Putting Next -Gen PON to Work

LiveLearning Webinars™ For Professionals

Thursday, June 17, 2021

11:00 am – 12:00 pm ET
Today’s Speakers

Alan Breznick
Cable/Video Practice Leader
Light Reading

Steve Harris
Executive Director
Technical Sales, Learning & Development
SCTE

Jason Morris
Marketing Manager
Corning Optical Communication

Rich Loveland
Director, Product Management
Vecima Networks

Jorge Figueroa
PON Solutions Manager
Harmonic

Douglas Clague
Solutions Marketing Manager
VIAVI Solutions
Agenda

• Light Reading—Fiber rollout trends & PON equipment outlook
• Corning—FTTX basics & typical deployment architectures
• Vecima—PON technology & MSO access network options
• Harmonic—Transitioning to a multi-access network
• VIAVI—Supporting new PON architectures & services
• SCTE—Training, standards & certifications
• Audience Q&A
Fiber network builds surging in U.S.
Fiber builds surging even more in Canada

Canada Has Experienced Extraordinary Fiber Broadband Growth
RVA Provider Study 2020

- 8.3 M Homes-Marketed
- 11% Growth in 2020
- 2.8 M Homes-Connected

Canada has now passed over half its households.
The remaining will become more difficult given more rural locations.
## North American SPs Racing to Deploy Fiber

<table>
<thead>
<tr>
<th>Service Provider</th>
<th>Fiber Plans &amp; Deployments</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
<td>Added more than 1 million new fiber subscribers over past 4 quarters, boosting its total to over 15 million. Plans to extend fiber to 3 million more residential and business locations in 2021, including 2 million homes. Has set goal of reaching 30 million locations with fiber by 2025. Reported 5.2 million AT&amp;T Fiber customers at end of Q1 2021.</td>
</tr>
<tr>
<td>Verizon</td>
<td>Now passes more than 15 million homes with fiber. Plans to add another 2.8 million homes by 2030. Says its One Fiber project, which calls for expanding to 60 new markets, is almost complete. Reported 6.3 million Fios Internet customers at end of Q1 2021.</td>
</tr>
<tr>
<td>Altice USA</td>
<td>Now passes over 1 million homes with fiber. Plans to extend fiber to 500,000 more homes in 2021 and another 1.5 million homes over 2022 and 2023, including 400,000 &quot;low-penetration and low-speed&quot; homes by the end of 2022.</td>
</tr>
<tr>
<td>Bell Canada</td>
<td>Aims to spend up to C$1.2 billion over next 2 years to fast-track fiber, wireless and rural network rollouts. Plans to add up to 250,000 fiber and 150,000 wireless homes in 2021 and more in 2022. Predicted to have 6.9 million locations passed by fiber by end of 2021.</td>
</tr>
<tr>
<td>Lumen Technologies (CenturyLink)</td>
<td>Now passes about 2 million homes with fiber. Plans to extend fiber to 6.8 million locations by 2030.</td>
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</table>
PON equipment forecast: Very strong growth

- PON is a fiber-efficient technology, enabling symmetrical, high-bandwidth services.
- 10G PON is gaining momentum, supporting high-end residential services, along with non-residential customers and applications, including enterprises, smart cities, and xHaul Transport.
- PON should be viewed as a complement to coax. It is rarely “either-or” for cablecos.
- Vendors are improving DOCISIS to PON adoption.

PON Equipment Revenue, by region/country

- Latin America & the Caribbean
- North America
- EMEA
- Asia & Oceania (excl. China)
- China

Source: Omdia

© 2021 Omdia
Movement to next-gen PON drives revenues

PON equipment revenue forecast by next-gen vs. non-next-gen

Source: Omdia

© 2020 Omdia
Jason Morris
Marketing Manager
Corning Optical Communication
Giving more fire power to existing PONs with higher bandwidth technologies

- **IEEE (Ethernet) based PONs use Ethernet packet protocol.**
- **ITU PONs based on GEM/10GEM protocol (Gigabit encapsulation mode).**
- **PONs use TDM in upstream (Time Division Multiplexing) – Individual ONT’s transmit in specified time windows.**
- **Coexistence important for leveraging existing infrastructure investment**
- **Standards allow vendors to commercialize solutions and carriers comfortable to deploy.**
- **Keeping ahead of bandwidth demands to ensure R&D time to develop products.**

<table>
<thead>
<tr>
<th>Standard</th>
<th>GPON</th>
<th>XG-PON1</th>
<th>XGS-PON</th>
<th>10G EPON</th>
<th>NG-PON2 (TWDM)</th>
<th>25G PON</th>
<th>50G G.HSP (TDM)</th>
<th>50G TWDM PON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of wavelengths (Upstream)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>up to 8 (4 currently)</td>
<td>4 options</td>
<td>1</td>
<td>up to 4</td>
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<tr>
<td>Number of wavelengths (Downstream)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>up to 8 (4 currently)</td>
<td>2 options</td>
<td>1</td>
<td>up to 4</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>2.5G DS / 1.25G US</td>
<td>10G DS / 2.5G US</td>
<td>10G DS / 2.5G US</td>
<td>10G DS / 10G US</td>
<td>10G/10G, 10G/2.5G (up to 80G/80G w/ channel bonding)</td>
<td>25G/10G 25G/25G 50G/10G 50G/50G (up to 80G/80G w/ channel bonding)</td>
<td>50G</td>
<td>50G</td>
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</tbody>
</table>
Typical Deployment Architectures
FTTx Basics

- **Home Run**
- **Centralized Split**
- **Distributed Split**
- **Distributed Tap**

NOTE: Assessments based on Corning models, field trials and deployments.
Pain Points
FTTx Basics

Speed
Optimization of contractor resources and management of skill bottlenecks

Cost
Nation-wide building and management of complex and variable mass infrastructure deployments

Quality
Consistent delivery of aesthetically pleasing, low consumer impact, high quality networks
FTTH Characteristics

- Labor and installation account for half of the cost of deployment.
- Availability of skilled labor is a challenge with large scale deployments.
- Involves the installation of cable and up to 40 different hardware components.
- Challenge is to reduce skilled labor requirements to enable deployment with a given level of man power.

Innovations

FTTx Basics

Labor costs make up an increasingly higher percentage of the total cost as equipment suppliers reduce network component/solution costs.
Putting Next Gen Fiber To Work
June 17th 2021
Agenda

01 | Explosive Growth of Fiber Deployment
02 | Government Funding Fiber Deployment
03 | PON Technology Options (Who’s using what)
04 | MSO access network Options
05 | Weighing the PON Options
06 | Unifying Access
07 | Summary

Putting Fiber To Work
Driving Fiber Deployment

Competition - Telcos Deploying
- AT&T >15 M HHP and building past another 3M homes and Businesses this year
- Verizon >15M HHP – planning to add another 2.8 M by 2030
- CenturyLink ~2M HHP going to 6.8 by 2030
- Frontier ~3M HHP
- Windstream ~1.3M HHP
- Bell Canada predicted to have 6.9M locations passed by end of 2021 (Lightwave Feb 8, 2021)

Government Funding
Greenfield
MDU complexes
Brownfield Hotspots

FTTH will pass 60 million by 2030, says New Street (US Homes)

1. New Street (Oct 27, 2020) the analyst group is forecasting that homes passed by fiber will increase from 40 million to 60 million over the next 10 years. That would increase the percentage of homes passed from 25% to 35%.
$20.4B USD to:
• Buildout rural fiber over 10 years
• Many Vecima customers have received funding
• Vecima Tier 1 operator initiating huge fiber build
• Incremental to existing FTTP opportunity

$100B USD to:
• Build high-speed broadband infrastructure to reach 100% coverage
• Promote transparency and competition
• Reduce the cost of broadband internet service and promote more widespread adoption

FACT SHEET: The American Jobs Plan Will Bolster Cybersecurity | The White House

FACT SHEET: The American Jobs Plan | The White House
### What technologies are being used?

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<thead>
<tr>
<th><strong>Telcos</strong></th>
<th><strong>MSOs</strong></th>
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</thead>
<tbody>
<tr>
<td>- Using GPON</td>
<td>- Using DPoE 10G EPON and some XGS/GPON</td>
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<tr>
<td>- Evolving to XGS PON</td>
<td>- Evolving to either 25G or 100G?</td>
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<td>- Developing 25G</td>
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<td>- ITU defining 50G single wavelength</td>
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<td>- NGPON2</td>
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</table>

- Infinera & Open XR Forum standardizing 100G and 400 subcarriers (25G subcarrier)
What options do MSOs have for their access network?

Coax has vast coverage, but some capacity limits.

Fiber brings capacity, but lacks ubiquitous coverage and can be expensive.

“Status Quo”
- Business as usual HFC capacity expansion with node splits, DOCSIS 3.1, spectrum reallocation
- Space, power, and distance limitations plus operational cost and complexity are blockers

Distributed Access Architecture
- Simplify the network by pushing certain cable functions to the node and virtualizing the headend
- Network expansion (fiber deep, node splits, DOCSIS 3.1/4.0) without cost, space, power, & distance bottlenecks
- Stepping stone to FTTP

FTTP
- Fiber to the home or business: 10G EPON, XGS PON, or P2P
- The ideal solution: unlimited capacity and future-proof – but slowed by required investment
Weighing the PON Options

- New OSS middleware/integration
- Traffic classification on L2 (P bit, VLAN, Port)
- Possible BRAS router also needed as DS traffic is typically managed on a high level router
- ONU/ONT Interoperability – Vendor variations in OMCI
- IPDR not always available on GPON on a per SF basis (GPON/XGS does not have SFs in the same manner)
- Defined by ITU which is Telco controlled

- Easy OSS Integration through CableLabs
- Traffic Classification on L2 (P-bit, VLAN, Port) & L3 (IP@, TCP port)
- BRAS functionality built in
- ONU/ONT interop a fundamental assumption from the beginning.
- Unified HFC/PON platforms
- IPDR statistics per SF
- Defined by IEEE and CableLabs where MSOs have more influence

Both are evolving to faster speeds
Both developing SDN style management
Unified Cable Access: R-PHY, R-MACPHY and PON together

**COMMON CONTROLLER**
- Access Controller
- VIVE Video Core
- Video Engine
- CCAP Core
- Interop
- Video Core

**CORE FLEXIBILITY**

**COMMON ROUTING & SWITCHING**
- All - IP Fiber
- CIN

**ANY SERVICE, ANY MEDIUM**
- Access Node R-PHY
- R-PHY
- Access Node R-MACPHY
- R-MACPHY
- Access Node R-OLT
- PON

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Putting Fiber to Work

• Introduce FTTP faster and easier with PON solution leveraging CableLabs DPoE
• Unified Access – DAA with Fiber Deep plus PON Solution for Competitive Advantage

www.vecima.com
Audience Poll I

Which network upgrade options is your company considering? (Feel free to select more than 1 choice).

• Going Fiber Deep
• Deploying FTTP
• Implementing DAA
• Deploying DOCSIS 4.0
• Deploying Next-Gen PON
• Implementing network virtualization
TRANSITIONING THE CABLE PROVIDER EDGE TO A MULTI-ACCESS NETWORK

Jorge Figueroa
2021 CABLE MARKET TRENDS

BROADBAND SERVICE EXPANSION

Greater connectivity in rural & urban areas
Increasing development of high-bandwidth apps

NETWORK CONVERGENCE

Multi-access & flexible compute
Sustainability
Leaner operations

DATA & ANALYTICS

Improvements in proactivity & monitoring
Flexibility & capacity management

DISRUPTION – TRANSFORMATION – SUCCESS
LAY THE FOUNDATION FOR THE ULTRA-CONNECTED FUTURE

Avoid Regrettable Spend
- Milk every investment in HFC
- Leverage existing infrastructures

Boost Capacity & Efficiency
- Scale sustainably
- Step on the path to 10G

Improve cost savings
- Reduce operational complexity
- Eliminate legacy hardware & related costs

Enable Future Evolution
- Gain flexibility & agility
- Get a versatile multi-access solution
# Cloud-Native Platform

<table>
<thead>
<tr>
<th>Server</th>
<th>k8s</th>
<th>Infra Service</th>
<th>MGMT</th>
<th>vCMTS Pod</th>
<th>vCMTS Pod</th>
<th>vCMTS Pod</th>
<th>Prov Pod</th>
<th>vBNG (Data) Pod</th>
<th>vOLT (Control) Pod</th>
</tr>
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</table>

## PON Interface SFP+

- **Outdoor**
  - R-PHY Node
  - R-OLT Node
  - R-PHY + R-OLT Node

- **Indoor**
  - DAAS
  - CIN
  - Switch

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## Legacy Network Architecture

<table>
<thead>
<tr>
<th>Headend</th>
<th>Hubs</th>
<th>Network</th>
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</thead>
<tbody>
<tr>
<td>Legacy CMTS</td>
<td>EdgeQAM Combining and Splitting</td>
<td>Analog Optics</td>
</tr>
<tr>
<td>Legacy BNG</td>
<td>Legacy OLT</td>
<td>Analog Node</td>
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<tr>
<td>Legacy OLT</td>
<td></td>
<td>Amp</td>
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</table>

### REGRETTABLE SPEND
### NETWORK EVOLUTION WITH A CLOUD NATIVE PLATFORM

<table>
<thead>
<tr>
<th>Headend</th>
<th>Hubs</th>
<th>Network</th>
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<tbody>
<tr>
<td>Resolving critical infrastructure challenges. Significant OPEX/CAPEX saving</td>
<td>PHY Shelf</td>
<td>Improved RF performance Node +</td>
</tr>
<tr>
<td>Cloud Native Platform</td>
<td>Analog Optics</td>
<td>R-PHY Node</td>
</tr>
<tr>
<td>Edge Router</td>
<td>Ethernet switch</td>
<td>R-PHY Node</td>
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<tr>
<td>Video core</td>
<td></td>
<td>Fiber Deep evolution Node 0</td>
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</tbody>
</table>

- **All-IP RF-less hubs**
- **Power/space saving**

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## NETWORK EVOLUTION – INCREASING UPSTREAM CAPACITY WITH MID/HIGH SPLIT

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<td>Platform</td>
<td>Analog Optics</td>
<td>Amp</td>
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<tr>
<td>Edge Router</td>
<td>Ethernet switch</td>
<td>Upgrade to 204Mhz</td>
</tr>
<tr>
<td>Video core</td>
<td>R-PHY Node</td>
<td>Amp</td>
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<td></td>
<td>Switch to HS diplexers</td>
<td>R-PHY Node</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High split (204Mhz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R-PHY Node</td>
</tr>
</tbody>
</table>

**Network Components:**
- Headend: Cloud Native Platform, Edge Router, Video core
- Hubs: PHY Shelf, Analog Optics, Ethernet switch, R-PHY Node
- Network: Amp, Upgrade to 204Mhz, High split (204Mhz)

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## NETWORK EVOLUTION WITH A CLOUD NATIVE PLATFORM

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<tr>
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<td>Video core</td>
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<td></td>
<td>OLT</td>
<td>R-PHY Node / Outdoor switch</td>
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<td></td>
<td>Ethernet switch</td>
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<td>Amp</td>
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<td>Amp</td>
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</table>

- **DOCSIS over Wireless or 3rd Party 5G**
- **LTE/5G MBH, or fix wireless transport**
- **10G PON and Ethernet**
UNIFORM PROVISIONING FOR ANY ACCESS

LEGACY & NEXT GEN CONFIGURATION/PROVISIONING
- CLI/SNMP
- NETCONF
- DOCSIS YANG
- TELCO & BBF YANG

DOCSIS SERVICE PROVISIONING
- DHCP
- TFTP

CLOUD NATIVE PLATFORM
- Server
  - vCMTS
  - MGMT

Provisioning
- Prov
- vCMs

vOLT (Control)
vBNG (Data)

CIN + IEEE OLT
- 10G EPON ONU
- 10G EPON ONU
- 10G EPON ONU

CIN + ITU OLT
- XGS ONU
- XGS ONU
- XGS ONU

CIN + RPD
- MMM

Cable Modem

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THANK YOU.
Douglas Clague
Solutions Marketing Manager
VIAVI Solutions
Putting Next Gen PON to Work
SCTE Live Learning Webinar

Speaker Name
Speacker Title
June 2021
**Existing PON Architectures**

- The larger the split ratio, the more attractive for the service provider
- Split ratio of up to 1x64 is largely deployed

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**SINGLE SPLIT**

- PON OLT
- 1x32 Splitter
- Hub/drop Terminal
- ONT

Optimized speed per customer

---

**CASCADED SPLIT**

- PON OLT
- 1x8 or 2x8 Splitter
- 1x8 Splitter
- Hub/drop Terminal
- ONT

Densification but could limit bit rate per customer

---

- The larger the split ratio, the more attractive for the service provider
- Split ratio of up to 1x64 is largely deployed
New Architectures

UNBALANCED OR TAPPERED

Uneven splitting ratio to increase cascading capability and scalability

DENSIFFICATION

Increase densification in standard PON architectures
PON Services

SPEED INCREASES

- Seeing more of the 10G services being deployed – XGS-PON & 10GE-PON

WHAT DOES THAT MEAN FOR SERVICE PROVIDERS AND INSTALLERS

- New service wavelengths in use
- New build networks going straight to XGS-PON & 10GE-PON
- Co-existence of services on already built / deployed PON

PON Spectrum: Wavelength Allocation and Co-existance Plan

Future Proof OTDR wavelength for in-service test = 1650 to 1675nm
What Does That Mean for Power Meters?  
Selecting the Right Power Meter

**BROADBAND POWER METER**
- Measures average peak power of **ALL** wavelengths present
- Will only provide accurate power measurement if only **one** wavelength is present
- **Does NOT** confirm which wavelength/ channel is present or being measured!

**PON POWER METER**
- Has ability to isolate individual service wavelengths
- Verifies power level and service presence simultaneously
- Has the ability to be inserted in-series to measure down and upstream signals
- Upstream signal is TDM and requires BURST measurement capability
The Drive for More Fibre PON Build
Selecting the Right Power Meter

FTTH / PON key trends and global stats:
- ‘Minimal test’ driven by deployment pressure
- Between 20% to 50% of homes don’t pass at first install and/or turn-up
- 3 additional fiber tech dispatches after first are mandatory in > 10% of the cases
- Early life failures average rate in the next 30 days after installation is > 5%.

IMPACT for Service Providers:
- Techs not meeting KPIs – not enough jobs closed per day
- Activation delay → bad customer experience, increased number of churns
- Excessive troubleshooting expenses, increased OPEX, low ROI, longer time to revenue.
What is your company's typical rate of first-time install failures for FTTH/PON services? (N=118)

- Under 10%: 49.2%
- 10 -> 20%: 23.7%
- 20 -> 30%: 18.6%
- 30 -> 40%: 6.8%
- Over 40%: 1.7%

Source: Heavy Reading
Steve Harris

Executive Director
Technical Sales, Learning & Development
SCTE
SCTE Fiber Education Programs

For more information go to: SCTE.org/courses

Boot Camps available, contact us at sharris@scte.org

<table>
<thead>
<tr>
<th>COURSE TITLE</th>
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<tbody>
<tr>
<td>BFI - Broadband Fiber Installation</td>
<td>ONLINE</td>
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<td>BTS - Broadband Transport Specialist</td>
<td>ONLINE</td>
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<td>DAA - Distributed Access Architecture Essentials</td>
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<td>EPON - Ethernet Passive Optical Network</td>
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<td>Fiber Restoration</td>
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<td>FSS - FTTx Splicer Specialist</td>
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<td>Maintenance Technology Level 2</td>
<td>ONLINE</td>
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<td>Network Testing and Maintenance Level 2</td>
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<td>OFC - Optical Fiber Construction</td>
<td>ONLINE</td>
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<td>Telecommunication Engineering 101</td>
<td>ONLINE</td>
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<tr>
<td>Understanding Multiplexing</td>
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</table>
The SCTE FTTH Course prepares SCTE Members for 3 Fiber Certifications!

For more information go to: SCTE.org/certification
The SCTE Transport Course prepares SCTE Members for 3 Fiber Certifications!

For more information go to: SCTE.org/certification
# Microlesson Fiber Topics

## Microlessons - Technical

<table>
<thead>
<tr>
<th>Topic</th>
<th>Type</th>
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<tbody>
<tr>
<td>5G</td>
<td>Primer</td>
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<td>AWG</td>
<td>Primer</td>
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<td>CBRS</td>
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<tr>
<td>CCAP</td>
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<td>Convergence</td>
<td>Primer</td>
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<tr>
<td>Cyber Security</td>
<td>Primer</td>
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<td>DOCSIS 3.1</td>
<td>Primer</td>
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<td>DOCSIS 3.1 PNM</td>
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<td>DOCSIS Profiles</td>
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<td>EPON</td>
<td>LightningMod</td>
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<td>F-Connector</td>
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<td>Fiber Cleaning</td>
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<td>Fiber Deep</td>
<td>LightningMod</td>
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<td>Fiber Deep</td>
<td>Primer</td>
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<td>FWA (Fixed Wireless)</td>
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<td>Full-Duplex DOCSIS</td>
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<td>OFDMA</td>
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<td>PKI</td>
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<td>Remote PHY (R-PHY)</td>
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<td>Wi-Fi</td>
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<td>10G</td>
<td>MicroLearning</td>
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<td>Anatomy of a Utility Pole</td>
<td>MicroLearning</td>
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<tr>
<td>Bonding and Grounding</td>
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<td>DAA</td>
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<td>MicroLearning</td>
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<td>IPv4 Addressing Part 1: Binary Numbering System</td>
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<td>IPv4 Addressing Part 2: Address Classes</td>
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<td>IPv4 Addressing Part 3: Subnet Masks</td>
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<td>IPv4 Subnetting</td>
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<td>IPv6 Addressing</td>
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<td>LTE</td>
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<td>Ohm's Law</td>
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<td>Pushable MPO</td>
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<td>Wi-Fi</td>
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## Microlessons - Soft Skills

<table>
<thead>
<tr>
<th>Topic</th>
<th>Type</th>
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<tbody>
<tr>
<td>5 Tips on How to Hire Great People</td>
<td>MicroLearning</td>
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<td>5 Tips on Time Management</td>
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<td>Benefits of Professional Certification</td>
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<td>Career Enhancement</td>
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<td>Creating a Winning Presentation</td>
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<td>Flashcards</td>
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<td>How to Avoid Meeting Malpractice</td>
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<td>How to Build the Creativity Muscle</td>
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<td>How to Delgate Effectively</td>
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<td>How to Motivate and Energize your Team</td>
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<td>Improving Recall and Retention</td>
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<td>Learning Preferences</td>
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<td>Learning through Peers</td>
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<td>Peer Networking</td>
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<td>Quizzing to Learn</td>
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<tr>
<td>Recalling Information a Little at a Time</td>
<td>MicroLearning</td>
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</tbody>
</table>

**Primers**: Answer the Question "What is" is less than 2 minutes

**LightningMods**: Overview of a course or topic in 8-10 minutes

**MicroLearnings**: Focused to meet a specific learning outcome in 2-5 minutes.

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