Dan Rice

VP Access Network Engineering

+1M

MILES OF FIBER + COAX

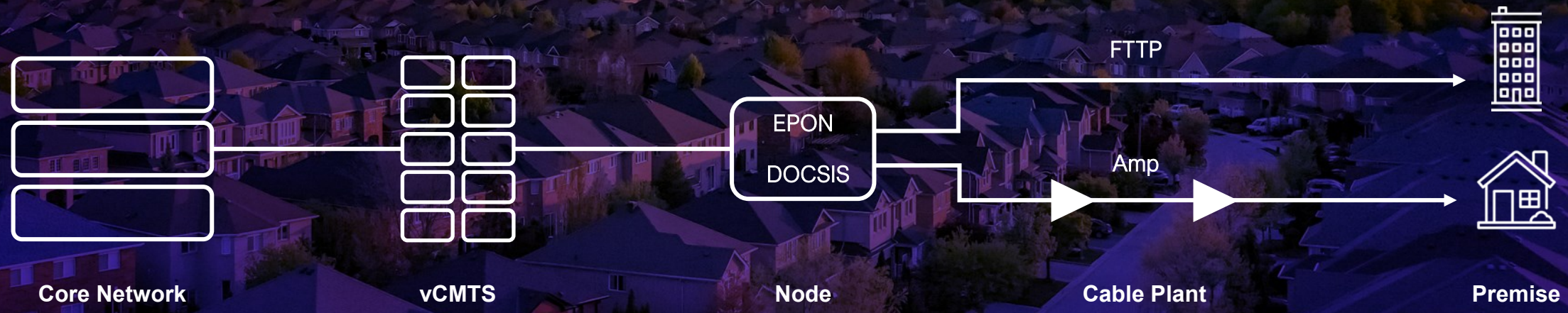
39

STATES

+60M

HOMES + BUSINESSES

Network from cloud to customer



CORE PILLARS OF 10G

Multi-Gigabit Symmetrical Speeds

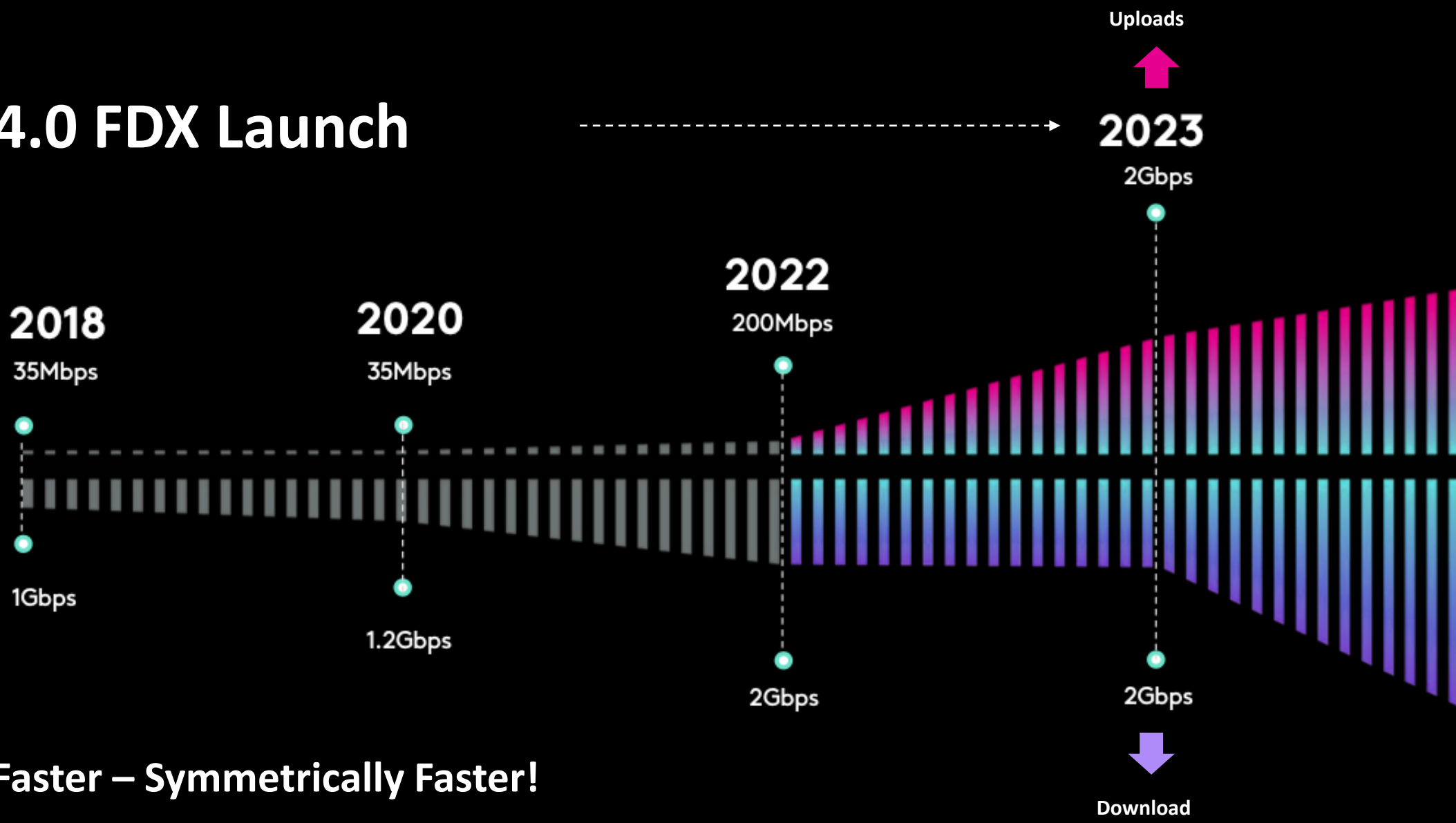
Enhanced Reliability

Low Latency

DOCSIS 4.0

In October last year we connected the first customers in the world over DOCSIS 4.0 using FDX in 3 Markets

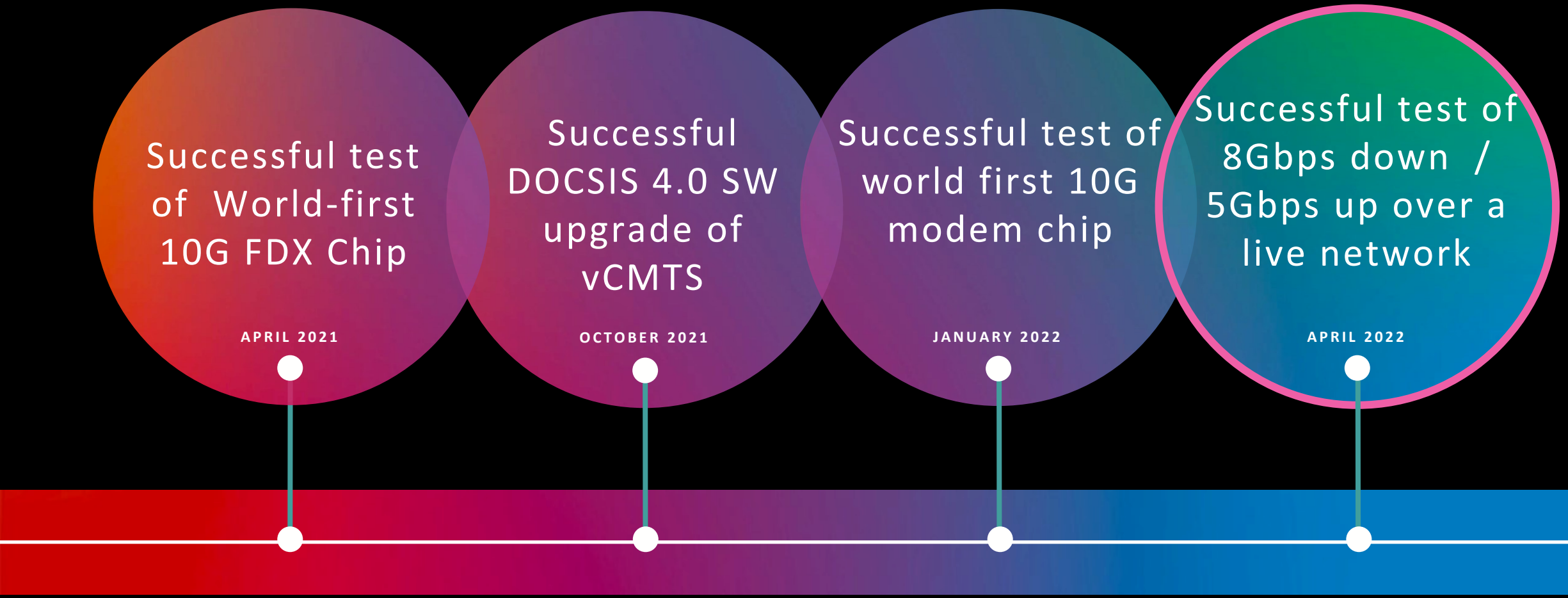
DOCSIS 4.0 FDX Launch



Not Just Faster – Symmetrically Faster!

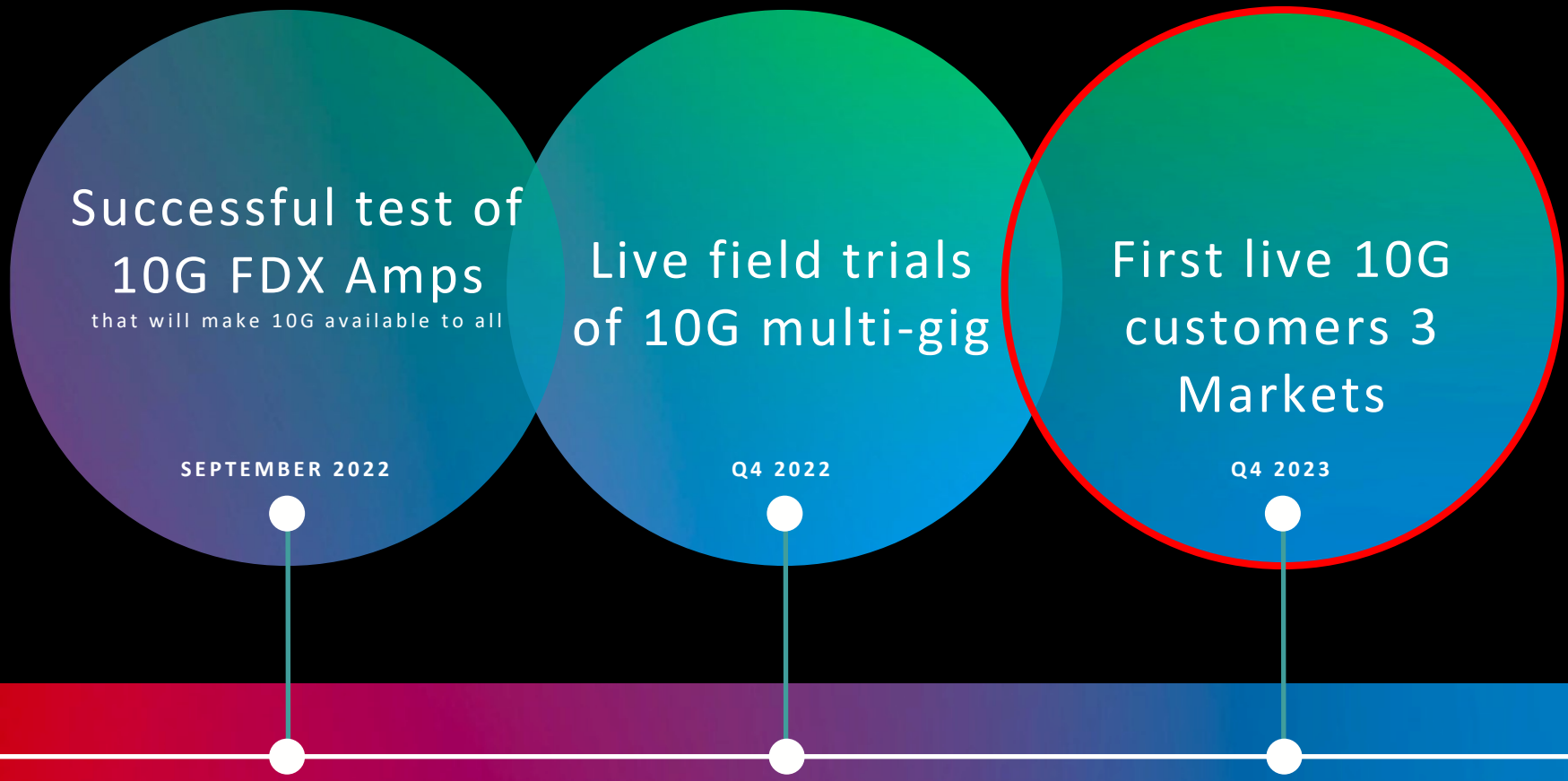
Technology poised to deliver on the promise of the Xfinity 10G

RAPID PROGRESS OF FIRSTs TO COMPLETE THE ECOSYSTEM



COMCAST | CONFIDENTIAL AND PROPRIETARY INFORMATION

10G LAUNCHED Q4 2023



Optical Access Network Convergence

2022

We demoed vCMTS delivering FTTH services over rOLT with vBNG.

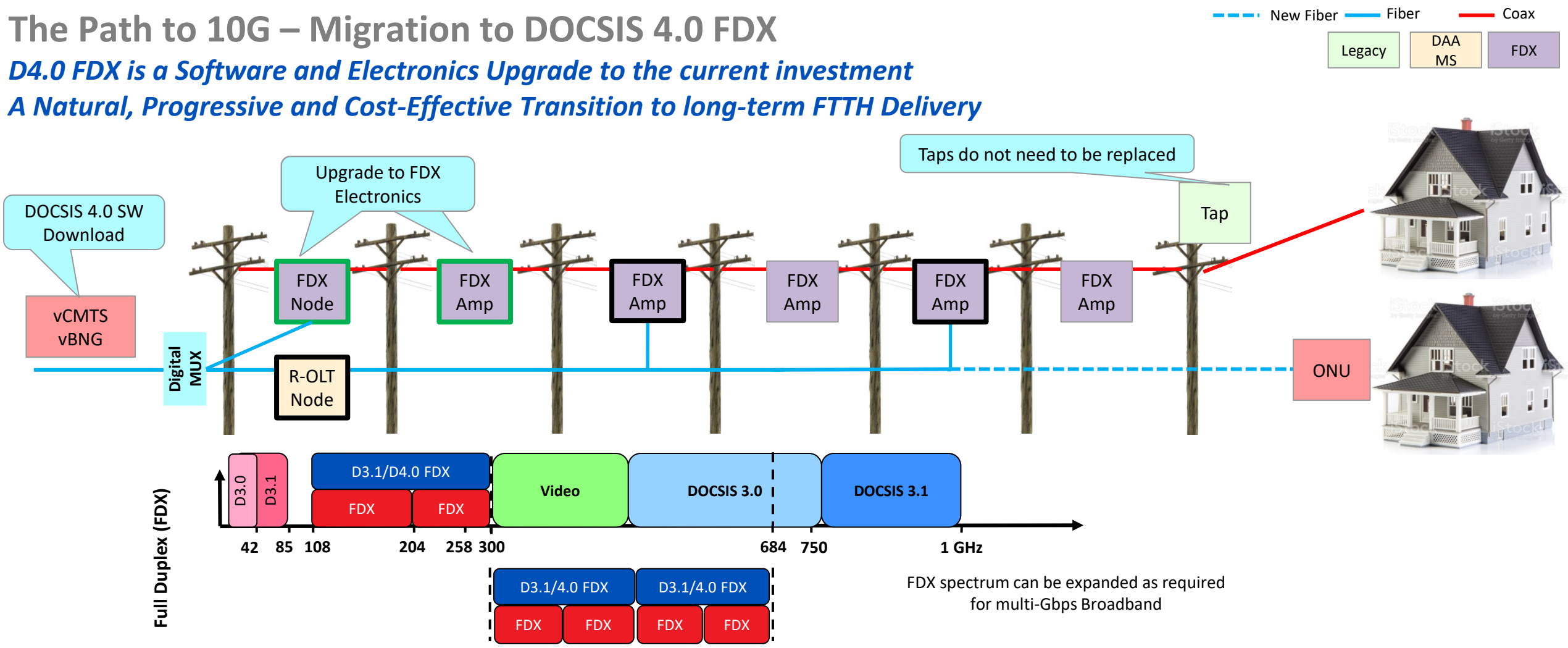
2023

vCMTS + vBNG-powered FTTH services launched nationally, PON now serving multigig to 100ks of homes

The Path to 10G – Migration to DOCSIS 4.0 FDX

D4.0 FDX is a Software and Electronics Upgrade to the current investment

A Natural, Progressive and Cost-Effective Transition to long-term FTTH Delivery



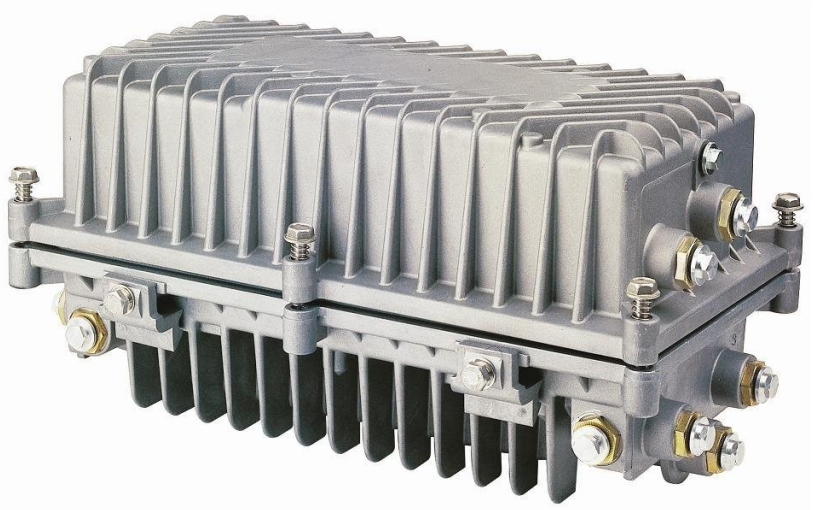
Key Callouts:

- Upgrade path to DOCSIS 4.0 FDX
  - vCMTS DOCSIS 4.0 FDX software upgrade
  - Electronic Swap on Digital nodes and amps to DOCSIS 4.0 FDX
  - FTTH Remote OLT supported from within same node
- Multi-Gig Upstream / Multi-Gig Symmetrical - ~8/5 Gbps HFC, 8/8 Gbps PON
- IP Video continues to expand as legacy QAM video is upgraded

Digital nodes

2022

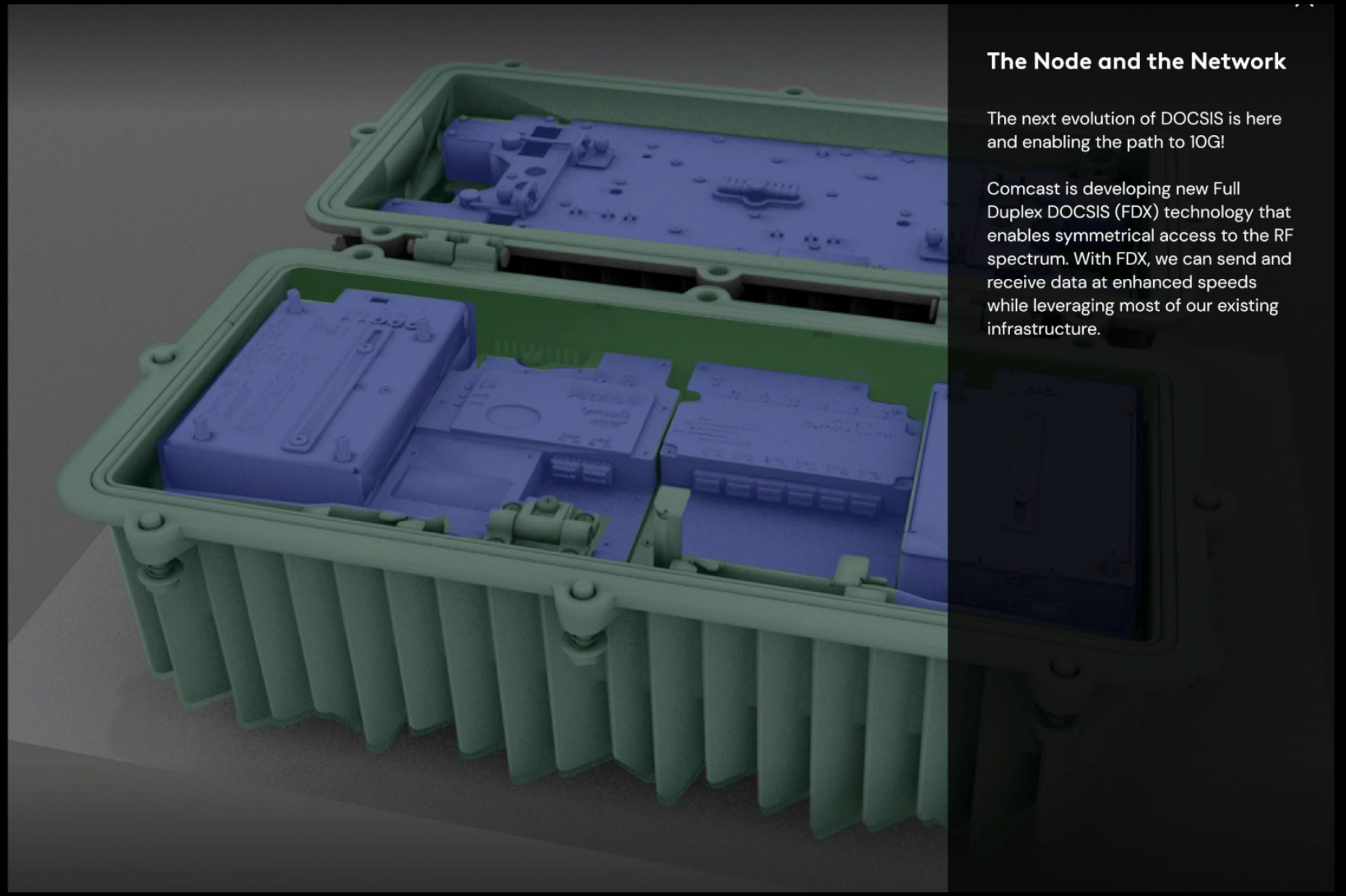
50K



2023

+140K

EVOLUTION OF THE TECHNOLOGY

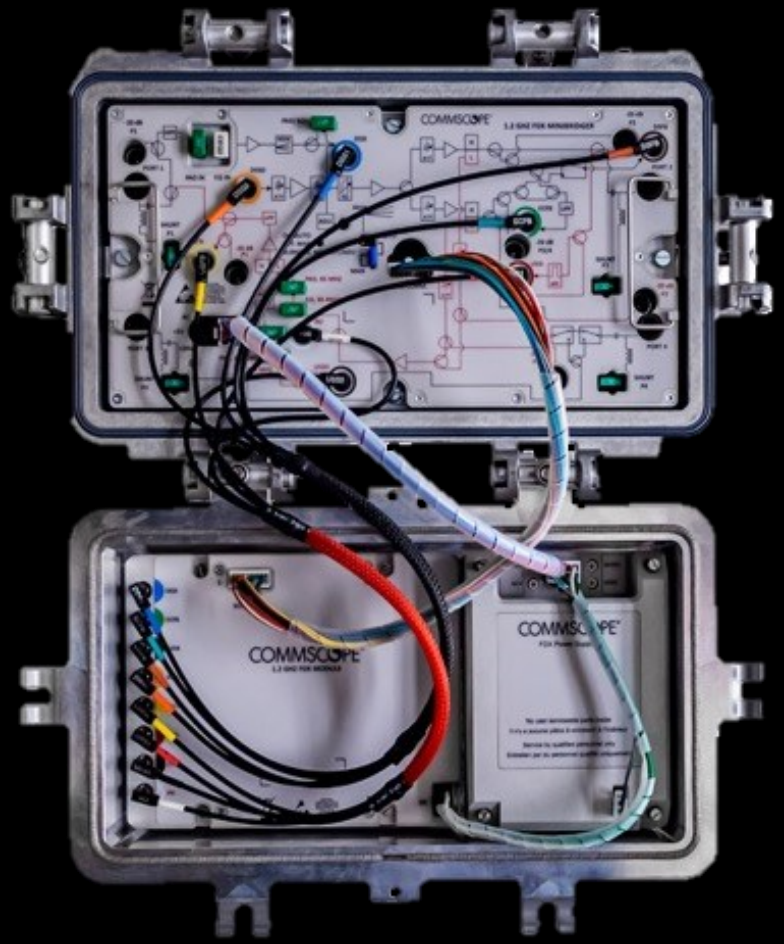


The Node and the Network

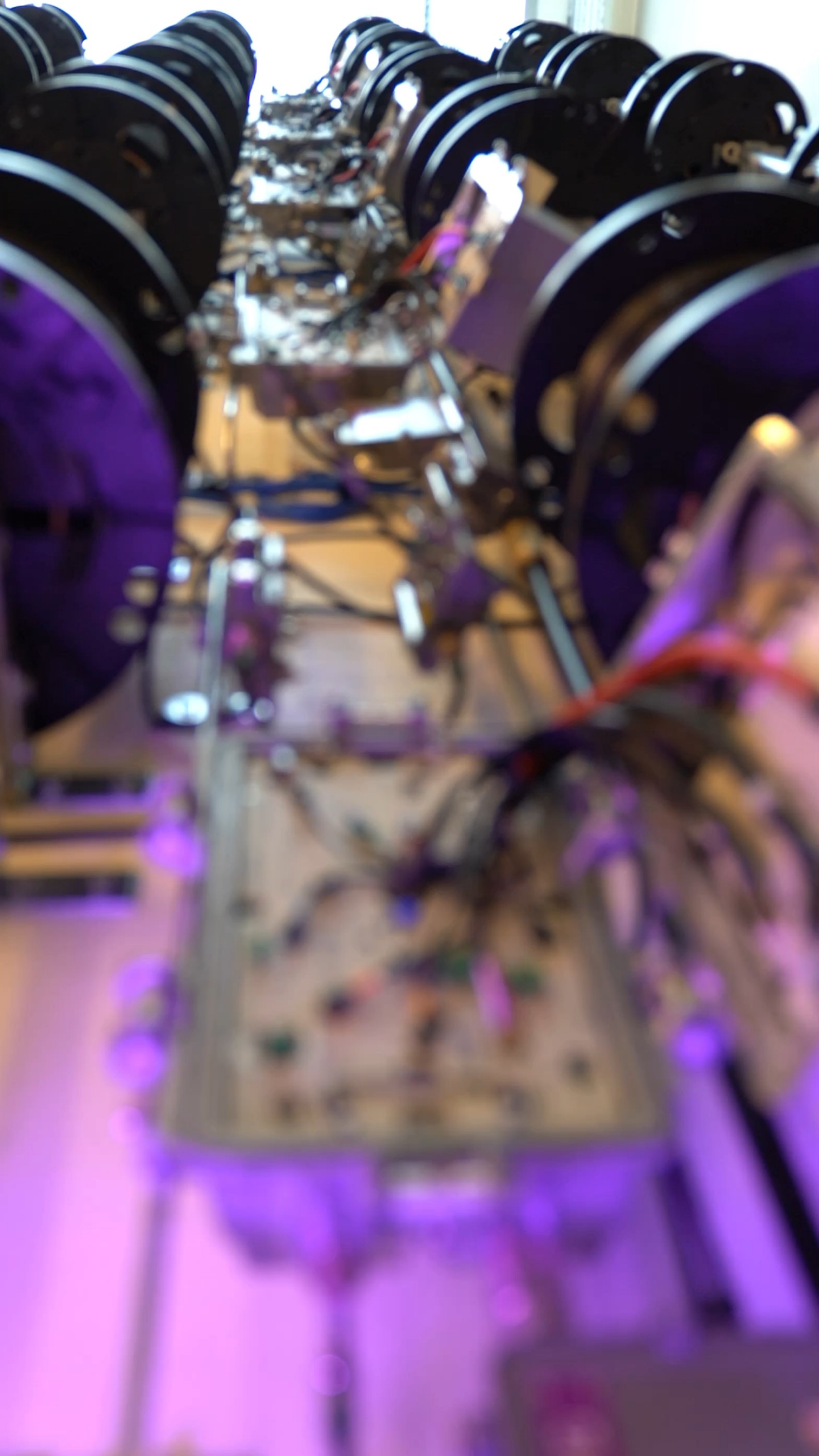
The next evolution of DOCSIS is here and enabling the path to 10G!

Comcast is developing new Full Duplex DOCSIS (FDX) technology that enables symmetrical access to the RF spectrum. With FDX, we can send and receive data at enhanced speeds while leveraging most of our existing infrastructure.

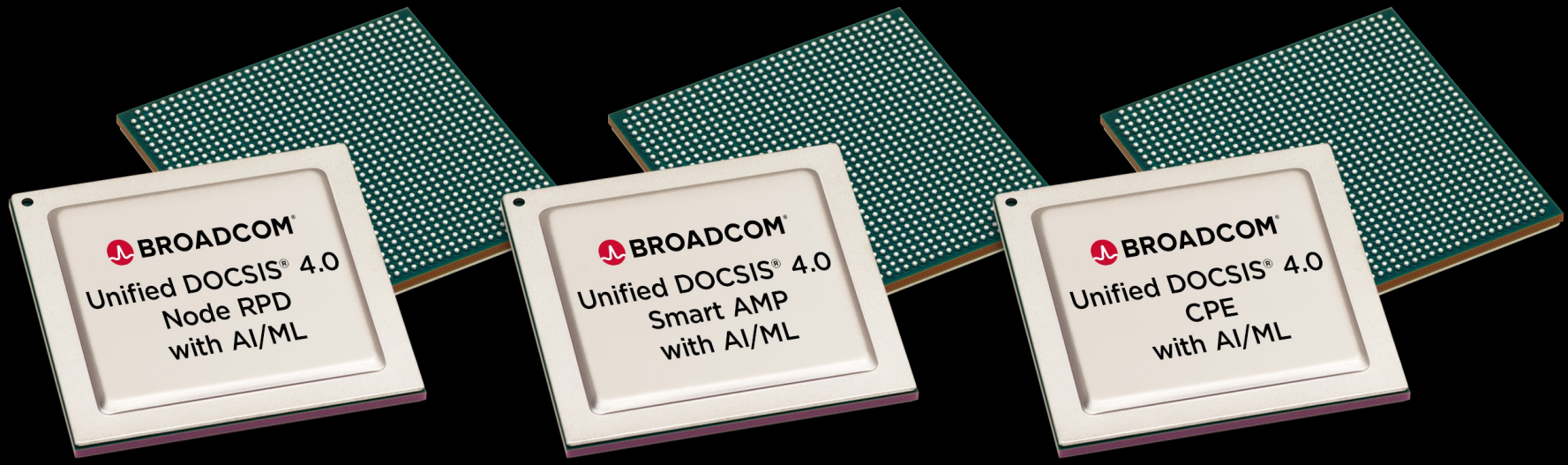
We’re Scaling even higher with the DOCSIS 4.0 amp + SW



- Automated setup
- RF monitoring
- Real-time telemetry
- Hands-free configuration
- Self-correcting
- ML/AI signature diagnosis



COMCAST + BROADCOM®



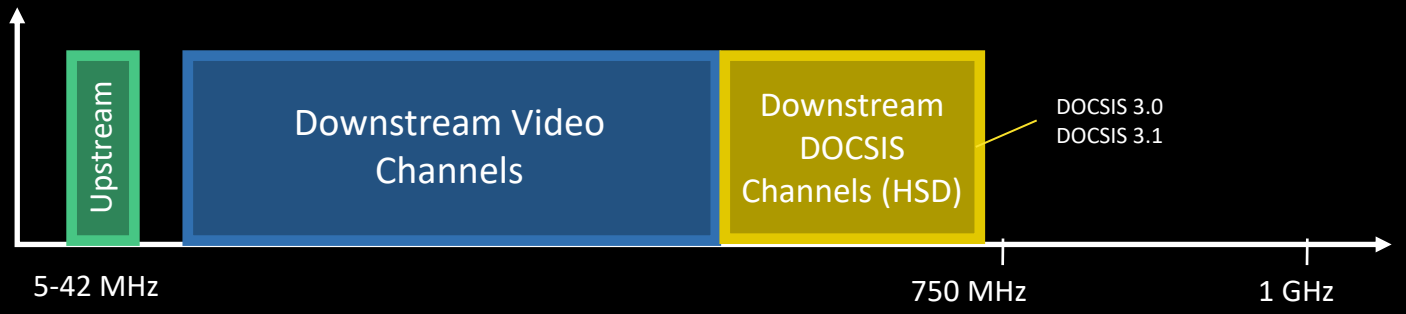
More transformation. **More optionality.** **More AI.**

DOCSIS 4.0 FULL DUPLEX (FDX) – THE BIG IDEA

Traditional Spectrum Allocation = Frequency Division Duplexing (FDD)

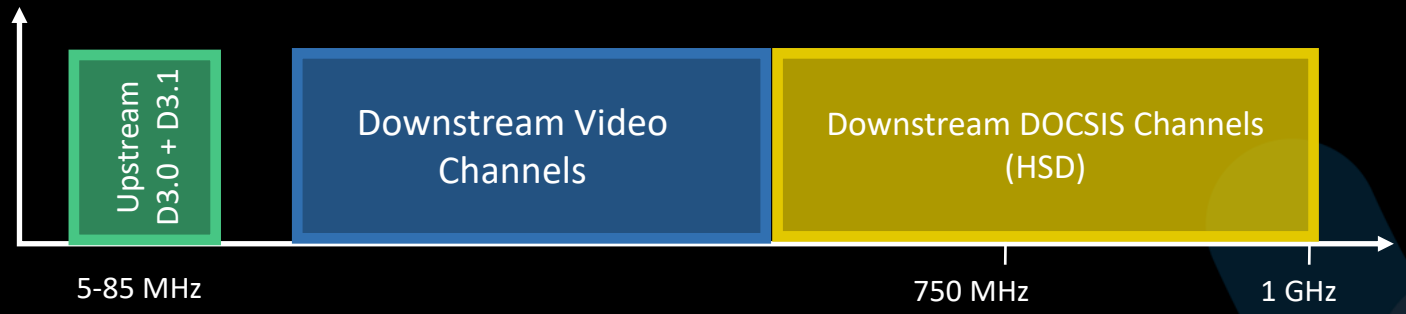
Yesterday

Traditional Network



Recent

Project Genesis



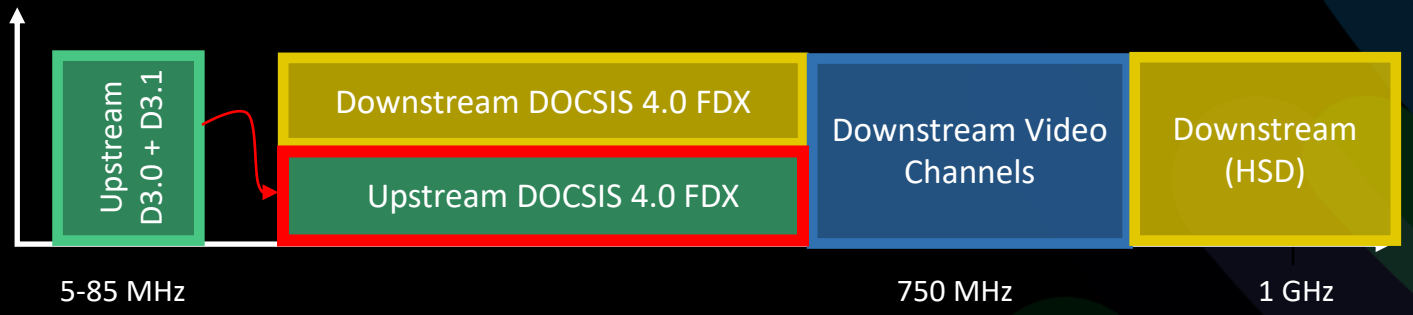
Down/Up Growth Capacity

Higher Speeds (2Gbps / 200 Mbps)

DOCSIS 4.0 Full Duplex (FDX)

Today and Tomorrow

10G FDX



Massive New Upstream BW >8x

No Loss of Downstream BW

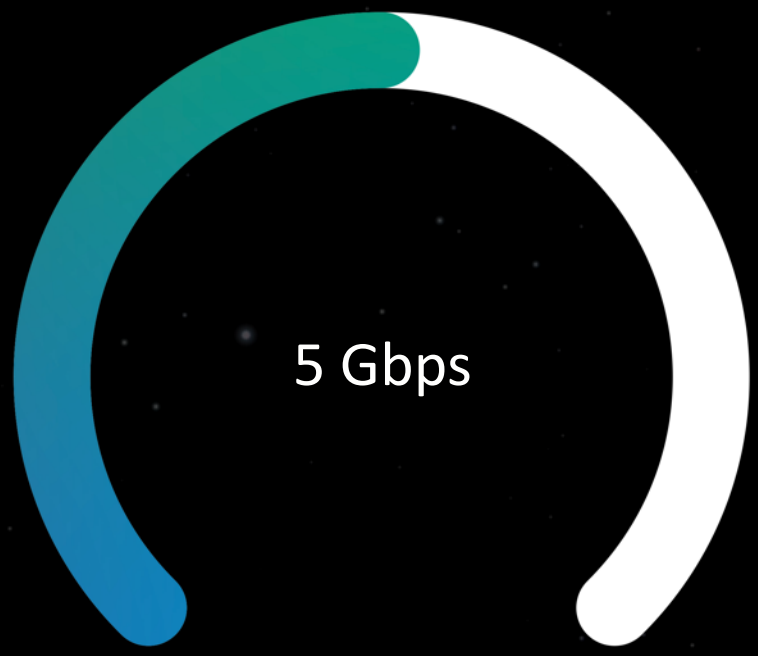
Fiber Competitive Multi-Gig Symmetric Speeds

10G SPEEDS

DOWNLOAD

4x Max Download Speed

UPLOAD



25x Upload Speeds

TWO KEY ENABLING DOCSIS 4.0 FDX INNOVATIONS

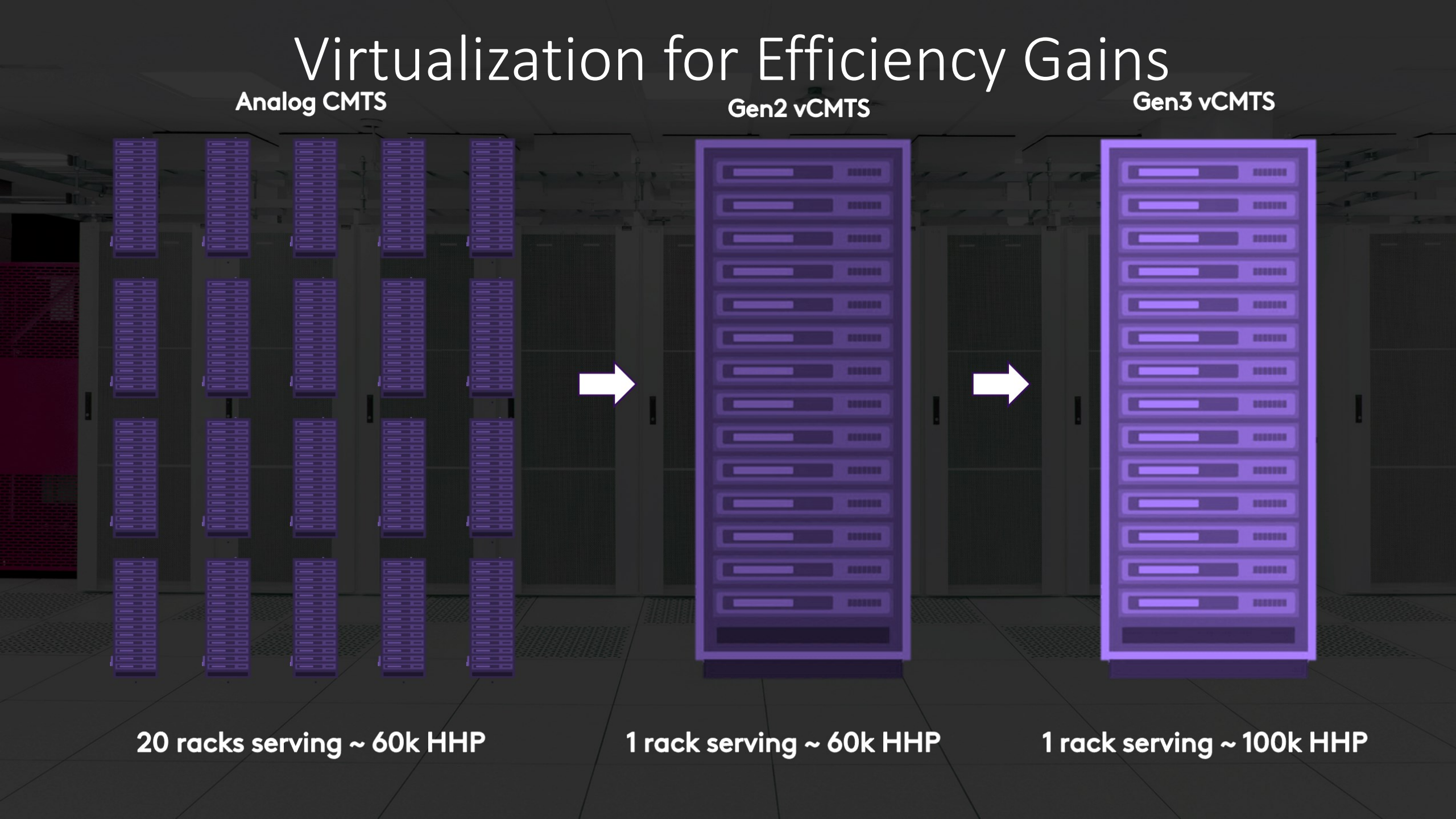
1

ECHO CANCELLATION
allows simultaneous use of spectrum without interference

2

COORDINATED SCHEDULING
when interference is unavoidable

Virtualization for Efficiency Gains



We are full steam ahead on scaling
DOCSIS 4.0 FDX.

Doubling of internet video traffic since 2019

Customers expect new and emerging technologies to just work

Privileged & Confidential

Cloud Gaming

Home Security

Best-Quality Streaming

Network: Future-proofed for all use cases

Massive File Uploads

School / Work From Home

Extreme VR / AR

Privileged & Confidential

Live sports is driving a shift.

prime video THURSDAY NIGHT FOOTBALL

NFL SUNDAY TICKET YouTube

MLS

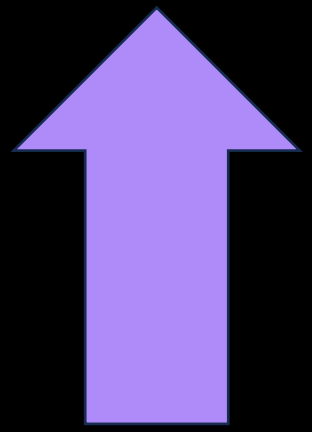
BIG SATURDAY NIGHT

peacock sports
From NBCUniversal

The most live sports of any streamer. 😀

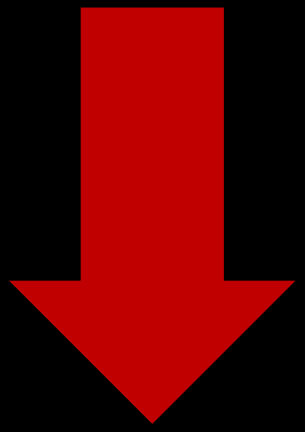
4x More Amazon Prime Viewership

Streaming sports has forced us to rethink how content is ingested and delivered on the network.



+7%

YouTube TV on Sunday



-10%

Netflix during Sunday football

Pre-COVID peak:
Sunday Night

During COVID peak:
Midweek 10 a.m. – 5 p.m.

Post-COVID peak:
Thurs. Night during football season

STREAMING

Peacock Exclusive AFC Wild Card Game Is Biggest Live-Streamed Event in U.S. History and Drives Internet Usage to Single Day U.S. Record

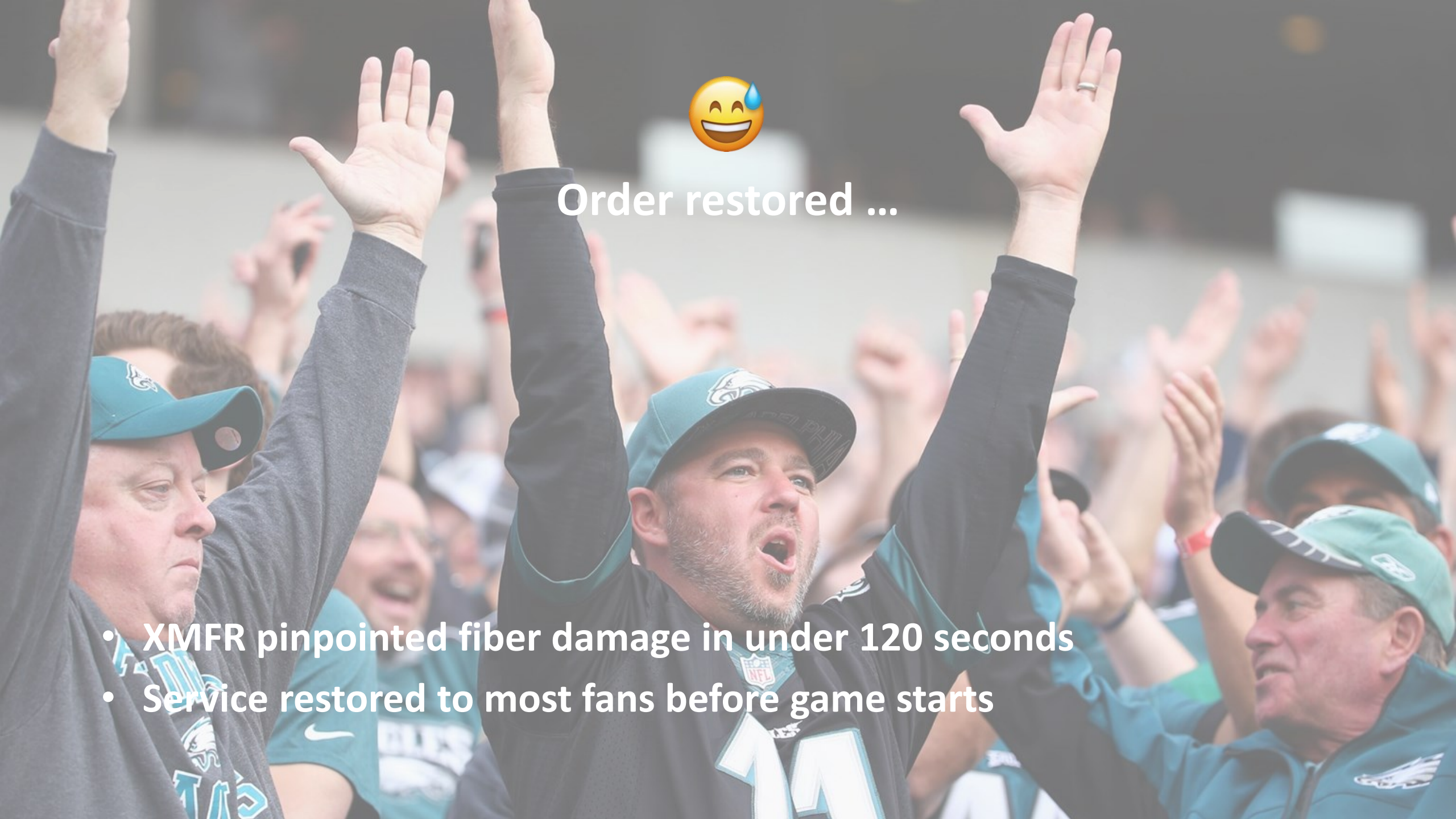
Jan 14, 2024

How do we deliver even better reliability?

… especially in Philadelphia.

Philadelphia cable outage on Super Bowl Sunday sends Eagles fans into tailspin

By Alicia de Artola | Feb 12, 2023



Order restored …

- XMFR pinpointed fiber damage in under 120 seconds
- Service restored to most fans before game starts

… but the other guys still won…

XMF Solutions: Continuous and Pervasive Optical Monitoring

XMF-R

Link DS OSA WL Data | Link US WL Data | Link OTDR Data | Base Line Data

Multi-link Optical Data Sets

Extract/Index/Store/Analyze/Visualize

Link Integrity – Proactive Network Management

WL Inventory/Fiber Cuts/Ice Chokes/Power Outage/SFP

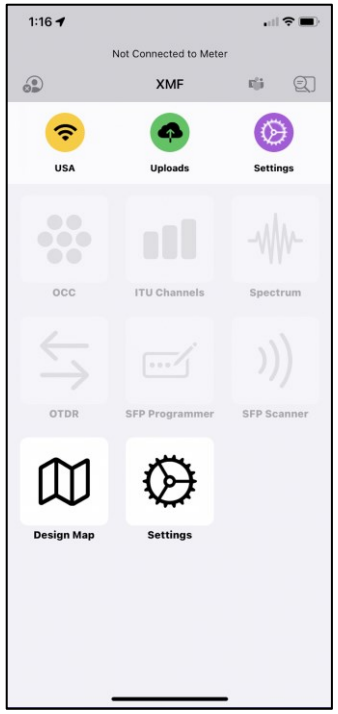
Monitoring all Digital Nodes + MetroE every 90 sec > 500 km of fiber,

XMF-H

SFP | **OTDR** | **OSA** | **OCC**

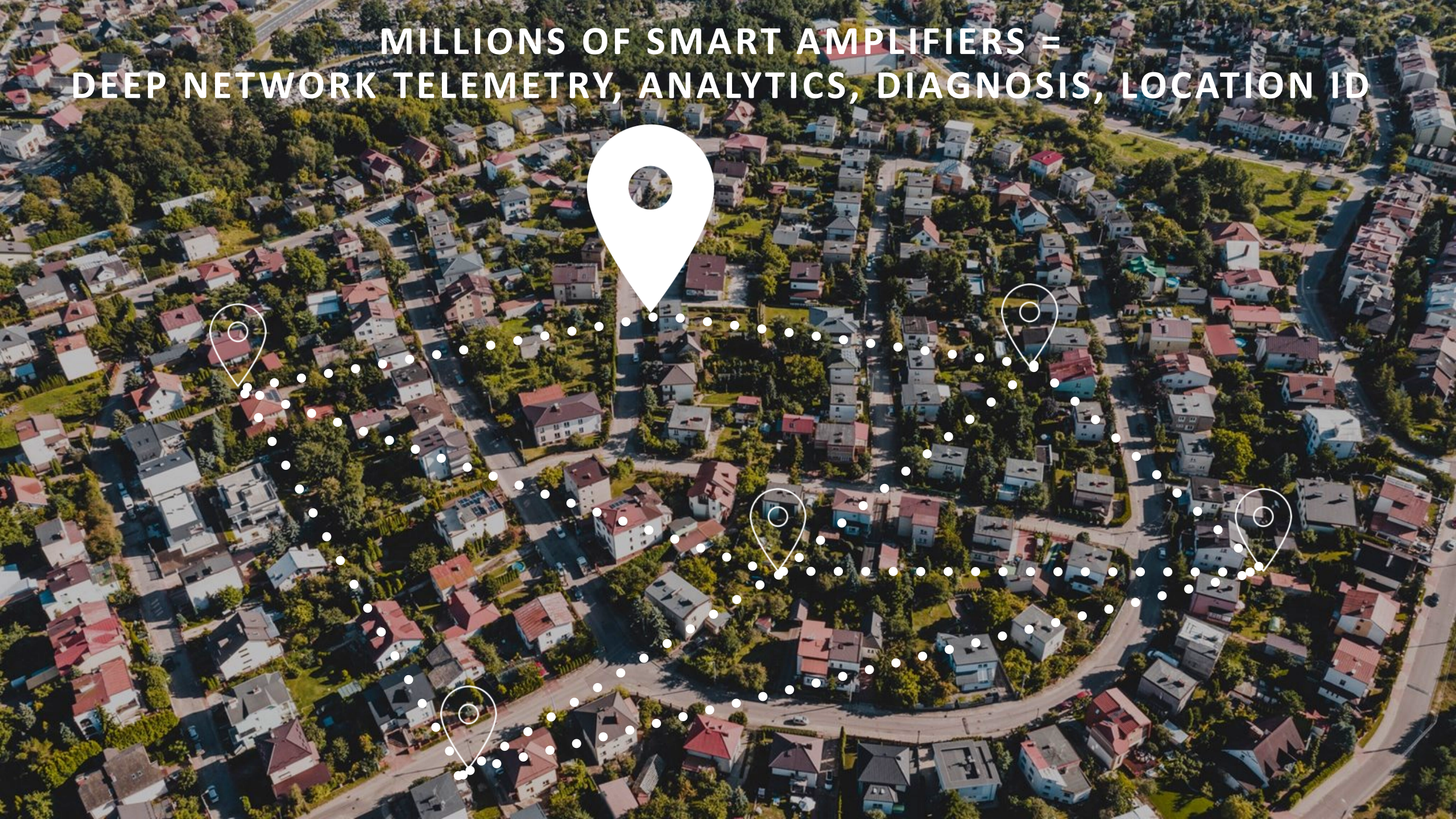
Extending Optical Technology to techs + BPs

XMF-App



View fiber cuts and restorations IRT
Digitize Dark Fiber Assets

MILLIONS OF SMART AMPLIFIERS =
DEEP NETWORK TELEMETRY, ANALYTICS, DIAGNOSIS, LOCATION ID



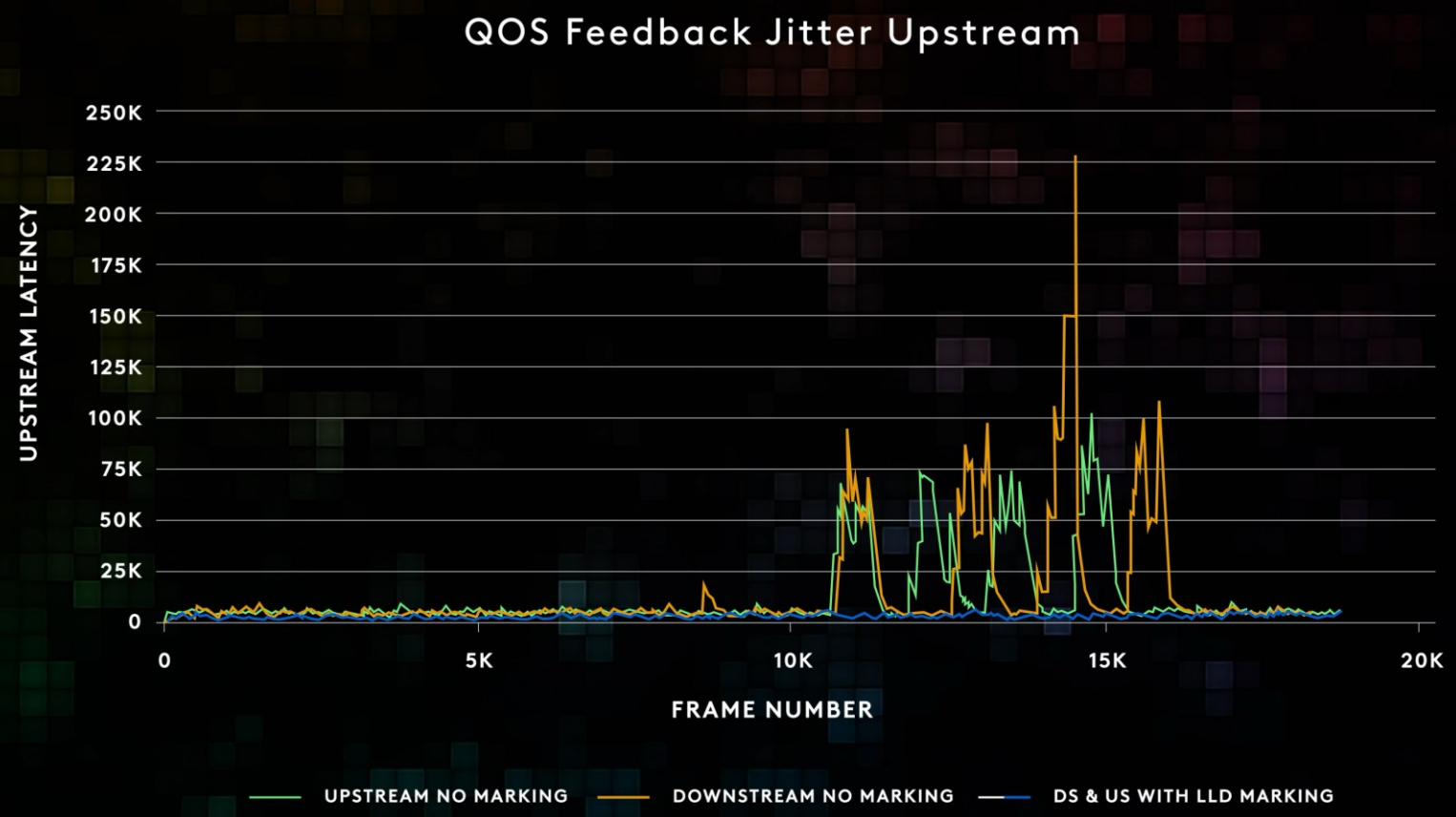
JCB

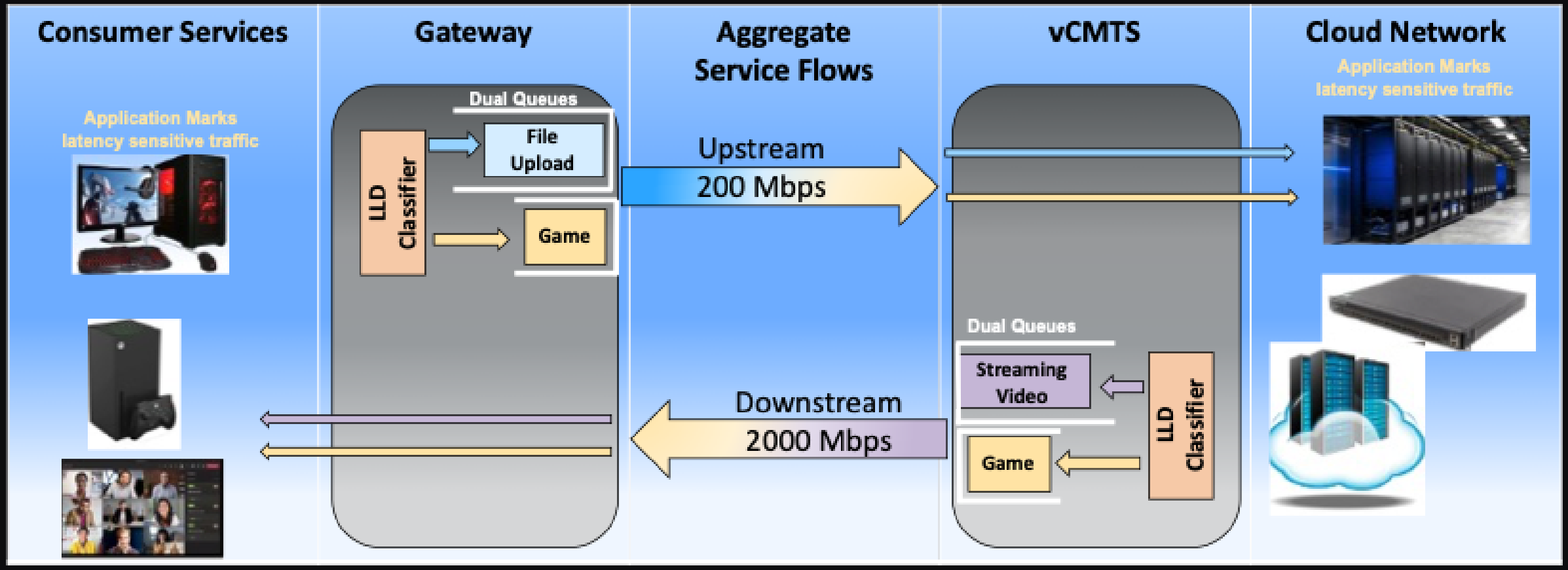
Ultra-Low Lag
Its not all about speed
NVIDIA
VALVE
Partners

Lower Latency Enabling New Internet Experiences

Trials Results

Lag Spikes ~10 ms vs 225 ms





- User controls low latency treatment
- Application marks traffic
- GW passes ECN & DSCP marking DS & US

Key Highlights:

Leverages the vCMTS architecture for optimal results

SW driven service provisioning for speeds & packet classification

Larger ecosystem support with application/server-based marking with partners

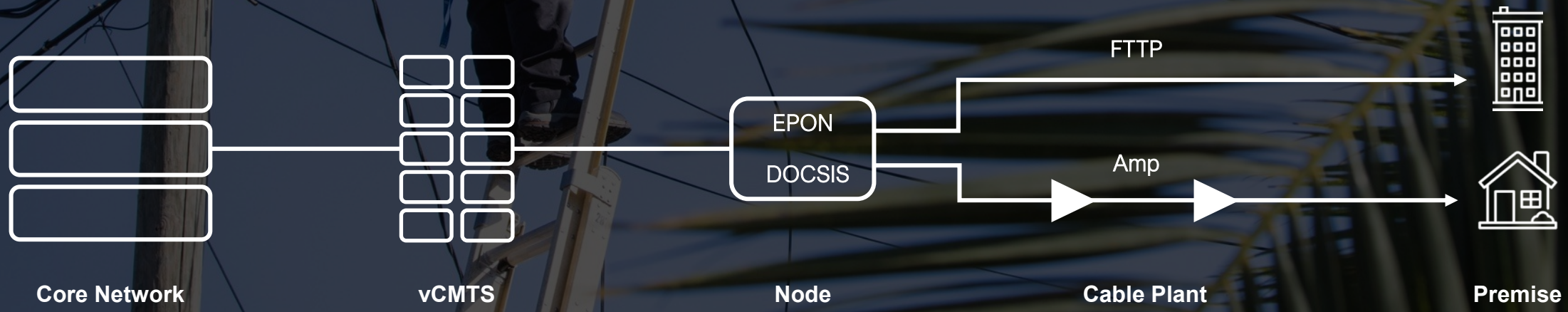
Flexibility in product offerings and application with partners

All application L4S support welcome and encouraged

- Edge application server marks traffic
- ECN & DSCP passed unbleached through core network
- Low latency treatment across core and access

Through AI / ML that always looks after our technicians and our customers.

Real-time visibility. Everywhere.



AI in our “Brilliant Network”:

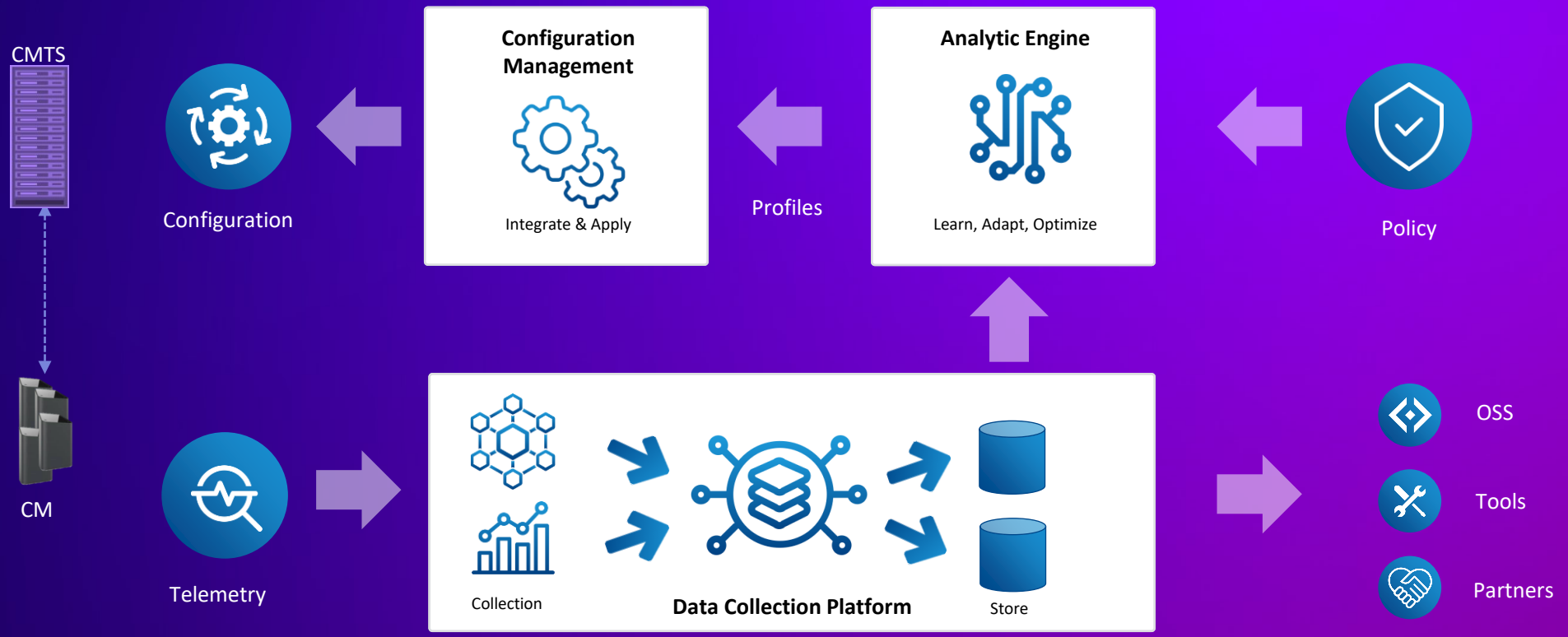
Reducing customer downtime through proactive fault diagnosis and repair

	Deployed Today			In Development	
Initiative	**XMF-R** *Xfinity Meter for Fiber Rackmount*	**Genesis** *Future Proof Connectivity and Deliver 10G*	**Octave** *Profile Management Appication*	**Storm** *Real-time Monitoring of 250K Power Supplies*	**Brilliant Technician** *Reduce Technician Transactions and time-to-repair*
Activity	Ensure highly available and reliable fiber connectivity	Detect, locate and mitigate vCMTS faults across **1M telemetry** points per month with **99.9996% availability**	Maximize capacity without compromising CX	Using AI off **30K historical outages** to predict utility issues & power supply runtimes to dispatch proactively 50% more accurately	Identify single vs. multi-home failures with ROCI, Pattern Detection and ANS Improve RF fault diagnosis and dispatch fiber repair within 2 poles
Impact	**80x Faster** *than previous approaches by **detecting and pinpointing** a fiber cut in **90 seconds***	**58%** *vCMTS alarms are self healed with* dynamic **spectrum allocation** identified in real-time	**+40% DS** **+20% US** *capacity gains to account for traffic growth*	**Early Results** **2.8 hrs** *more time to prioritize field resource deployments*	**30 - 45 min** *saved per job with **ML driven RF pattern detection** trained on 10K labels*	**50%** *lower repeat trouble rate*

Octave: AI Optimizing our Broadband Network

Great returns with SW investment: Higher capacity, more efficiency, lower latency

> 44% downstream | 20% D3.0 upstream (40% with new US CH) | OFDMA > 50% capacity increase



Across the entire network, including the core.

We’re here to change people’s lives.

Scale

Stability

10G

Innovation

Security

PROJECT UP

Adoption

Portfolio

Track Record