Introduction to Distributed Access Architecture (DAA) and Remote PHY

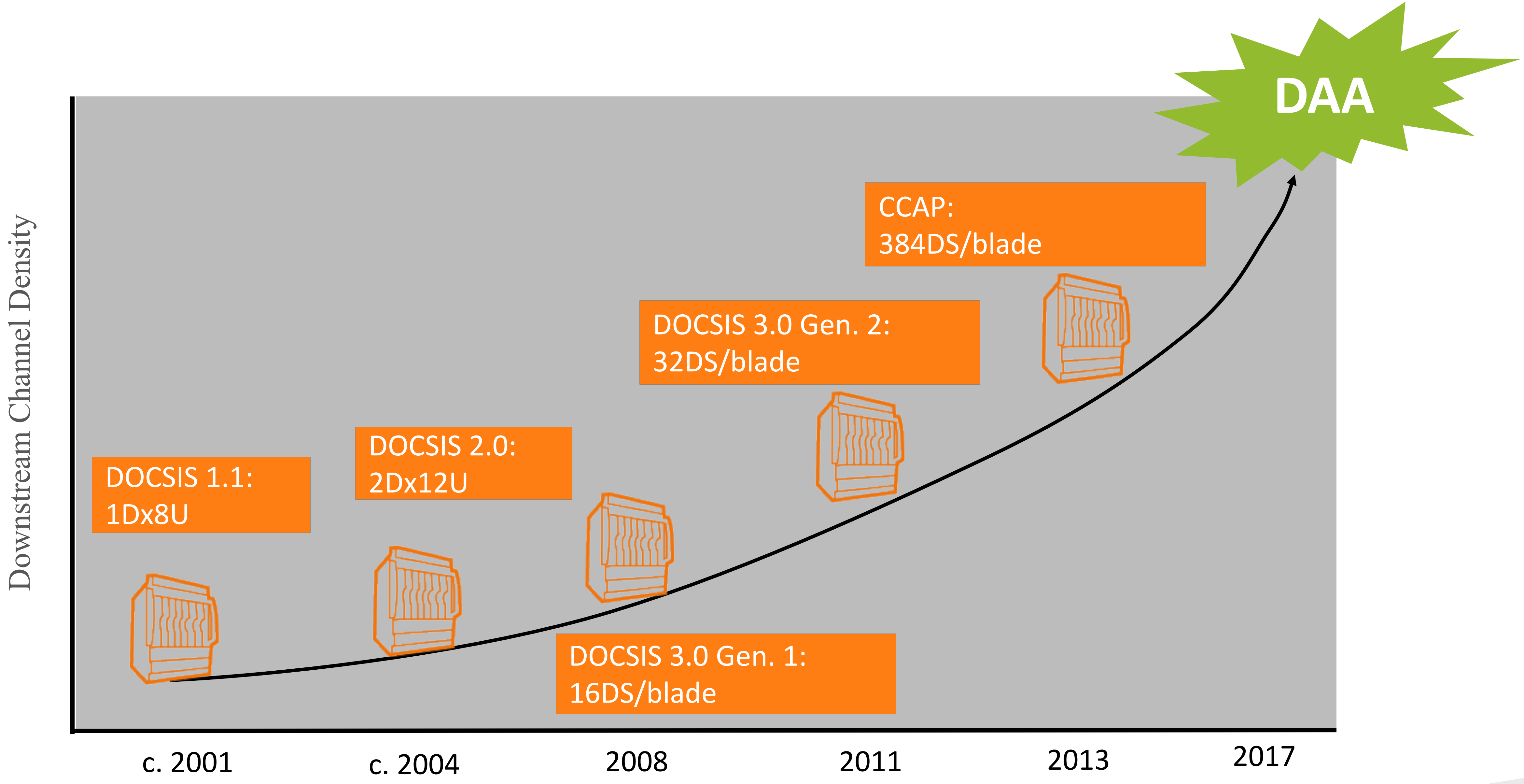
SCTE Chicago, 2017

Stephen Kraiman

Agenda

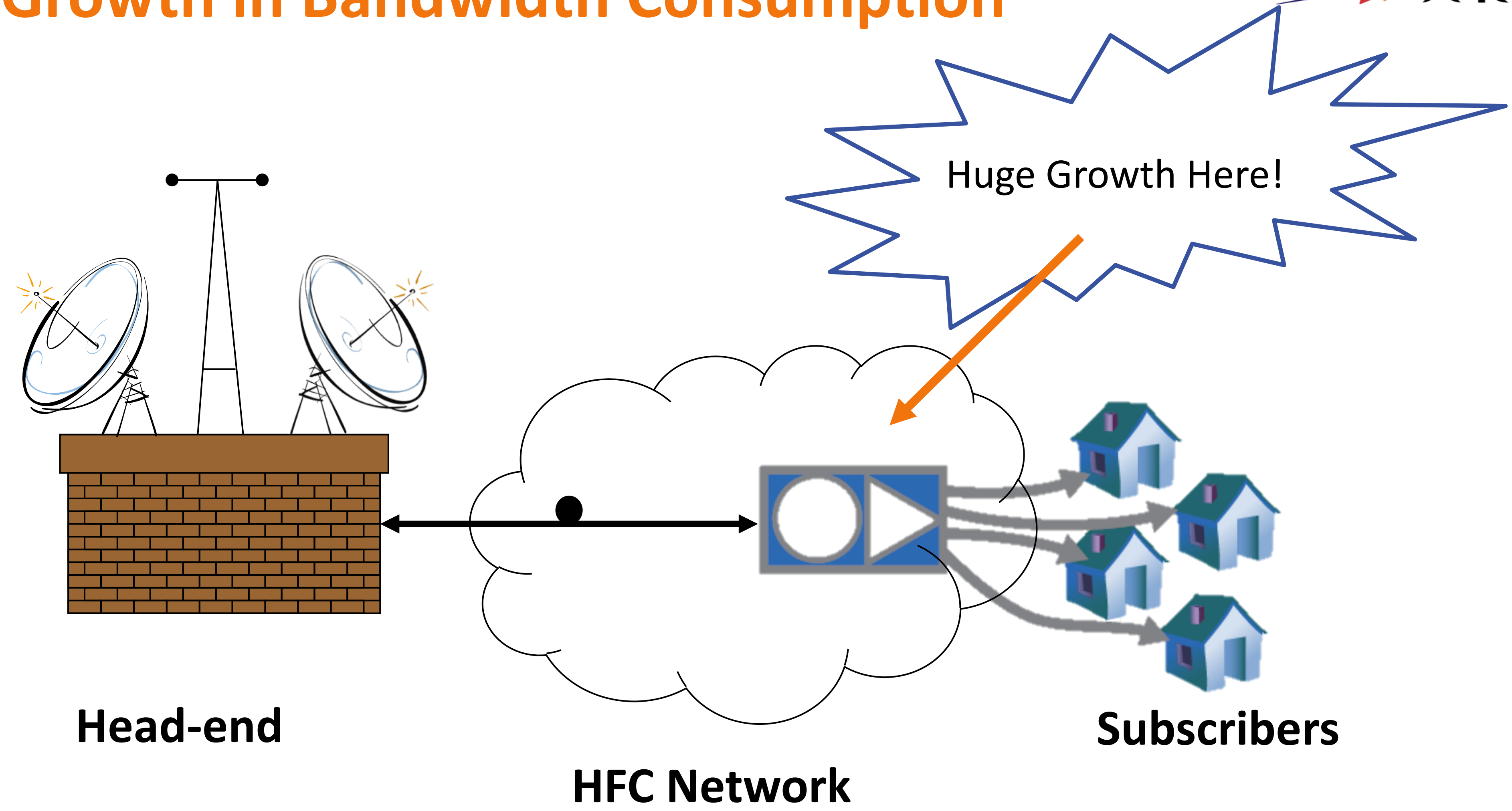
- What is Distributed Access Architecture
  - Description
  - Benefits & Drawbacks / Use cases
  - Forms of DAA
- Deeper Dive: Remote PHY
  - Standards (include OpenRPD) and Interop
  - Ecosystem

How Did We Get Here? CMTS Evolution

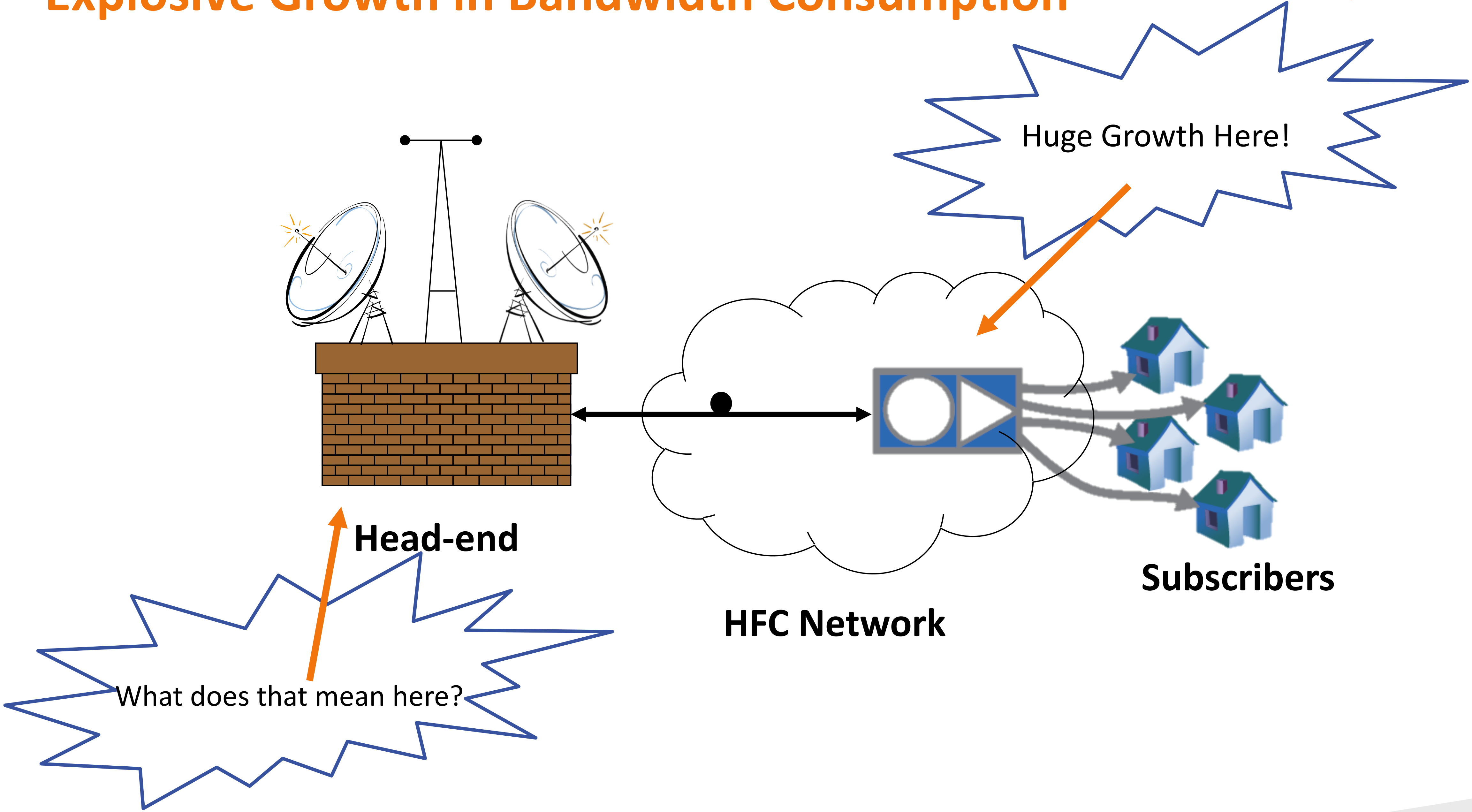


What Is Distributed Access Architecture?

Explosive Growth in Bandwidth Consumption



Explosive Growth in Bandwidth Consumption

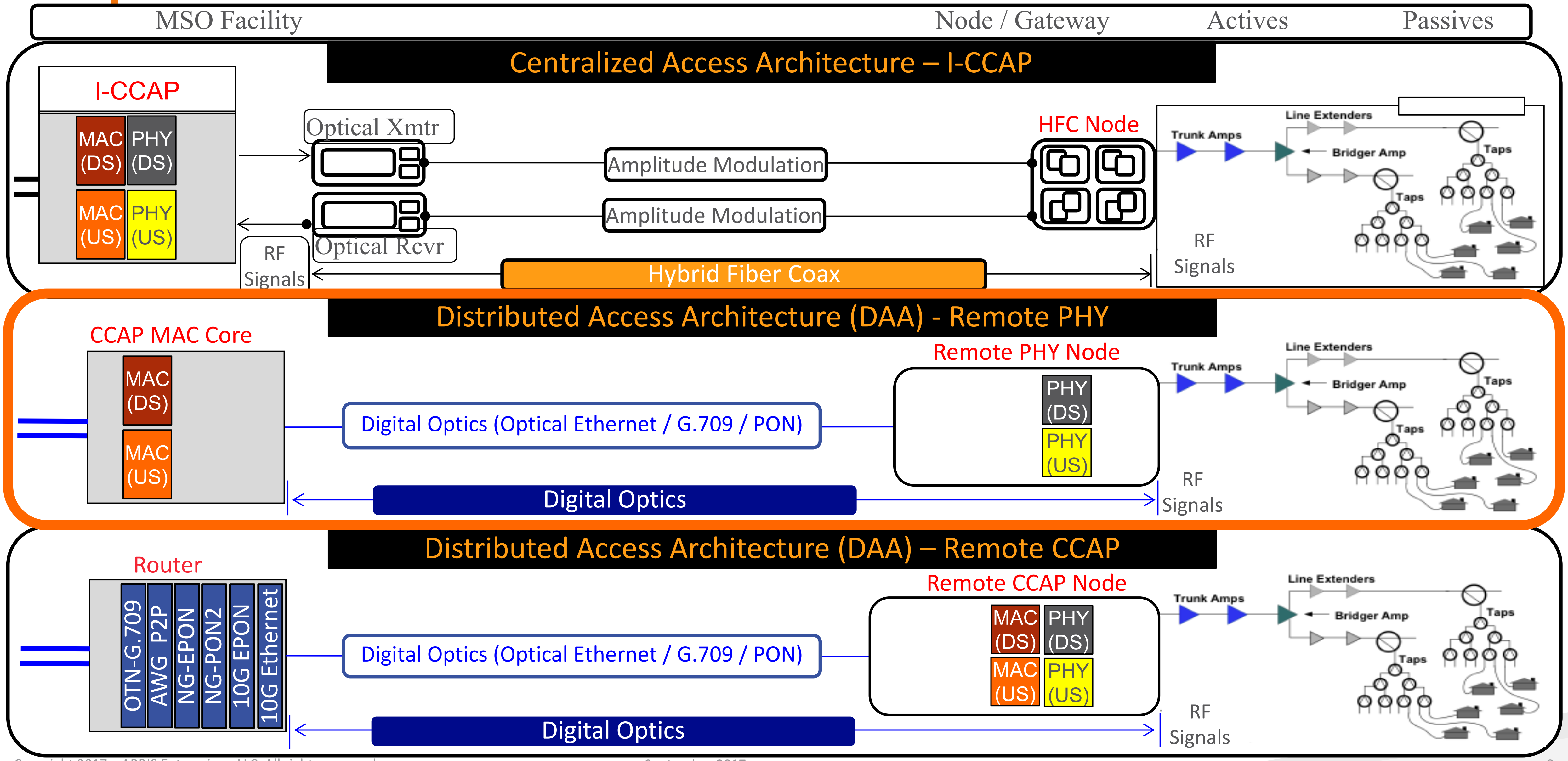


A Working Definition….

- What does Distributed Access Architecture mean?

- Replacing analog distribution (analog lasers) with a standard digital (Ethernet) optical transport.
- Distributed Access Architectures can solve head-end space, power, and HVAC capacity issues by moving some key functions of today's CCAP to reside inside the fiber node.
- Remote PHY (RPD) is one such technology that also can provide the MSO with the advantage of cost reduction by eliminating the analog lasers and reducing amplifier cascades thus improving SNR.
- Widespread deployment of DAA can also enable consolidation of existing head-end facilities into larger, more centralized data centers.

Centralized & Distributed Access Architectures - Simplified



Distributed Architecture Benefits

Increase HFC Bandwidth Capacity

- Better end-of-line signal quality
- Better spectral efficiency
- More wavelengths, better reach

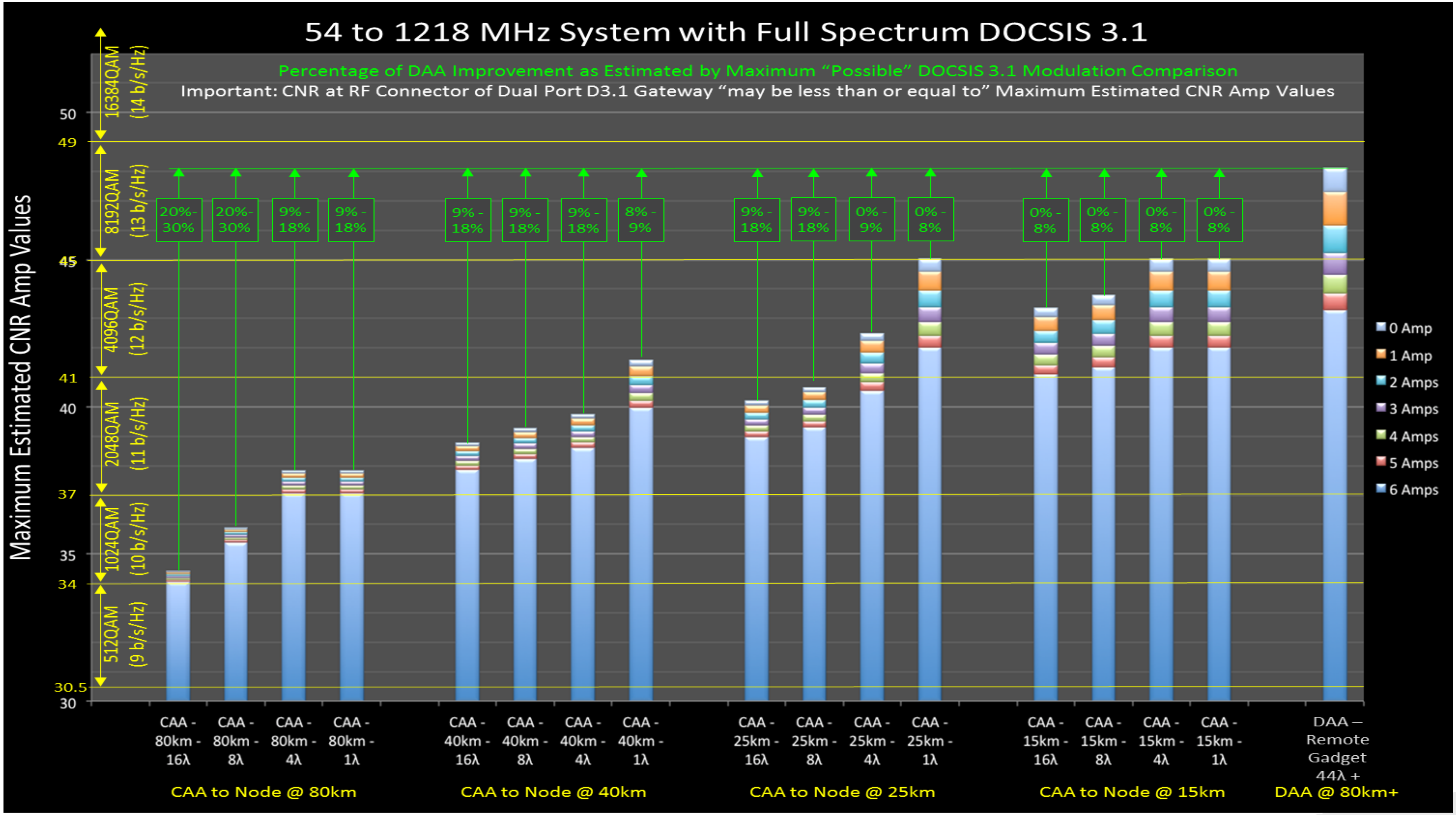
Operational Efficiencies

- Reduce headend power, space, and cooling requirements; hub consolidation
- Add QAMs without changing RF combining network, plant balance
- Partitions scope of change on a node-by-node basis
- Digital fiber “set and forget”

IP Convergence

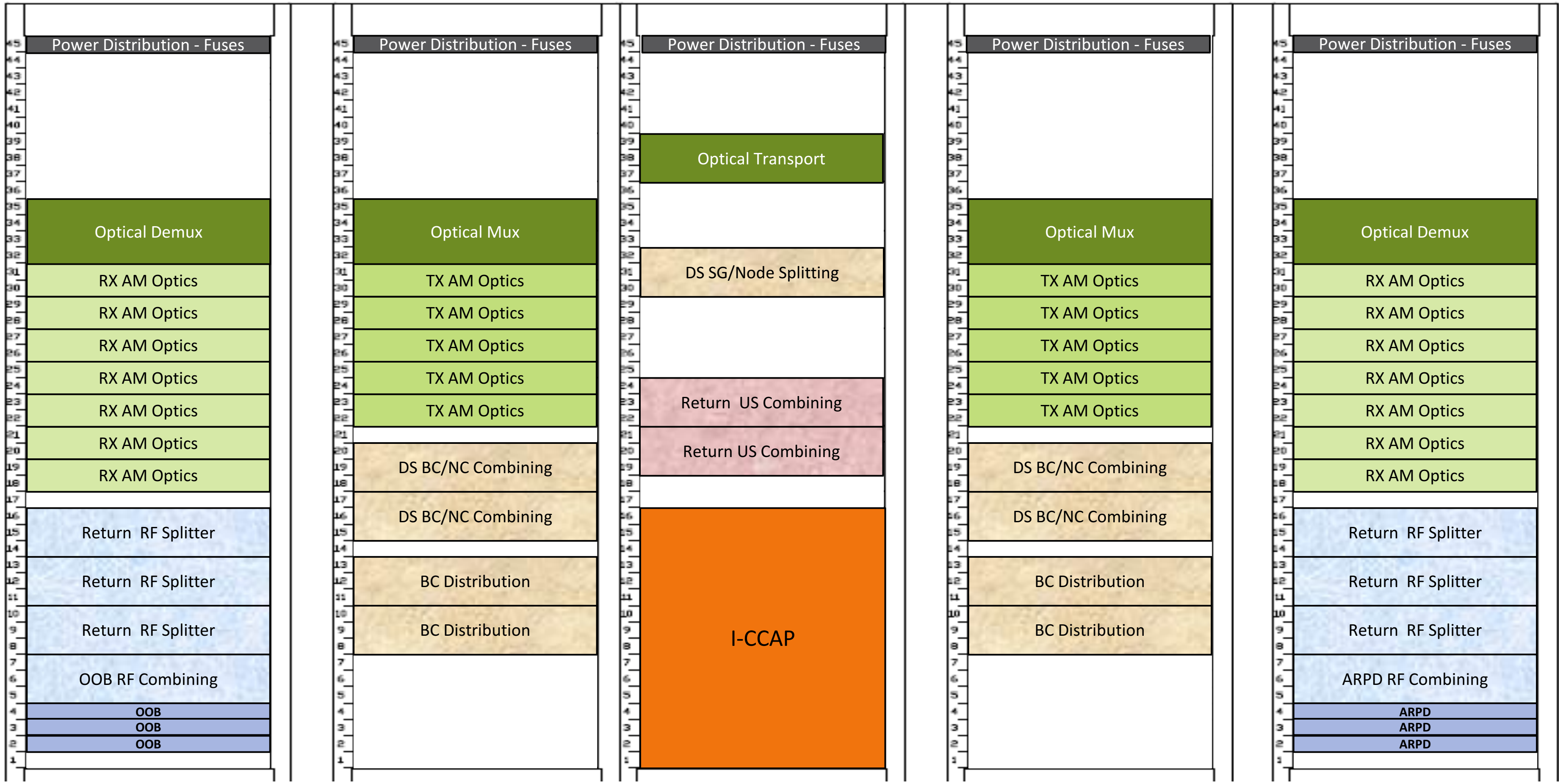
- Extend IP network to the node
- Alignment with FTTx build-out
- Leverage standards-based interconnectivity & economies of scale

DAA Improvement Relative I-CCAP (CAA) Deployments



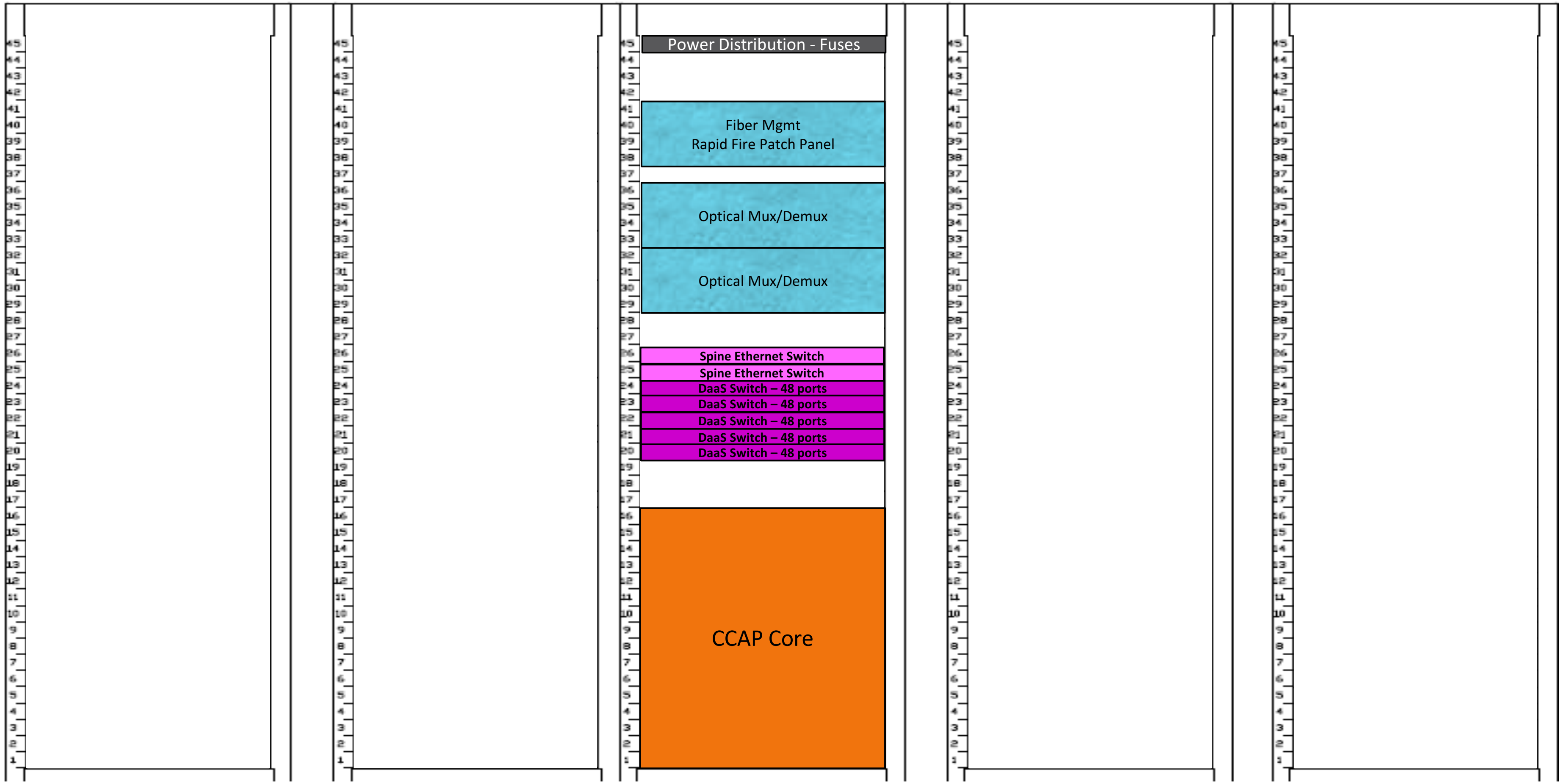
Headend Space: Case Study

- I-CCAP, multiple nodes per SG



Headend Space: Case Study

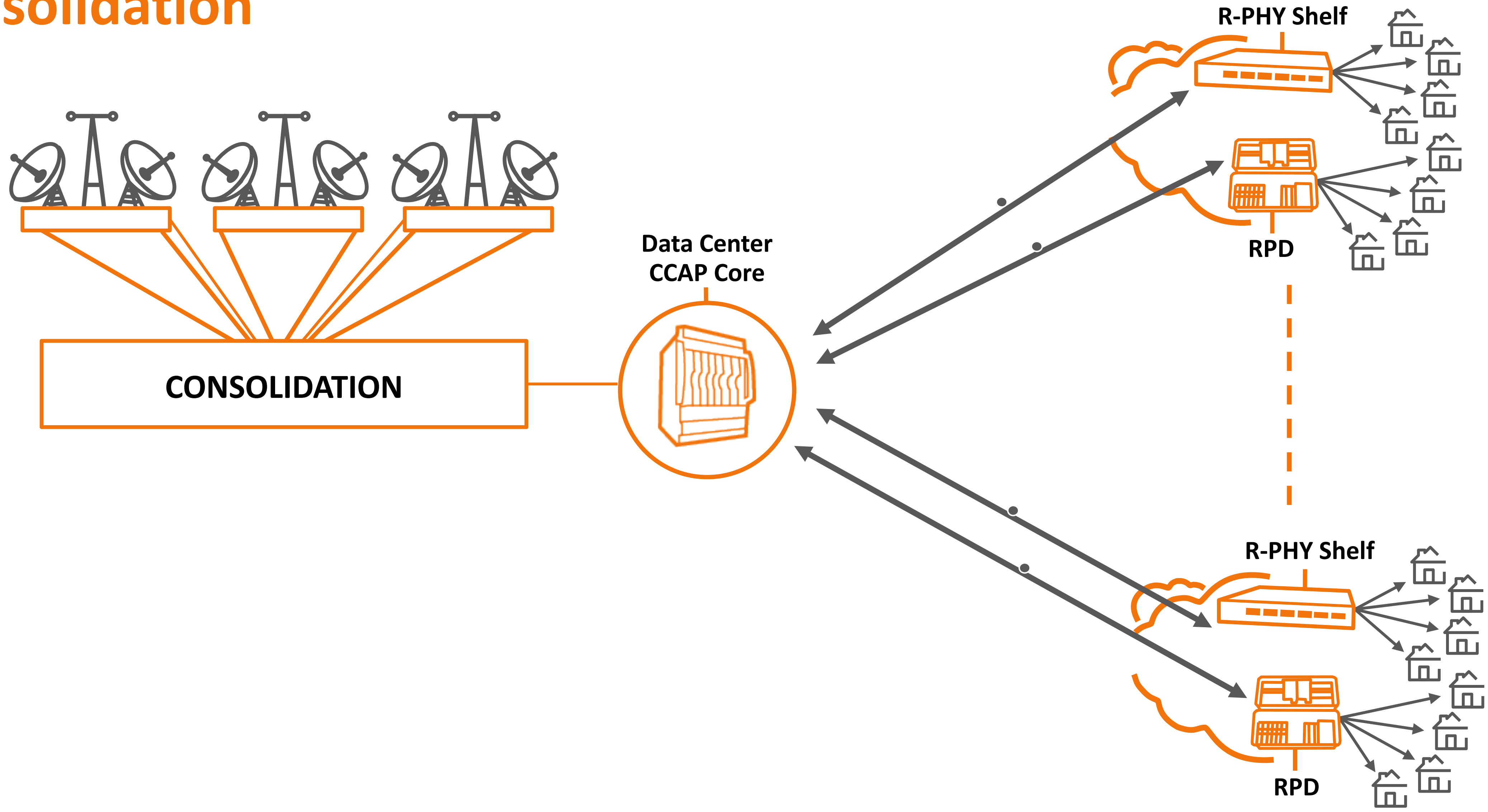
- CCAP Core, single node per SG



Key RPHY Benefits vs RMACPHY

	R-PHY	R-MACPHY
Vendor Ecosystem and Standards	• More vendor competition—can choose best-in breed for Core/Node separately. • More scope for virtualization • DEPI/UEPI/GCP explicit specifications	• No cable-specific networking protocols • Ethernet /PON spec maturity (vs DEPI/UEPI/GCP) • No need for R-DTI clock
Node	• Less power, lower module cost • Simpler software (less risk of “bricking”) • Can fit in smaller footprint • Lower thermal profile	• Doesn’t require Core/RPHY “handshake”—operates as an Ethernet/IP-attached device • Headend becomes agnostic to ”flavor” of DAA (DOCSIS, PON, WiFi,…)
MAC Scaling	• MAC and PHY can scale independently • Supports Multi-Gbps MAC for FDX	• Can support small scale / “as needed” deployment better • Shorter distance from MAC to subscriber – possible latency benefits
Operations	• Management and provisioning similar to I-CCAP	• Supports existing I-CCAP vendor enhancements without needing multivendor Core/PHY interop

Possible Application of RPHY – Facility Consolidation



What Is Remote PHY?

- Standards and Interop

CableLabs MHAv2 Specifications

www.cablelabs.com/specs →DOCSIS→Modular Headend Architecture

- CM-SP-R-PHY (Remote PHY Specification) aka “R-PHY”
- CM-SP-GCP (Generic Control Plane Specification) aka “GCP”
- CM-SP-R-DEPI (Remote Downstream External PHY Interface Specification) aka “R-DEPI”
- CM-SP-R-UEPI (Remote Upstream External PHY Interface Specification) aka “R-UEPI” or “UEPI”
- CM-SP-R-DTI (Remote DOCSIS Timing Interface Specification) aka “R-DTI”
- CM-SP-R-OOB (Remote Out-of-Band Specification) aka “R-OOB”
- CM-SP-R-OSSI (Remote OSSI) aka “R-OSSI”
- CM-SP-DRFI Appendix D
- CM-TR-MHAv2 (Modular Headend Architecture v2 Technical Report)
- CM-TR-DCA (Distributed CCAP Architectures Technical Report)
- Also
  - CableLabs Remote PHY ATP working group (ATP-Init, ATP-Service, ATP-Management)
  - CableLabs OpenRPD software working group

Remote PHY Interoperability

- CableLabs® Interops
  - Monthly in Denver, starting December 2016
  - Ghent, May 2017
- CableLabs Dry Run
  - First ATP Dry Run targeted for September
- CableLabs Qualification
  - TBA
- Operator-driven activities
- Vendor-driven activities

Interoperability: CableLabs OpenRPD Software Working Group

- Framework for multi-vendor collaboration , with an emphasis on spec interpretation
  - Started March 2016

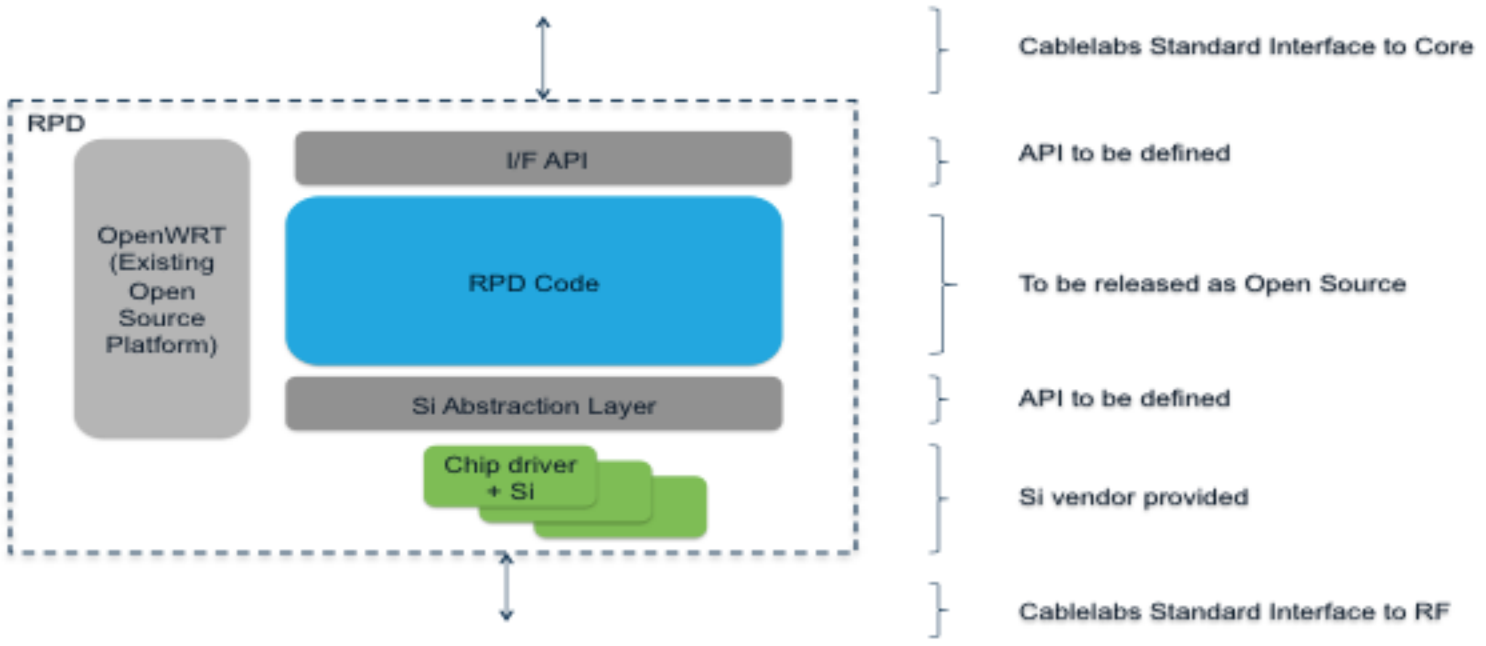
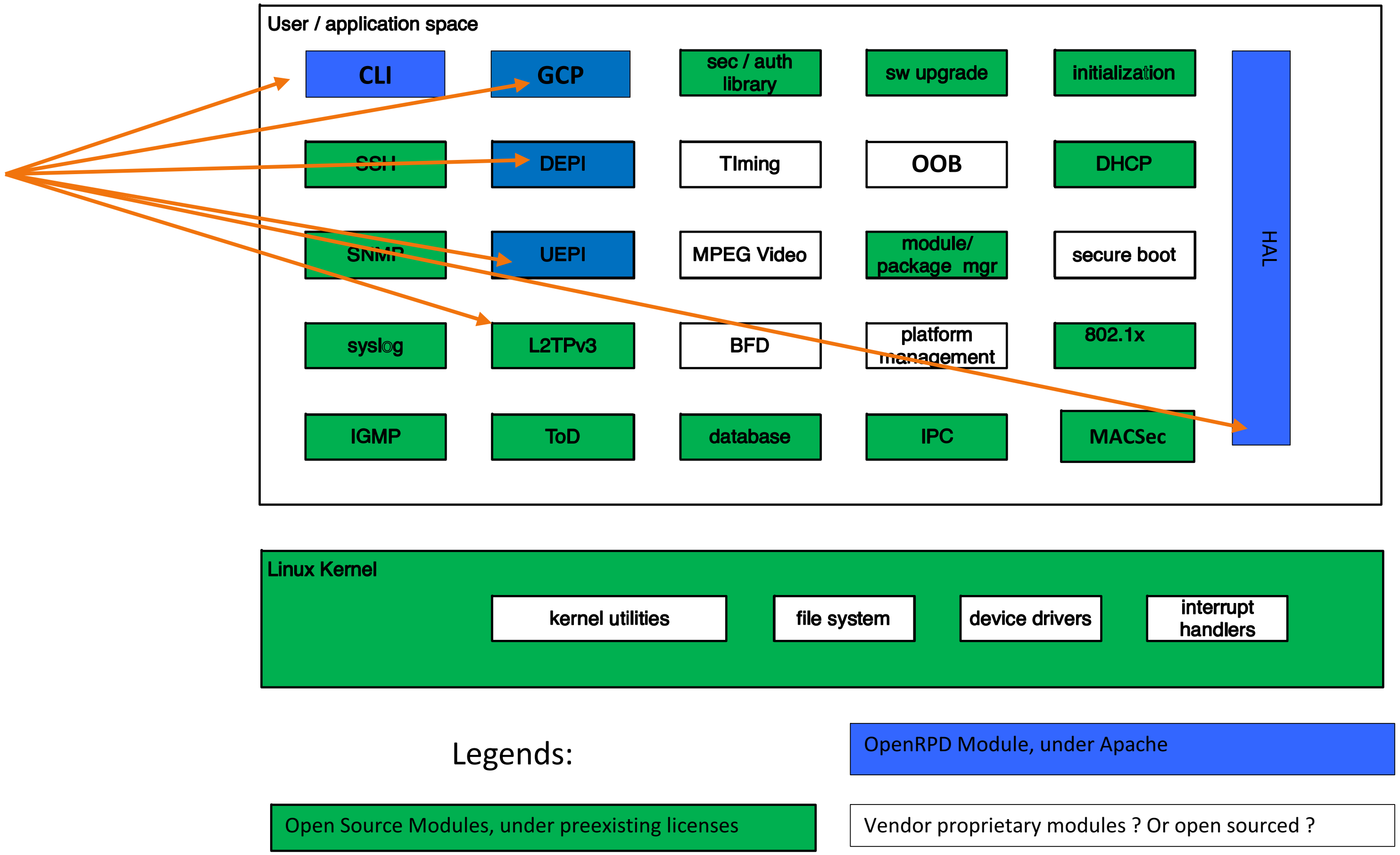


Figure 2 - RPD Software Environment

What is included in the OpenRPD software?

- OpenRPD software modules are a subset of an RPD's software suite
  - Target OpenRPD modules include CLI, GCP, DEPI, UEPI, HAL, L2TPv3
  - Other modules will be either developed in-house or licensed from third-party suppliers
  - Focus on interpretation for interoperability



What Is Remote PHY?

- CCAP Core and Remote PHY Device (RPD)

R-PHY Internal Components

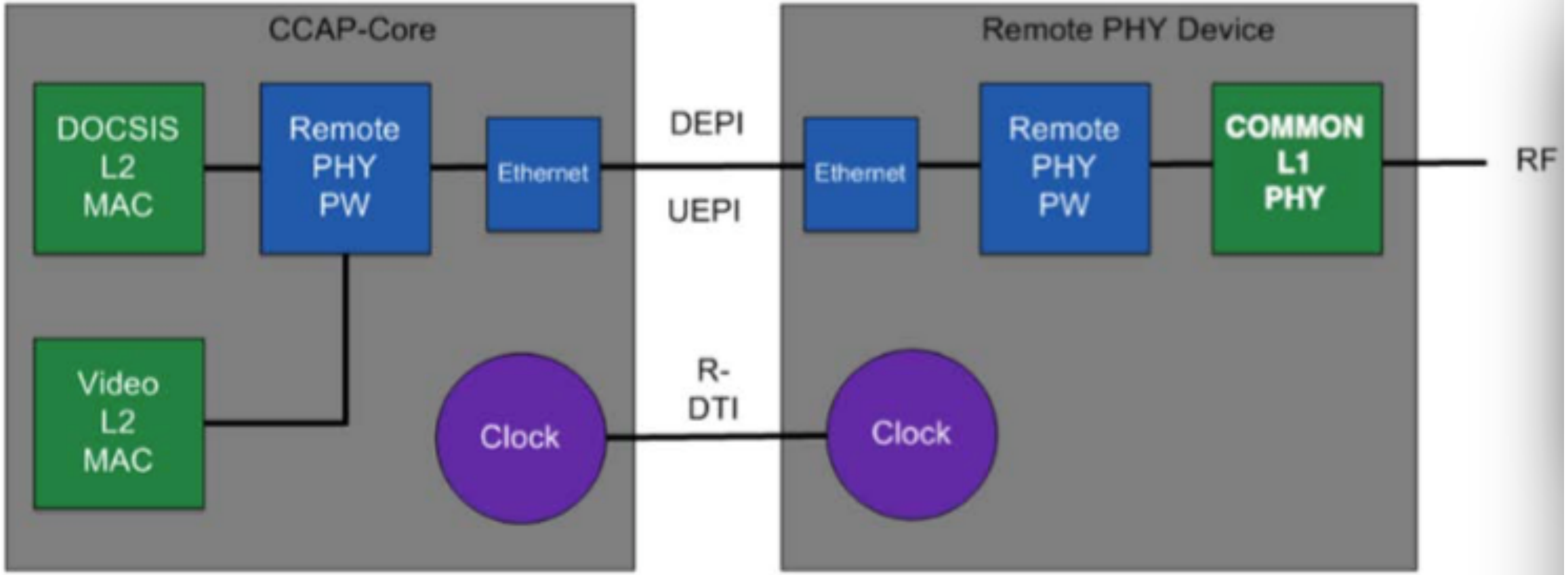
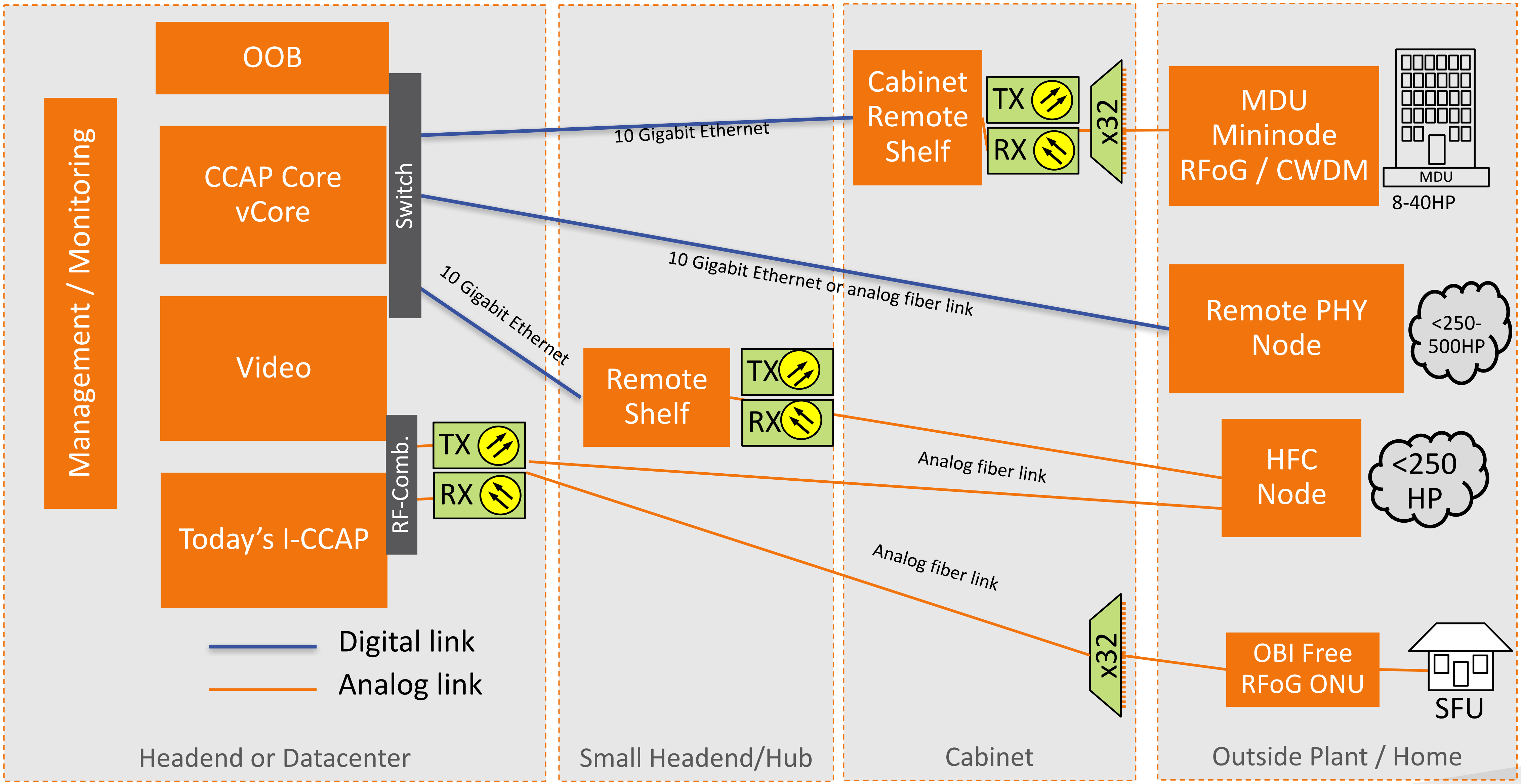


Figure 5 - R-PHY Internal Components[2]

- Also: Security, Management, Out of Band

Remote PHY Access Architecture Variations



How Does the Ecosystem Change?

- Data, Switching, Timing, OOB, Video

Ethernet Switch Considerations

- IPv6 vs IPv4
- PTP/IEEE 1588 Transparent Clock vs Boundary Clock
- DHCP Relay
- Security (MACSec, 802.1x)
- Multicast Features (MLD, static, PIM,…)
- IEEE 802.3ad/LACP
- OpenFlow (future SDN)
- Port mix (100G, 40G, 10G)

IEEE 1588 Precision Time Protocol (PTP) Grandmaster Clock

- Receives a GPS input as a primary reference for high-precision packet network synchronization

- Vendors at CableLabs as of July 2017
  - Microsemi
  - ADVA

Video OOB Support (SCTE 55-2)

from CM-SP-R-OOB-I05-170111

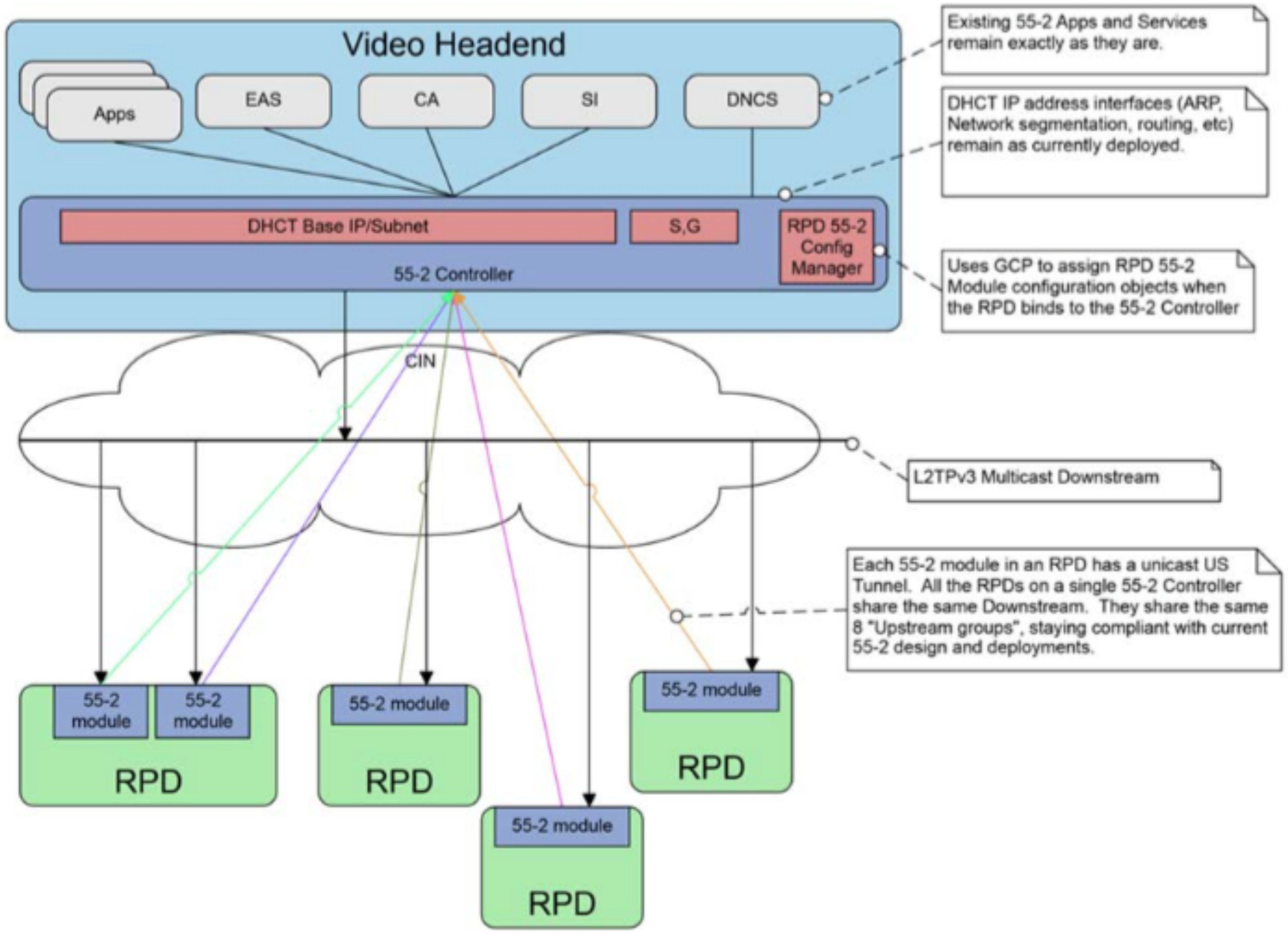


Figure 1 - 55-2 Remote PHY Solution

Video OOB Support (SCTE 55-1)

from CM-SP-R-OOB-I05-170111

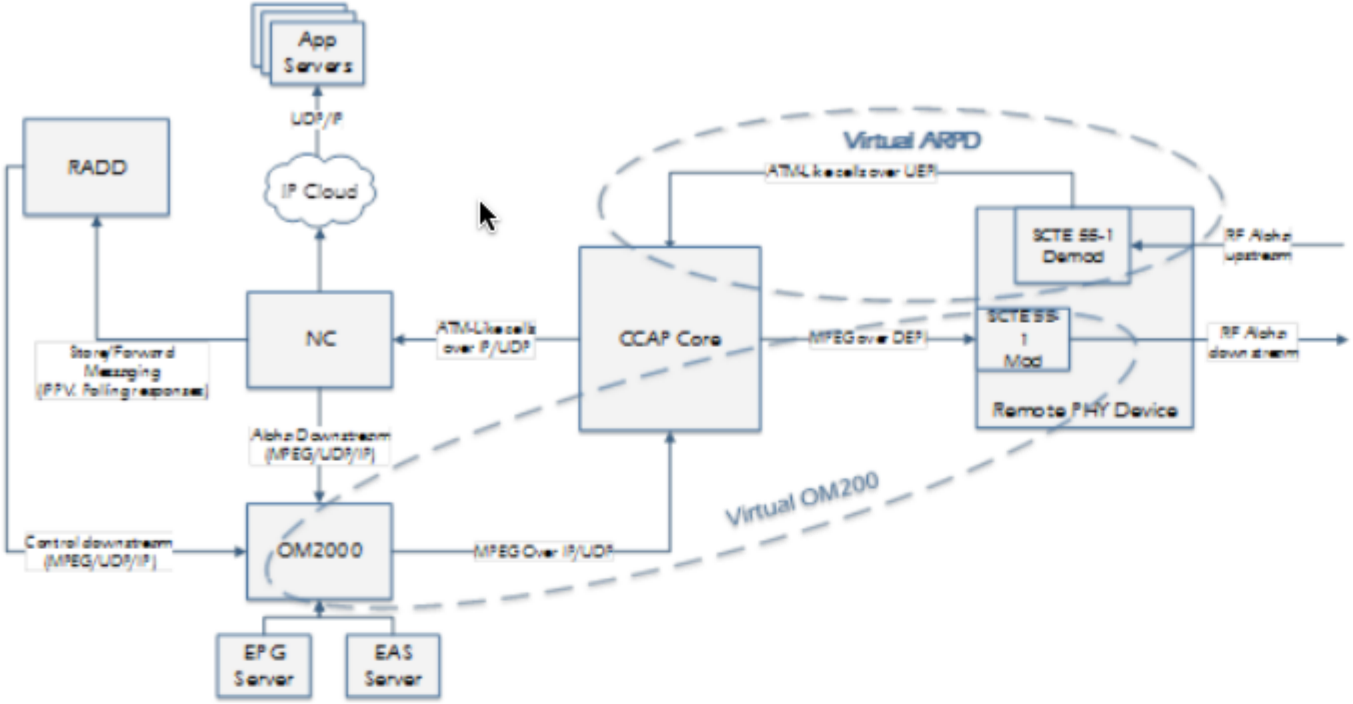


Figure 9 - SCTE 55-1 Remote PHY Implementation

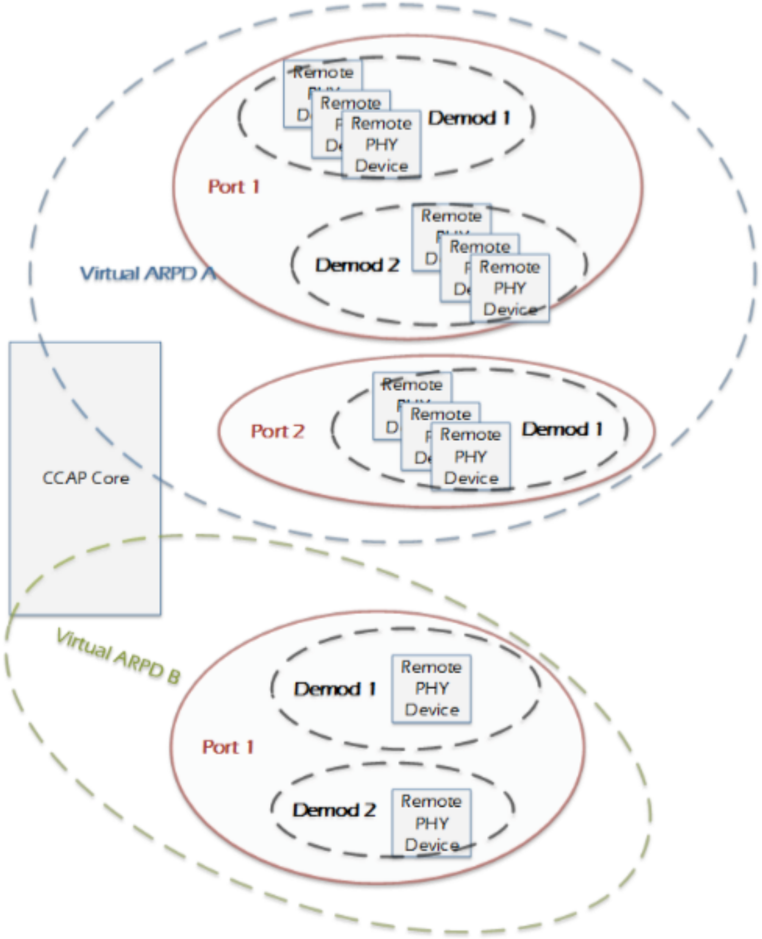


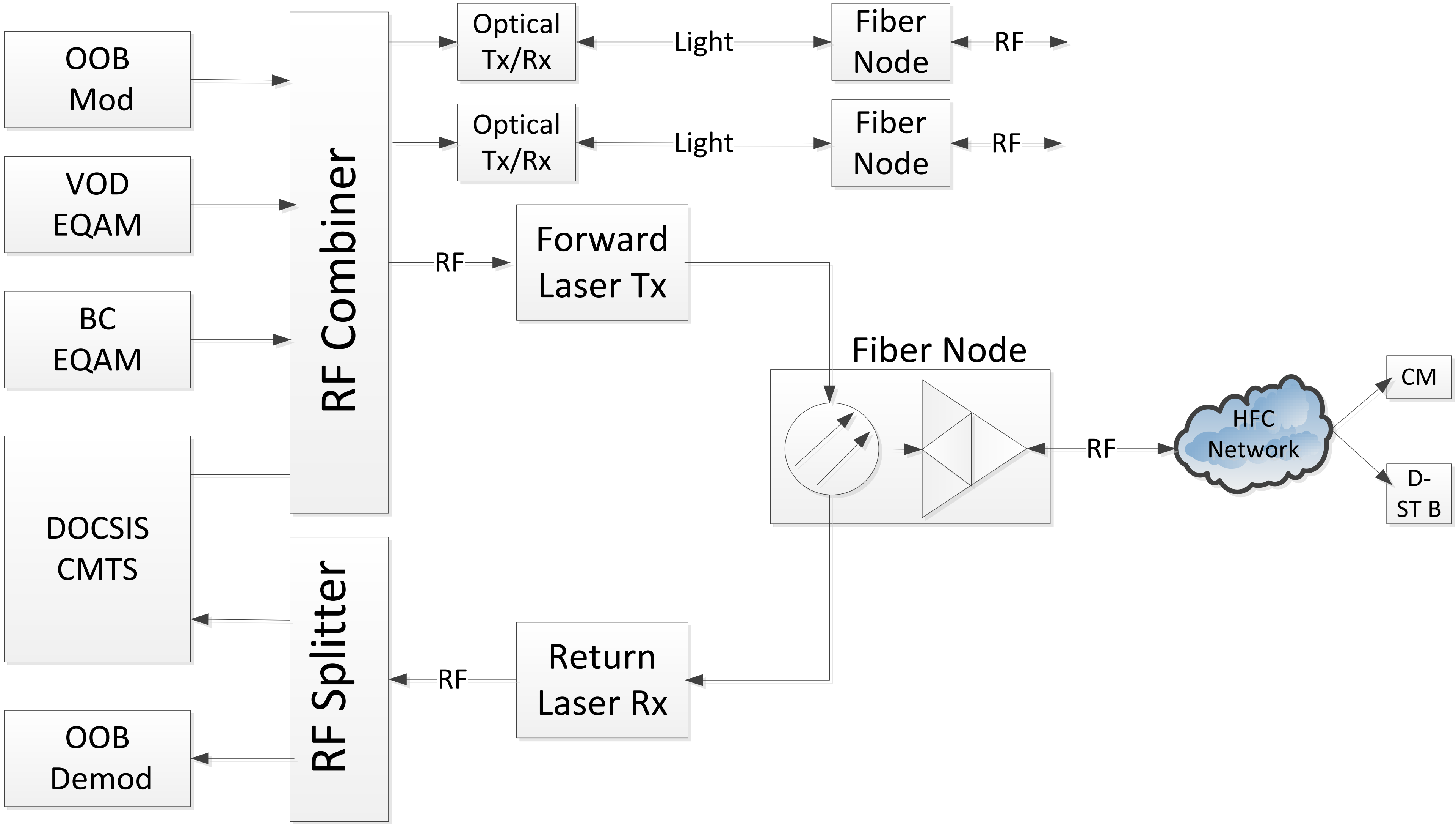
Figure 12 - Example Virtual ARPD/Remote PHY Device distribution

Other OOB Signals

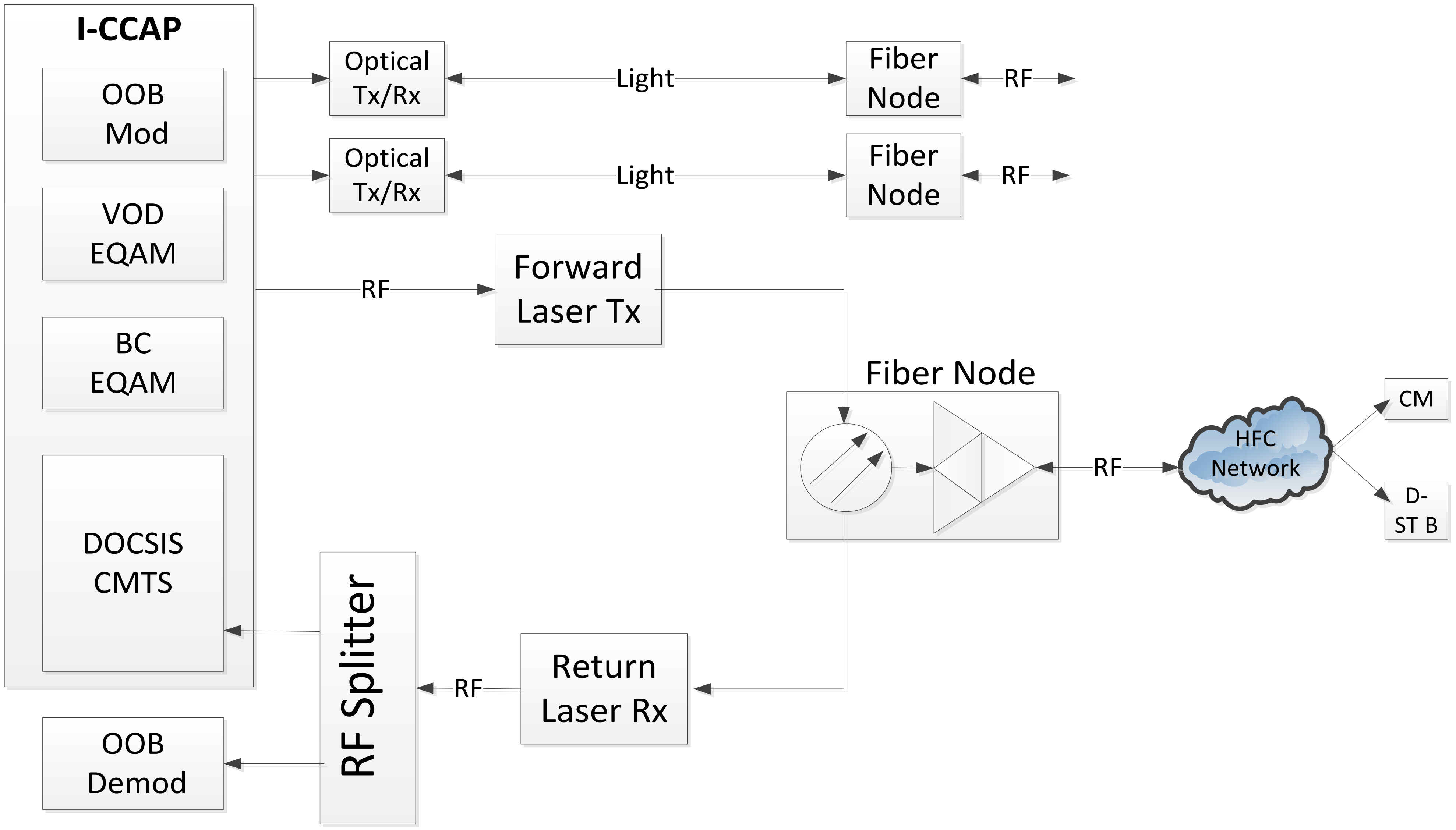
- Leakage
- AGC
- Alignment and other pilot tones
- Sweep
- Telemetry (Ingress detection, amp control, etc)

Depending on vendor solution, these can be supported natively or via NDF/NDR or forward/return HFC overlay

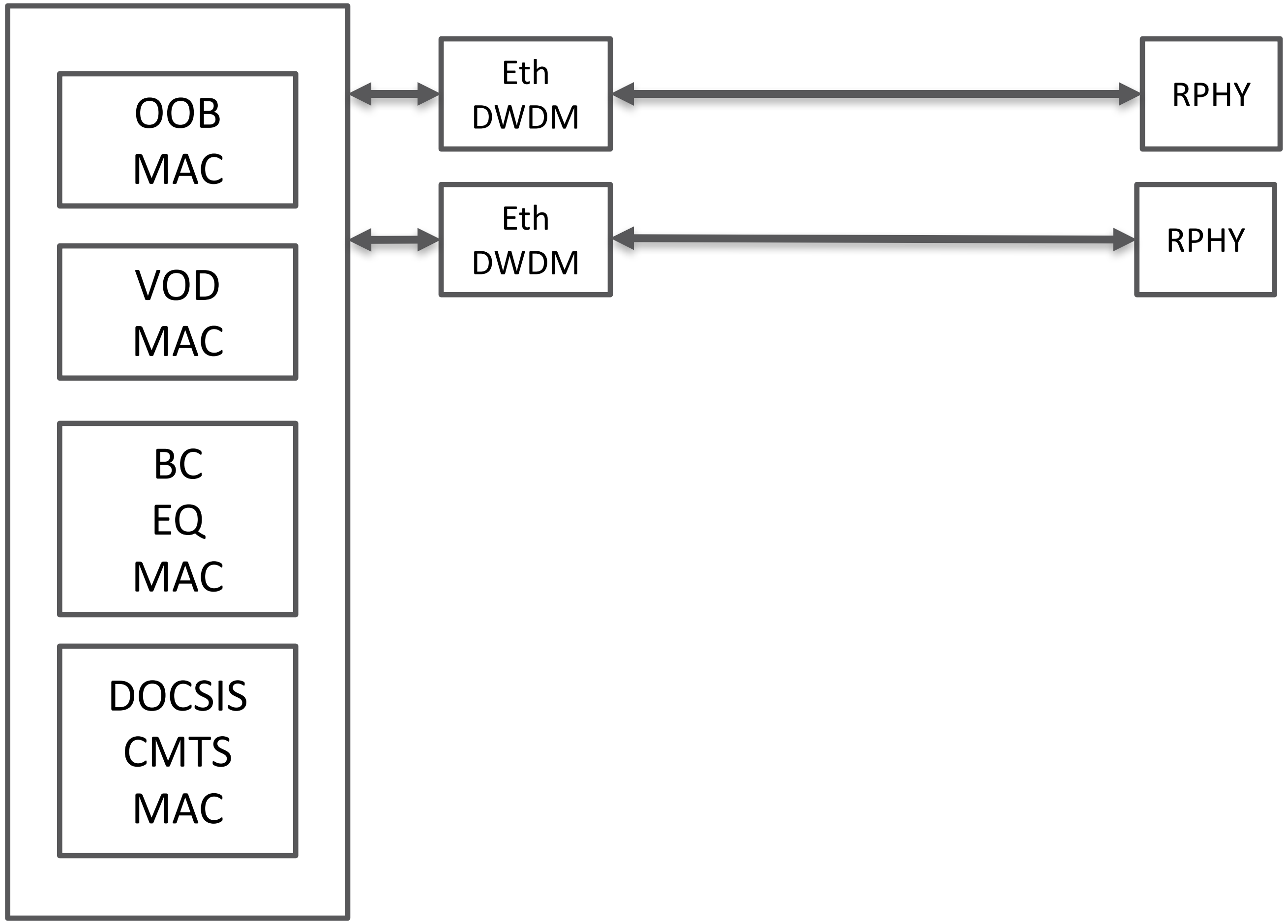
Traditional HFC Access Network



ICCAP HFC Access Network Architecture (1st Evolution)



I-Core HFC Access Network Architecture (2nd Evolution) – No Analog Video!



Is DAA Right for You?

- Migration considerations, and what comes next?

Is DAA right for you?

- Does it solve a problem for you cost-effectively? In the right timeframe?
- Is it in line with your corporate strategy?
- Does it provide sufficient flexibility to avoid stranded investments?

  – Video infrastructure (broadcast, narrowcast, conditional access)
  – Data bandwidth capacity, DOCSIS 3.1, FDX, US/DS split, frequency expansion
  – OOB infrastructure
  – Fiber build out
  – HFC distances / hub consolidation / inside and outside plant infrastructure
  – Personnel expertise and training, competitive services

Thank You!

Stephen Kraiman, stephen.kraiman@arris.com