SCTE ISBE CABLE-TEC EXPO '16

SEPTEMBER 26-29 PHILADELPHIA

Aboard the Technology Wave: Surf Report

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Comcast

SCTE Society of Cable Telecommunications Engineers

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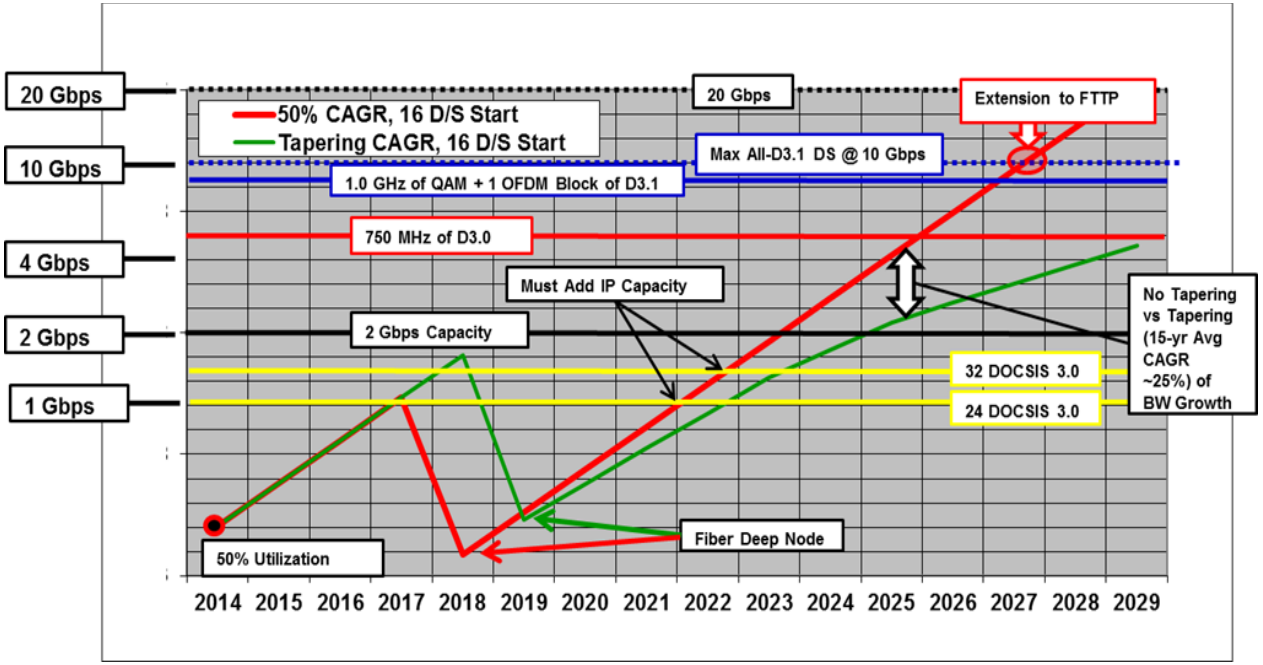
Essential Knowledge for Cable Professionals™

Agenda

- Problem and Solution Options (2)
- Current Wave and Readouts (9)
  - Fiber Deep
  - DOCSIS 3.1
  - FTTP
  - All-IP
- Wave 2 (5)
  - Distributed Architectures
  - Virtualization
  - Full Duplex DOCSIS
  - Wireless
- Timing and Synergy

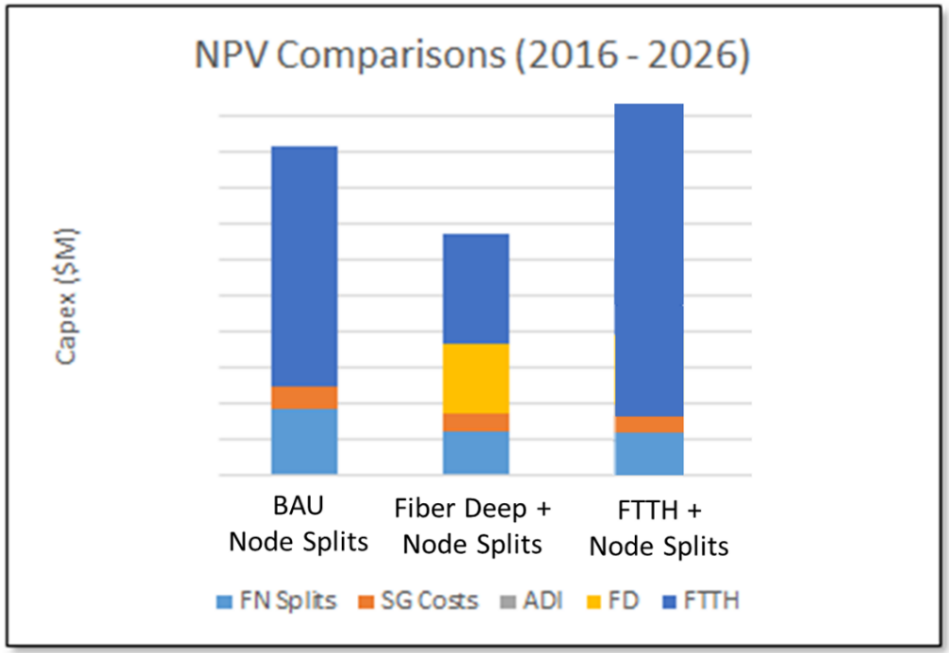
Persistent Forcing Function



- CAGR continues
- Implications can be projected
- Multiple tools to manage
- Drives decision and investment timeline
- Many years to observe trends and adapt

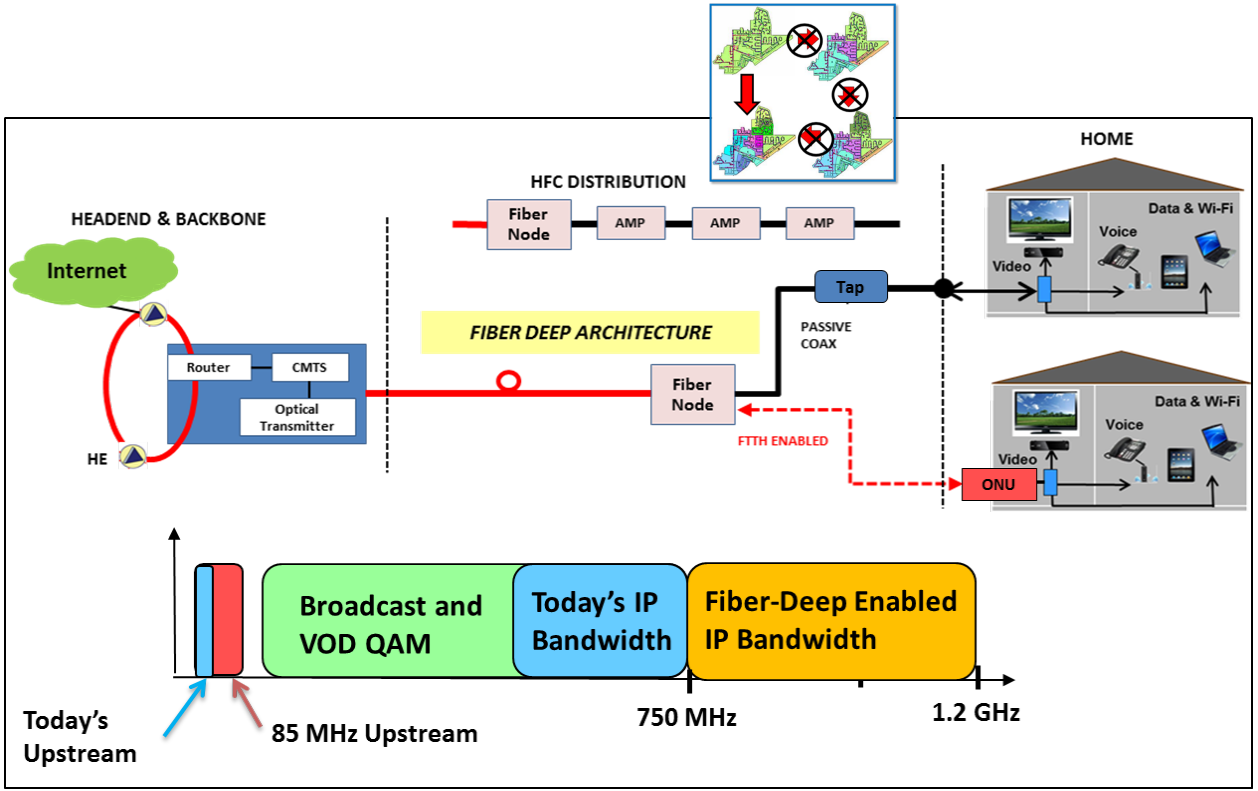
Quantifiable Options

Time Perspective Matters



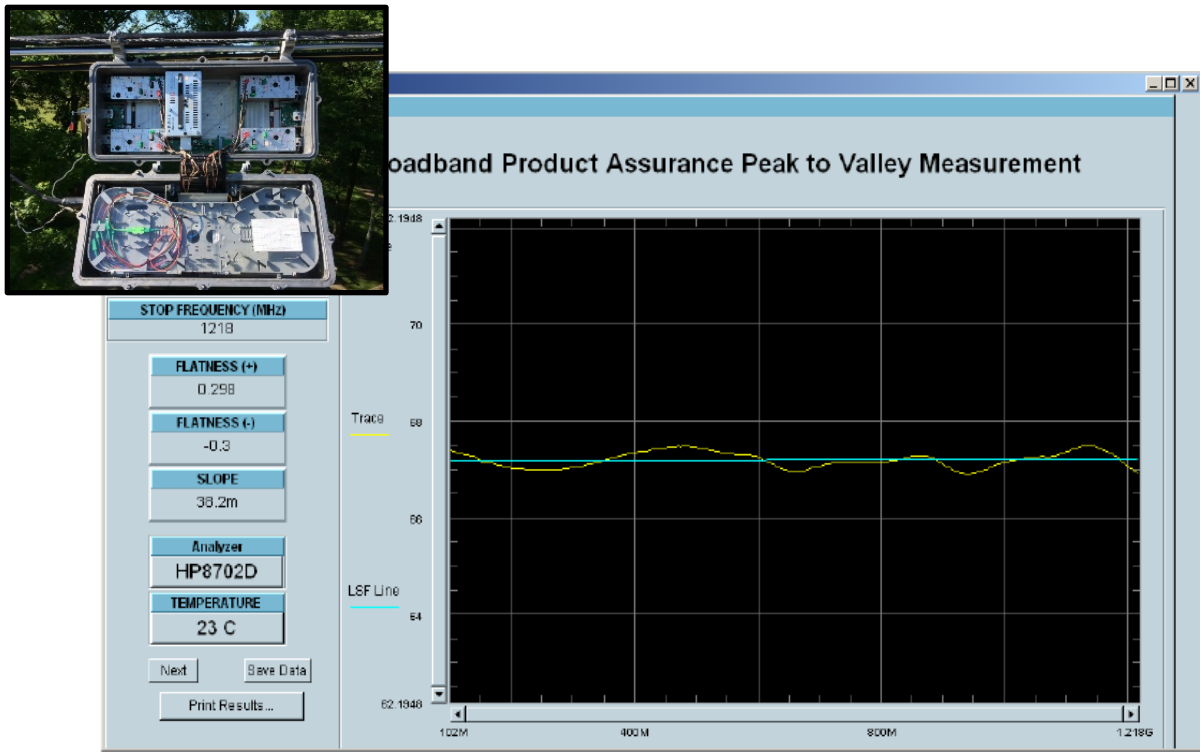
- Long-term investment window – BAU limitations
- Capacity, product, operations, and architecture strategy considerations
- Results lead to Fiber Deep recommendation

Fiber Deep: Building Now



- Passive coax
- More spectrum
- Flexible spectrum
- Smaller serving groups
- Convenient access for FTTP

Fiber Deep: Technology Partners Delivering



- World's first deployed 1.2 GHz node
- New PA technology to maximize reach optimize economics with extended tilt line
- Modular Node for DAA DOCSIS and EPON options

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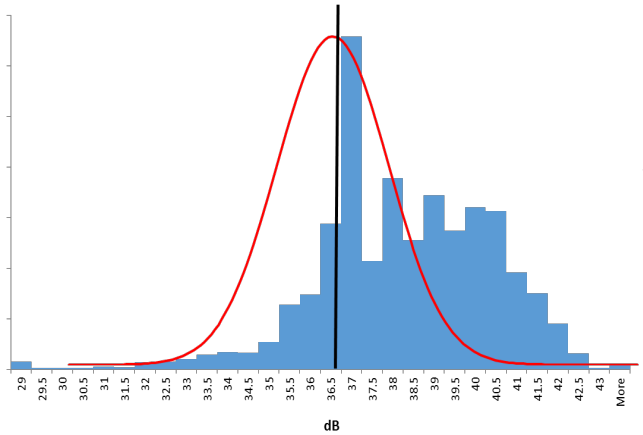
Fiber Deep: Expectations Being Met



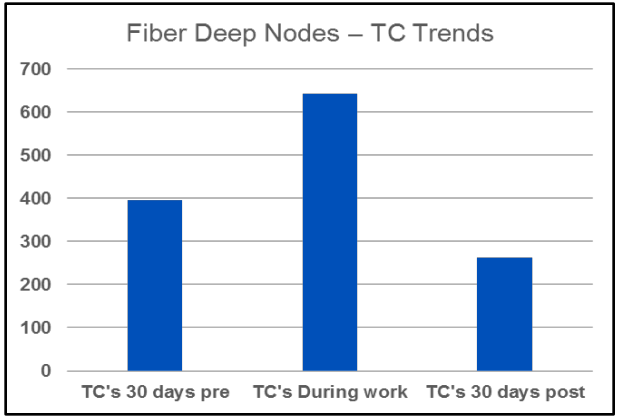
Increased EOL MER observed

More BW-efficient QAM for D3.1

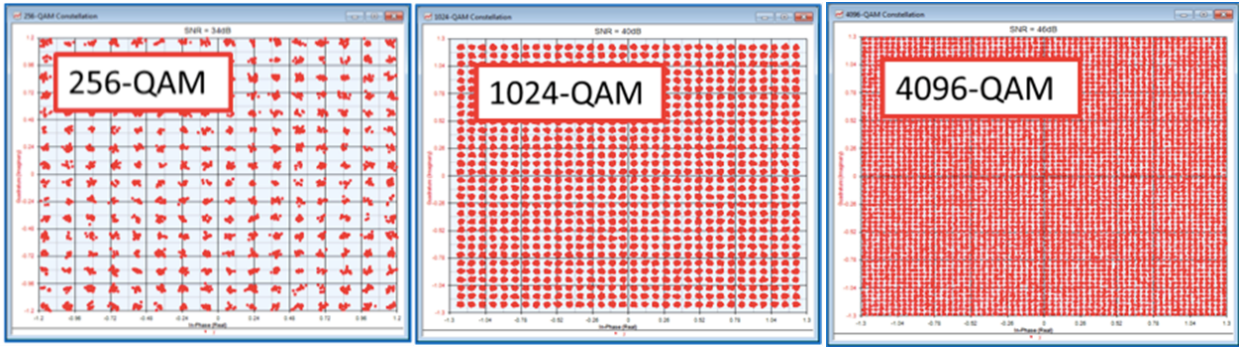
> 1 bps/Hz average gain

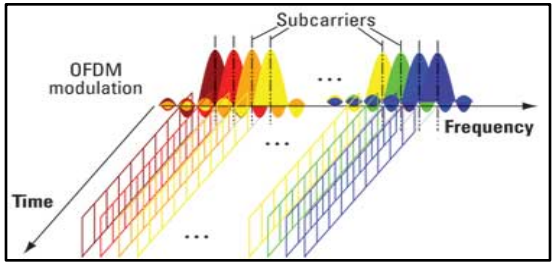
Steady state before / after trouble calls: -30%

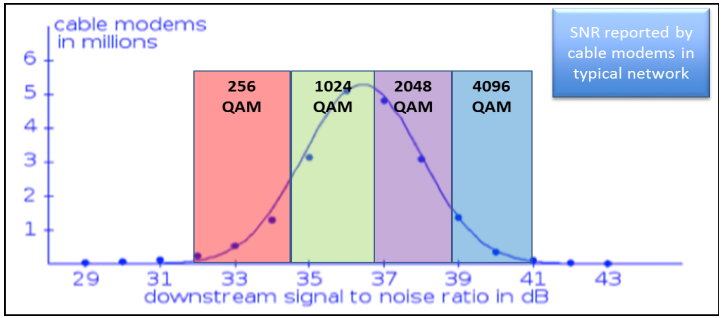
Increase during – typical but expect to get better



DOCSIS 3.1: PHY Makeover Definition

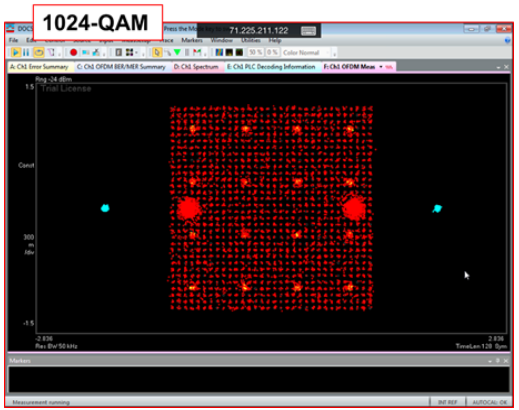


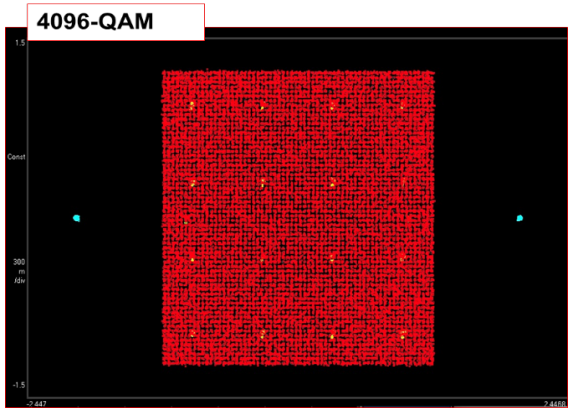


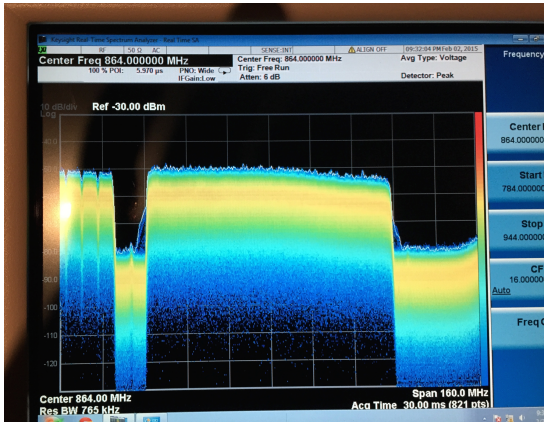


- Better BW efficiency and capacity were primary objectives
- Multiple QAM profile optimize network usage rather than throw away dB

DOCSIS 3.1: Launched

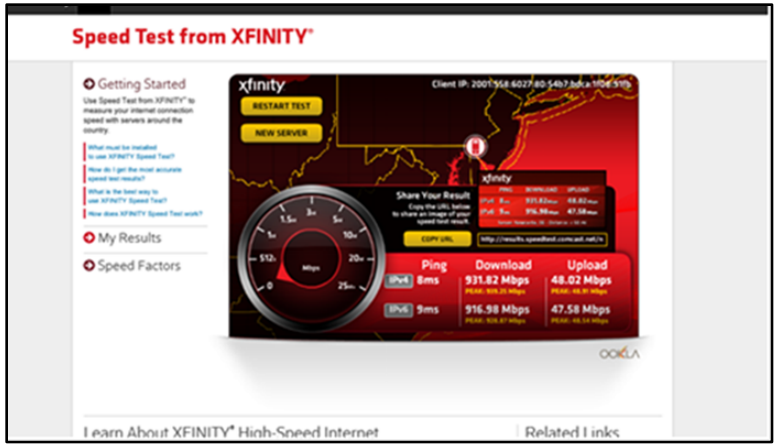






- Field versions of 1024-QAM and 4096-QAM from D3.1 trials
- OFDM spectrum operating in the roll-off band in Philadelphia trial system

DOCSIS 3.1: Mission Accomplished

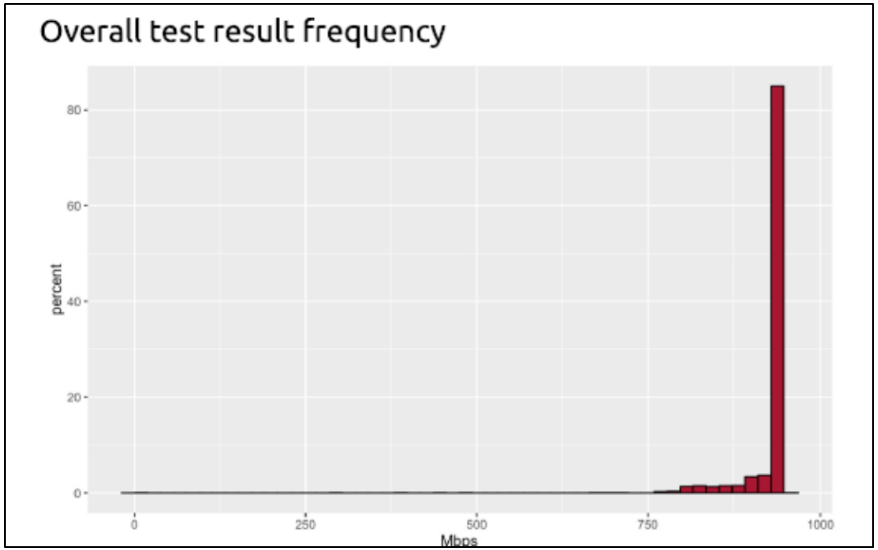


Bonding of D3.1 and D3.0 spectrum proven

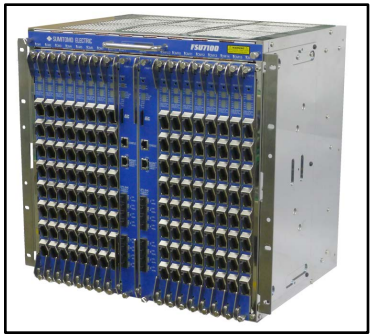
Enabling of Gbps service speeds over coax

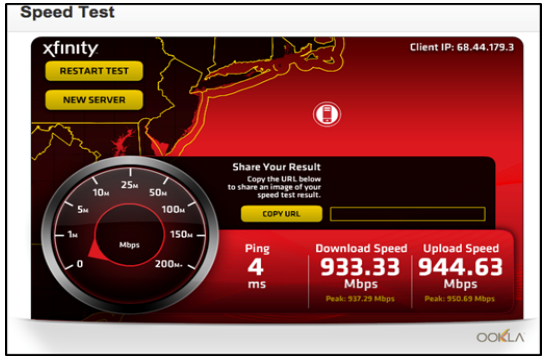
Robust, repeatable Gigabit service speeds achieved

Periodic speed testing



FTTP: Align to Capacity, Product, All-IP





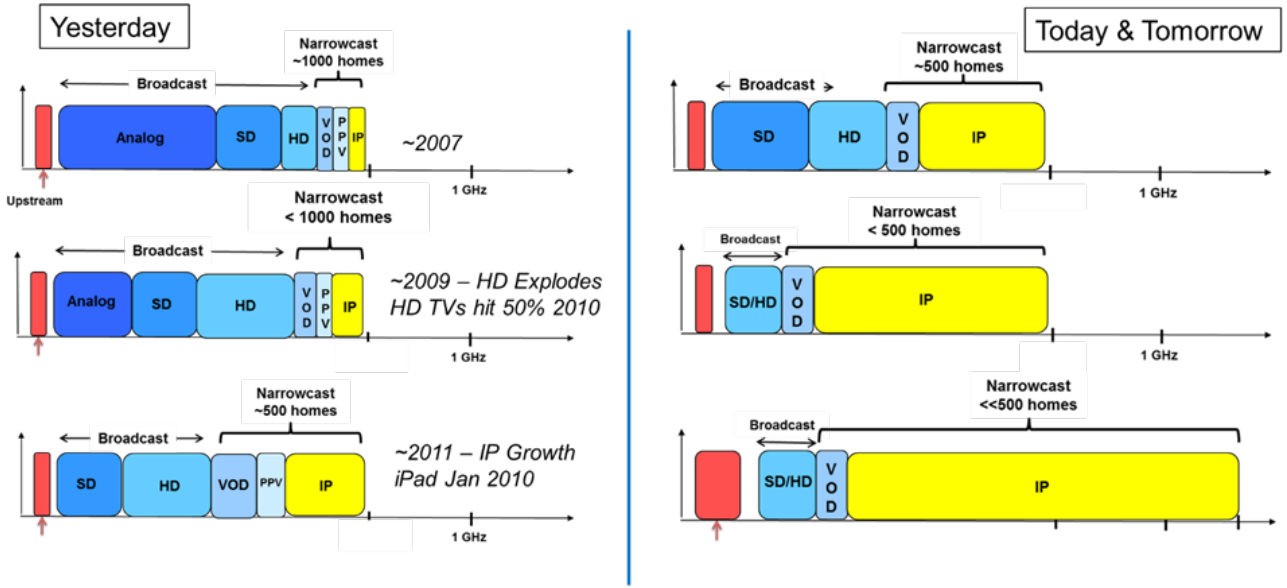
- Support capacity growth, matching long term HFC
- EPON Interoperability
- Multi-Gig speeds
- Business services growth
- All-IP Services
- DPoE
- IEEE standard

FTTP: Adapted to Cable Networks

	OLT Config	Trunk	PON	10 ONU DS	10 ONU US	60 ONU DS	60 ONU US
1	**Control Test**	**0km**	**20km**	**8,400Mbps**	**8,400Mbps**	**8,339Mbps**	**7,670Mbps**
2							
3	cable distance 10 - 30	20km	0km	8,400Mbps	8,400Mbps	8,339Mbps	7,670Mbps
4	cable distance 30 - 50	40km	0km	8,400Mbps	8,400Mbps	8,339Mbps	7,670Mbps
5	cable distance 50 - 70	60km	0km	8,400Mbps	8,400Mbps	8,339Mbps	7,670Mbps
6	cable distance 60 - 80	70km	0km	8,400Mbps	8,400Mbps	8,339Mbps	7,670Mbps
7	cable distance 70 - 90	80km	0km	8,400Mbps	8,400Mbps	8,339Mbps	7,670Mbps
8	cable distance 80 - 100	90km	0km	8,400Mbps	8,400Mbps	8,339Mbps	7,670Mbps
9	cable distance 80 - 100	90km	10km	8,400Mbps	8,296Mbps	8,339Mbps	7,670Mbps
10	cable distance 80 - 100	100km	0km	Fail	Fail	Fail	Fail
11	cable distance 10 - 100	90km	20km	Fail	Fail	Fail	Fail

- HFC and PON / Telco architecture differences
- Distance and hhp/fiber (or hhp/lambda) differences
- PON “Extender” overcomes limits and enhances architecture flexibility

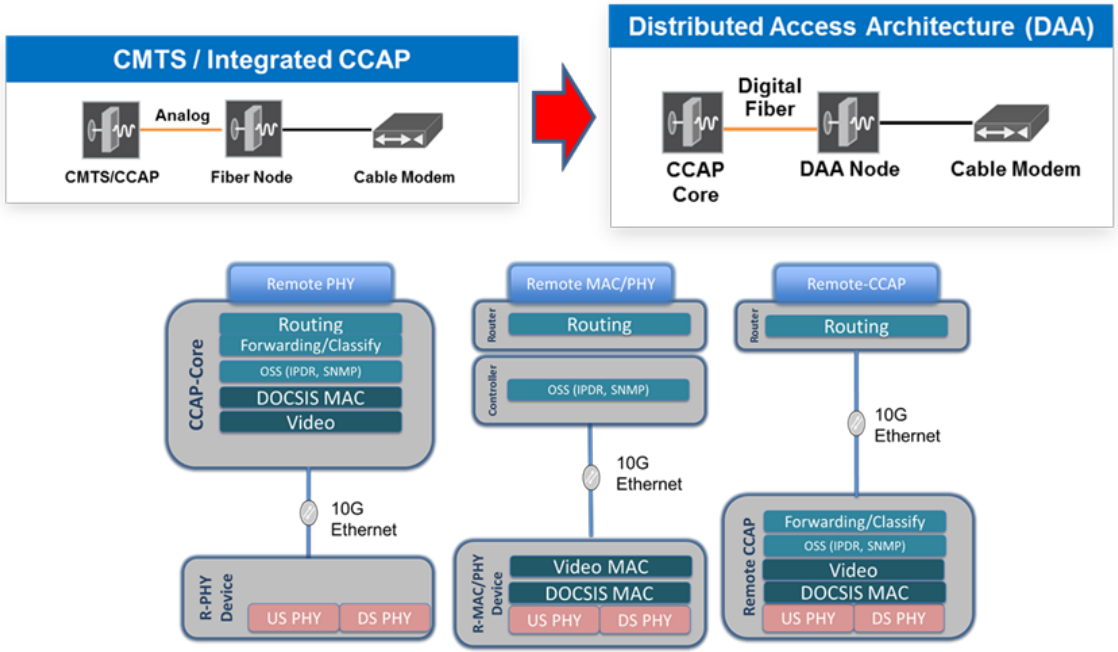
All-IP: Continuous Spectrum Management



- Analog reclaimed
- Digital TV
- HD TV
- Higher Efficiency video encoding
- IP Explosion
- IPTV

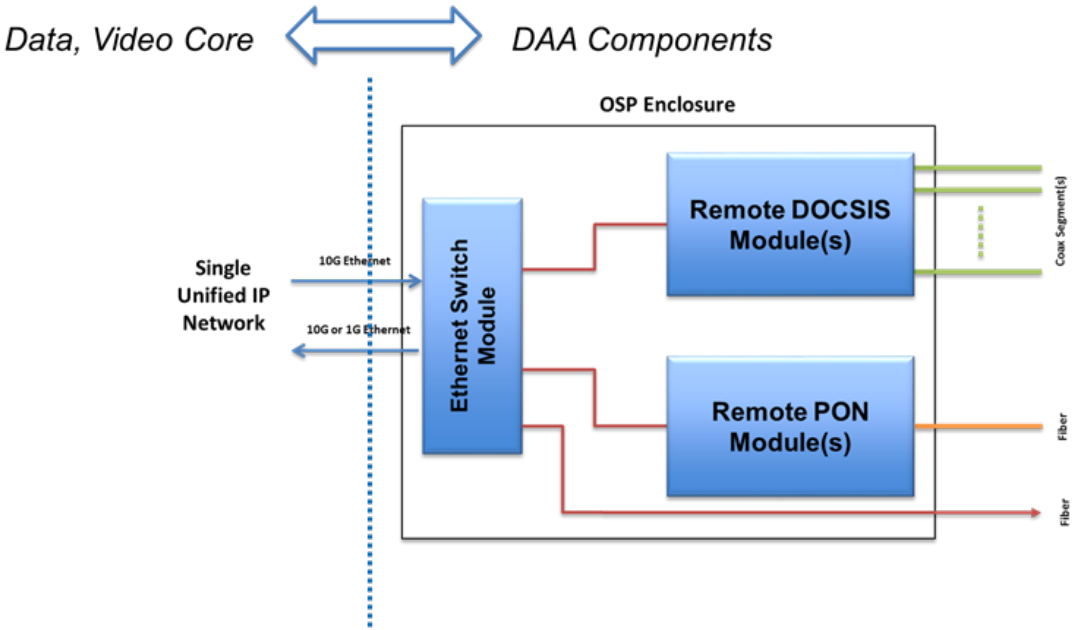
Wave 2 – Next Up

Distributing Benefits



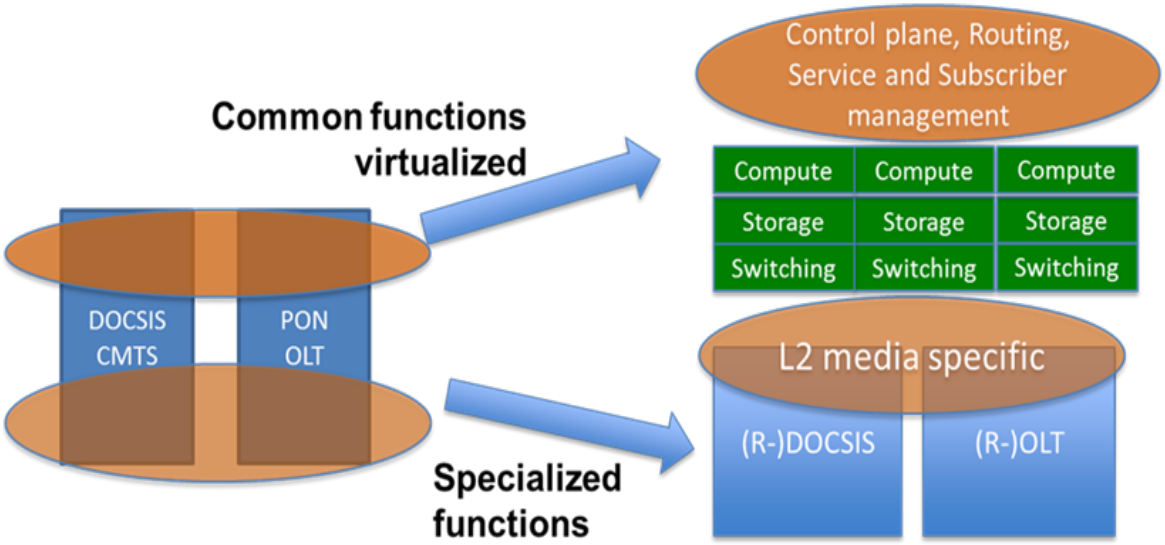
- Fiber Efficiency
- Fiber reach
- Ethernet
- Facility Efficiency
- EOL RF Performance
- Alignment to NFV / SDN Architecture

Not Just for DOCSIS



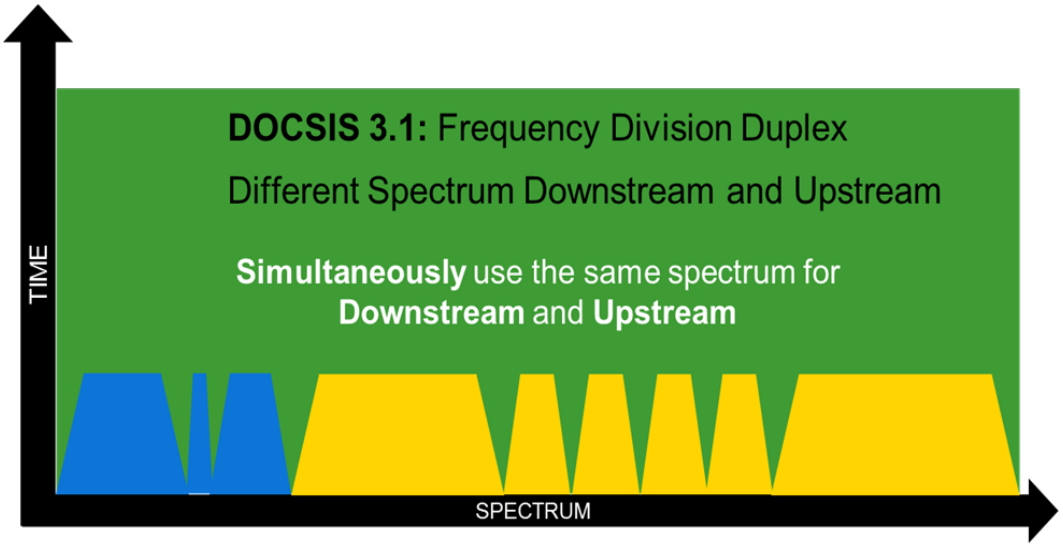
- Common problem statement
- Common Network interface
- Common transport protocol
- Agnostic to last-mile access technology

DAA Benefits at Both Ends



- Distribute
- Virtualize
- Converge
- Standardize

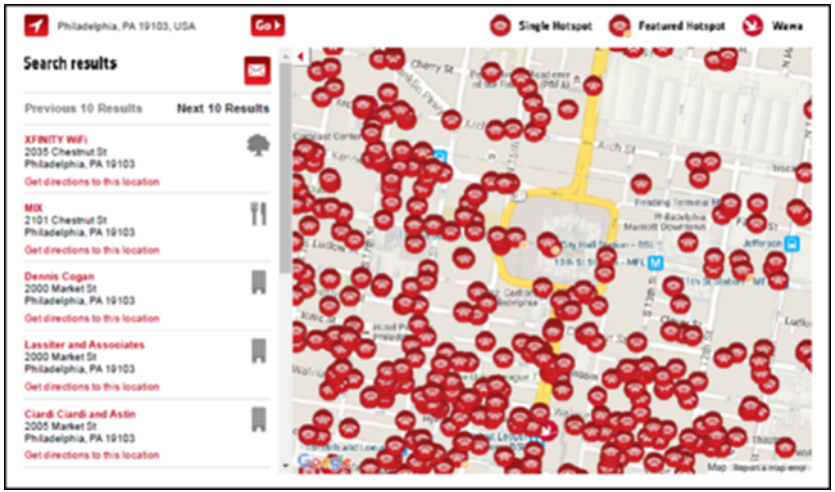
Unify Service Deployment



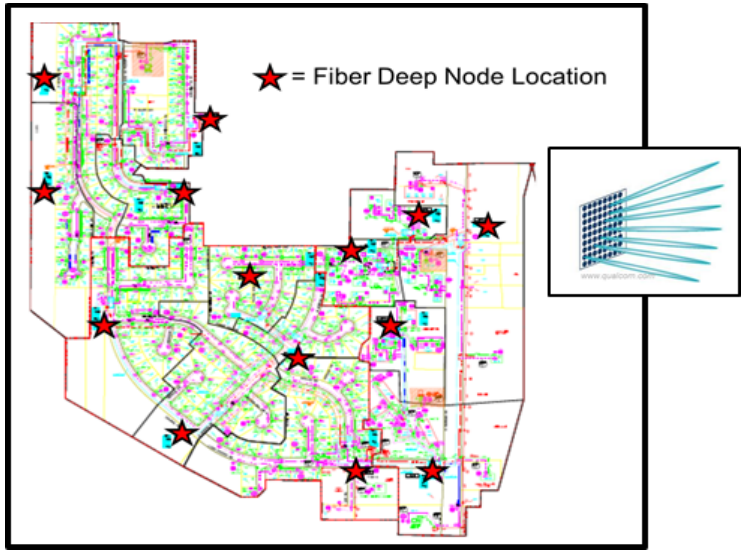
B. Hamzeh, Full Duplex DOCIS, 2016 CableLabs Winter Conference

- Fiber Deep, DAA, D3.1 dependencies
- Enhance HFC upstream capacity and speed
- Maintain downstream capacity
- Common last mile service capability regardless of fiber or coax drop

Something in the Air



- High density WiFi Aps extend customer HSD access today



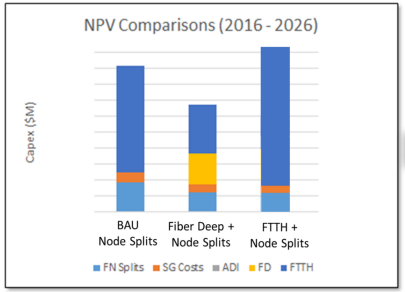
- High density access to fiber such as FD is enabling of mobile and/or mm-wave access

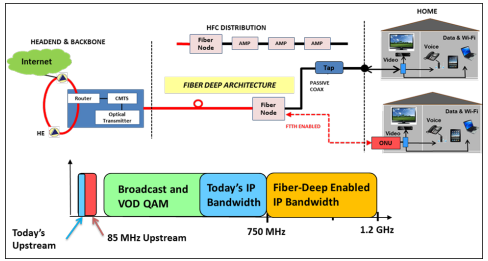
Timing and Synergy

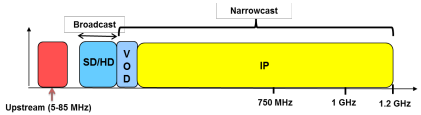
- Migration to Fiber Deep
  - Capacity, Speed, FTTP Extension
- Introduce DOCSIS 3.1
  - Maximize FD Spectrum to 10G, All-IP
- Implement 10G (EPON) also in FTTP
- Introduce “DAA” architecture to scale FD
  - FD + DAA → FDX Enablement
- With “Distributed” move to “Virtualize” core
- Distributed + Virtualized + Multiple Last Mile Access → Converged, Automate
- FD = Dense Fiber Access → Aligns with wireless mobile access strategies

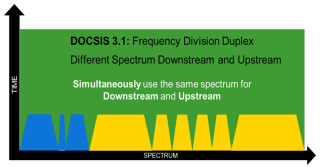
Conclusion

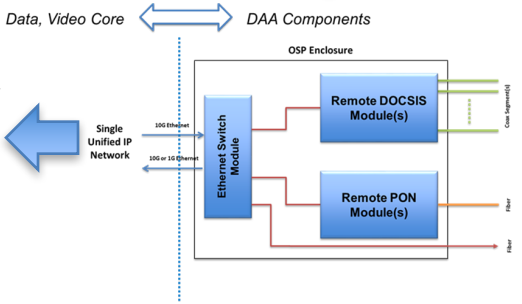
- Long-term evolution playbook developed and executing
- Technology moves faster than infrastructure change
- Options for new services and operational efficiencies
- Must place bets projecting emerging technology complements, disruptors, and timing
- Playbook is a living document

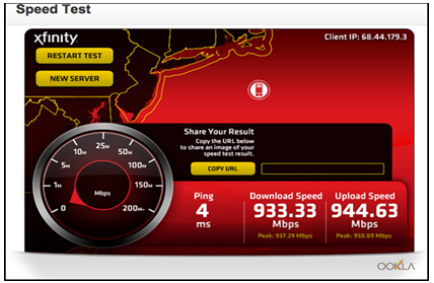












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