



# Future Network Drivers and Access Architectures (Traffic Engineering Trends, CAA, DAA, and Virtualization)

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# What's Coming In The Access Network?

## Topology Evolution

Mid-split – High-Split?

Fiber Deeper or FTTH?

**MSO**

**Decisions, Decisions,  
Decisions**

Evolution vs. Revolution

## Technological Bifurcation

DOCSIS 3.1 / Extended Spectrum / FDX / RFoG -  
AgileMax / GPON / 10G EPON - DPoE / Wireless

## Architectural Bifurcation

Centralized vs.  
Distributed  
Architecture

RPHY vs.  
RMACPHY

Appliance-based vs.  
Virtual (SDN/NFV) vs.  
Both PNF & SDN

## Customer and Competition Drivers

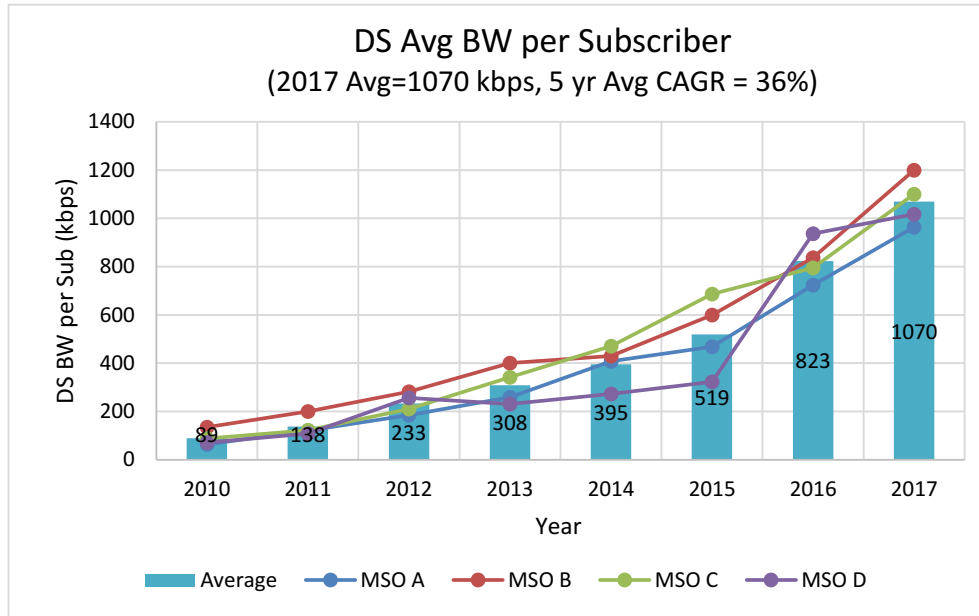
Exponential  
Bandwidth  
Growth

Increased  
Competition  
SPs & OTT



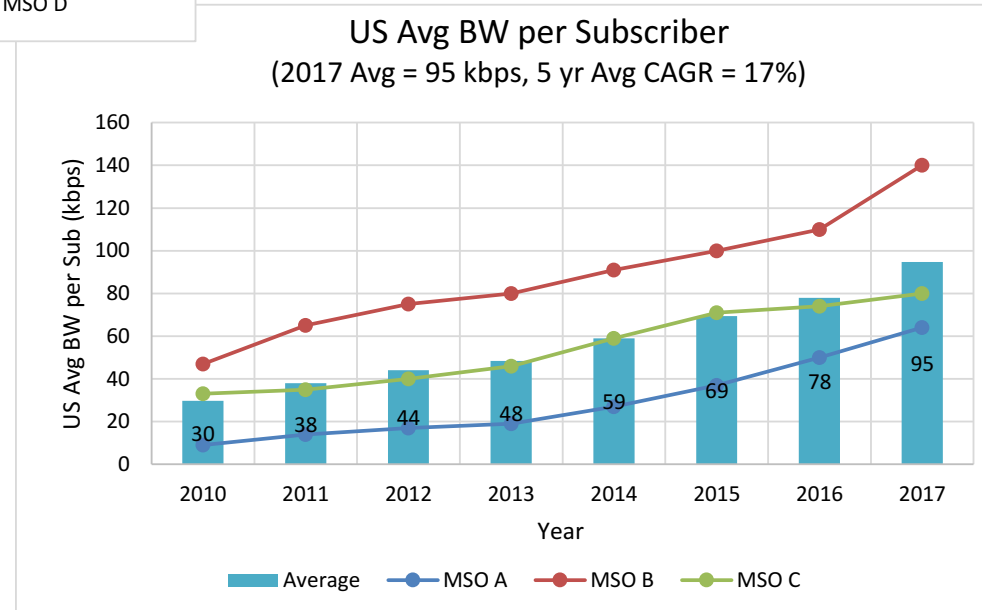
- Traffic Engineering for the Gigabit per Second Era
- MSO Architectural Options
- Drivers and Assessment of CAA and DAA

# Recent MSO Avg BW Traffic Trends



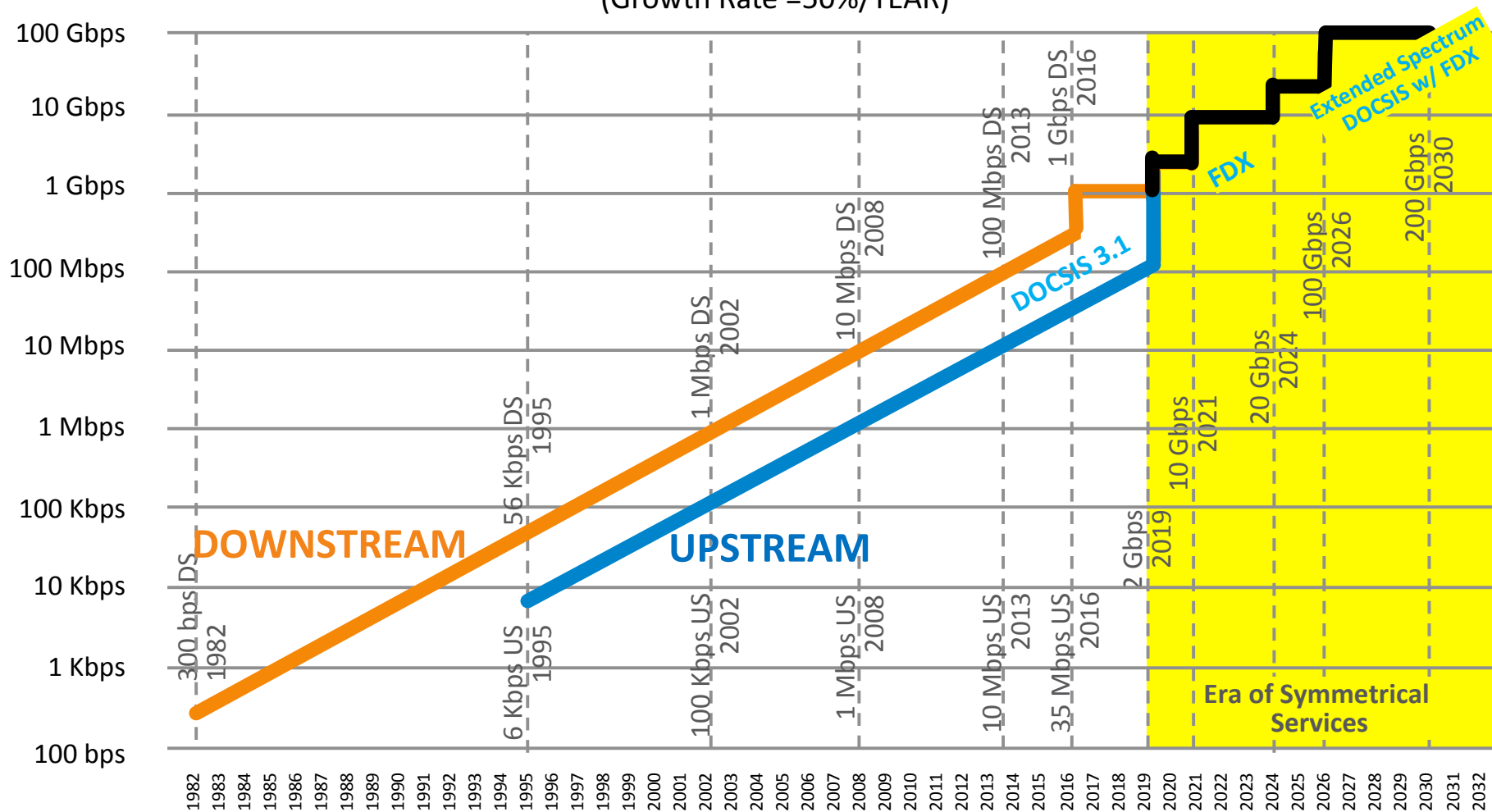
- DS Tavg passes 1Mbps in 2017
- DS Tavg CAGR below 40%
  - Not quite doubling every other year

- US Tavg almost 100Kbps in 2017
- US Tavg CAGR below 20%
  - Doubling every ~4-5 years
  - For Network Capacity planning, typically use 20% to double every 4 years



# 50 Years of Billboard Bandwidth Trends

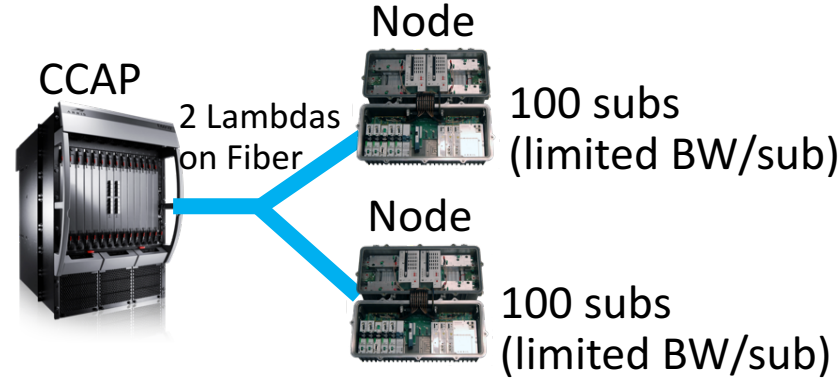
**NIELSEN'S LAW OF INTERNET BANDWIDTH**  
(Growth Rate = 50%/YEAR)



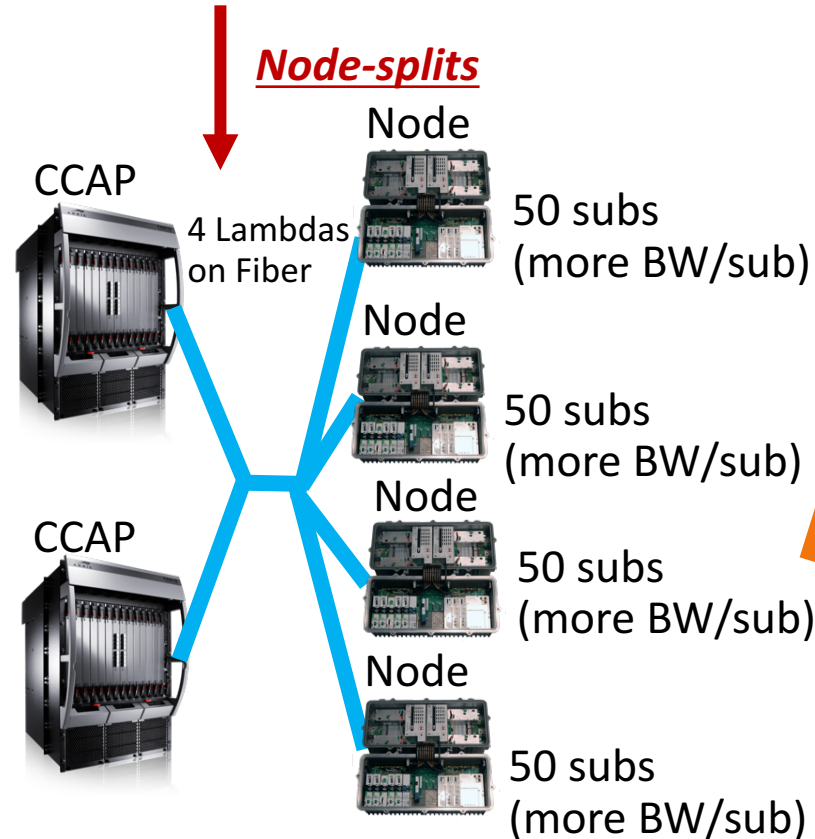
# Changes Leading to Changes Leading to Changes...

## Bandwidth Growth

Year	High SLA BW (Gbps)
2030	100
2026	30
2022	10
2019	3
2016	1



## Node-splits



## Networking & Infrastructure Issues

- The Head-end Rack-Space Issue...
- The Head-end Power Issue...
- The Lambda Exhaustion Issue on DWDM Fibers...
- The SNR Decrease Issue...



## Relief Techniques

- Move functions out of the Head-end and into the Node
- Use Digital Ethernet on Fiber instead of AM Optical Signals (80 lambdas instead of 32... better SNRs)

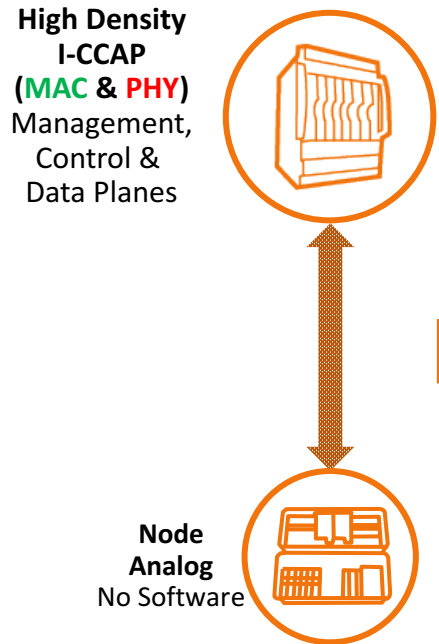
- Traffic Engineering for the Gigabit per Second Era
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# Integrated CCAP and Distributed Architectures — Architectural Divergence

## CAA

### I-CCAP (DOCSIS or PON)

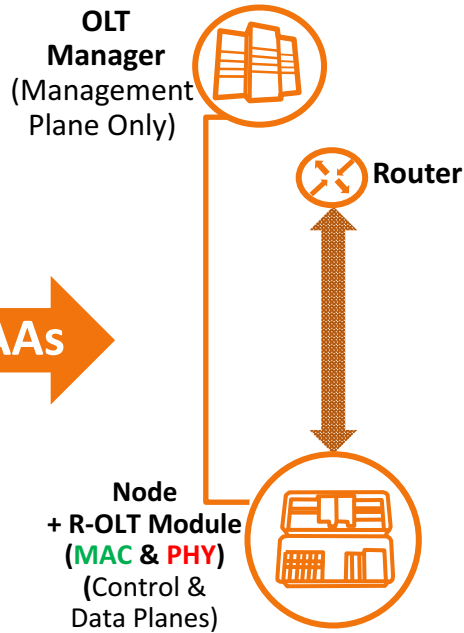


**Benefits:**

- No Software / Simple
- Lowest OSP Power
- Lowest MTBF / MTTD / MTTR
- Familiar OAM&P

## DAA

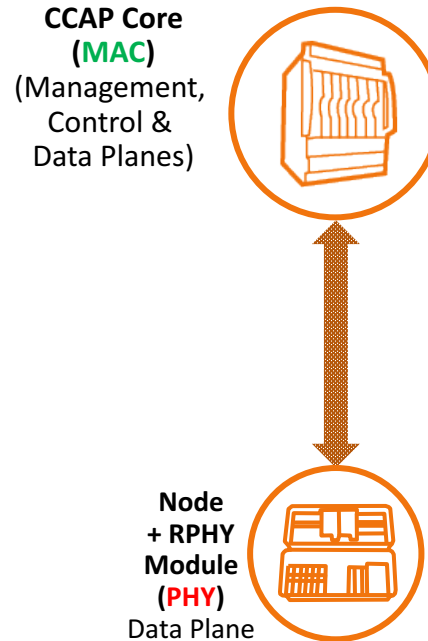
### Remote OLT OLT Mgr & R-OLT



**Benefits:**

- Low Rackspace in HE
- Low Power in HE
- More Lambdas on Fiber
- Elasticity & Feature Velocity w/ SDN & NFV

### CCAP Core & RPHY

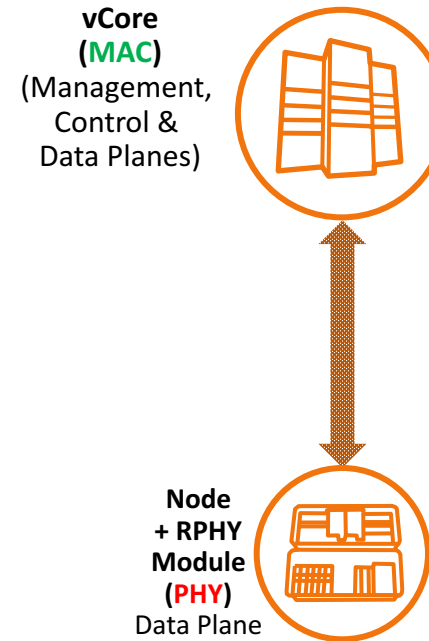


**Benefits:**

- Low Rackspace in HE
- Low Power in HE
- More Lambdas on Fiber

## DAA

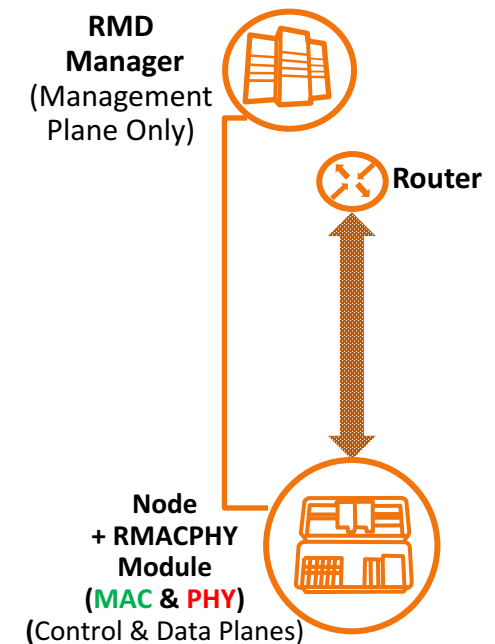
### Virtualized Core (vCore) & RPHY



**Benefits:**

- Med. Rackspace in HE
- Low Power in HE
- More Lambdas on Fiber
- Elasticity & Feature Velocity w/ SDN & NFV


### Remote MAC/PHY RMD Mgr & RMD



**Benefits:**

- Low Rackspace in HE
- Low Power in HE
- More Lambdas on Fiber
- Elasticity & Feature Velocity w/ SDN & NFV

MAC = Packet-level processing  
PHY = Bit-to-RF level processing

- Traffic Engineering for the Gigabit per Second Era
- MSO Architectural Options
-  • Drivers and Assessment of CAA and DAA
- Conclusions

# The “Why’s” Behind Distributed Access Architectures

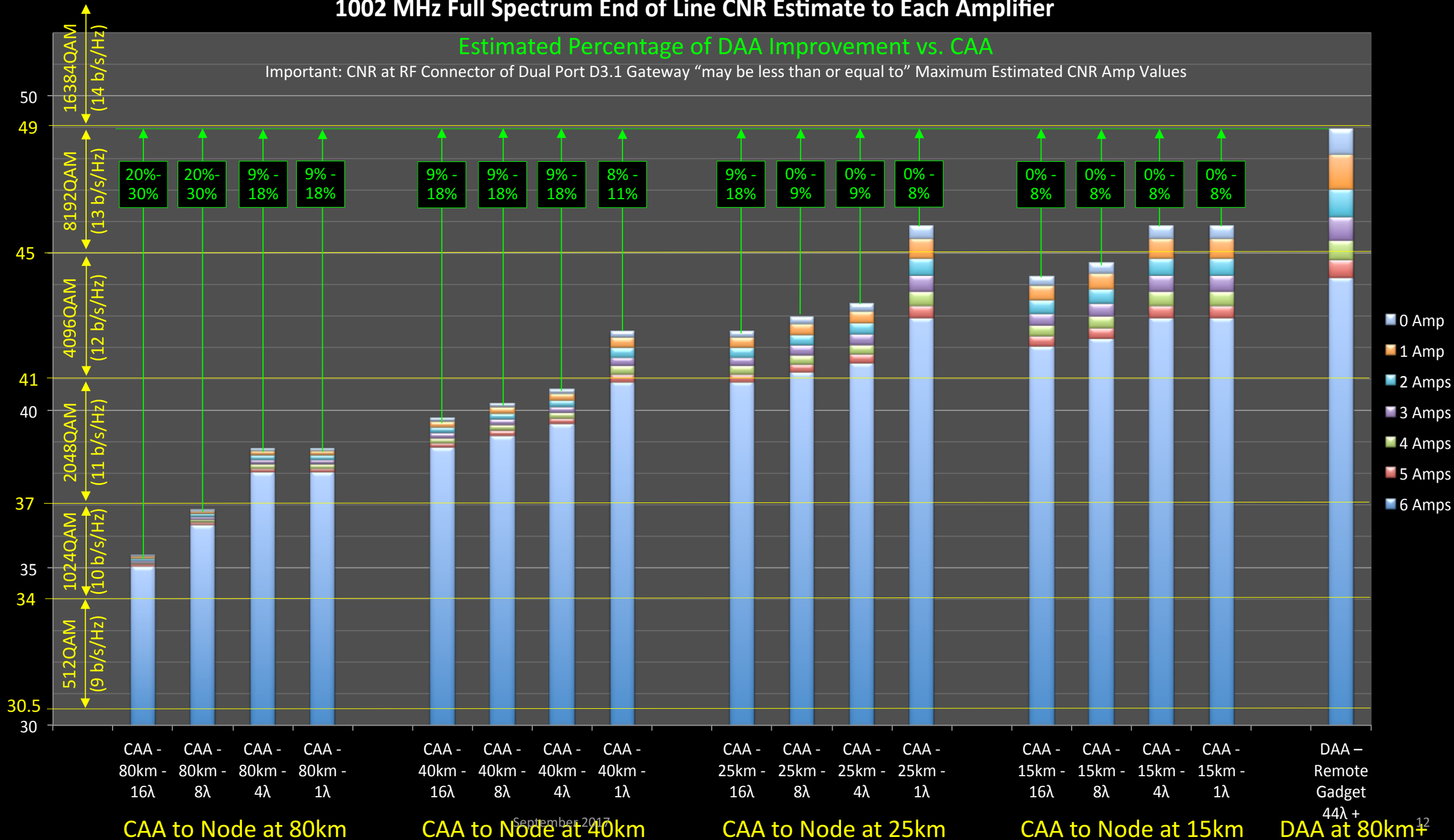
- 1 **Head-end space/power ...**
  - How can we support SG growth given space and power constraints in current head-ends?
- 2 **Fiber utilization...**
  - Can we support more wavelengths on a fiber? (40-80 for Digital Optics vs 16-32 for AM Optics)
- 3 **End-of-line signal quality...**
  - Can we improve plant robustness and bandwidth capacity (better spectral density) using node-based RF generation?
- 4 **Facility consolidation/FTTx alignment**
  - Can we help reduce the number of head-ends with longer fiber runs via digital optics? Can we plan for both DOCSIS growth and FTTx plant migration?
- 5 **Set-and-forget operational simplification ...**
  - Can we simplify operational maintenance with digital optics vs AM optics?

# 1002 MHz Full Spectrum End of Line CNR Estimate to Each Amplifier

## Estimated Percentage of DAA Improvement vs. CAA

Important: CNR at RF Connector of Dual Port D3.1 Gateway "may be less than or equal to" Maximum Estimated CNR Amp Values

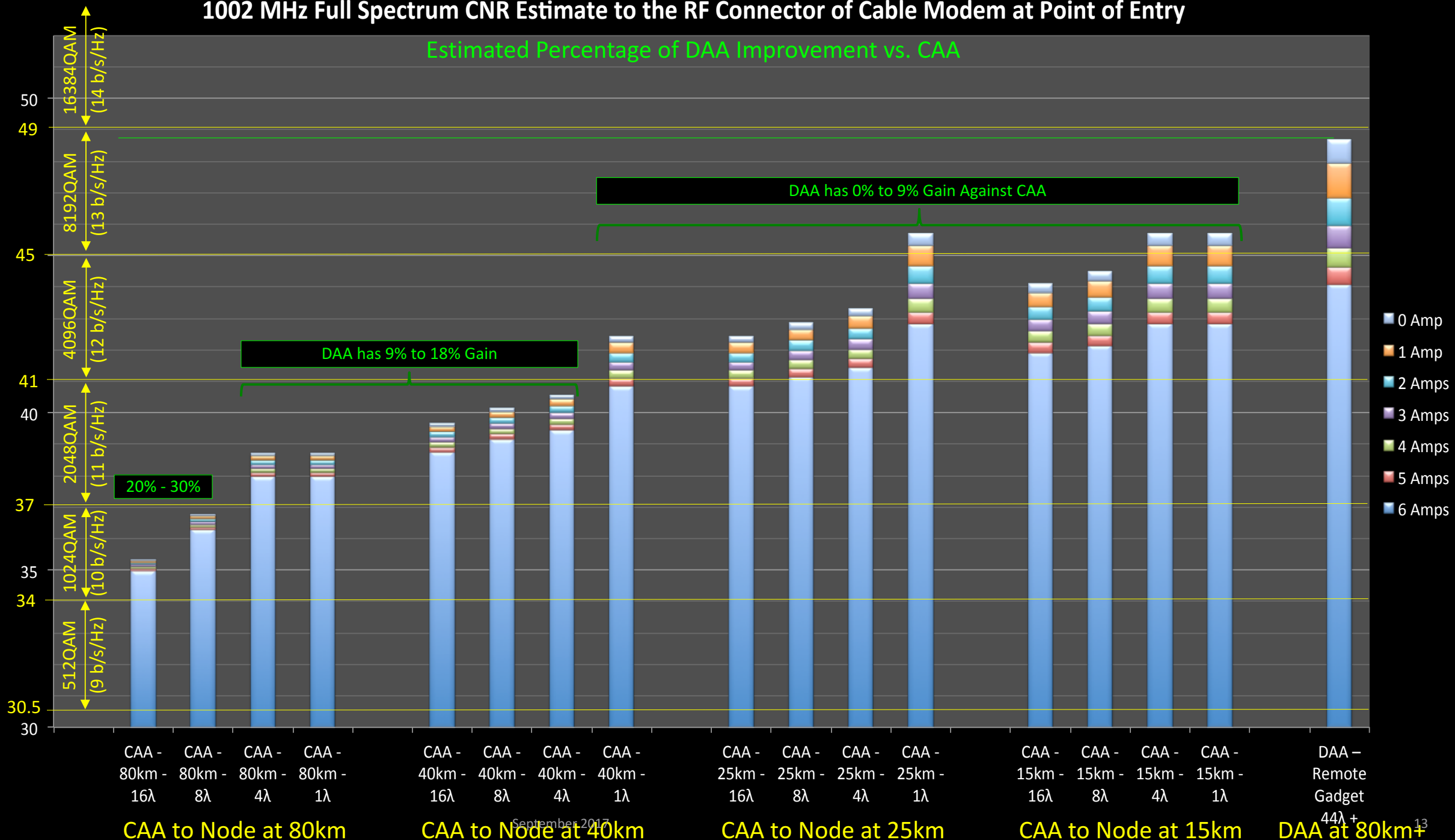
Maximum Estimated CNR Amp Values



# 1002 MHz Full Spectrum CNR Estimate to the RF Connector of Cable Modem at Point of Entry

Estimated Percentage of DAA Improvement vs. CAA

Estimated CNR



CAA to Node at 80km

CAA to Node at 40km

CAA to Node at 25km

CAA to Node at 15km

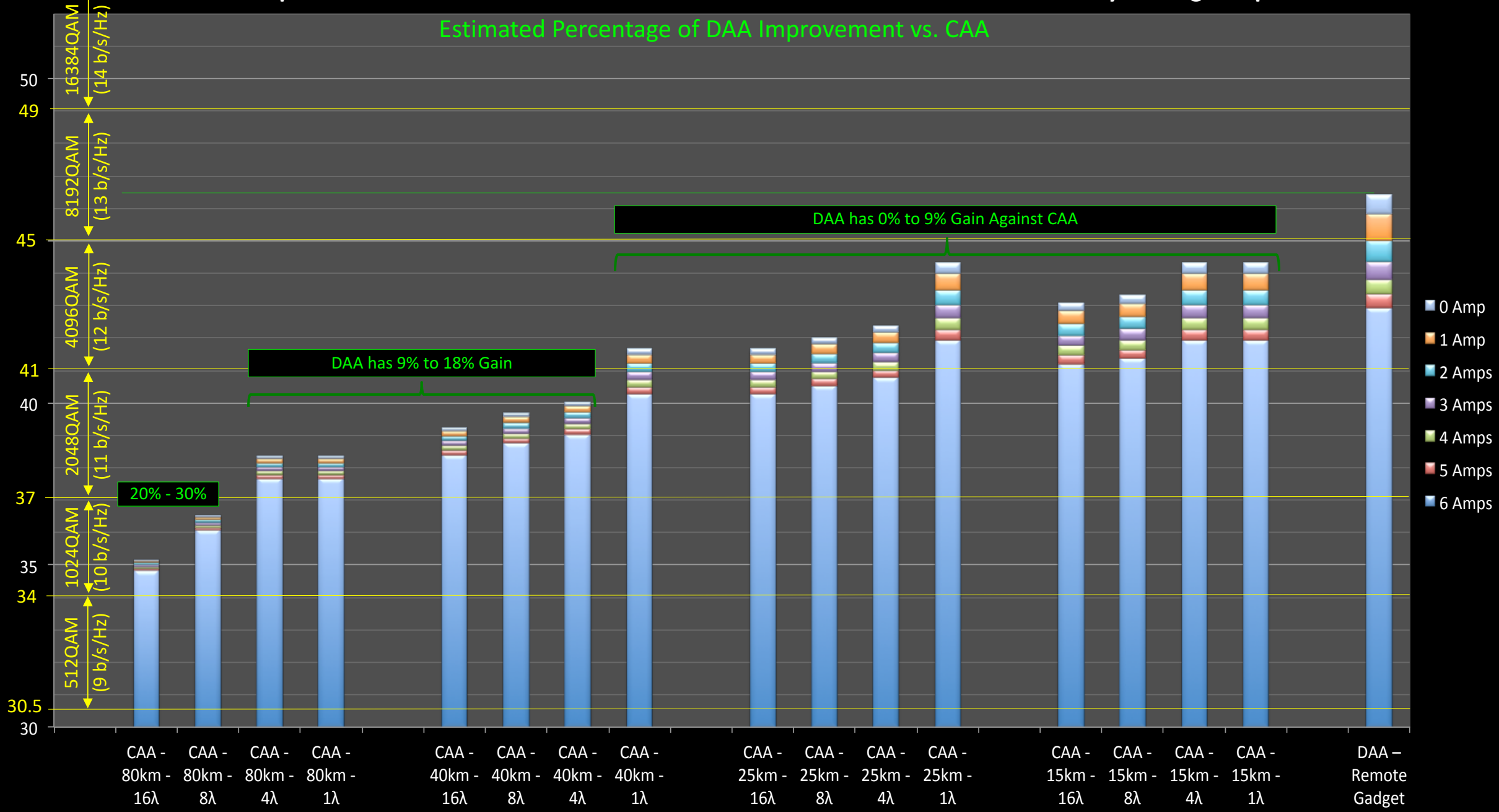
DAA at 80km+

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# 1002 MHz Full Spectrum CNR Estimate to the RF Connector of Cable Modem at Point of Entry Through 1 Splitter

Estimated Percentage of DAA Improvement vs. CAA

Estimated CNR



CAA to Node at 80km

CAA to Node at 40km

CAA to Node at 25km

CAA to Node at 15km

DAA at 80km+

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Questions?



A top-down view of several people's hands stacked together in a circle. The hands are of various skin tones and are positioned in a way that suggests a group hug or a gesture of support. One hand has red nail polish, and another has a black braided bracelet. The background is a blurred, light-colored floor.

# Thank you!