

Engineering the DOCSIS® 4.0 Network (FDX & ESD)

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Thursday, Sept. 23, 2021

11:00 am – 12:00 pm ET

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Today's Speakers



Alan Breznick
Cable/Video Practice Leader
Light Reading



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Senior Director
Engineering & Standards
SCTE



David Whitehead
Senior Director
Cable Solutions
Harmonic



Jan Ariesen
Chief Technology Officer
Technetix Inc



Amol Chobe
Principal Solution
Architect
Red Hat

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

FDX

ESD

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



ENGINEERING THE DOCSIS 4.0 NETWORK – FDX and ESD

David Whitehead

September 23, 2021





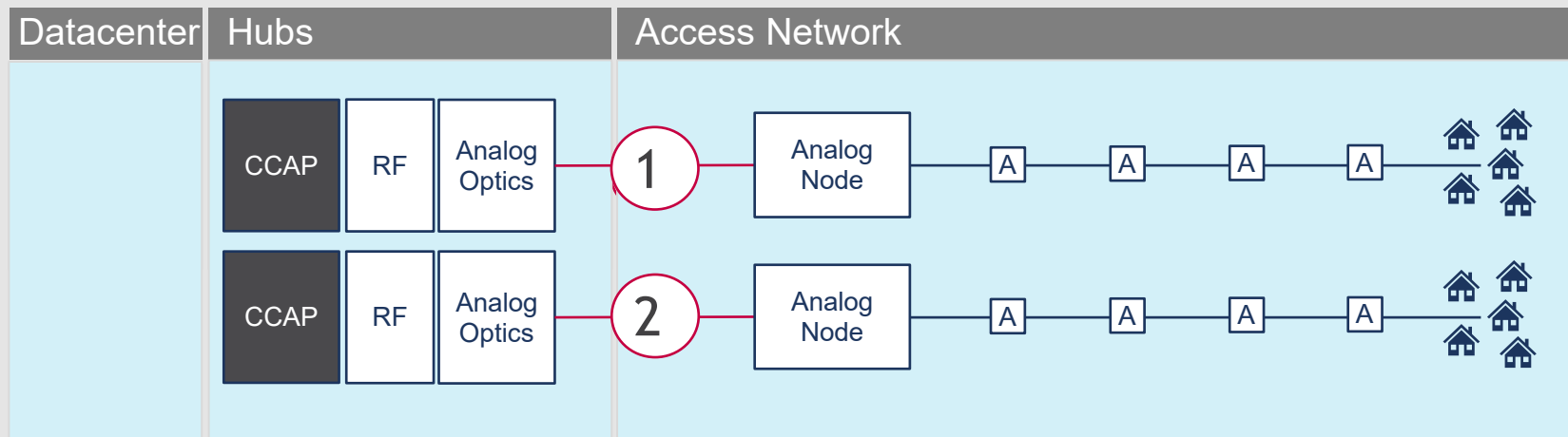
BROADBAND MARKET CURRENT STATUS FOR CABLE



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



LIMITATIONS

1 SPECTRUM / UPSTREAM BANDWIDTH

Upstream 5-42Mhz 100Mbps	Downstream 100-750/860Mhz 2Gbps
--------------------------------	---------------------------------------

2 EXPANSION = MORE SPACE & POWER



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



DISTRIBUTED ACCESS: FIBER DEEP/DIGITAL FIBER

- Improve DOCSIS Performance
- Higher order modulation
- More reliable services
- **Multi-Gigabit DOCSIS 4.0**



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VALUE ADDED SERVICES

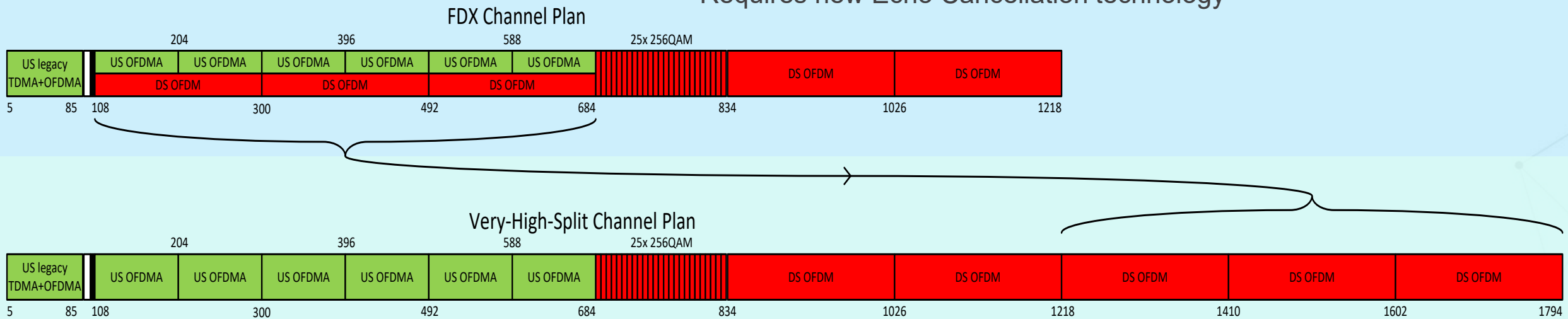
- Higher QoE (Low Latency)
- Network & Service Analytics
- Edge Compute
- Multi Access Infrastructure

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

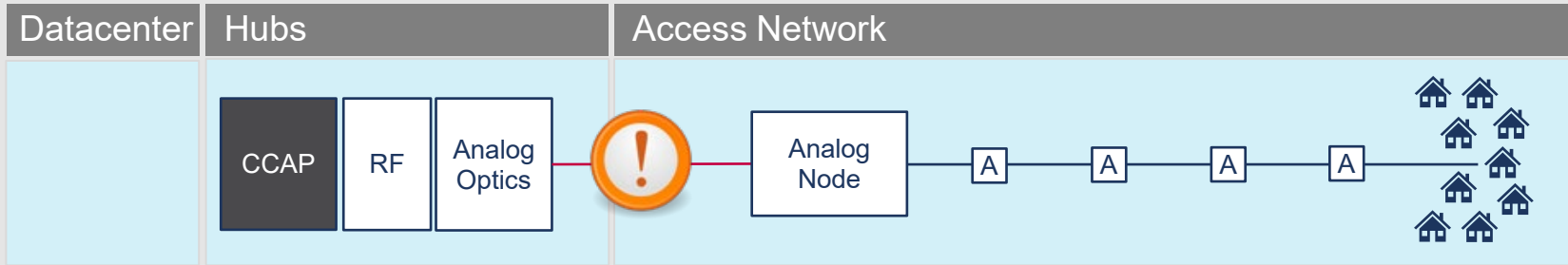
CABLE OPERATOR BROADBAND INVESTMENT OPTIONS

DOCSIS 3.1, DOCSIS 4.0 and FTTH/PON



Upstream

Downstream



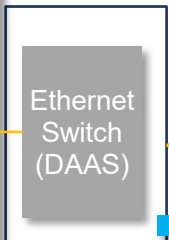
SPECTRUM / UPSTREAM BANDWIDTH

100Mbps

2Gbps

BROADBAND CONVERGED PLATFORM

- vOLT/vBNG
- Video core
- Edge router
- vCMTS
- vCMTS



EXPANDED UPSTREAM, HIGH SPLIT

For symmetrical Gigabit. Multi Gigabit DS. Available now.

1.7Gbps

8Gbps

1



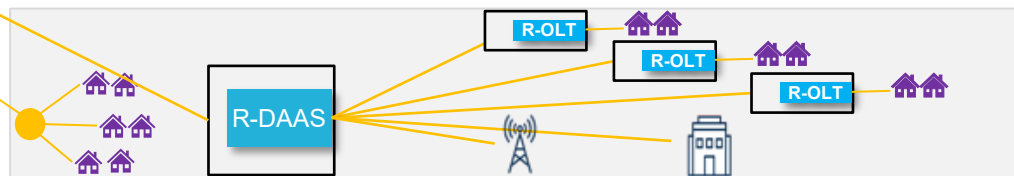
NEW DOCSIS 4.0

For symmetrical multi-Gigabit. 2023-2025 target

6 Gbps

10 Gbps

2



FTTH/PON

Network construction and new CPEs

10G Symmetric

3

harmonic®

THANK YOU.



Audience Poll I

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

- There are two technologies to achieve the 10 Gbps goal

Full Duplex DOCSIS - FDX

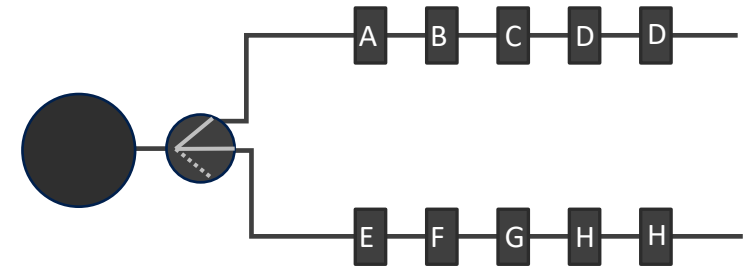
- By using the same frequency for up and downstream, both paths can be upgraded for new throughputs
- Advantages
 - Network stays at 1.2 GHz
 - No tap swap required
 - More efficient use of existing bandwidth
- Disadvantages
 - N+0 architecture
 - Isolation challenges
 - Expensive rebuild

Extended Spectrum DOCSIS - ESD


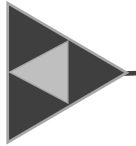


- By extending the bandwidth to 1.8 GHz, more space is available for upstream and downstream throughput
- Advantages
 - Same network structure as 1.2 GHz
 - N+3/5 network, easy installation
 - Wider acceptance
- Disadvantages
 - Higher loss in high frequencies
 - Greater power consumption
 - Upgrade all components

Full Duplex DOCSIS

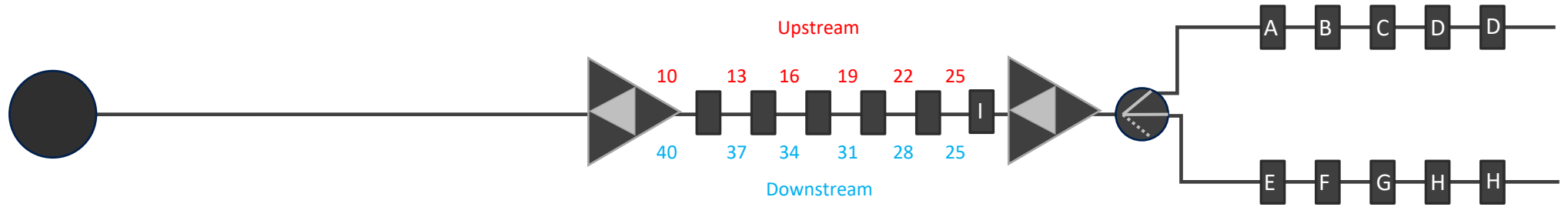
Typical Legacy 750 MHz/ 860 MHz / 1 GHz Network => FDX




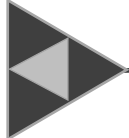


Legend

-  Node
-  FDx amplifier
-  Line Passive
-  Outdoor tap

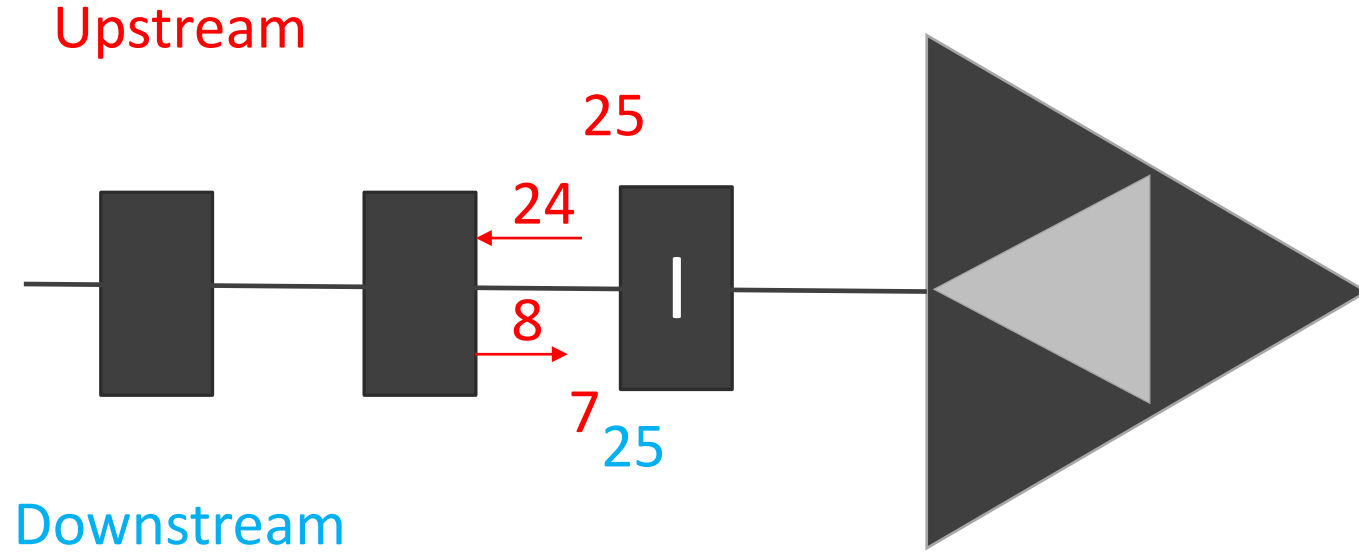
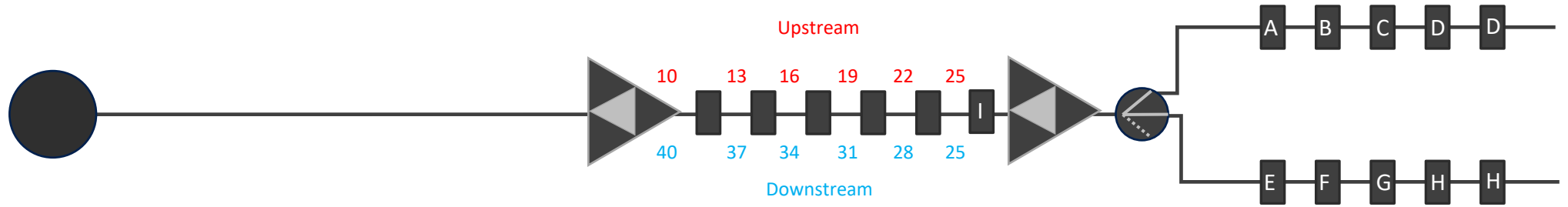
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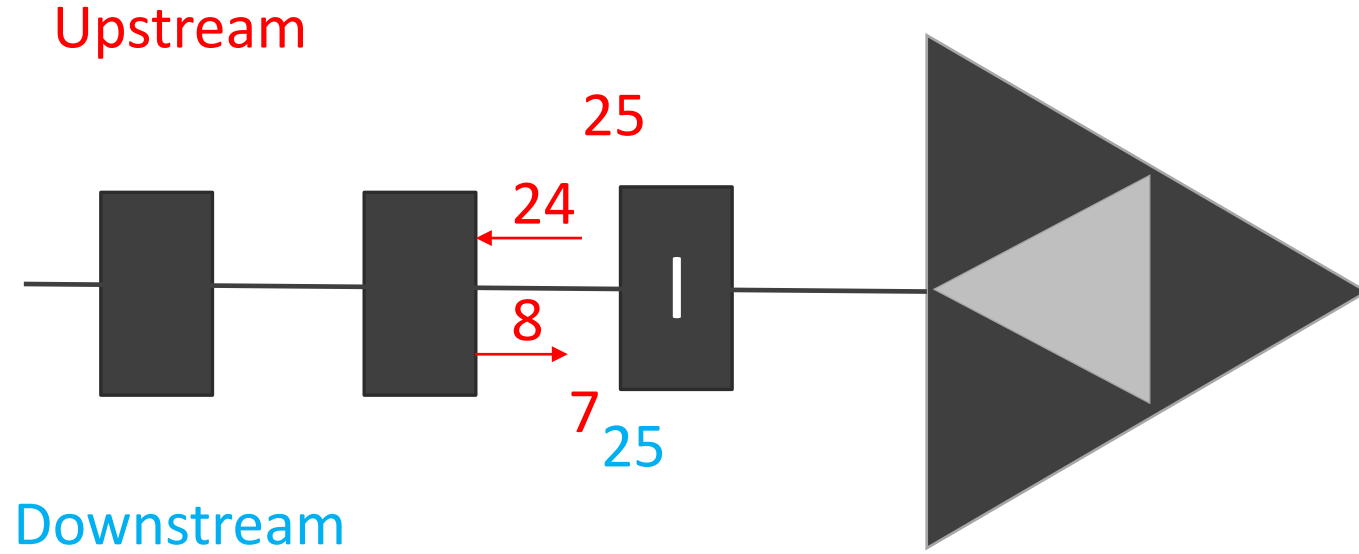
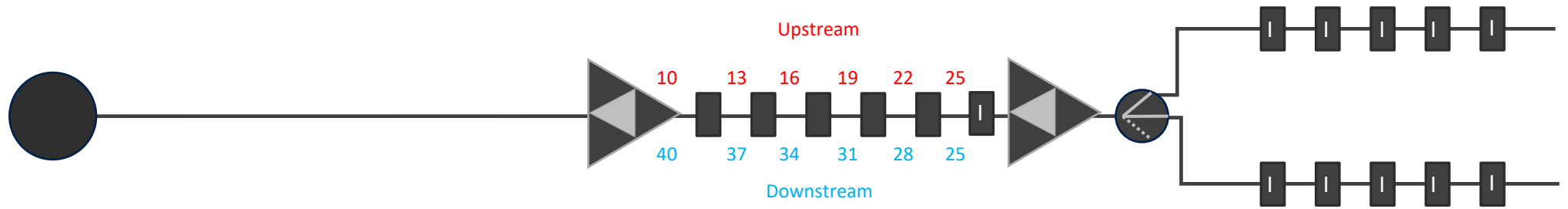
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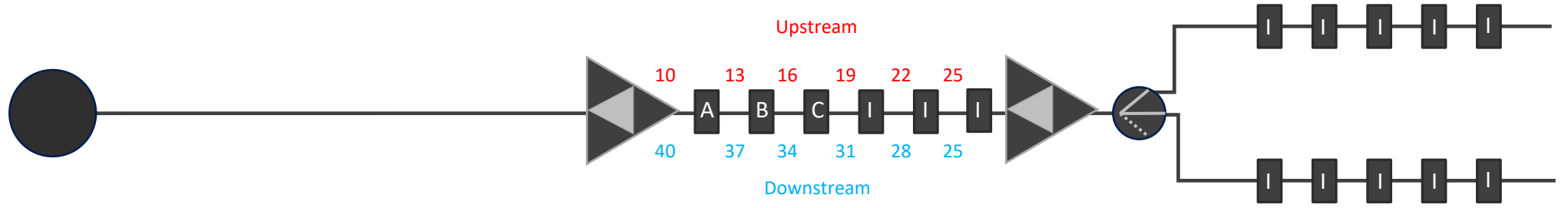
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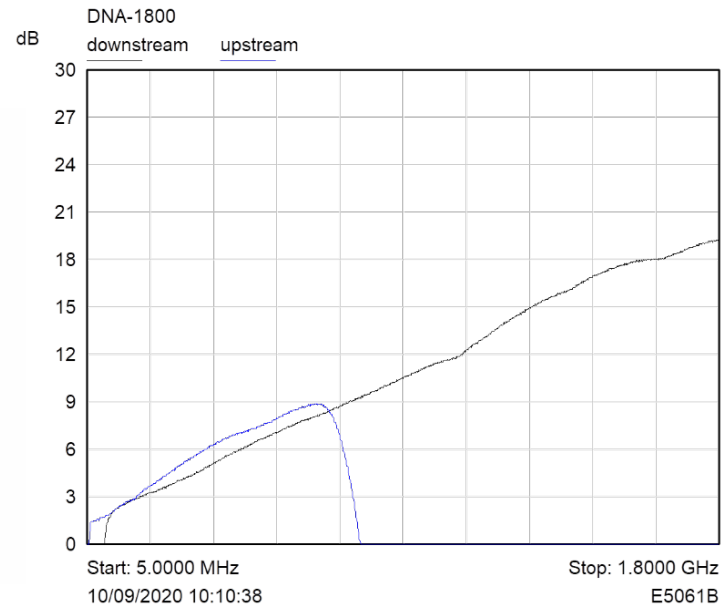
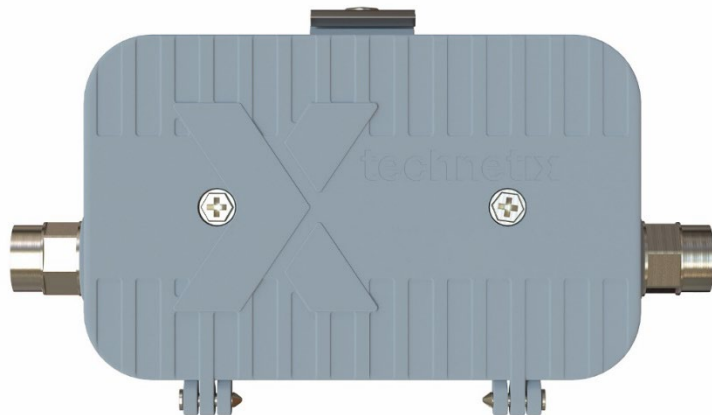
Legend

- Node
- FDx amplifier
- Line Passive
- Outdoor tap

Typical Legacy 750 MHz/ 860 MHz / 1 GHz Network => FDX



- FDX + 2 with FDx amplifiers can work
 - Because there are no duplex 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.

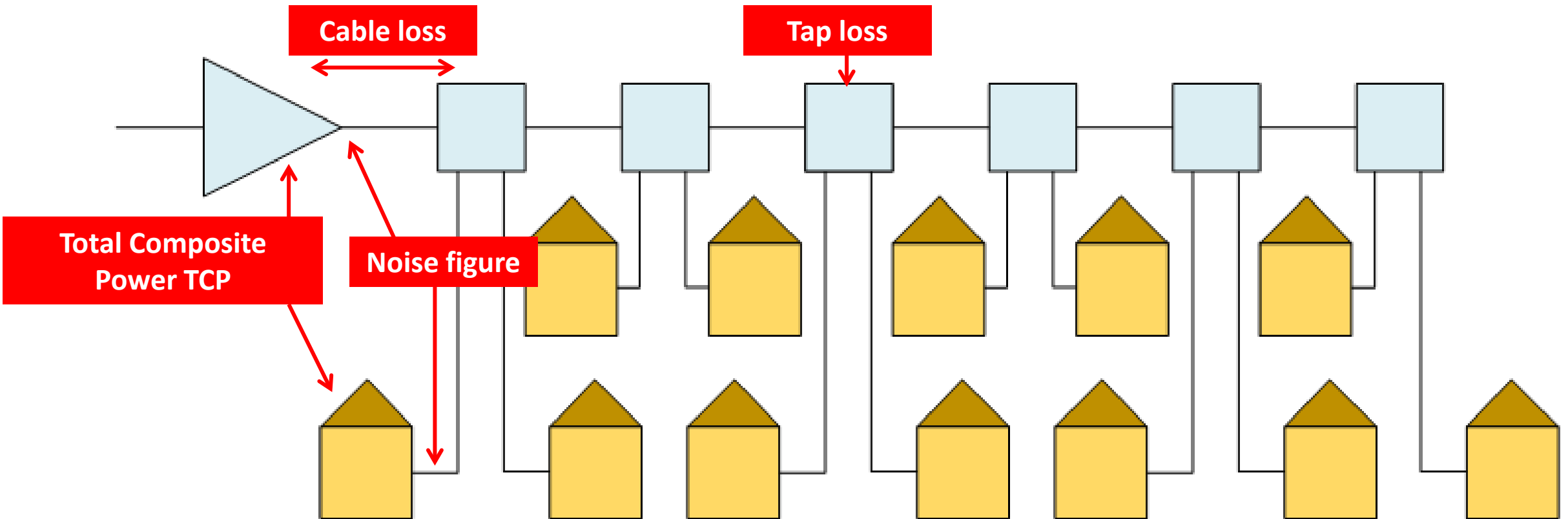


Legend

- Node
- FDx amplifier
- Line Passive
- Outdoor tap

Extended Spectrum DOCSIS

Challenges for 1796 MHz Downstream



Three scenarios to solve the ESD 1.8 GHz challenge



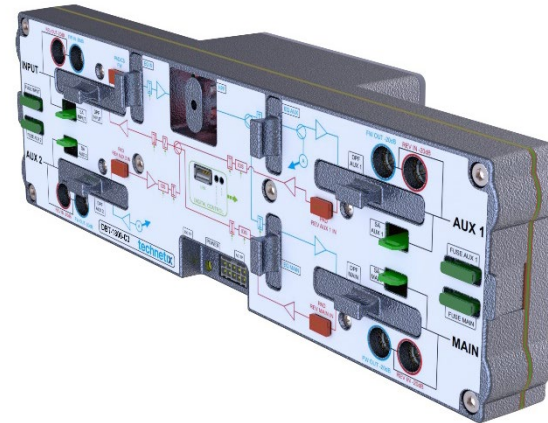
- High Power Amplifiers (HPA)

- 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



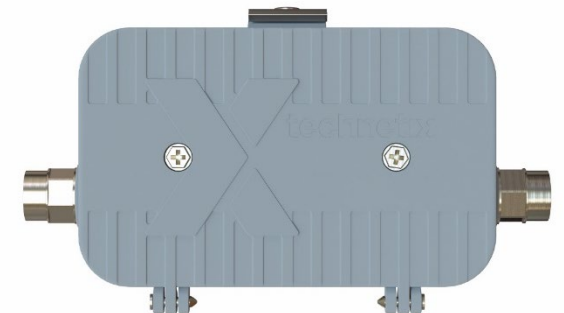
- Medium Power Amplifier with Booster (MPA+)

- 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)

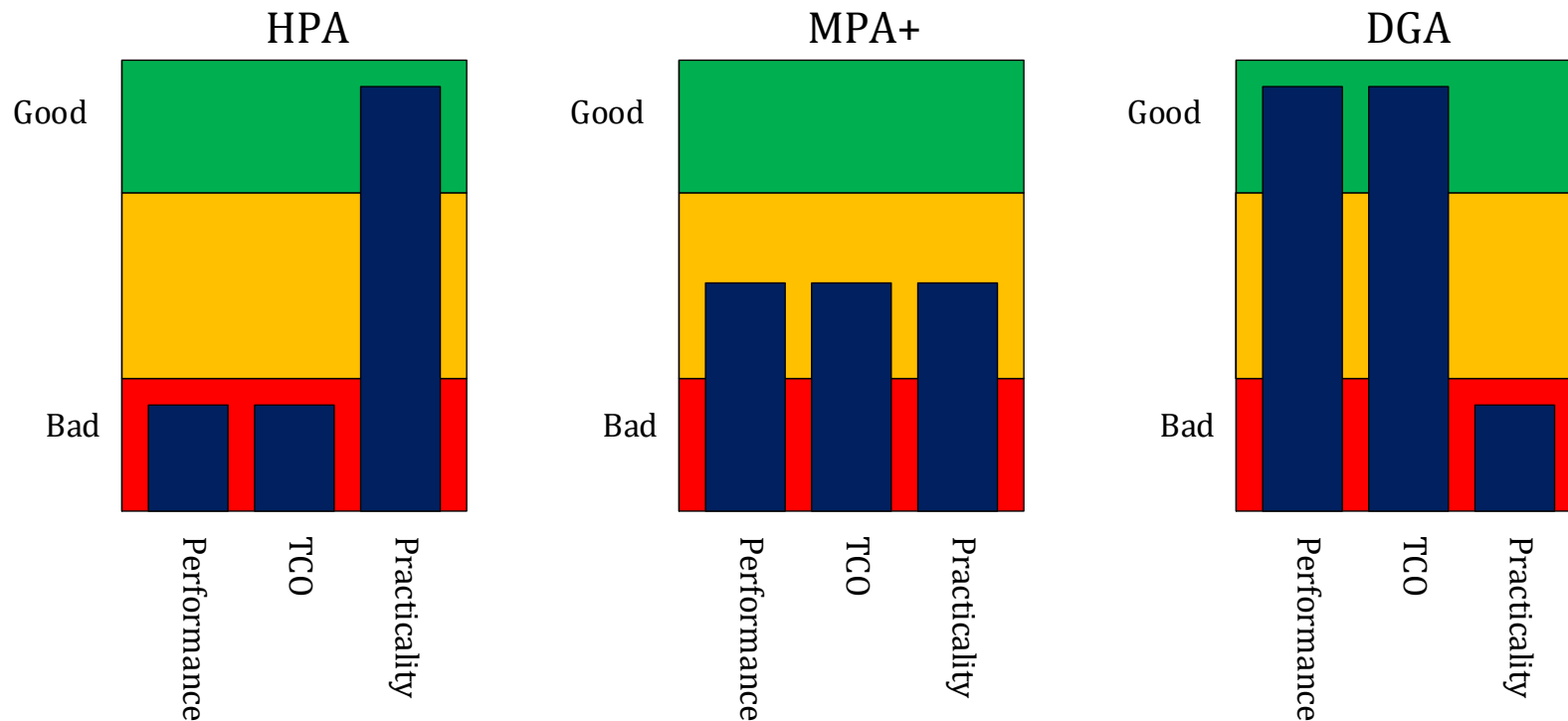
- Rebuild network with DGA amplifiers
 - Works on 862, 1218 and 1794 MHz networks
 - Lower power consumption
 - No DPF
 - no guardband
 - more data throughput
 - FDD and flexi-split



Differences between HPA, MPA+, DGA



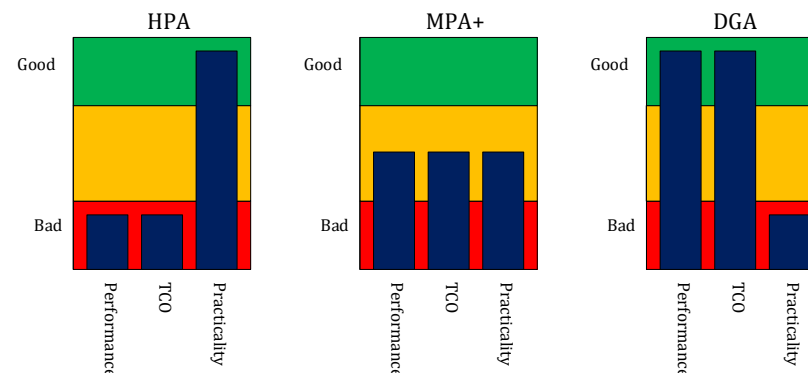
- Upgrading a network to 1.8 GHz has three drivers:
 - Performance
 - Practicality
 - TCO
- There are three ways of upgrading a network:
 - High power amplifiers HPA
 - Medium power amplifier with Booster MPA+
 - Distributed Gain Architecture
- Based on the above we have the following overview:



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



HW optimization

Transform your existing infrastructure



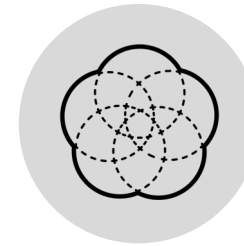
Hybrid cloud infrastructure

Improve & accelerate IT service delivery



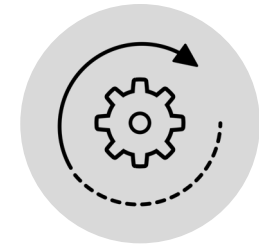
Cloud-native development

Build innovative applications faster



Agile integration

Integrate your applications & services







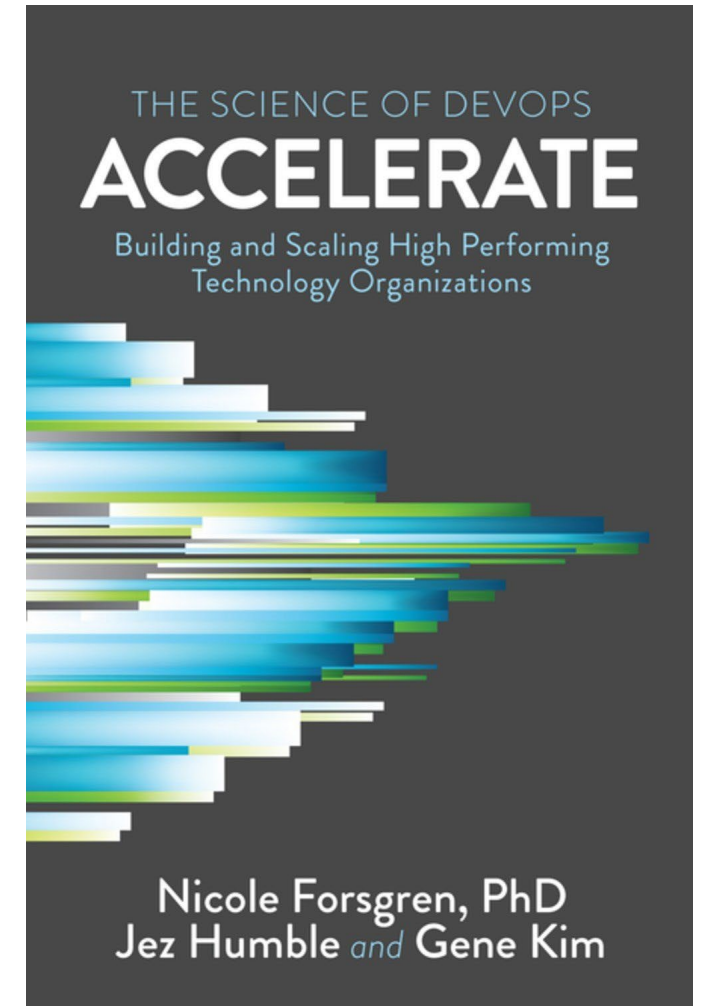
Automation

Automate infrastructure & applications

Enablers :- DAA , node splitting, DOCSIS, network orchestration

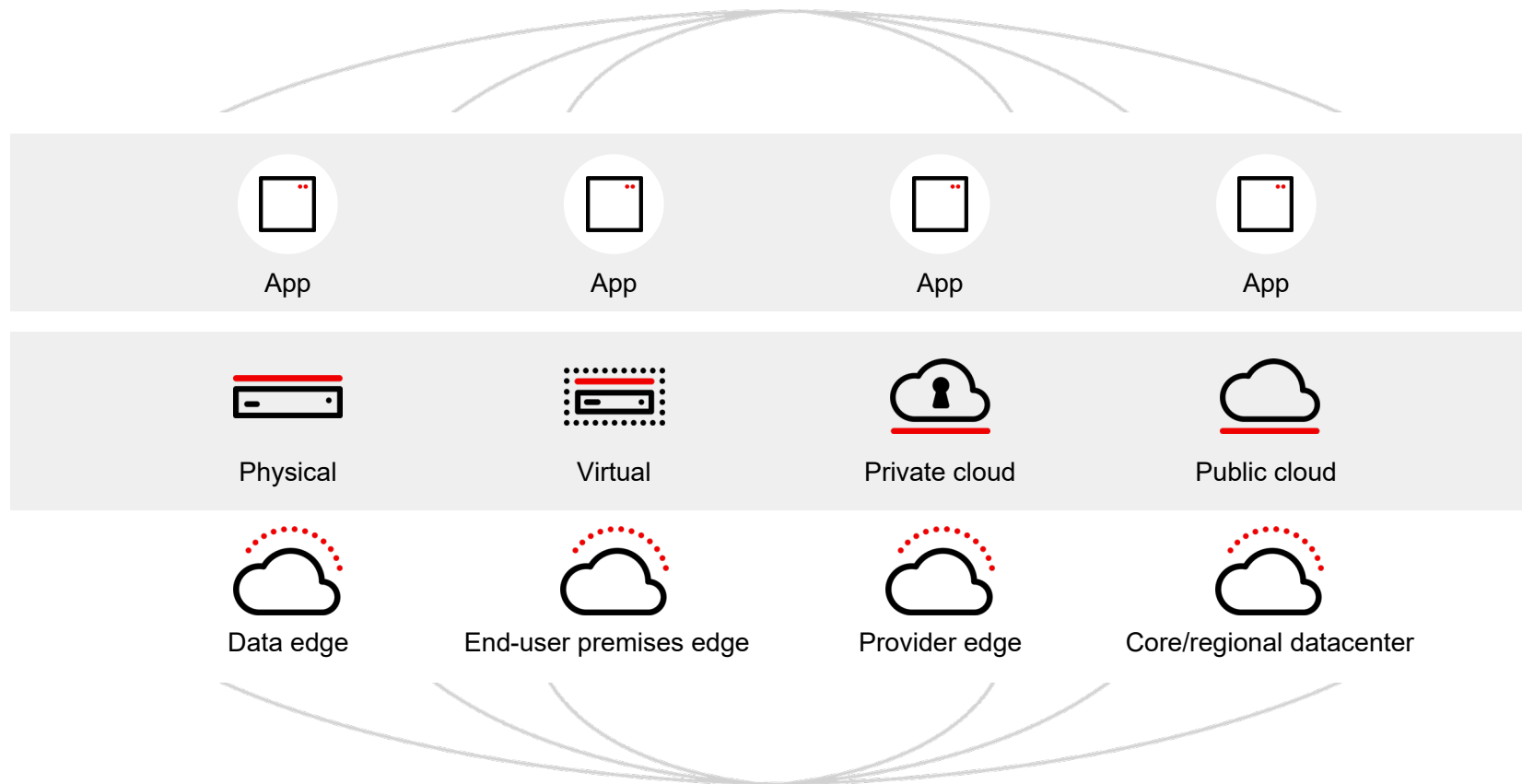
Why?: The metrics

	 LEAD TIME FOR CHANGE	 DEPLOYMENT FREQUENCY	 MEAN TIME TO RECOVERY (MTTR)	 CHANGE FAILURE RATE*
	Measures of MARKET AGILITY		Measures of RELIABILITY	
WHAT	Time from code committed to deployed to production	Proxy for batch size, how often does an app deploy to production	How long it takes systems to recover from failures in production	Percentage of deployments requiring rollback and/or fixes
WHY	Shorter is better. Enables faster feedback cycles and makes you better able to adjust to the marketplace	Indicator of batch size. Smaller batch size leads to more market agility	Critical to ensure that we aren't speeding up delivery at the expense of negative customer impacts	*Secondary indicator of stability

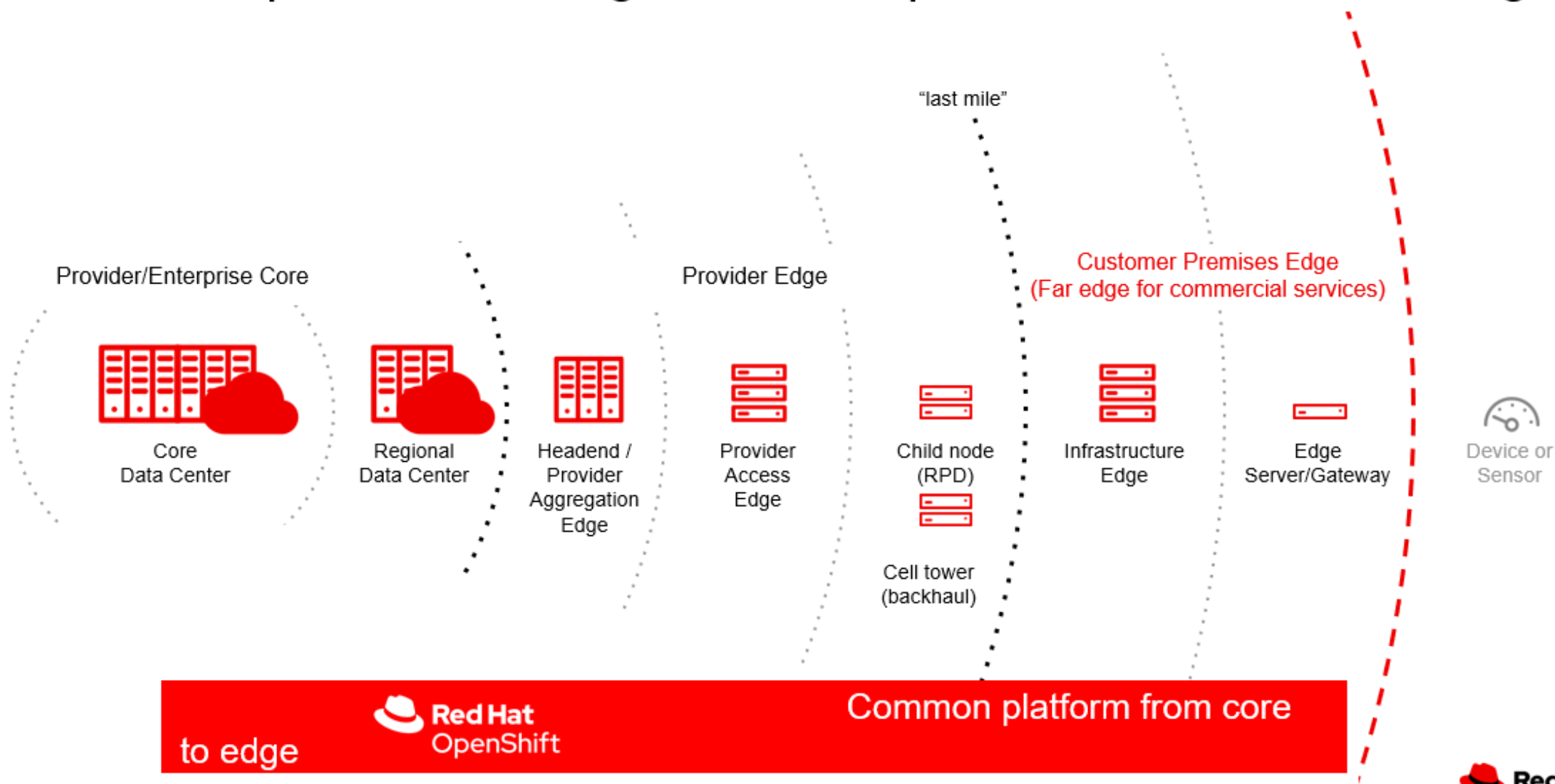


Open hybrid cloud

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

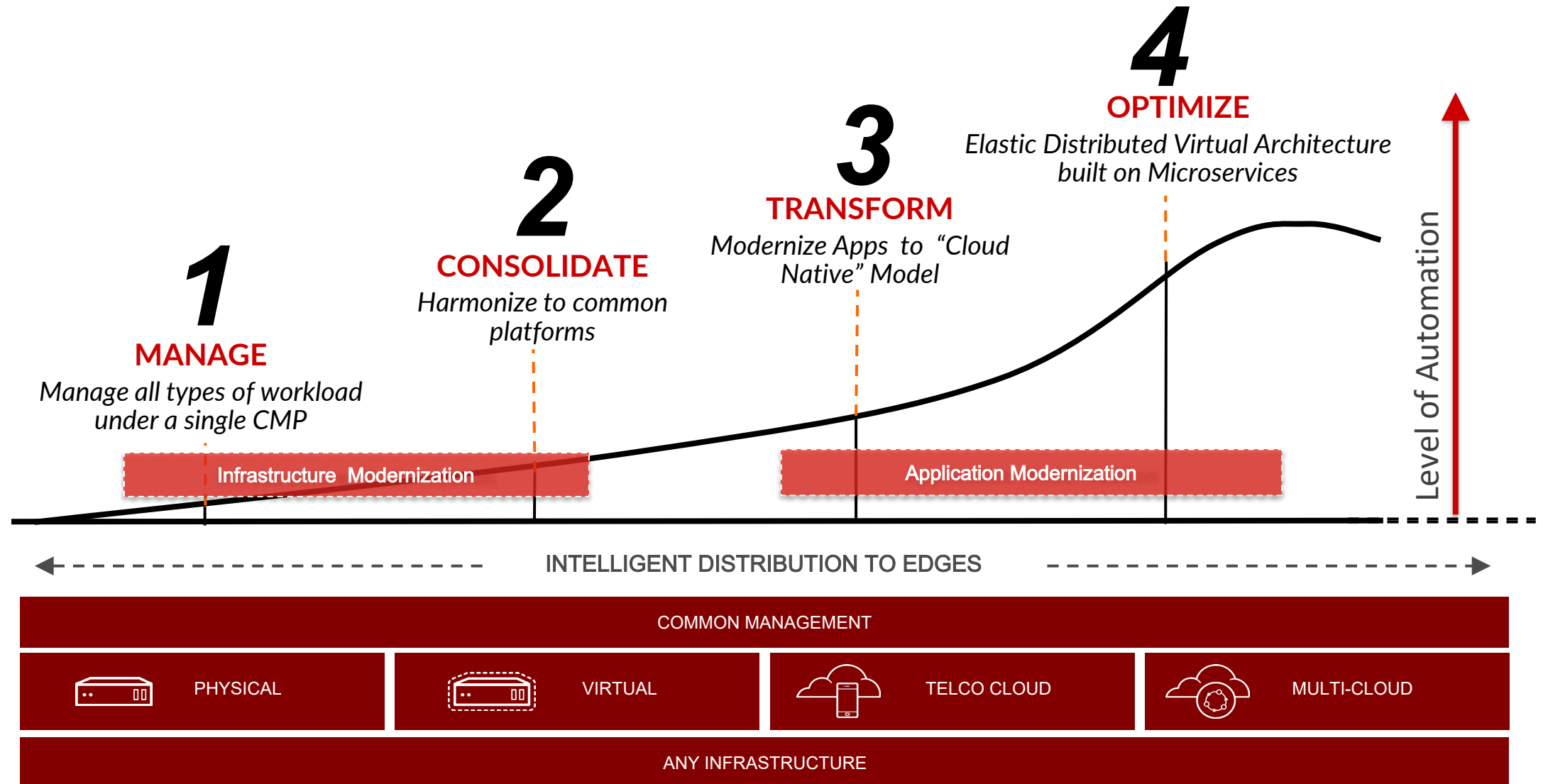
 **20%**
higher application developer productivity

 **US\$21.6 million**
higher revenue per year per organization

 **71%**
less unplanned downtime

 **21%**
more efficient IT infrastructure teams

JOURNEY TO A MICROSERVICES ARCHITECTURE



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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Dean Stoneback

Senior Director, Engineering & Standards
SCTE





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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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