicators for optical and DC power

Two coax outputs for powering directly or through power inserter

CommScope
BRIGHTPATH
NETWORK INTERFACE UNIT
MODEL: BP-NIU-2000

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NIU Functional Schematic

BrightPath's NIU "Squelchs" Return Path Noise

Unlike FIBER DEEP

Fiber Deep is *"Death by a Thousand Paper Cuts"*

NIU →

CommScope
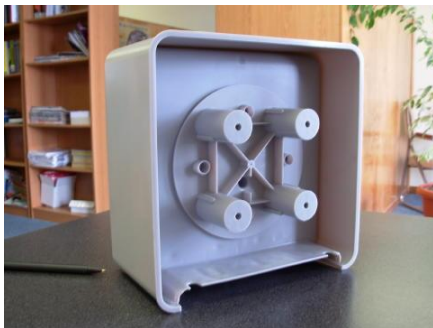
Optical Tap

- Passive signal distribution
- 2, 4 and 8 port versions with family of dB values
- SC-APC connectors
- Fits in 9.0" OD pedestal
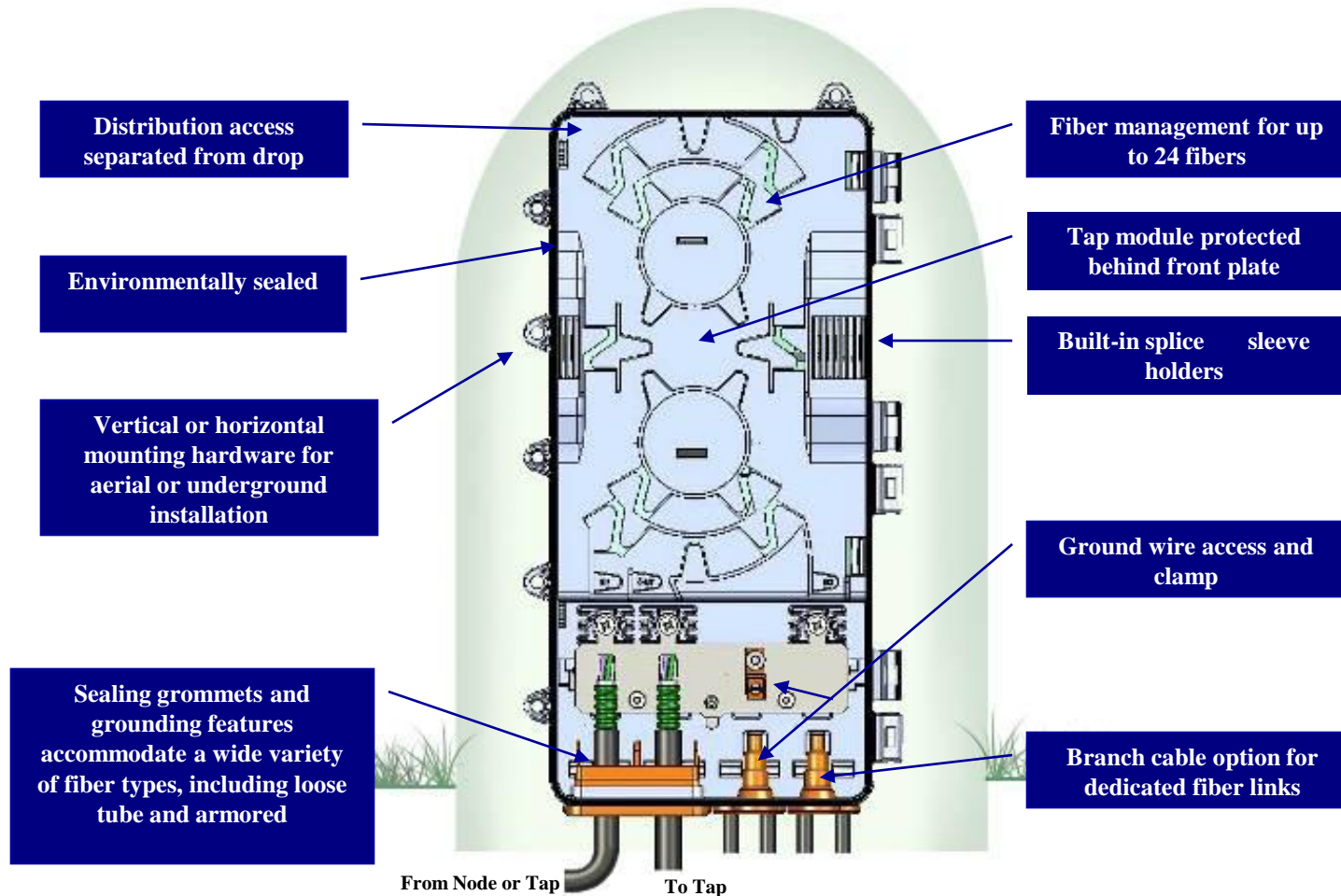- Single fiber connection to NIU

New Features

- 8 port tap option
- Accommodates wide variety of cable types
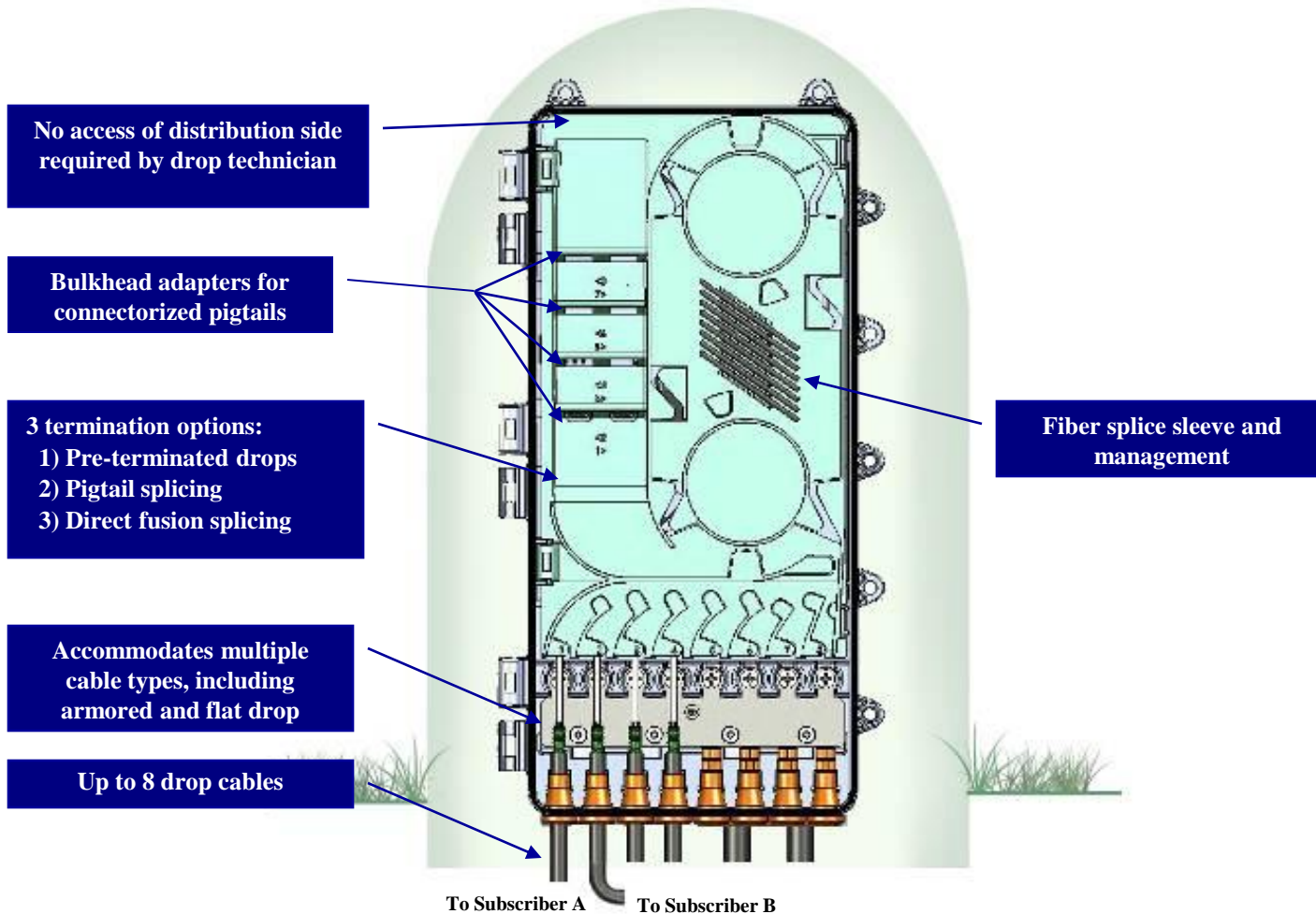- Pigtail splicing option
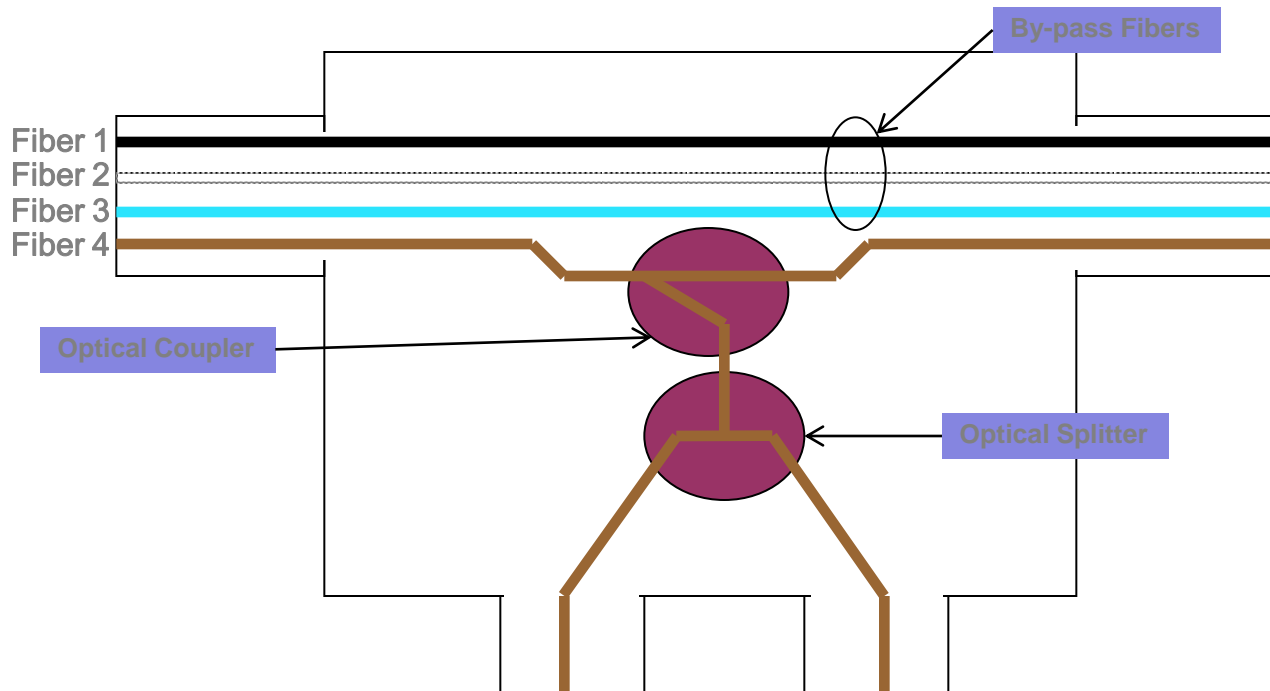- Branch cable option

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Tap – Distribution Side

Distribution access separated from drop

Environmentally sealed

Vertical or horizontal mounting hardware for aerial or underground installation

Sealing grommets and grounding features accommodate a wide variety of fiber types, including loose tube and armored

Fiber management for up to 24 fibers

Tap module protected behind front plate

Built-in splice sleeve holders

Ground wire access and clamp

Branch cable option for dedicated fiber links

From Node or Tap   To Tap

Tap – Drop Side

No access of distribution side required by drop technician

Bulkhead adapters for connectorized pigtails

3 termination options:
1) Pre-terminated drops
2) Pigtail splicing
3) Direct fusion splicing

Fiber splice sleeve and management

Accommodates multiple cable types, including armored and flat drop

Up to 8 drop cables

To Subscriber A   To Subscriber B

CommScope

Logical Optical Tap Layout

By-pass Fibers

Fiber 1
Fiber 2
Fiber 3
Fiber 4

Optical Coupler

Optical Splitter

14 - 2

(Tap Value in dB) – (# Ports)

Sample Tap Design (4 Port)

| 17 dB | 17 dB | 15 dB | 13 dB | 13 dB | 10 dB |

13 dBm Launch Power

Optical Level At NIU

| -3.9 | -4.9 | -4.5 | -3.0 | -5.0 | -4.4 |
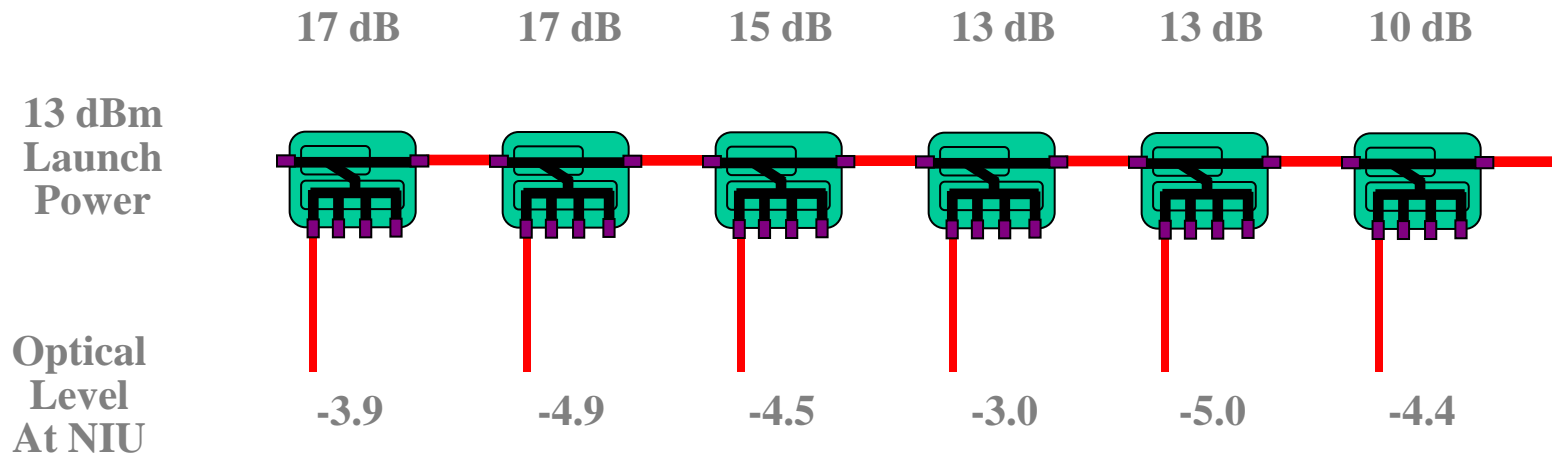
• Minimum Design input to NIU: -5.0 dBm @ 1550 nm

Tap Values

2-Port	4-Port	8-Port
17	17	17
15	15	15
14	13	14
12	11	12
10	10	10T
8	9	
7	7T	
5		
4T		

BRIGHTPATH

Sample Designs – 88 Homes per Mile
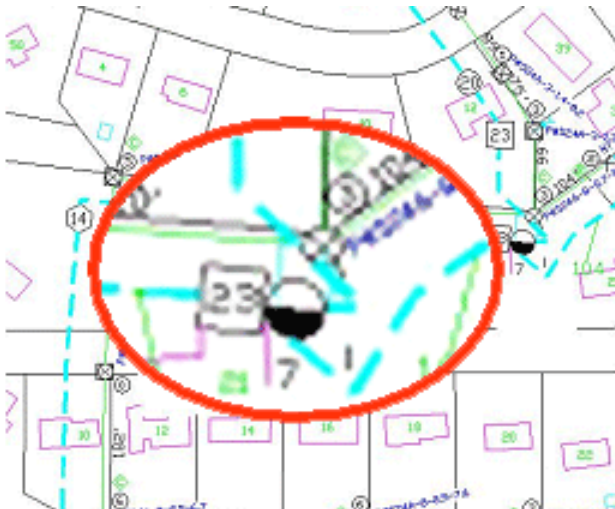
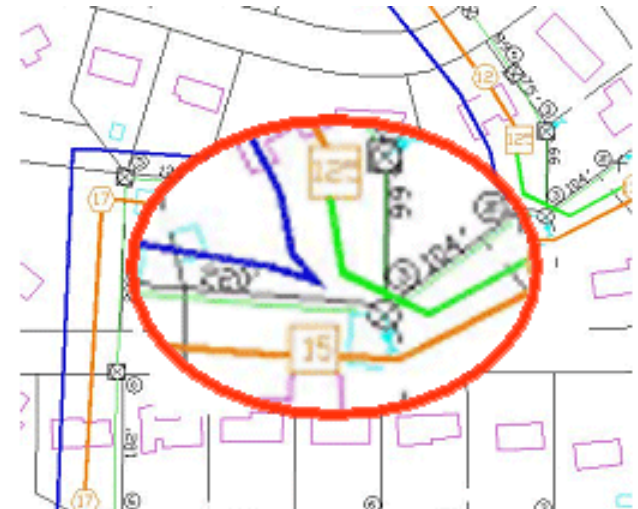**FTTH**

HFC

CommScope
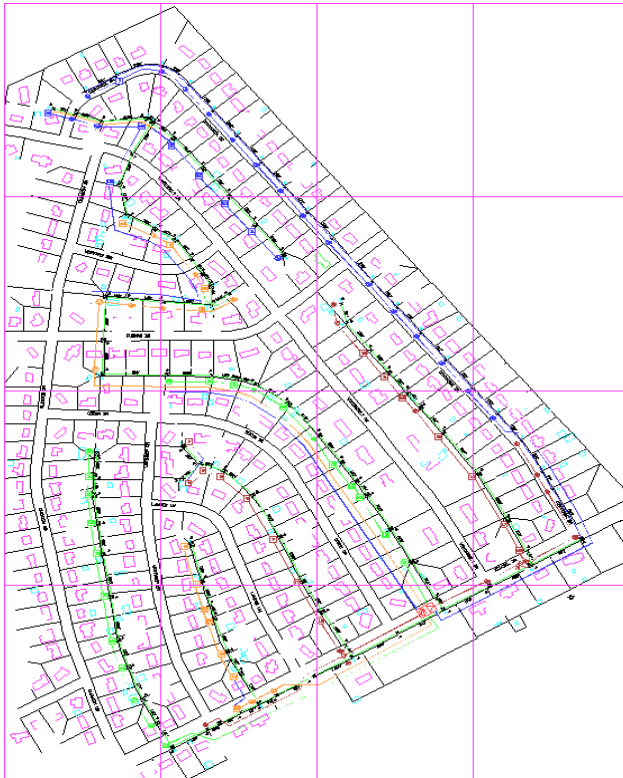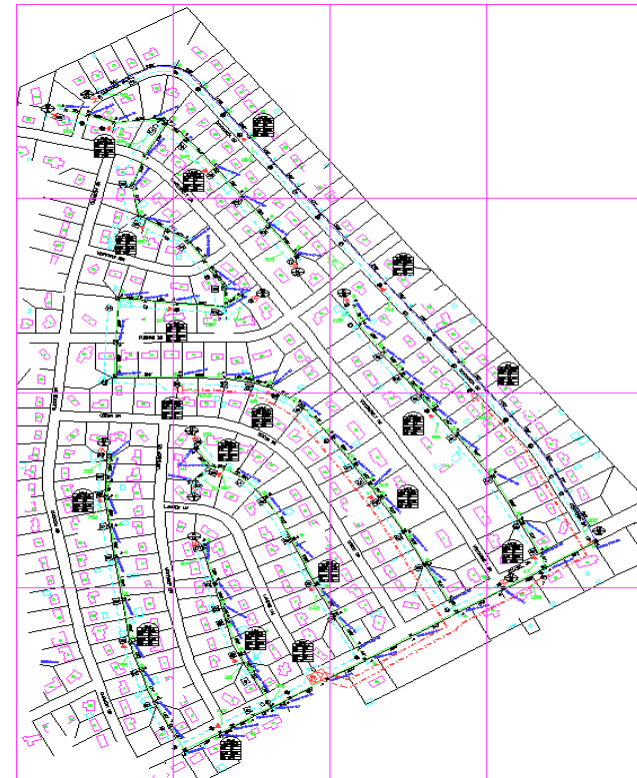
HFC Splitters *Vs.* FTTH "Loop Back"
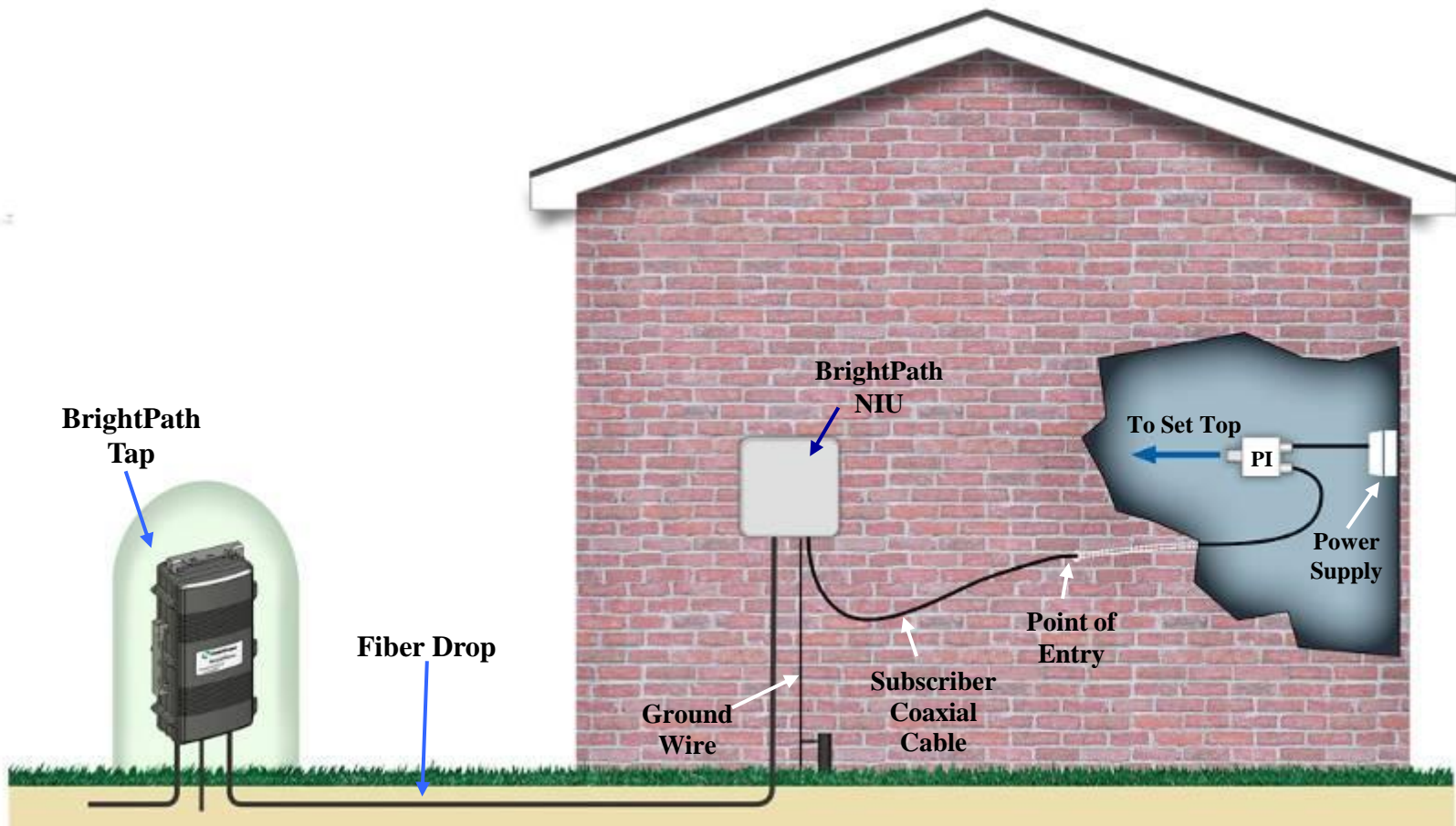
Standard HFC Splitter configuration

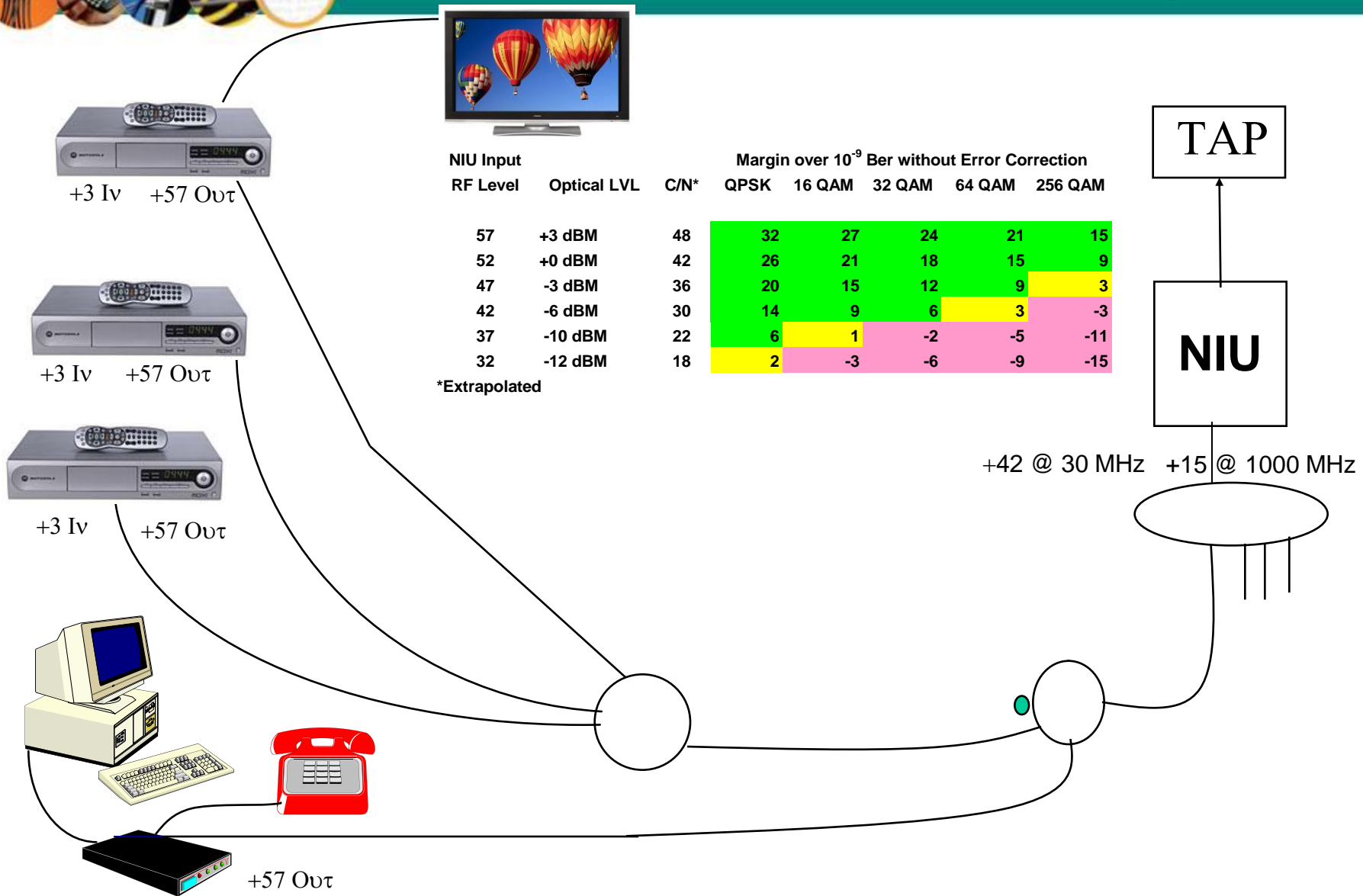**Unused fiber can be used for a "loop back" segment to avoid using a Splitter/coupler**

NIU Installation

BrightPath
Tap

Fiber Drop

BrightPath
NIU

To Set Top

PI

Power
Supply

Point of
Entry

Subscriber
Coaxial
Cable

Ground
Wire

*Can also direct power NIU

+3 Ιν   +57 Ουτ

+3 Ιν   +57 Ουτ

+3 Ιν   +57 Ουτ

+57 Ουτ

NIU Input			Margin over 10^{-9} Ber without Error Correction				
RF Level	Optical LVL	C/N*	QPSK	16 QAM	32 QAM	64 QAM	256 QAM
57	+3 dBM	48	32	27	24	21	15
52	+0 dBM	42	26	21	18	15	9
47	-3 dBM	36	20	15	12	9	3
42	-6 dBM	30	14	9	6	3	-3
37	-10 dBM	22	6	1	-2	-5	-11
32	-12 dBM	18	2	-3	-6	-9	-15

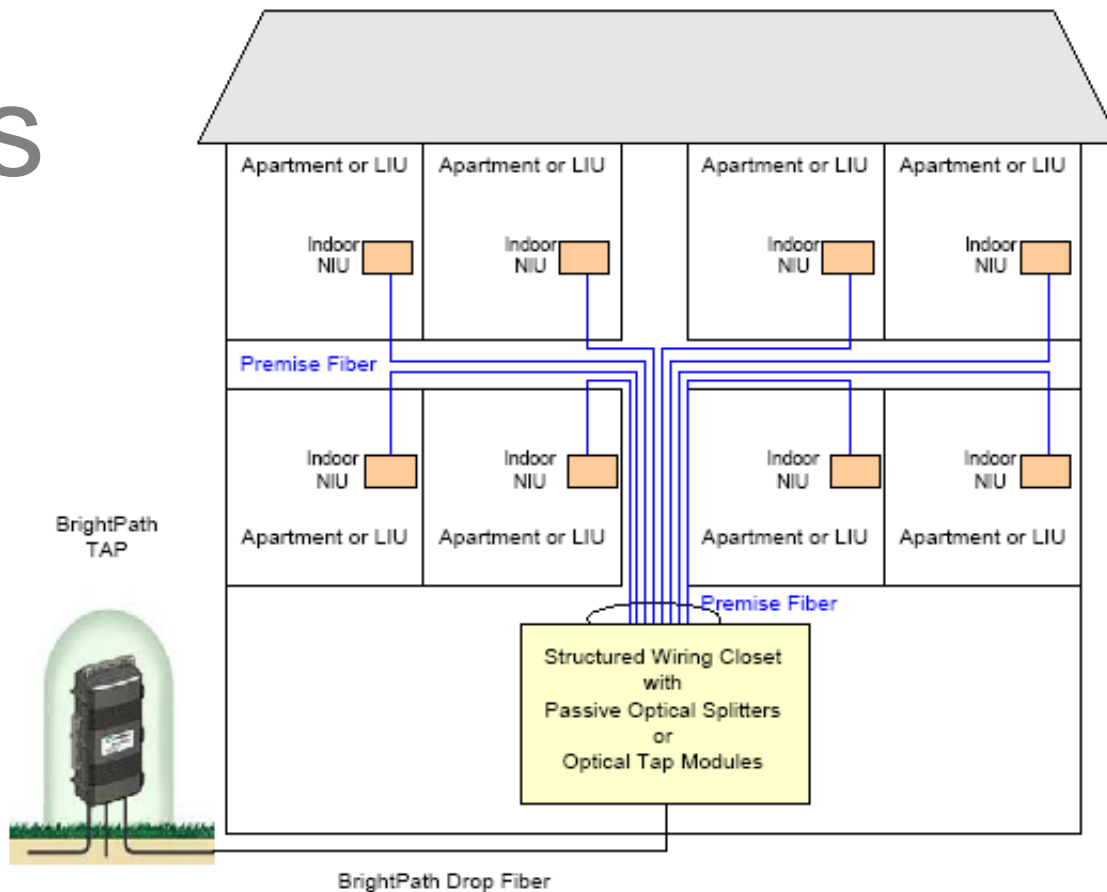*Extrapolated

TAP

NIU

+42 @ 30 MHz   +15 @ 1000 MHz

Four Shared MDU Units

CommScope

Solution 1: Fiber to the Apartment, one NIU per LIU

MDUs

Taps May Be Placed "Off Campus"

Constituent Components of Solution 1

- Indoor Apartment NIU
- Indoor single fiber drop cable
- Optical Splitters/Optical tap Modules
- Structured Wiring Enclosure

Advantages of Solution 1

- FTTH continued; Minimal Upstream Ingress
- One NIU fits all; Repackage Electronics for Indoor
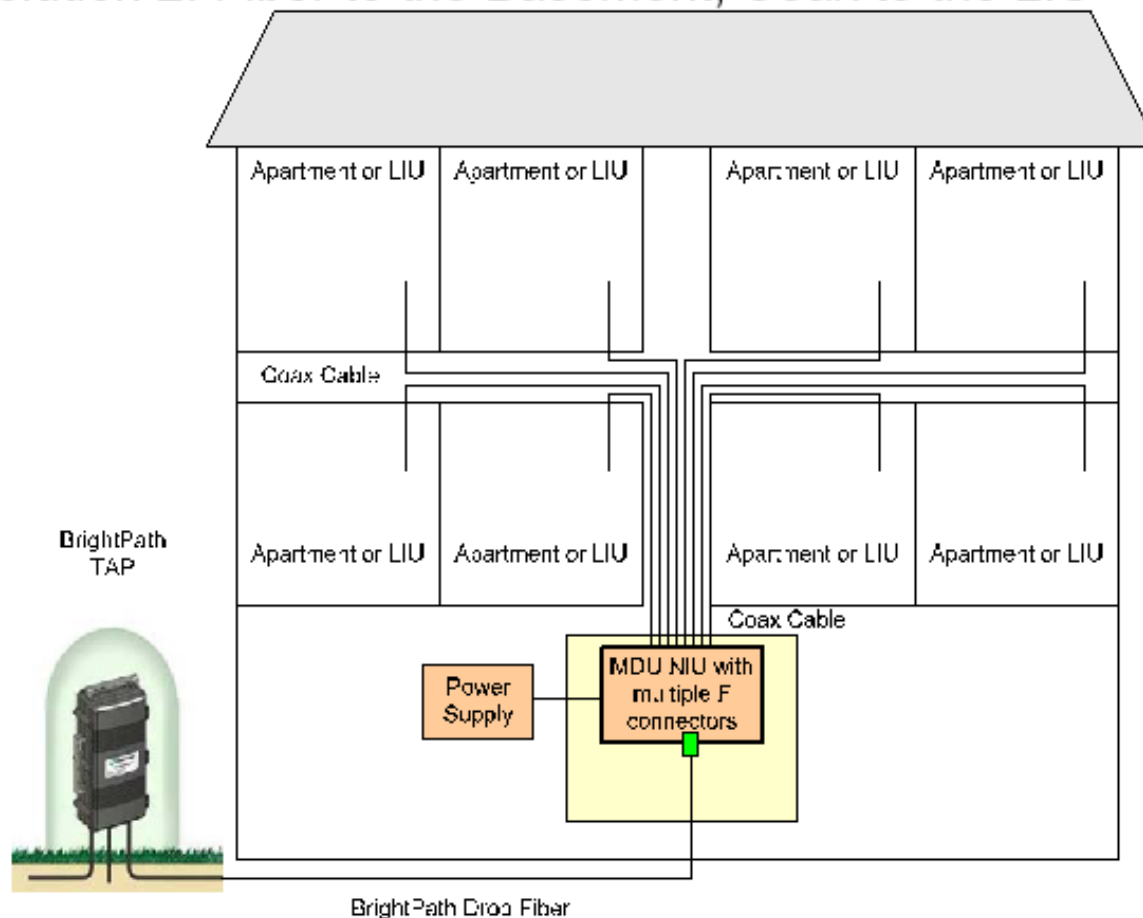- Inside Wiring/Management in CommScope Portfolio already

Disadvantages of Solution 1

- Cost of NIU per apartment
- No cable operator access to the NIU
- New Cabling in MDU
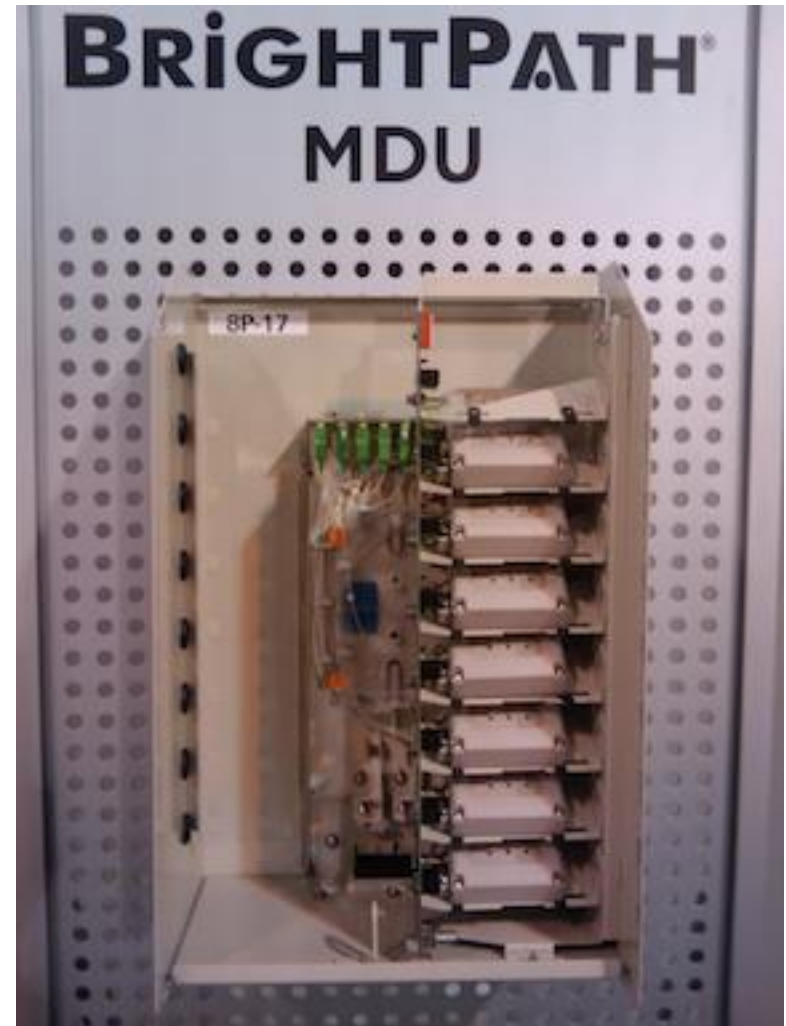
Solution 2: Fiber to the Basement, Coax to the LIU

Multiple NIUs
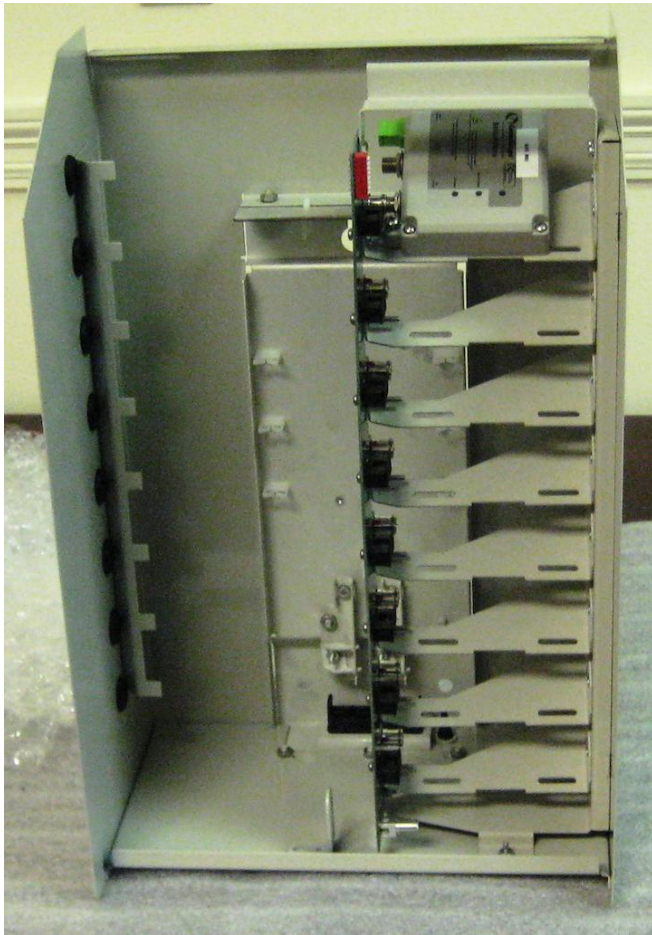
Coax to Living Unit

CommScope

Constituent Components of Solution 2

- Indoor/Outdoor multi-port NIU
- Structured Wiring Enclosure
- Coax Cable Drops

Advantages of Solution 2

- Low Equipment Cost: One NIU serves many subscribers
- Reuse of existing coax wiring
- Operator Access to MDU NIU

Disadvantages of Solution 2

- Multiple MDU NIU models
- Powering
- Susceptibility to Ingress Noise

Solution 3: BrightPath™ SFH NIU plus amplifiers

Constituent Components of Solution 3

- Existing BrightPath™ SFH NIU
- Off the shelf RF Amplifiers and Splitters
- Coax Cable Drops

Advantages of Solution 3

- Low Equipment Cost: One NIU serves many subscribers
- Reuse of existing coax wiring
- Operator Access to NIU and amplifiers
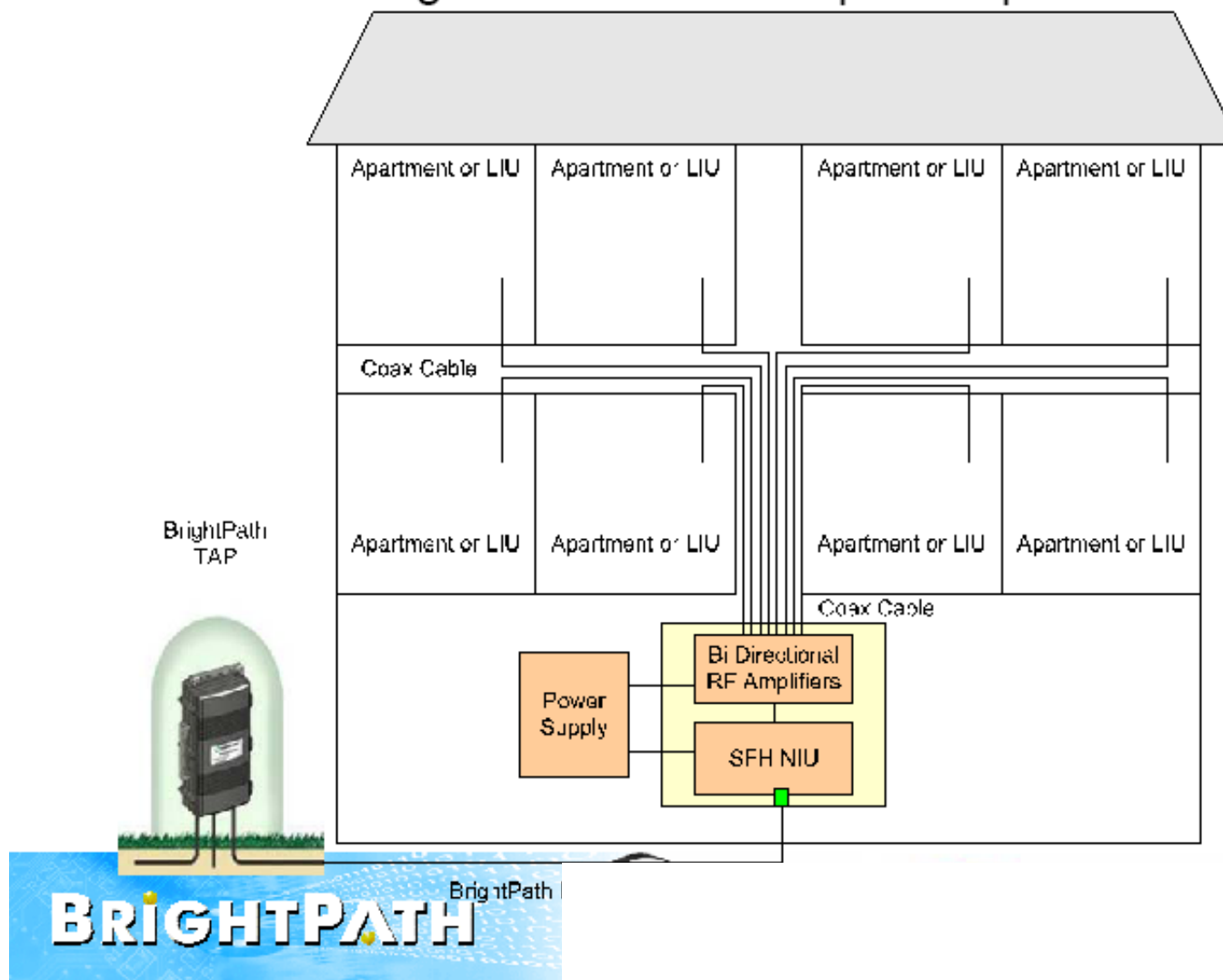
Disadvantages of Solution 3

- Multiple RF Amplifier/Splitter Solutions
- Additional Revenue for CommScope?
- Powering
- Susceptibility to Ingress Noise

BRIGHTPATH

NEW -
Battery Back-Up Unit

Features:

- **30W at 12 VDC**
  - **BrightPath NIU draws less than 2W**
- **Over 20 hours of stand-by power**
- **Reserves 40% of battery power for E911 availability**
- **Operating temperature**
  - **w/o heater option: -4° to 127° F**
  - **w/ heater option: -22° to 127° F**
- **Coax interface**

CommScope

Battery Backup Unit

- Small form factor indoor battery backup unit.

- Works with NIU standard 12 Vdc power supply.

- F connector input/output.

- Utilizes standard disposable or rechargeable AA batteries.
    - Enables users to provide their own batteries.

- Typically provides 8 hours of backup.

- LED status indicators:
    - Improperly installed batteries
    - Battery life

- Visual and Audible alarms when nearing end of battery life (audible alarm can be disabled by the subscriber).

BrightPath cables

Distribution cable

The preferred distribution cable is CommScope's **DA armored central tube** cable used for direct burial or in buried conduit. These are robust cables with a proven design.

BrightPath **DF flat cable** can be used for either distribution or drop. DF is a central tube cable with a flat design supported by twin fiberglass-reinforced plastic support members. It can be directly buried, buried in conduit or installed aerially.

Options for high-density builds are CommScope's **LA armored loose tube** cable (each subunit can hold up to 12 fibers) and CommScope's **LN all-dielectric loose tube** construction. Both cables can be installed aerially, buried in conduit or directly buried.

Drop cable

The preferred drop cable is CommScope's **DF flat drop** cable is a central tube cable with a flat design supported by twin fiberglass-reinforced plastic support members. It is self-supporting at distances of up to 709 ft (216 m) at 1% sag and can also be buried.

DA armored central tube drop cable is available in a single-fiber version for drop applications.
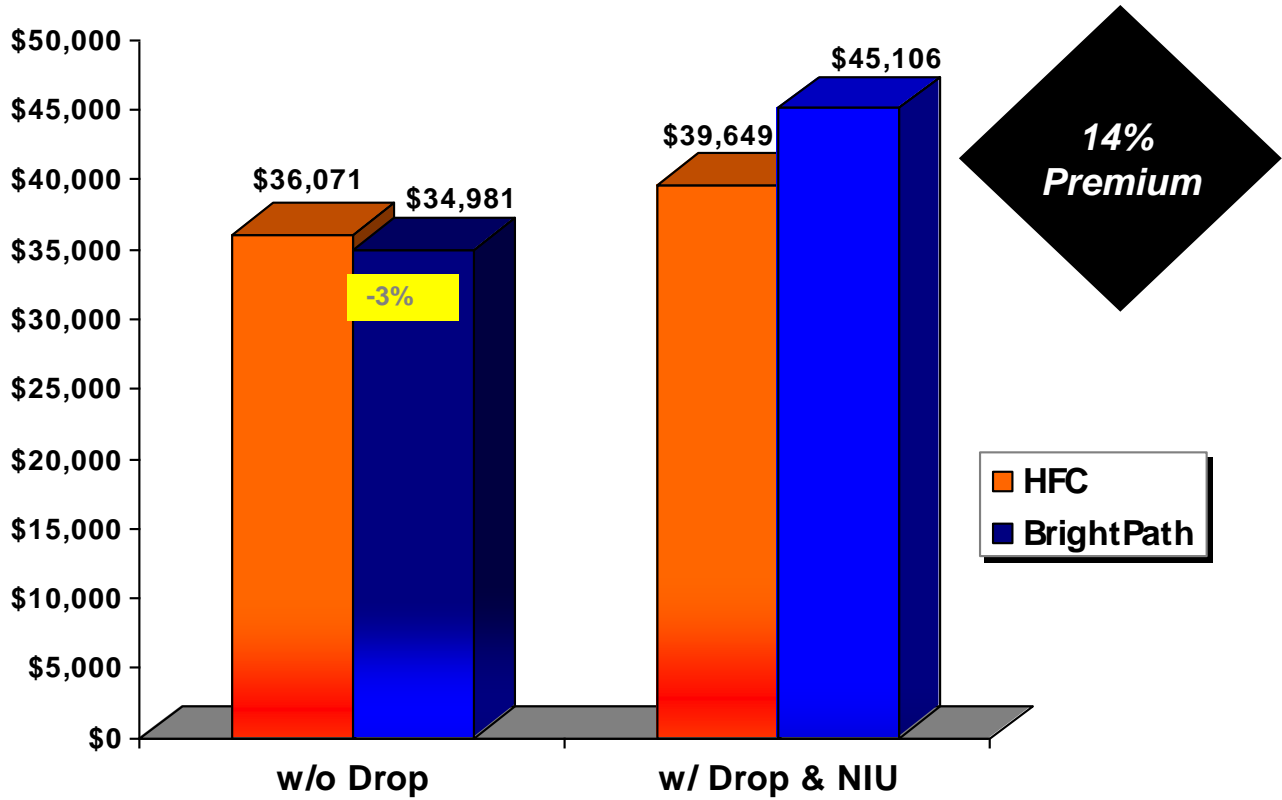
HFC vs. BrightPath™
New Build Cost/Mile –
HIGH DENSITY

Assumptions:
- 75 Homes/Mile
- 60% Penetration

Includes:
- *HE Equipment*
- *Design*
- *Installation*
- *Cable & Hardware*

14% Premium

Legend:
- HFC
- BrightPath

Chart values:

w/o Drop: $36,071 (HFC), $34,981 (BrightPath), -3%

w/ Drop & NIU: $39,649 (HFC), $45,106 (BrightPath)
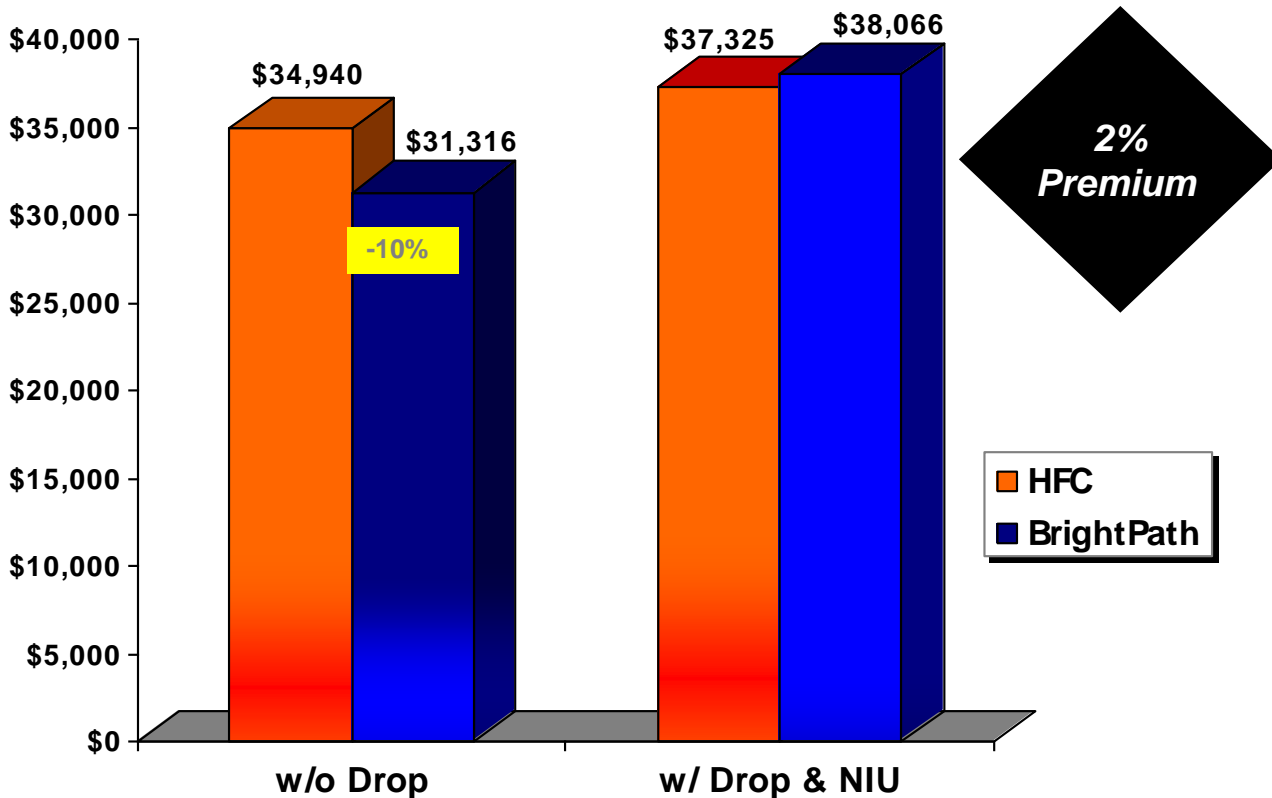
BRIGHTPATH

CommScope
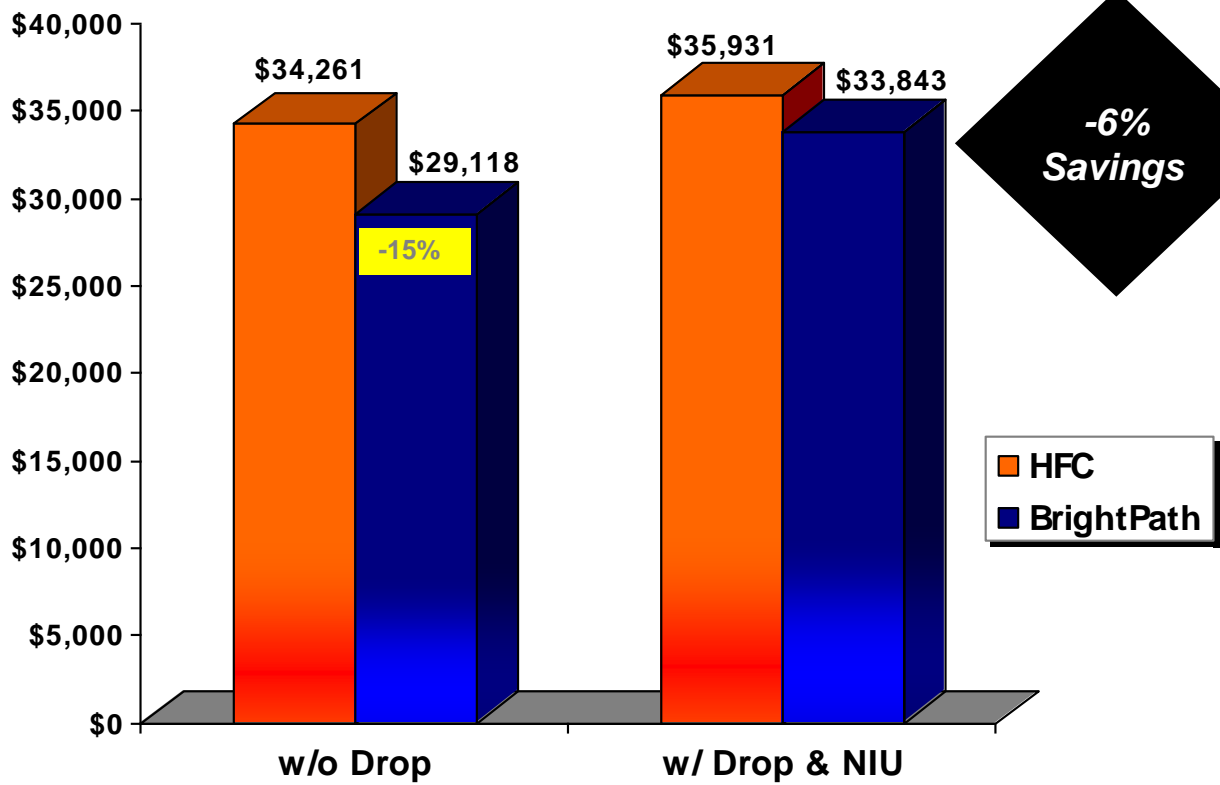
HFC vs. BrightPath™
New Build <u>Cost/Mile</u> –
MEDIUM DENSITY

Assumptions:
- 50 Homes/Mile
- 60% Penetration

Includes:
- *HE Equipment*
- *Design*
- *Installation*
- *Cable & Hardware*

Chart showing:

w/o Drop
- HFC: $34,940
- BrightPath: $31,316 (-10%)

w/ Drop & NIU
- HFC: $37,325
- BrightPath: $38,066

2% Premium

Legend:
- HFC
- BrightPath

Problems Facing Cable Companies

1. Competitive threat from Telcos, Satellite & Wireless
2. Premium HD Expansion
3. June 2009 Digital Transition & Analog carriage requirement
4. Spectrum Pressure on HFC
5. New business service demands
6. Wall Street pressure on architecture changes
7. Capex for new CPE equipment is in short supply
8. HFC Return Band (5-42 MHz) Limits Service Growth
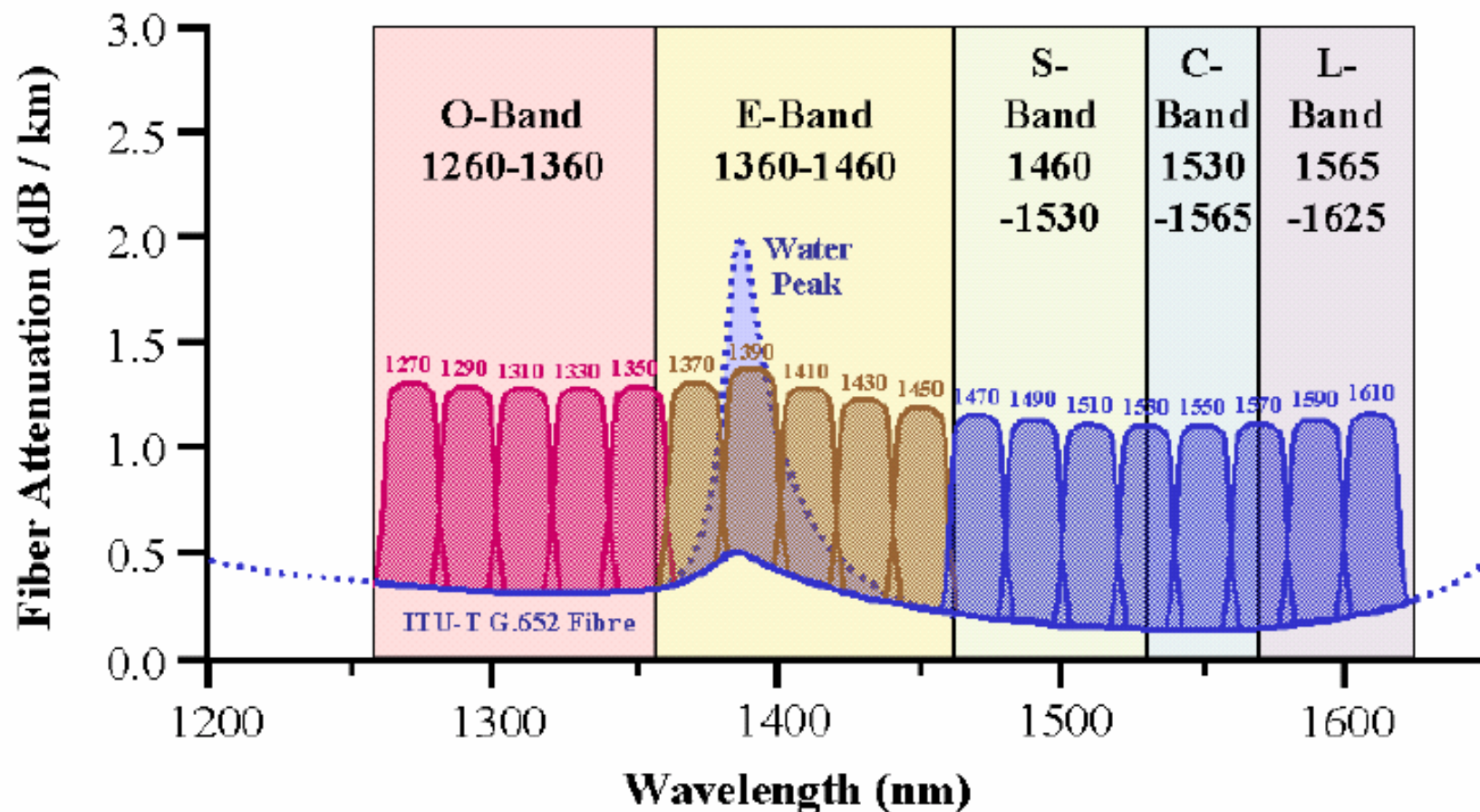
RFoG For Business
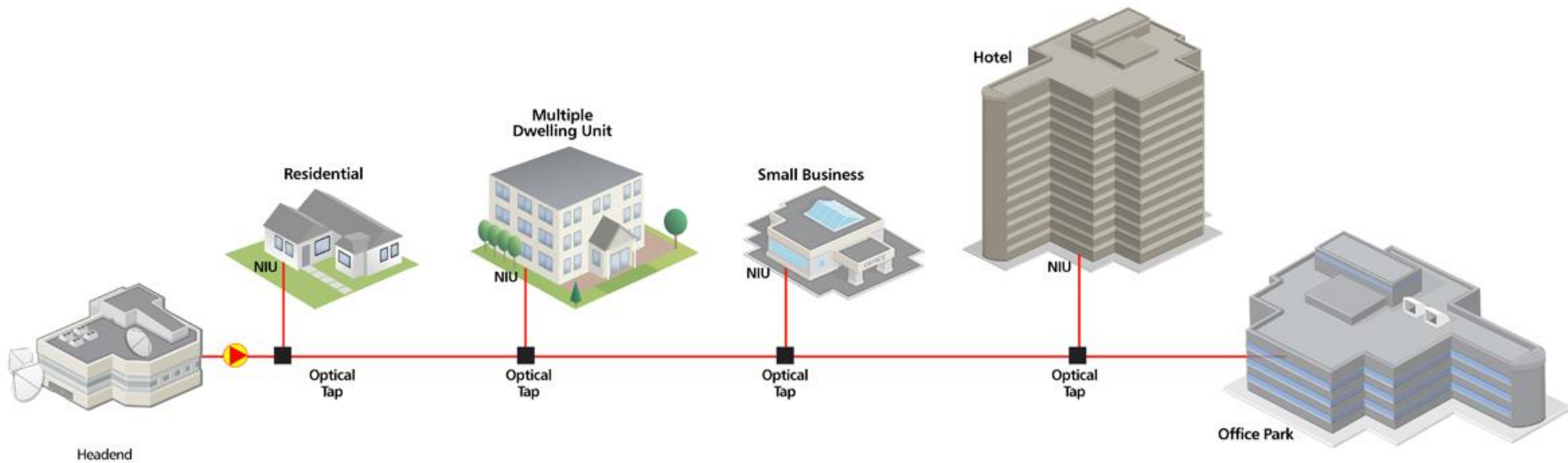
Figure 2   Metro CWDM Wavelength Grid as specified by ITU-T G.694.2

Three Levels of Business

• There is an underserved market of business subscribers who are located either within or on the periphery of residential zoned areas.

• Small office / home office customers are generally content with a Cable Modem based service.

•Large Business Parks are served with direct fiber links.

• Intermediate size business would eagerly sign up for a high capacity (100 MB/s, 1 Gig, 10 Gig), fully symmetrical data service, which could include a video offering as well.

Serving the Needs of Business

FAST E – Gig E – 10 Gig E - Symmetrical

A minimal cost adder to the BrightPath network makes this possible.
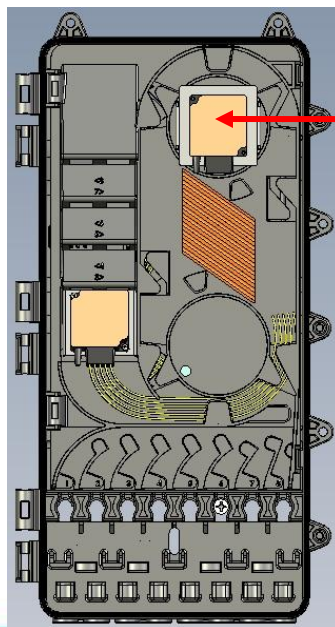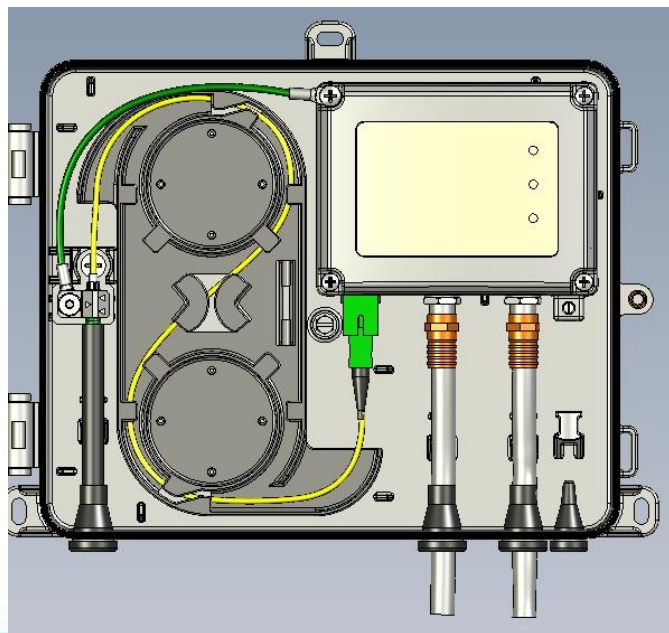
Addition of OADM

Optical Add / Drop Module
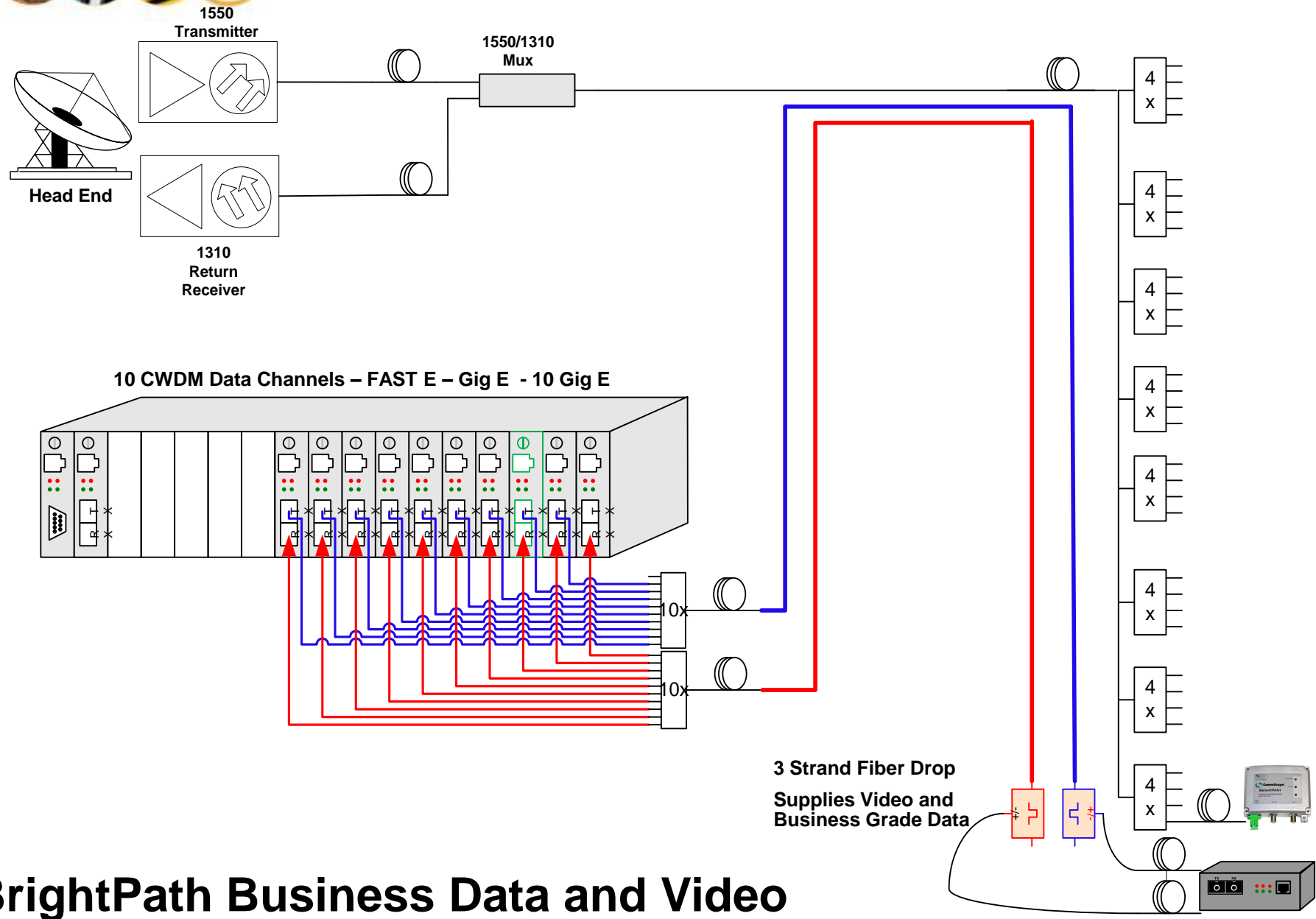
BrightPath Business Data and Video

CommScope
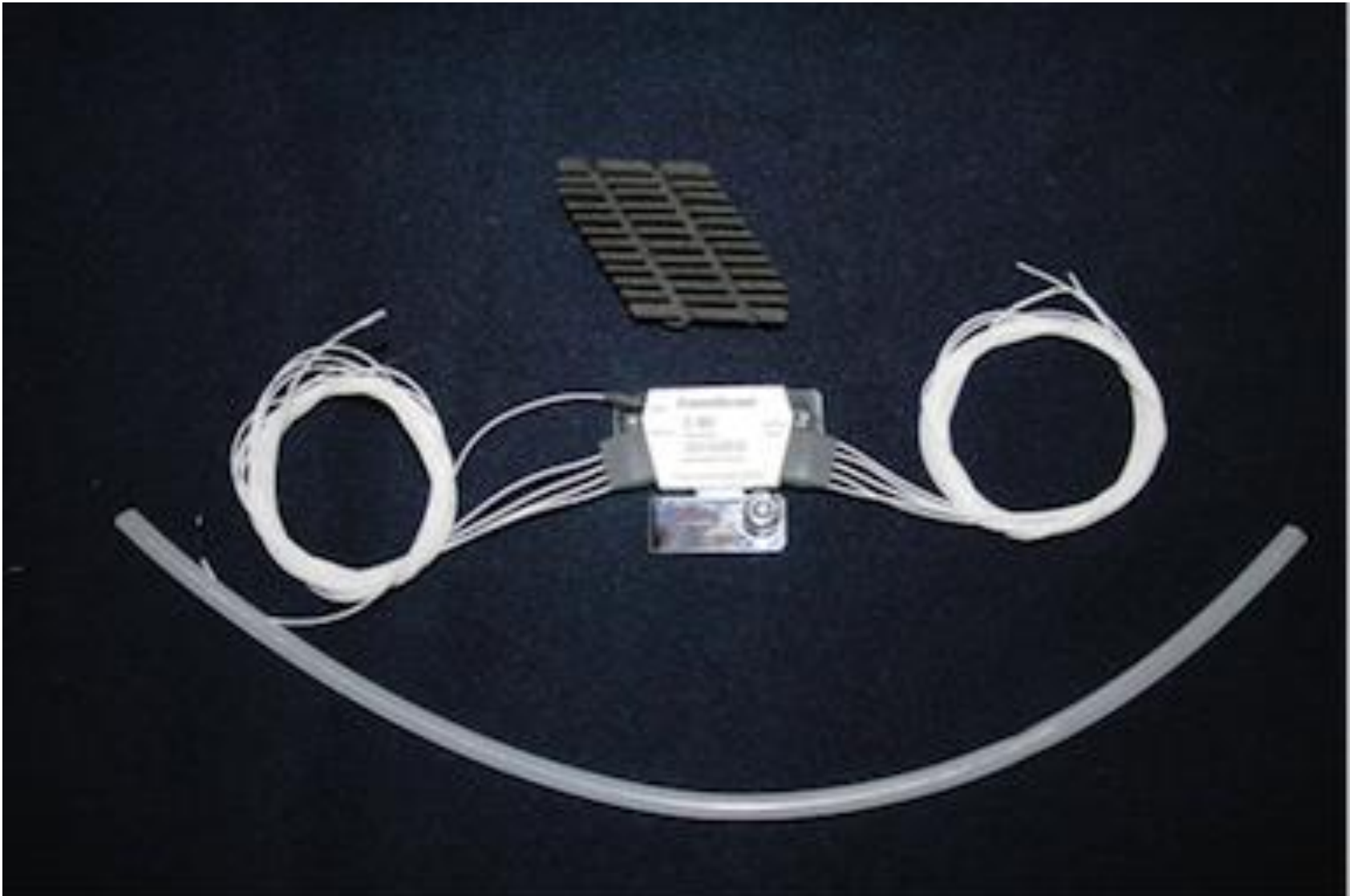
BrightPath for Business
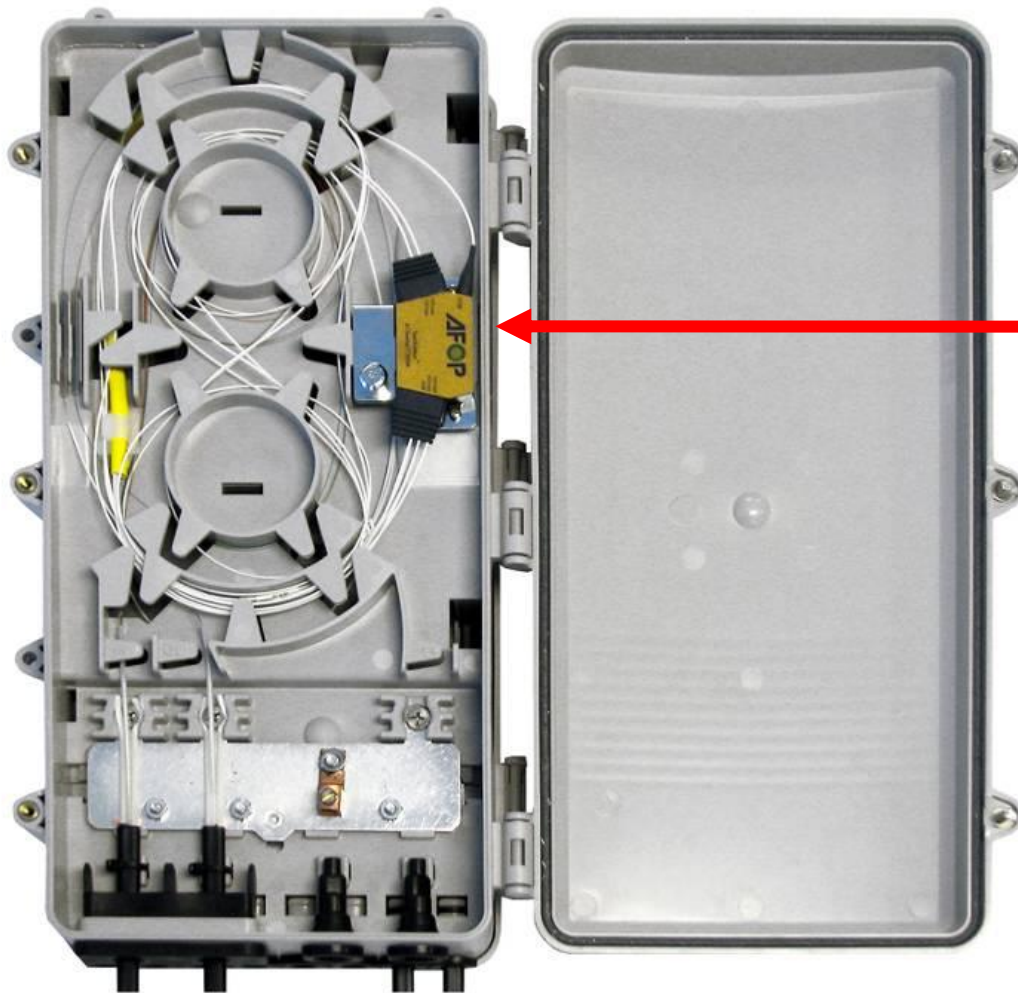
Addition of OADM

Optical Add / Drop Multiplexer

Summary of Advantages

Critical Differences

- **Carrier Class Data Solution**

- **GPON / GEPON Compatible**

- **No Financial Impact on Legacy Network**

BrightPath® USDA / RUS Acceptance

- In the Spring of 2009 CommScope received acceptance of the BrightPath product line by the Technical Standards Committee of the Rural Utilities Telecommunications Program.

- RUS acceptance of the BrightPath product line is a major milestone in providing rural operators with an economical FTTH solution.

BrightPath Roadmap

- 1550/1610nm GPON Compatible
  - Can coexist with G/GEPON wavelengths but not 10 G/GEPON wavelengths.

- 1550/1610nm RFoG Compliant
  - Will meet requirements of RFoG standard when complete.
  - Includes compatibility with G/GEPON and 10 G/GEPON wavelengths.

- 1550/1310nm w/ Addressability
  - Support on/off and selective filtering

- 1550/1310nm High Gain
  - Provide higher output for MDU applications

IPS Working Group 5 Activities (Interface Practices Subcommittee)

Preparing an RF over Glass (RFoG) architecture/system description document
(IPS 910)

Liaison with IEEE 802.3 Ethernet Working Group

➢ **WG 5 meets in conjunction with IPS four times a year plus teleconferences**

➢ **Membership in the SCTE Standards Program is required (and welcomed!)**

➢ **Certification?**
- **SCTE does not provide certification services or recognize certifications**

- **SCTE does not prohibit claims of conformance**

CommScope

BRightPath

BrightPath is NOT a PON

ITU-T G.983

APON (ATM Passive Optical Network). This was the first Passive optical network standard. It was used primarily for business applications, and was based on ATM.

BPON (Broadband PON) is a standard based on APON. It adds support for WDM, dynamic and higher upstream bandwidth allocation, and survivability. It also created a standard management interface, called OMCI, between the OLT and ONU/ONT, enabling mixed-vendor networks.

ITU-T G.984

GPON (Gigabit PON) is an evolution of the BPON standard. It supports higher rates, enhanced security, and choice of Layer 2 protocol (ATM, GEM, Ethernet). Verizon is in the process of implementing this.

IEEE 802.3ah

EPON or GEPON (Ethernet PON) is an IEEE/EFM standard for using Ethernet for packet data.

IEEE 802.3av

10GEPON (10 Gigabit Ethernet PON) is an IEEE Task Force for 10Gbit/s backwards compatible with 802.3ah EPON. 10GigEPON will likely be based on Wave Division Multiplexing (WDM) technology.

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New From CommScope in 2010

![BRIGHTPATH]
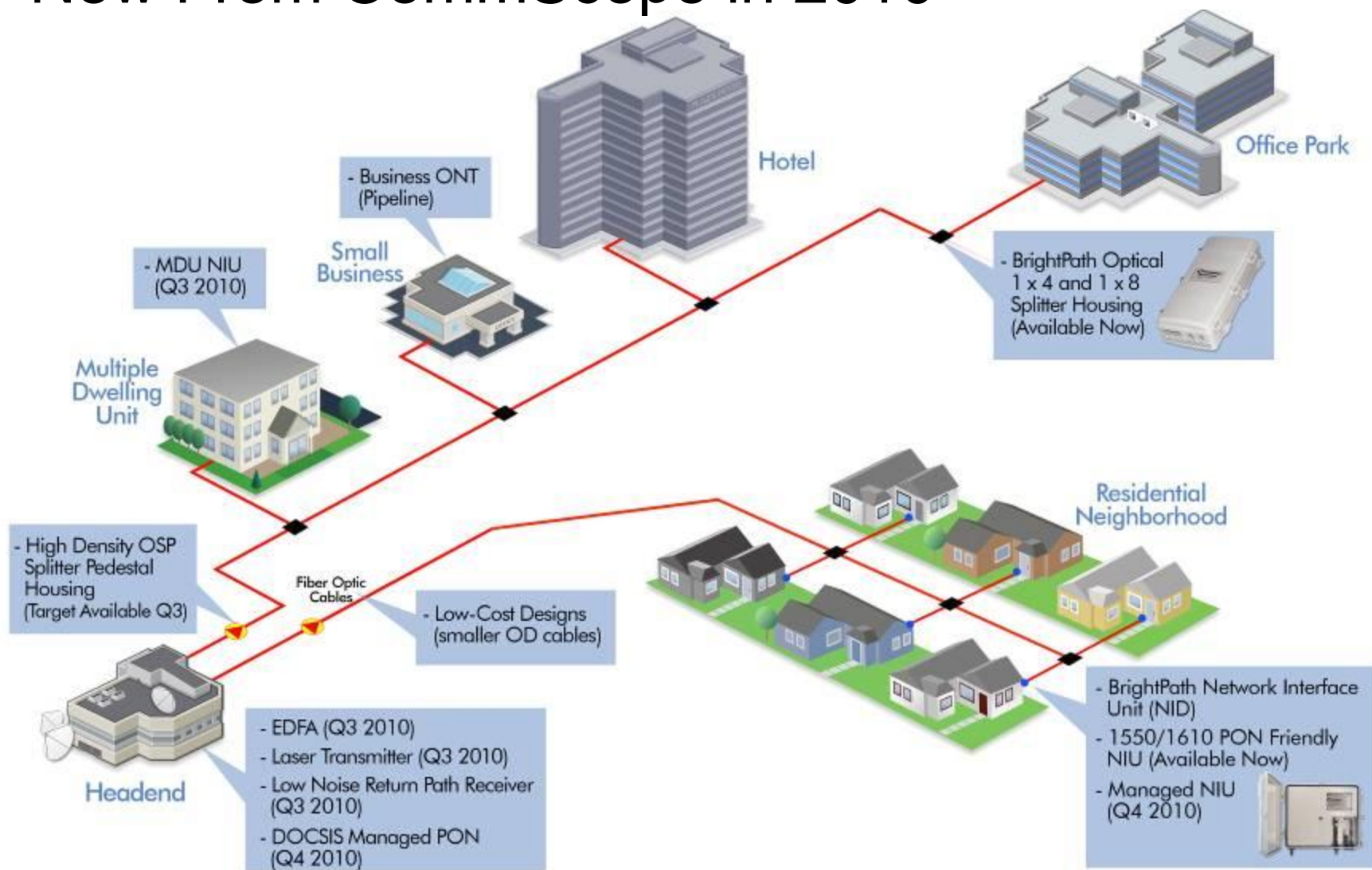
RFoG Products

OSP Products
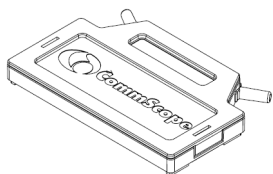
Full Spectrum
Splitters/Taps

Ruggedized
1x32
Splitter

Above Grade
Closure

Below Grade
Closure

Head End Products   Subscriber Products

Low Noise
RPR

RFoG ONUs

Battery
Backup
Unit

High Power
RFoG ONUs

NID

CommScope

High Power Output Unit for MDUs

- CommScope is launching 6 new models of RFoG ONUs (R-ONU) within two product lines

  - ## Standard Power R-ONU   (+17 dBmV)
    - 1310nm return – No PON support
    - 1610nm return – PON friendly
    - 1610nm return with integrated PON WDM

  - ## High Power R-ONU for MDU applications (+34 dBmV)
    - 1310nm return – No PON support
    - 1610nm return – PON friendly
    - 1610nm return with integrated PON WDM

1610 nm Return Path

- Meets the developing SCTE RFoG standard
- Delivers PON Compatible DOCSIS based services
- Works on the same ODN with any PON that uses ITU compliant wavelengths (10G EPON, EPON, GPON)
- 1 GHz RF spectrum provides extended RF capacity.
- Fast laser activation prevents degradation of upstream bursts.
- RF-based AGC to provide constant RF output over optical input range.
- High RF output with up-tilt reduces need for in-home amplifier.
- Transparent return path allows use of existing CPE (All Cable Modems & Set-top Boxes).
- Return transmission threshold suppresses noise from the subscriber's residence (Full 5 – 42 MHz band is available).
- Dedicated F port for powering
- Die-cast aluminum housing protects electronics and provides excellent shielding.
- Temperature Hardened

1610 nm Return Path
w/ PON Pass Through

- **Adds Support for PON ONTS s**
  - Integrated WDM provides fiber connectivity with ONT
  - WDM provides 1490/1310 nm PON wavelengths
- Delivers PON and DOCSIS based services
- 1 GHz RF spectrum provides extended RF capacity.
- Fast laser activation prevents degradation of upstream bursts.
- RF-based AGC to provide constant RF output over optical input range.
- High RF output with up-tilt reduces need for in-home amplifier.
- Transparent return path allows use of existing CPE (All Cable Modems & Set-top Boxes).
- Return transmission threshold suppresses noise from the subscriber's residence (Full 5 – 42 MHz band is available).
- Dedicated F port for powering
- Die-cast aluminum housing protects electronics and provides excellent shielding.
- Temperature Hardened

High Power 1610 nm Return Path

- **Extra high RF output with up-tilt to support MDU applications.**
- Delivers PON Compatible DOCSIS based services
- Works on the same ODN with any PON that uses ITU compliant wavelengths (10G EPON, EPON, GPON)
- 1 GHz RF spectrum provides extended RF capacity.
- Fast laser activation prevents degradation of upstream bursts.
- RF-based AGC to provide constant RF output over optical input range.
- Transparent return path allows use of existing CPE (All Cable Modems & Set-top Boxes).
- Return transmission threshold suppresses noise from the subscriber's residence (Full 5 – 42 MHz band is available)..
- Dedicated F port for powering
- Die-cast aluminum housing protects electronics and provides excellent shielding.
- Temperature Hardened

High Power 1610 nm w/ PON Pass Through

- **High RF output with up-tilt to support MDU applications.**
- **Adds Support for PON ONTS s**
  - Integrated WDM provides fiber connectivity with ONT
  - WDM provides 1490/1310 nm PON wavelengths
- Delivers PON Compatible DOCSIS based services
- Works on the same ODN with any PON that uses ITU compliant wavelengths (10G EPON, EPON, GPON)
- 1 GHz RF spectrum provides extended RF capacity.
- Fast laser activation prevents degradation of upstream bursts.
- RF-based AGC to provide constant RF output over optical input range.
- Transparent return path allows use of existing CPE (All Cable Modems & Set-top Boxes).
- Return transmission threshold suppresses noise from the subscriber's residence (Full 5 – 42 MHz band is available).
- Dedicated F port for powering
- Die-cast aluminum housing protects electronics and provides excellent shielding.
- Temperature Hardened

**CommScope**

Ruggedized Splitters

- Supports OSP environment -55 C to +85C
- Fiber ends protected in segmented storage
- Input leg designated by red colored boot
- Special ruggedized jacket material keeps cable flexible at low temperature.
- Individual legs 129.5 cm long – reaches all ports
- Fiber separators prevent twisting
- Available with SC or LC connectors

Optical Splitter/Tap Enclosure

- ## Optical Components
  - 1260 to 1620 nm support
  - Planar devices:
    - 1x4, 1x8 splitters
    - 4 and 8 port taps (2 port FBT)
  - SC/APC & direct splice versions
  - Optical modules stackable

- ## Enclosure
  - Pedestal or aerial mounting
  - Separate distribution/drop access
  - Fiber management and bend control
  - Support multiple cable types/designs
  - 8 fiber drop and 1 fiber extension ports
  - Supports CWDM overlay.
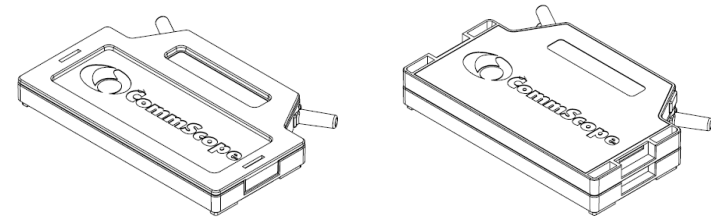
Optical Modules
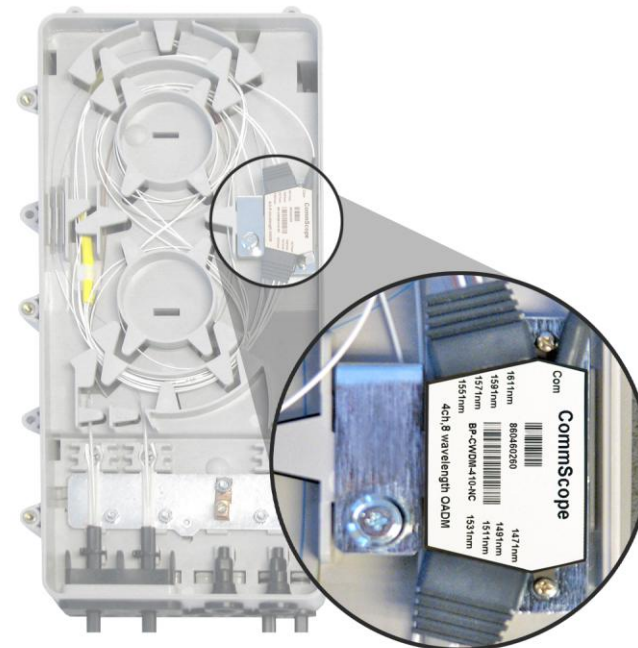
Optical Splitter/Tap Enclosure Below Grade

- Below grade splice enclosure for optical splitters and taps:
    - Utilizes same optical modules as above ground closure
- Supports fiber extension and up to 12 flat drop cables (8 drop armored).
- Supports multiple drop and distribution cable sizes and types (flat, messenger, armored, all dielectric, etc.)
- Available with up to 5 splice trays (24 splices per tray)
- Integral cable termination and grounding.
- Basket for storage and management of unused buffer tubes

CommScope
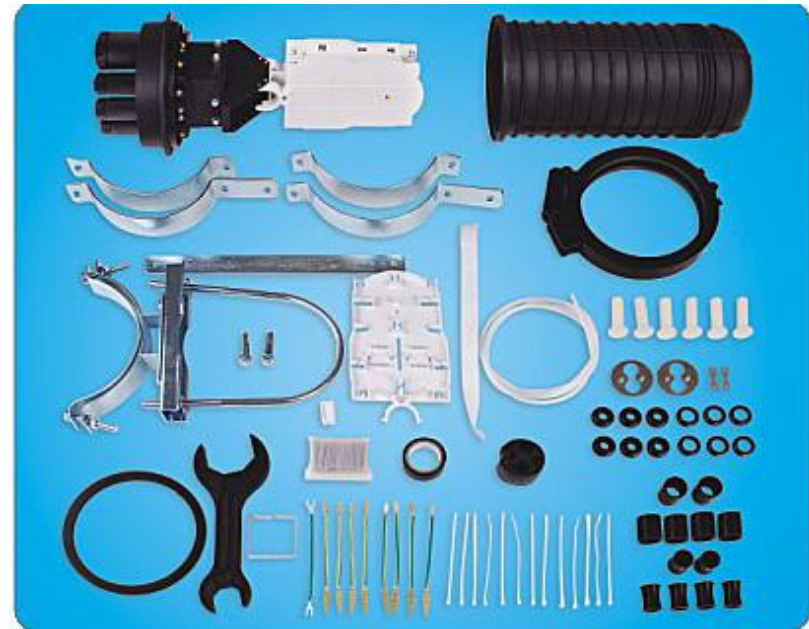
Low Noise Return Path Receiver
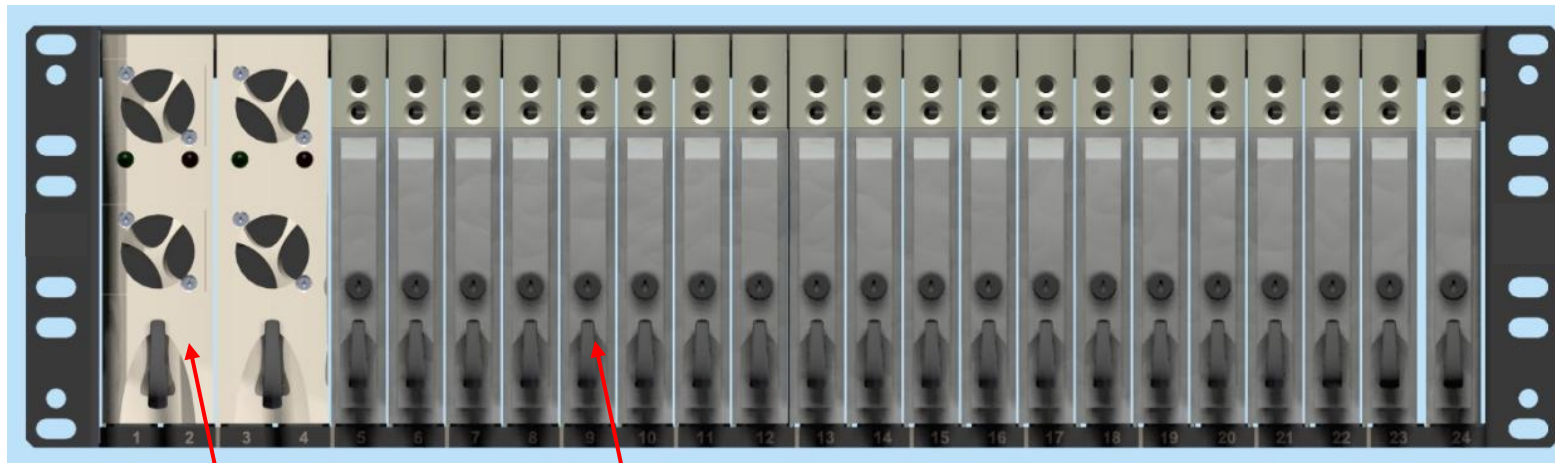
Power Supply
(Dual Wide Card)

Dual LNRX
(Single Wide Card)

- 19", 3 RU chassis with integrated communications module,
- 20 single wide cards per shelf (MCX)
- Redundant chassis power supply
- Single wide, dual receiver card
- Fully SNMP manageable
- 0 to 50° C operating temperature range

CommScope

Low Noise Reverse Path Receiver
Specifications

- **Optical**
  - SC/APC Connectors
  - Wavelength: 1260 - 1620nm
  - Sensitivity: -13 to -28 dBm
- **RF**
  - RF Bandwidth: 5 – 85 MHz
  - Flatness: +/- 1.0 dB
  - 30 dBmV minimum output
  - Output Level Adjustment: 0 dB to 30 dB (1dB increments)
  - RF Test Point: -20 +/- 0.5 dB from RF output power
  - Return Loss (min): 16 dB
- **Performance**
  - EIN: <1.5 pA/$\sqrt{Hz}$
  - 30 dB NPR dynamic range @ -20dBm receive power: 15 dB

CommScope

Managed RFoG ONUs – Q4 2010

- Goes beyond RF connectivity to add management and diagnostic capabilities to CommScope RFoG networks

- Managed parameters include:
  - Remote on/off control of services
  - Optical power level detection and monitoring in forward & return paths
  - Laser power and bias current
  - RF input level high/low alarms
  - Unit temperature reporting and alarms
  - External alarm inputs (contact closure type) for environmental alarms, intrusion alarms, intelligent power source (e.g. UPS) alarms, etc

- Slightly larger form factor from existing Brightpath   ONUs

- Adds test points for optical & RF power

- Current functionality and performance maintained
  - SCTE standards-compliant

Forward Path Transmitter
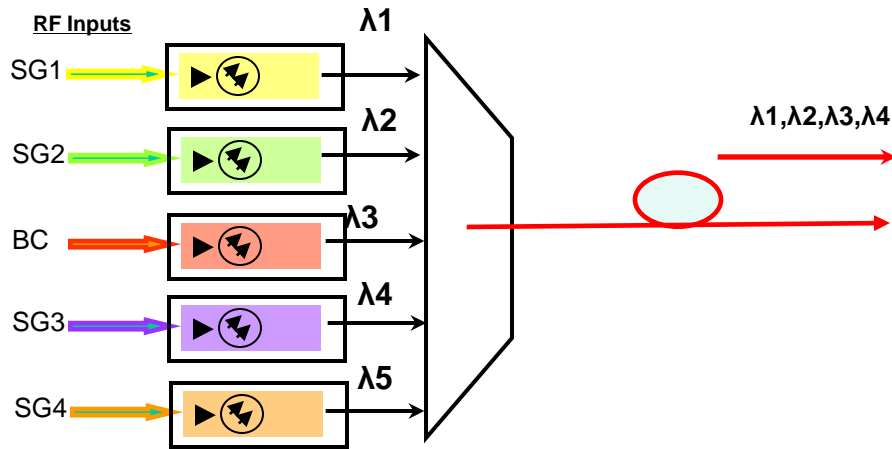
- Instead of using multiple Xmod transmitters and externally WDM muxing them together, we believe there is a better low cost approach to narrowcasting
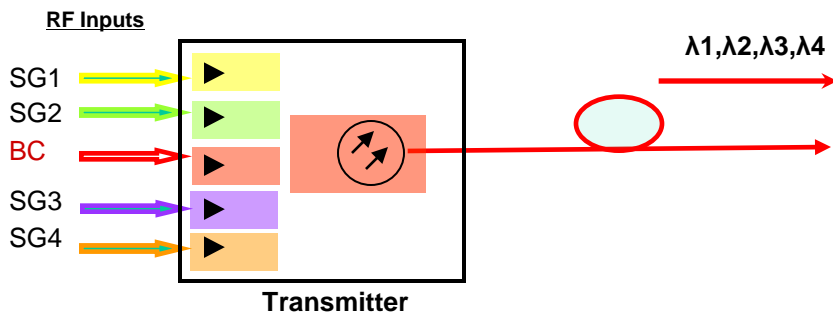
- A single 1GHz transmitter able to provide a broadcast and four narrowcast signals

4 Wavelengths To The Node

- *1 Node*
- *Single Fiber*
- *4 Wavelength 1550nm DWDM Transport*
- *4 way Forward Node Segmentation*

RF Inputs

SG1 — RF

SG2 — RF

BC — RF

Transmitter

4 TX's
$\lambda_1, \lambda_2, \lambda_3, \lambda_4$

SG3 — RF

SG4 — RF

EP

$4\ \lambda$

0 - 40 Km

Segmentable Node

D M U X

EP

Rx1
Rx2
Rx3
Rx4

BC + SG1

BC + SG2

BC + SG3

BC + SG4
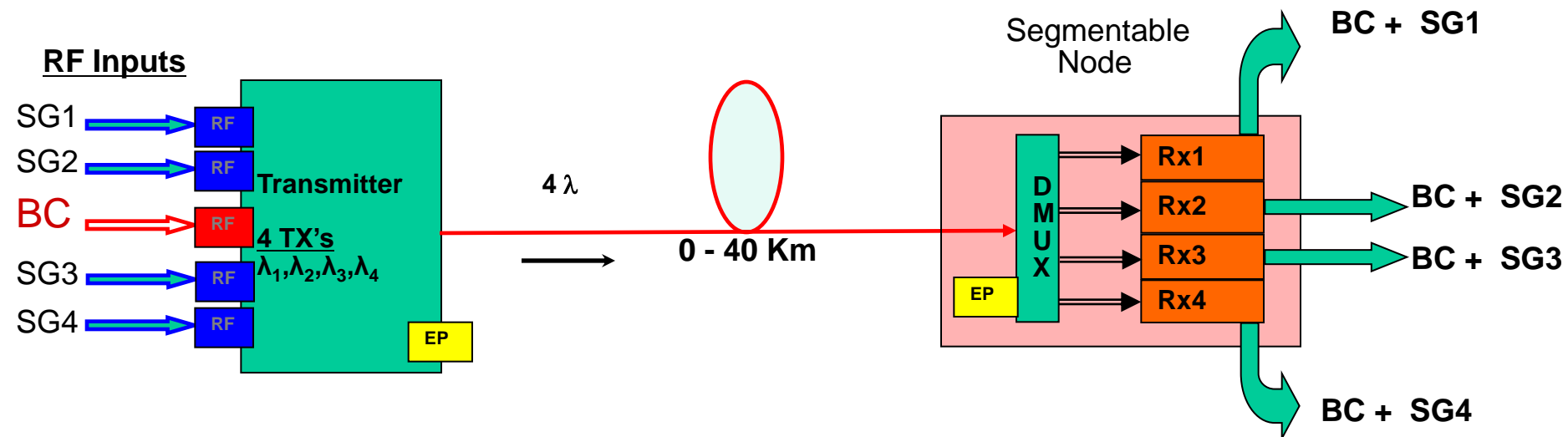
Return signals can be brought back on separate fibers or on the same fiber

CommScope

Multi-wavelength Transmitter – July 2010

- Supports 4 Narrowcast and 1 Broadcast wavelength with one transmitter
- 1 RU width
- -48V DC and AC Power options
- +6 dBm output,
- ITU Grid 29, 27, 25, 23

CommScope

EDFA – July 2010

- Supports the full 1540 to 1565 nm RFoG optical wavelength range
- 1 RU width
- 50 mW (17 dBm) output model: 1, 2, 4, or 8 ports
- 100 mW (20 dBm) output model: 1, 2, or 4 ports
- The noise figure is 3.7 dB typical with Pin = 6 dBm

MSO Deep Fiber
RFoG & PON – One Fiber Infrastructure
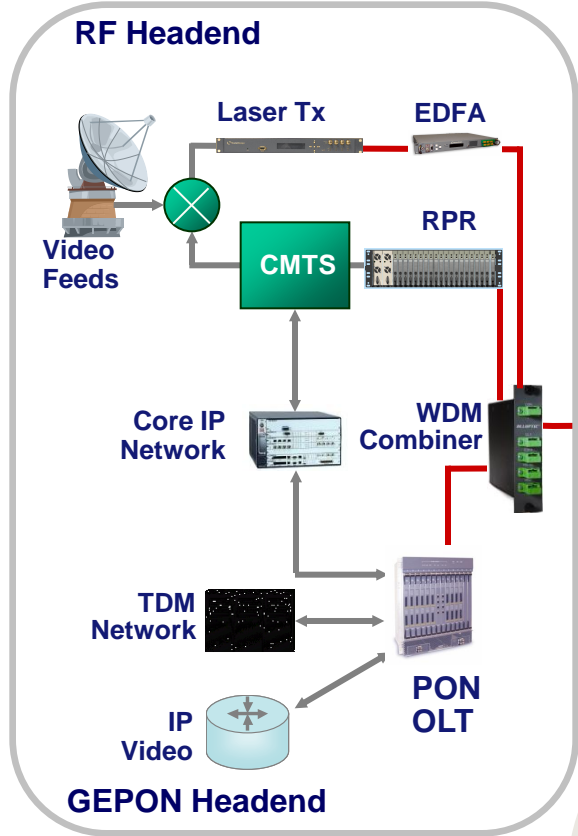
RF DOCSIS and GEPON Ethernet Share Same Fiber Infrastructure

Delivers Services to Fit Subscriber Needs

RF Headend

Laser Tx   EDFA

Video Feeds

CMTS   RPR

Core IP Network

WDM Combiner

TDM Network

IP Video

PON OLT

GEPON Headend

Residential Development

RFoG ONU

RFoG ONU

Residence

Residence

RFoG Residential Services

Packet Cable & Data

Apartment

HP RFoG ONU

Residential MDU

Video Services

PON ONT

T1 or Ethernet

Backhaul

Corporate Offices Business Parks

PON ONT

T1   **PBX**   **Router / Switch**

Ethernet

CommScope

PON Topology & Products (Q4 2010)

BRIGHTPATH

ONTs

OLT

FTTH

BOA-ON-4000

Residence

POTS
Ethernet
Video

FTTB

BOA-ON-1000

Small Business

POTS
DS1
Ethernet
Video

Optical Splitter

1
32

MDU/FTTB

BOA-ON-6000

High Density/Multi-Tenant

Ethernet
Video

GE-PON

1.25 Gbps symmetrical
Voice, Data, Video
1490 nm downstream
1310 nm upstream
1550 nm RF Video, IP Video

BOA-OLT-10

FTTB

BOA-ON-9000

Corporate Offices/
Business Parks

POTS
DS1
Ethernet
Video

Packet Voice

**Ethernet /
IP Data**

IP Video

RF Video

Headend

CommScope

BOS-OLT-10 OLT

- **Unmatched Density**
    - Up to 80 x 1G-EPON per shelf
    - Up to 20 x 10G-EPON per shelf
    - 32 or 64 split ratio per PON
- **Scalable & Protected Investment**
    - 160 Gbps Bi-Directional Switching Capacity
    - Bi-Directional 800 Gbps Backplane
    - Per slot 10G-EPON and 1G-EPON support
    - NIM, PIM, FAB card 1:1 redundancy and hot swappable
    - Pluggable optics (SFP, XFP)
- **Carrier Class Architecture**
    - Redundancy is optional for any active electronics
        - Switch Controller, Power Supply, Fan, NIM, PIM, FAB
    - NEBS 3 compliant
    - MEF 9 & 14 Certified
    - Link Aggregation protection for network interfaces

CARRIER ETHERNET
MEF
Certified Compliant

CommSco

Summary

- New, updated Brightpath Optical Solution (BOS)
  - Multiple versions of RFoG ONUs (1310nm, 1610nm, 1610nm w/ PON WDM)
  - Complete Outside Plant Solution
    - Splitters or Taps
    - Enclosures, Power, NIDs
  - Additional RFoG ONUs planned
    - High Power MDU versions (August)
    - Managed versions (Q4 2010)
  - Headend solution
    - Transmitter, EDFA, RPR (July)

  - PON Solution (Q4 2010)
    - DOCSIS Management
    - EPON & 10G EPON

Schedule

Product	Schedule	
	CI	**GA**
1610 nm ONU	June 2010	July 2010
1610 nm w/PON WDM ONU	June 2010	July 2010
1310 nm NIU	June 2010	July 2010
HP ONUs	Aug 2010	Sept 2010
Ruggedized 1x32 Splitter	Now	
Low Noise Reverse Path Receiver	June 2010	July 2010
Full Spectrum Components	May 2010	June 2010
Below Grade Enclosure	June 2010	July 2010
Battery Backup Unit	August 2010	September 2010

Telecommunications infrastructure solutions provider

Thanks For Listening

Solutions today for the technology of tomorrow!