Engineering the DOCSIS® 4.0 Network (FDX & ESD)

LiveLearning Webinars™ For Professionals

Thursday, Sept. 23, 2021
11:00 am – 12:00 pm ET

TODAY'S WEBINAR IS SPONSORED BY:
Today’s Speakers

Alan Breznick
Cable/Video Practice Leader
Light Reading

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Principal Solution Architect
Red Hat

David Whitehead
Senior Director
Cable Solutions
Harmonic

Jan Ariesen
Chief Technology Officer
Technetix Inc

Dean Stoneback
Senior Director
Engineering & Standards
SCTE
Agenda

• **Light Reading**—DOCSIS 4.0 & 10G Overview
• **Harmonic**—FDX & FDD/ESD (DOCSIS 4.0)
• **Technetix**—Journey to DOCSIS 4.0
• **Red Hat**—Journey to a Microservices Architecture
• **Audience Q&A**
Welcome to DOCSIS 4.0

- Multi-Gigabit speeds, support for symmetrical services:
  - 10 Gbit/s downstream and up to 6 Gbit/s upstream
- Support for lower-latency applications (online gaming, telemedicine, etc.)
- Enhanced security
- Two technological approaches:
  - Full Duplex DOCSIS (FDX)
  - Extended Spectrum DOCSIS (ESD)
- Specifications released by CableLabs in March 2020
- First prototype products could emerge in 2021, with certification testing to follow in 2022
- Work on 3GHz technology already underway (DOCSIS 4.1?)
- Ties into industry’s broader, multi-access 10G initiative
Cable’s Great 10G Quest

- Branded at CES in 2019 with 5G wireless in mind
- Access network agnostic: HFC, FTTP, wireless, etc.
- Targeting symmetrical speeds of at least 10 Gbit/s
- Enhanced security
- Lower latency
Cable’s Early 10G Efforts

• Mediacom conducts 10G Smart Home demo in Ames, Iowa
• Comcast tests symmetrical 1.25 Gbit/s on HFC in Jacksonville, Fla.
• Virgin Media trials symmetrical 2.2 Gbit/s on HFC in Southampton & Manchester
• Comcast tests symmetrical 4+ Gbit/s over HFC (FDX) in Denver lab trial
David Whitehead
Senior Director of Cable Solutions
Harmonic
ENGINEERING THE DOCSIS 4.0 NETWORK – FDX and ESD

David Whitehead

September 23, 2021
BROADBAND MARKET CURRENT STATUS FOR CABLE
NEXT-GEN INFRASTRUCTURE: A MUST FOR CABLE

- Impressive broadband subscriber count and $ ARPU to protect
- Cable got there by being first to massively rollout (downstream) gigabit
- Now, they need to keep up with (upstream) bandwidth demand and competition
- Requires additional investment

LEGACY CABLE ARCHITECTURE

<table>
<thead>
<tr>
<th>Datacenter</th>
<th>Hubs</th>
<th>Access Network</th>
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<tbody>
<tr>
<td>CCAP</td>
<td>RF Analog</td>
<td>A A A A</td>
</tr>
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LIMITATIONS

1. SPECTRUM / UPSTREAM BANDWIDTH
   - Upstream: 5-42Mhz 100Mbps
   - Downstream: 100-750/860Mhz 2Gbps

2. EXPANSION = MORE SPACE & POWER
CABLE’S NEXT-GEN SOLUTION

DISTRIBUTED ACCESS: FIBER DEEP/DIGITAL FIBER
- Improve DOCSIS Performance
- Higher order modulation
- More reliable services
- Multi-Gigabit DOCSIS 4.0

DISAGGREGATION: COTS, VIRTUALIZATION
Scalability & Performance:
- Lower Cost, Space & Power
- Commodity infrastructure

VALUE ADDED SERVICES
- Higher QoE (Low Latency)
- Network & Service Analytics
- Edge Compute
- Multi Access Infrastructure

A CONVERGED BROADBAND PLATFORM
CABLE’S NEXT-GEN SOLUTION

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A CONVERGED BROADBAND PLATFORM
FDX and FDD/ESD (DOCSIS 4.0)

**FDX**
- Enables symmetric multi gigabit in same 1.2 GHz Spectrum
- Extension for DOCSIS 3.1
- Maintains backward compatibility, uses existing Taps
- Allows N+X (with new FDX amplifier)
- New RPD silicon and new CM for FDX
- Requires new Echo Cancellation technology

**FDD/ESD**
- Move 3xDS OFDM channels of FDX band (108-684 MHz) to 1218-1794
- ESD modem can use 684/804 MHz diplexer
- Requires new Taps, Passives, Amplifiers
- Allows N+X with new ESD amps
- Requires new RPD silicon and new CM for Extended Spectrum

FDX allows use of existing Taps, but requires new Amplifiers as self interference requires advanced Echo Cancellation

ESD adds capacity in additional spectrum – requires new Taps as well as amplifiers
CABLE OPERATOR BROADBAND INVESTMENT OPTIONS
DOCSIS 3.1, DOCSIS 4.0 and FTTH/PON

- **Datacenter**: CCAP, RF, Analog Optics
- **SPECTRUM / UPSTREAM BANDWIDTH**
  - 100Mbps
  - 2Gbps

BROADBAND CONVERGED PLATFORM

1. **Outdoor Node Platform**
   - DAA3.1
   - EXPANDED UPSTREAM, HIGH SPLIT
     - 1.7Gbps
     - 8Gbps
   - For symmetrical Gigabit. Multi Gigabit DS. Available now.

2. **NEW DOCSIS 4.0**
   - 6 Gbps
   - 10 Gbps
   - For symmetrical multi-Gigabit. 2023-2025 target

3. **FTTH/PON**
   - Network construction and new CPEs
   - 10G Symmetric
THANK YOU.
When do you think cable operators should start offering 10G services?

• They should be doing so already
• By the end of this year
• By the end of 2022
• By the end of 2023
• 2024 or later
• Never
Jan Ariesen
Chief Technology Officer
Technetix Inc
Engineering the DOCSIS network
FDX and ESD solutions

Jan Ariesen
Chief Technology Officer
DOCSIS 4.0

There are two technologies to achieve the 10 Gbps goal:

**Full Duplex DOCSIS - FDX**
- By using the same frequency for up and downstream, both paths can be upgraded for new throughputs
- **Advantages**
  - Network stays at 1.2 GHz
  - No tap swap required
  - More efficient use of existing bandwidth
- **Disadvantages**
  - N+0 architecture
  - Isolation challenges
  - Expensive rebuild

**Extended Spectrum DOCSIS - ESD**
- By extending the bandwidth to 1.8 GHz, more space is available for upstream and downstream throughput
- **Advantages**
  - Same network structure as 1.2 GHz
  - N+3/5 network, easy installation
  - Wider acceptance
- **Disadvantages**
  - Higher loss in high frequencies
  - Greater power consumption
  - Upgrade all components
Full Duplex DOCSIS
Typical Legacy 750 MHz/ 860 MHz / 1 GHz Network => FDX

Legend
- Node
- FDx amplifier
- Line Passive
- Outdoor tap
Typical Legacy 750 MHz/ 860 MHz / 1 GHz Network => FDX
Typical Legacy 750 MHz/ 860 MHz / 1 GHz Network => FDX

Legend
- Node
- FDx amplifier
- Line Passive
- Outdoor tap
Typical Legacy 750 MHz/860 MHz/1 GHz Network => FDX

Legend
- Node
- FDx amplifier
- Line Passive
- Outdoor tap

Upstream
- 24, 25, 25

Downstream
- 7, 8, 24
- FDX + 2 with FDx amplifiers can work
  - Because there are no diplex filters
    - FDD and flexi-split are also feasible
  - If there are passives in the express line, the first taps are full duplex, the rest are half duplex.
Extended Spectrum DOCSIS
Challenges for 1796 MHz Downstream

- Total Composite Power TCP
- Cable loss
- Tap loss
- Noise figure
Three scenarios to solve the ESD 1.8 GHz challenge

- **High Power Amplifiers (HPA)**
  - Replace existing amplifier with a 1.8 GHz HPA
    - 3 dB more output power and gain
    - Will partly solve the additional loss in the coax and passives
    - Double power consumption with high heat dissipation

- **Medium Power Amplifier with Booster (MPA+)**
  - Replace existing amplifier for 1.8 GHz MPA and compensate the additional loss with booster amplifier
    - Additional Low Gain Amplifiers in the network
    - Flexible, only use if needed
    - Will compensate the 1.8 GHz loss
    - Slight increase in power consumption

- **Distributed Gain Architecture (DGA)**
  - Rebuild network with DGA amplifiers
    - Works on 862, 1218 and 1794 MHz networks
    - Lower power consumption
    - No DPF
      - no guardband
      - more data throughput
      - FDD and flexi-split
Upgrading a network to 1.8 GHz has three drivers:  
- Performance  
- Practicality  
- TCO  

Based on the above we have the following overview:  

There are three ways of upgrading a network:  
- High power amplifiers HPA  
- Medium power amplifier with Booster MPA+  
- Distributed Gain Architecture
Conclusion

- **DOCSIS 4.0** covers two main new technologies to improve the data throughput:
  - FDX
  - ESD

- **FDx+2 with DFx amplifiers can work**
  - Because there are no DPF:
    - FDD and flexi-split are also feasible.
  - If there are passives in the express line, the first taps are full duplex, the rest are half duplex.

- **Three solutions to make ESD work**
  - High Power Amplifiers (HPA)
    - Replace existing amplifier for a 1.8 GHz HPA
  - Medium Power Amplifier with Booster (MPA+)
    - Replace existing amplifier with 1.8 GHz MPA and compensate the additional loss with booster amplifiers
  - Distributed Gain Architecture (DGA)
    - Rebuild network in a DGA amplifiers
Audience Poll II

Which next-gen technology is your company considering?

• Deploying Full Duplex DOCSIS
• Deploying Extended Spectrum DOCSIS
• Deploying XGS-PON
• Deploying 10G PON
• Deploying DAA
• Deploying FTTH
Amol Chobe
Principal Solution Architect
Red Hat
Ramping Up for DOCSIS 4.0

Amol Chobe
Red Hat Telco Media and Entertainment
Challenges in today's world

Enablers: - DAA, node splitting, DOCSIS, network orchestration
Why?: The metrics

**LEAD TIME FOR CHANGE**
- **What:** Time from code committed to deployed to production
- **Why:** Shorter is better. Enables faster feedback cycles and makes you better able to adjust to the marketplace

**DEPLOYMENT FREQUENCY**
- **What:** Proxy for batch size, how often does an app deploy to production
- **Why:** Indicator of batch size. Smaller batch size leads to more market agility

**MEAN TIME TO RECOVERY (MTTR)**
- **What:** How long it takes systems to recover from failures in production
- **Why:** Critical to ensure that we aren't speeding up delivery at the expense of negative customer impacts

**CHANGE FAILURE RATE**
- **What:** Percentage of deployments requiring rollback and/or fixes
- **Why:** *Secondary indicator of stability*

**Measures of MARKET AGILITY**
- **LEAD TIME FOR CHANGE**
- **DEPLOYMENT FREQUENCY**

**Measures of RELIABILITY**
- **MEAN TIME TO RECOVERY (MTTR)**
- **CHANGE FAILURE RATE**
Open hybrid cloud

Enabling developer velocity and operational efficiency all the way to the edge
Common platform, management, and processes from core to edge
Realizing business value from a cloud native + hybrid cloud strategy

- 636% return on investment over 5 years
- 10 months to payback
- 54% lower 5-year cost of operations
- 3x more new features per year
- 20% higher application developer productivity
- US$21.6 million higher revenue per year per organization
- $71% less unplanned downtime
- 21% more efficient IT infrastructure teams

Source:
# Journey to a Microservices Architecture

## Manage
Manage all types of workload under a single CMP

## Consolidate
Harmonize to common platforms

## Transform
Modernize Apps to "Cloud Native" Model

## Optimize
Elastic Distributed Virtual Architecture built on Microservices

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<tr>
<th>Level of Automation</th>
<th>Infrastructure Modernization</th>
<th>Application Modernization</th>
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<tbody>
<tr>
<td>1</td>
<td>Manage</td>
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<tr>
<td>2</td>
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<td>4</td>
<td>Optimize</td>
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**Intelligent Distribution to Edges**

**Common Management**
- Physical
- Virtual
- Telco Cloud
- Multi-Cloud

**Any Infrastructure**
How Do We Continue on the Path to Success?

- Basic fiber architecture of an HFC system does not change to support DOCSIS 4.0
- Interoperability testing.
- Start with "plumbing" of the network in preparation for DOCSIS 4.0, which requires DAA.
- MSOs are expected to "exhaust" the capabilities of their DOCSIS 3.1 networks before pushing hard on DOCSIS 4.0.
- Each operator is in different phase of the DOCSIS journey, some will start to deploy DOCSIS 4.0-capable taps with installations of new nodes and amplifiers set to follow.
- Get ready with the preplanning setup and modernize your infrastructure, for e.g vCMTS adoption and reduce in TCO.
- Focus on operator network and back office automation in a way that carries to the edge.
- Don’t reinvent functionality of the community.
- Getting involved! Which communities is your organization leveraging that are vital to your success?
Thank you

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Next Months Webinar

Lighting Up Coherent Optics

10/21/2021 11:00 am New York / 8:00 am Los Angeles

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