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FAST FORWARD 2021
ATLANTA, GA
OCTOBER 11-14
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UNLEASH THE POWER OF LIMITLESS CONNECTIVITY
2021 Fall Technical Forum
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Wireline Access Network

Extended CIN

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2021 Fall Technical Forum
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VIRTUAL EXPERIENCE
OCTOBER 11-14

Collaborations

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Bill Wall, Cox Communications

James Stockdill, Cox Communications

Remote PHY Core

- Remote PHY enables cable operators to deliver Gigabit service
- CCAP Chassis in every facility
- Substantial amounts of rack space, power, and HVAC
- Non-feasible/cost intensive facility augments

Network design to deploy CCAP chassis non-locally?

Cisco cBR8 CCAP

Weight: 429 lb. (195 kg) max

Height: 13 RU (22.75 in)

Width: 17.45 in no rack mounts,
17.65 in with rack mounts

- Lifetime Facility Power : 9000 W
- Hardware Facility Power (D3.0): 7300 W
- Hardware Facility Power (D3.1): 7900 W
- Average fully loaded: 4500 - 5200 W

Agenda

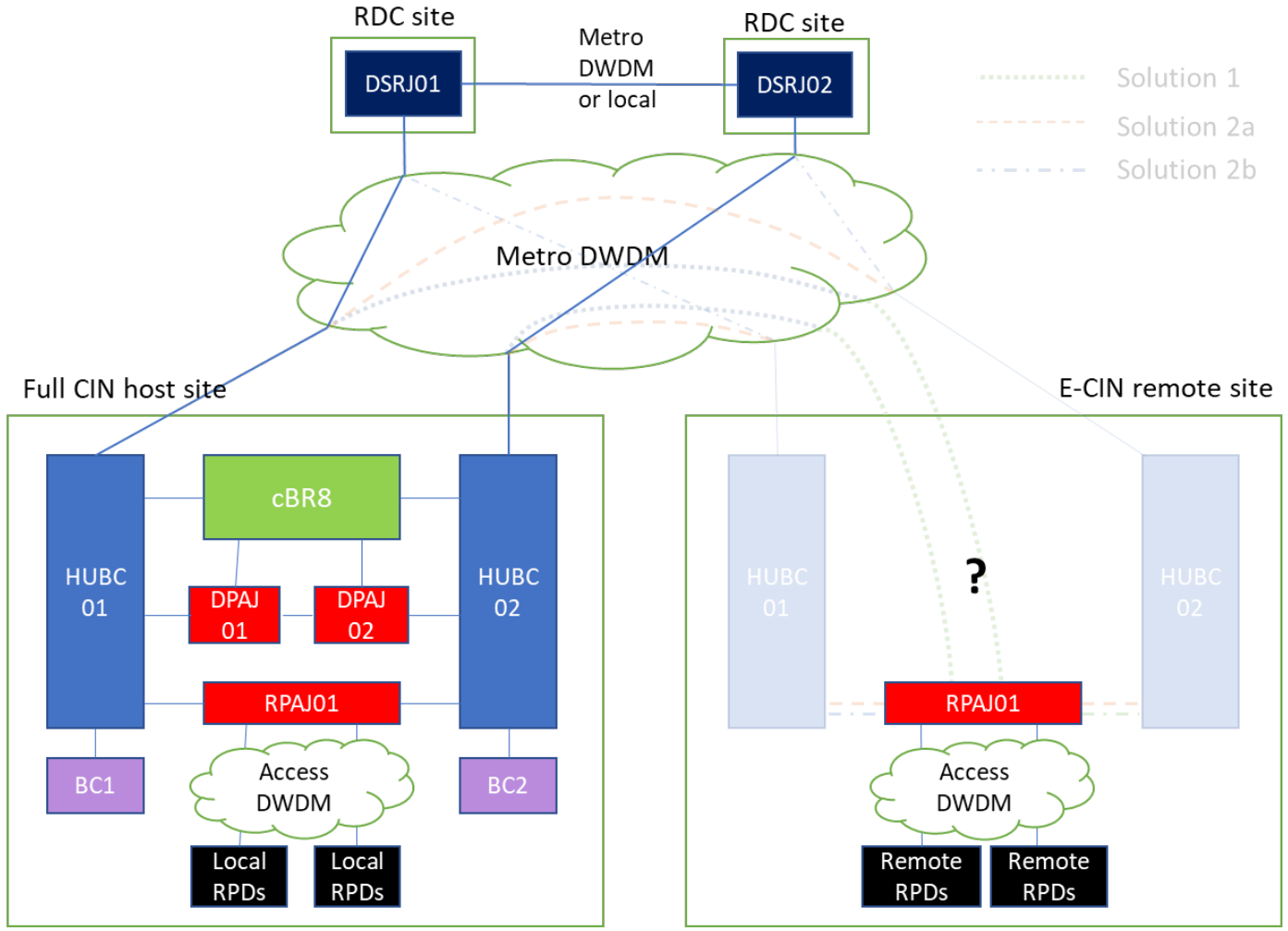
1. Network Design
   - Topology
   - Reliability Analysis
2. Implementation
   - Networking
   - Video support
3. Performance – Latency, Throughput, Distances
4. Business Impact
   - Capacity planning
   - Cost Estimate
5. Conclusion

Topology

FULL CIN VS E-CIN

- In standardized full CIN solution, hub routers uplink to the backbone over metro DWDM
- "Remote site": E-CIN edge facility
- "Host site": CCAP core facility

- What are the topological solutions for E-CIN?
- How to chose an optimal host?

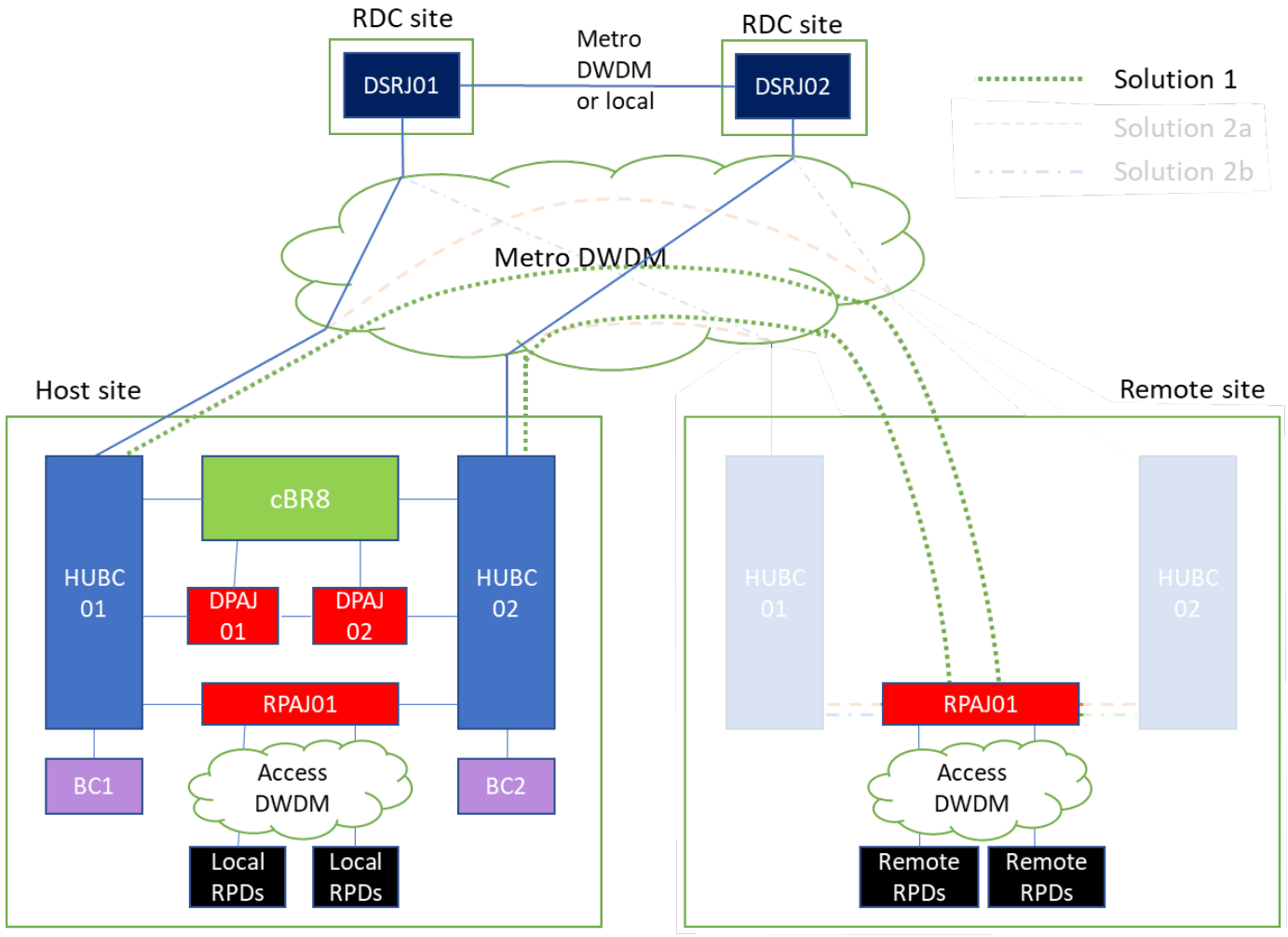


Topology

E-CIN SOLUTION 1

- Direct DWDM links between remote access aggregation device and host hub routers

- Pros: Least hops, low latency
- Cons: Not scalable
- Use case: No growth small site

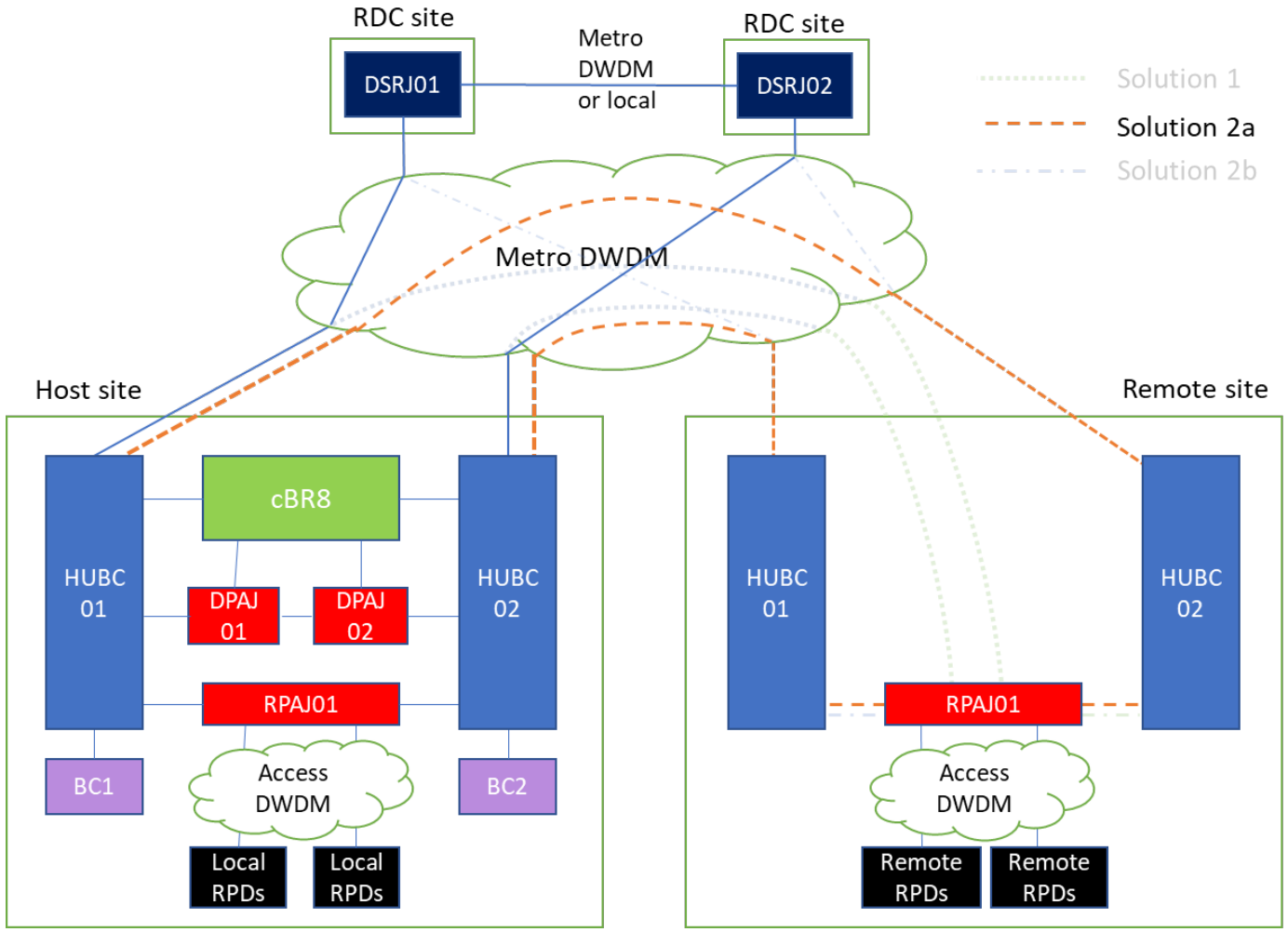


Topology

E-CIN SOLUTION 2A

- Route via remote hub routers with direct DWDM links to host hub routers

- Pros: Scalable, few hops
- Cons: Hybrid topology, non-optimal DWDM aggregation
- Use case: Direct fiber pair to subtended site

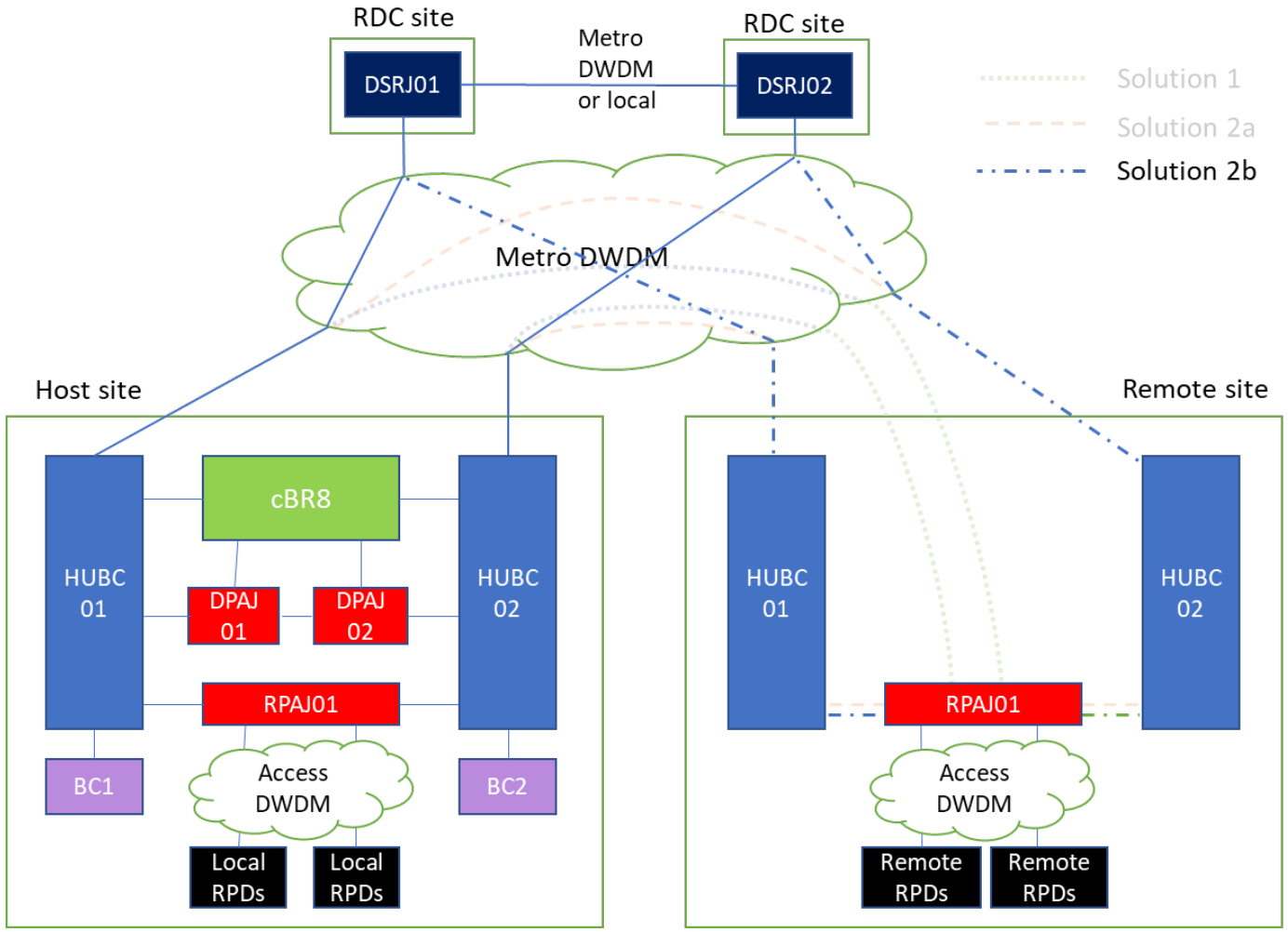


Topology

E-CIN SOLUTION 2B

- Route via remote hub routers and DSRs back to host hub routers over DWDM links

- Pros: Scalable, standardized topology, optimal DWDM aggregation
- Cons: More hops, higher latency, lower reliability
- Use case: Generic, performance dependent on host selection



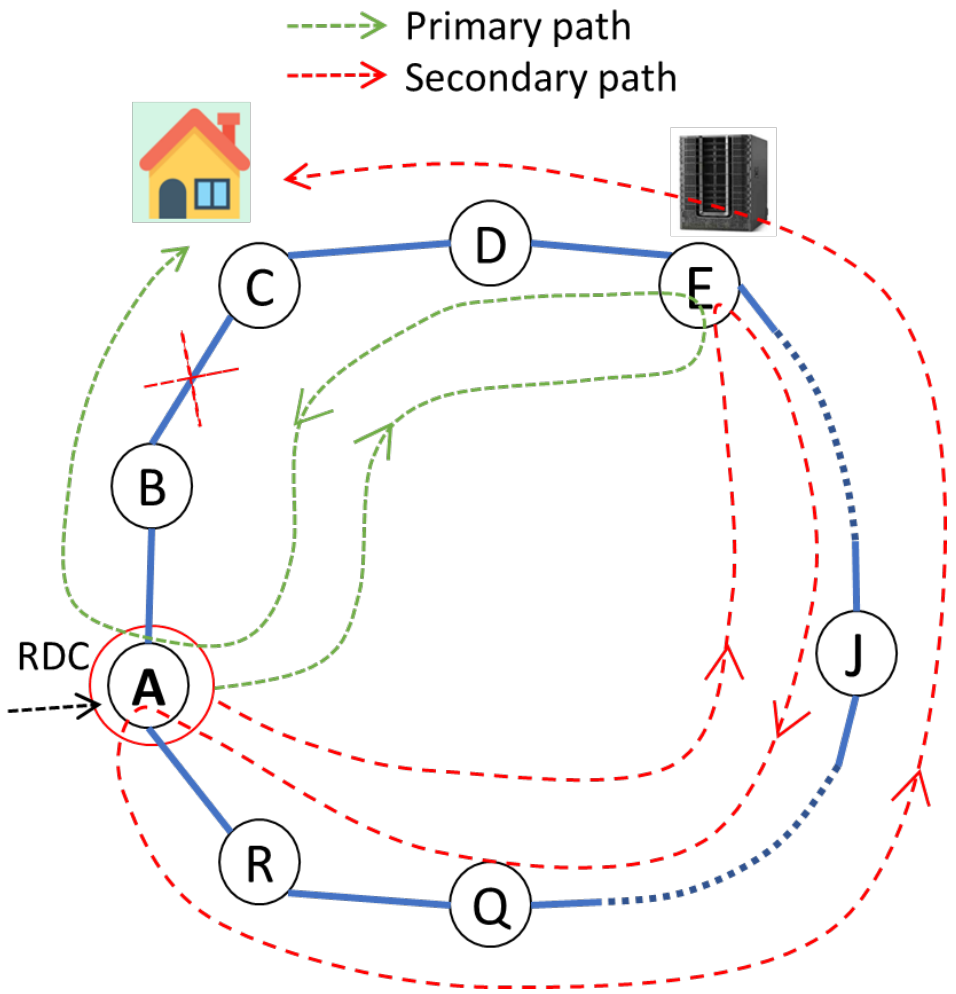
Reliability Analysis

2B CASE STUDY

- Metro optical ring spanning ≈1300km, 18 sites
- Individual distances for metro and long-haul

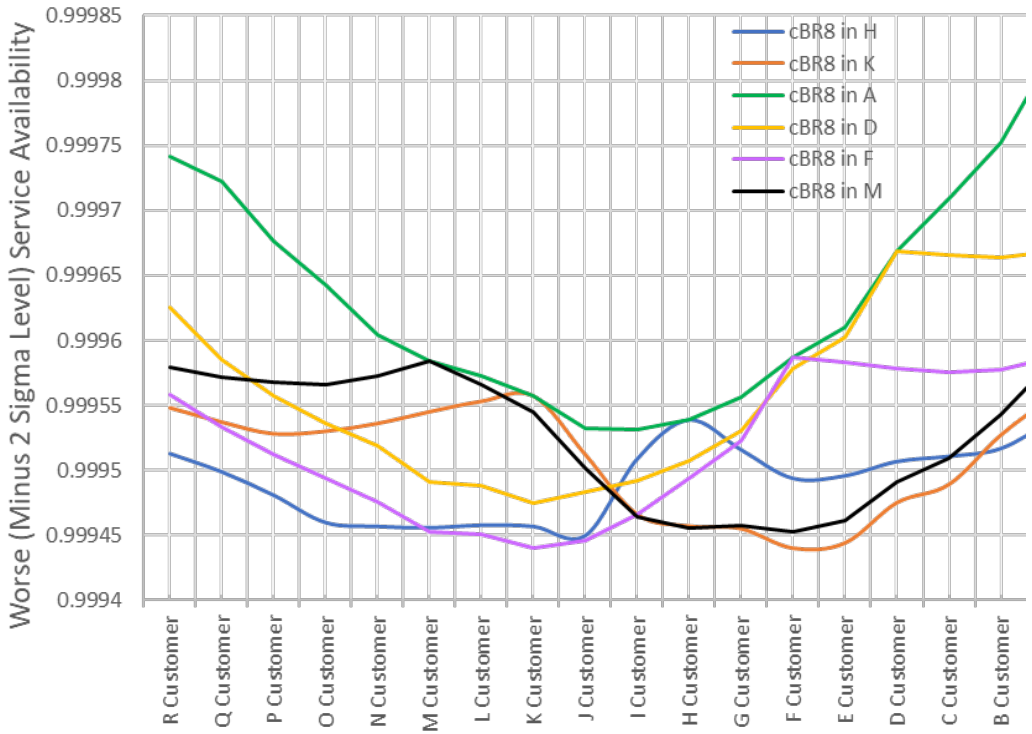
MODELING

- ReliaSoft BlockSim package
- MTTR = 4hrs for comparison, log-normal for last mile with μ = 3.3.4576 and σ = 0.5287
- Last mile simulation with hardware, software, human factor, and power outages, > 1000 blocks, 5 yrs of operation, 5000 iterations

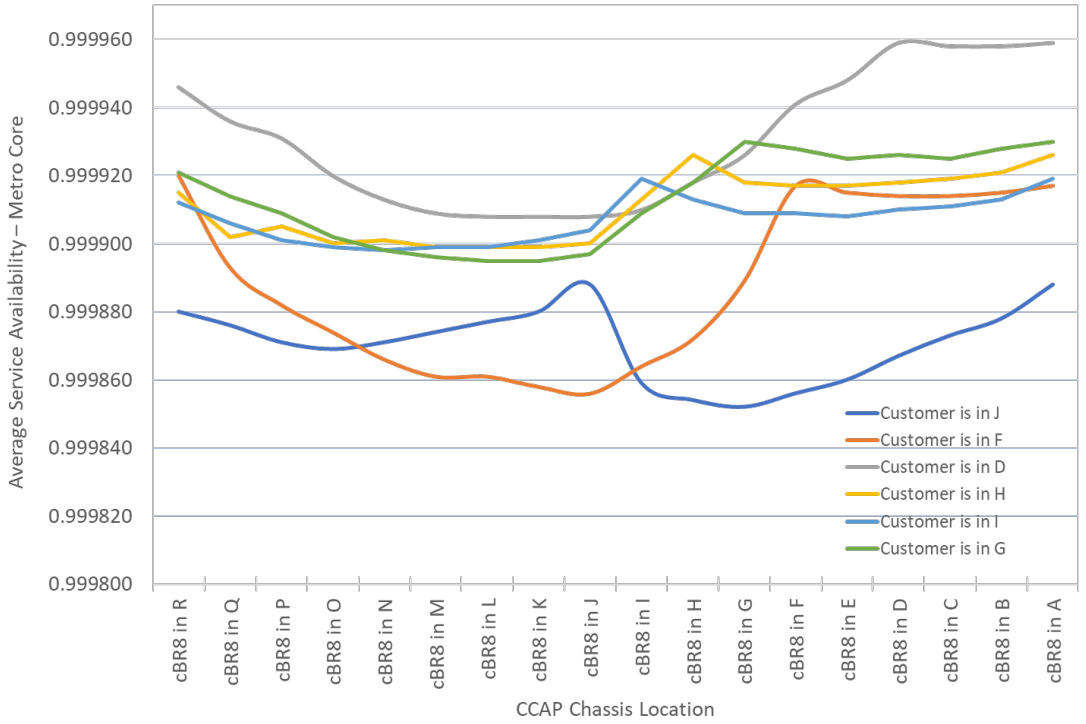


Reliability Analysis

SIMULATION RESUTS – METRO CORE



Ex: For “Last mile” drop by 0.00028, customer site J with cBR8 in RDC A has a mean availability of 99.964%. Does it qualify SLA?



Topology Selection

SUMMARY

Priority 1: **Subtended hub-hosted** (Solution 2a)

- Another hub site as host with direct fiber pair links

Priority 2: **RDC-hosted** (Solution 2b)

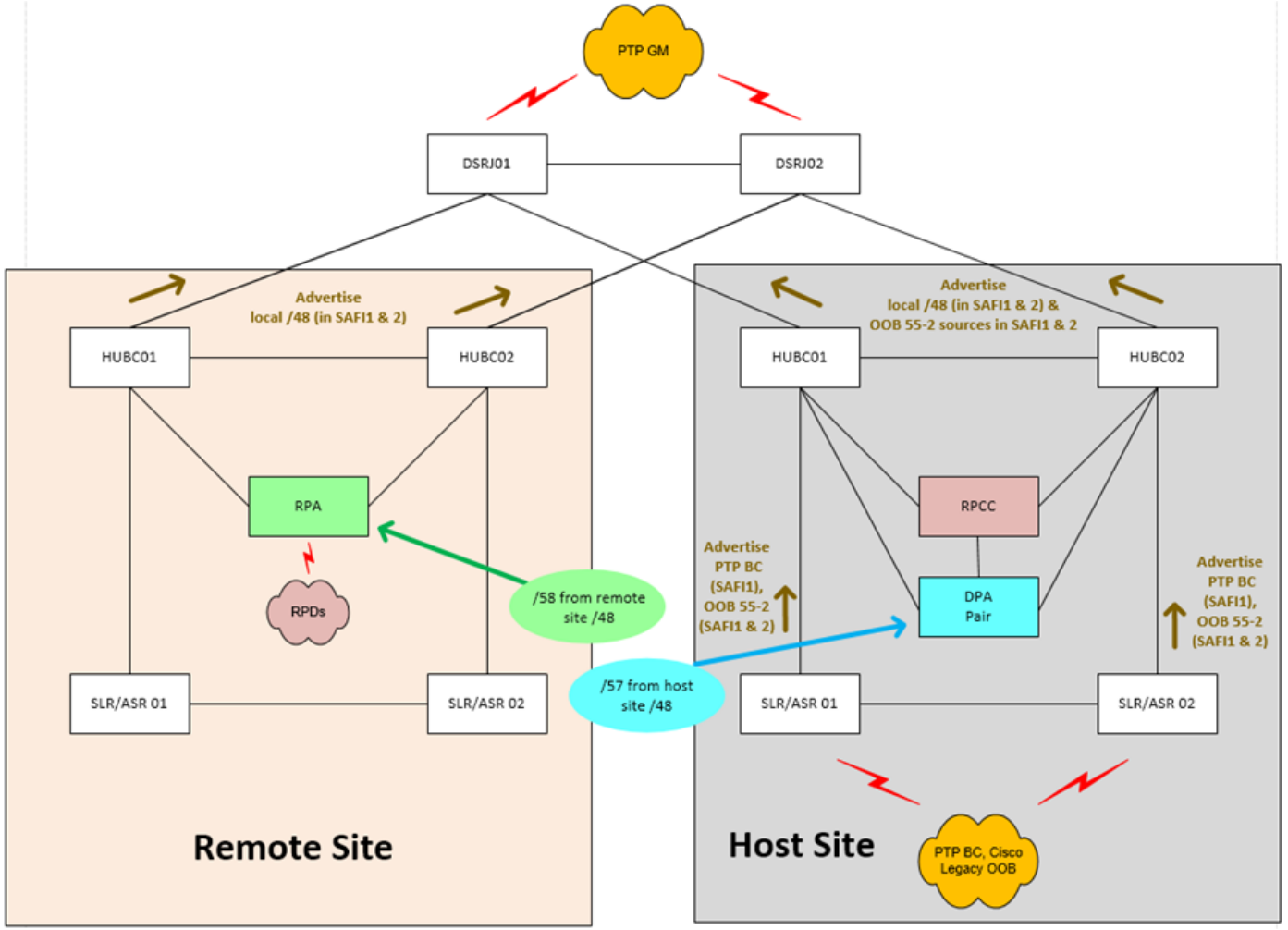
- RDC as host with standard L3 hub-and-spoke topology

Priority 3: **Hub-hosted** (Solution 2b)

- Another hub site, preferably of highest reliability, as host with standard L3 topology

Networking

- CIN routing policies apply
- IP addressing and route advertisement updates for reachability between RPA, CCAP core, and boundary clocks (BCs)
- Remote edge leverages host site BCs for timing
- BC preference set by the R-DTI profile



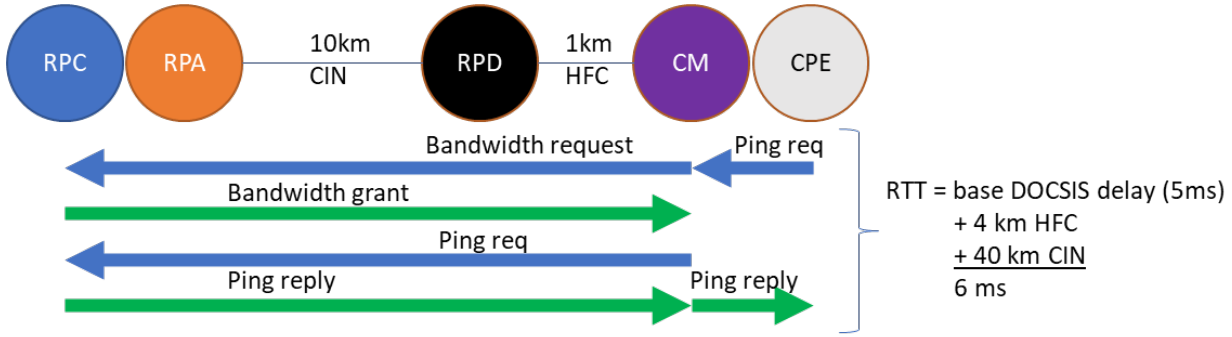
Video Support

- Increased operational complexity
- Additional CCAP configurations when channel lineup, ad zones, DSG tunnels, OOB, and PEG channels differ between remote and host sites
- CCAP configuration best practices
  - No more than 6 full BSGs per CCAP
  - No more than 12 BSGs per CCAP including PEG
  - One Conditional Access System per CCAP
  - One main SDV lineup on a CCAP

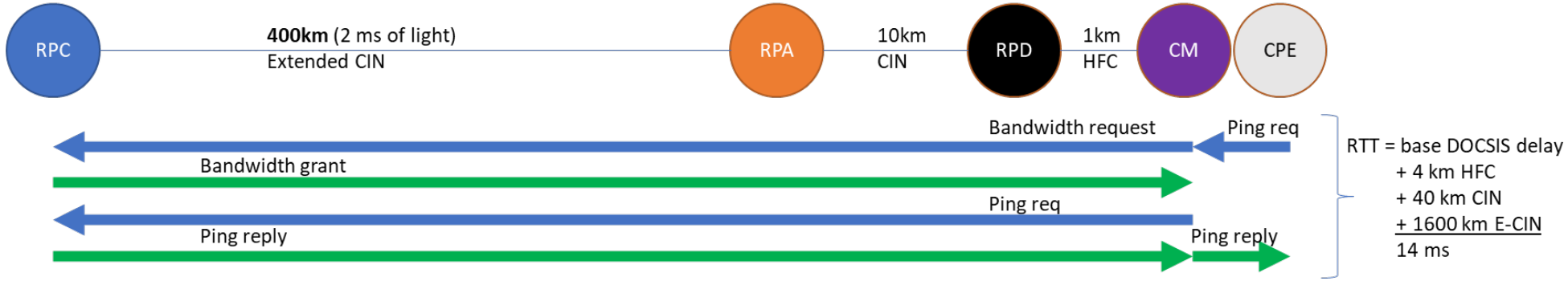
Multiple remote site hosting options:

1. All remote sites on all CCAPs - Most flexible, high complexity, potentially reduced DOCSIS SG capacity
2. Segregation of CCAPs by serving footprint – optimal configuration, requires tracking of RPD mapping
3. Standalone dedicated video core – Full CCAP utilization for DOCSIS, only DSG tunnel configurations

DOCSIS Request/Grant Cycle

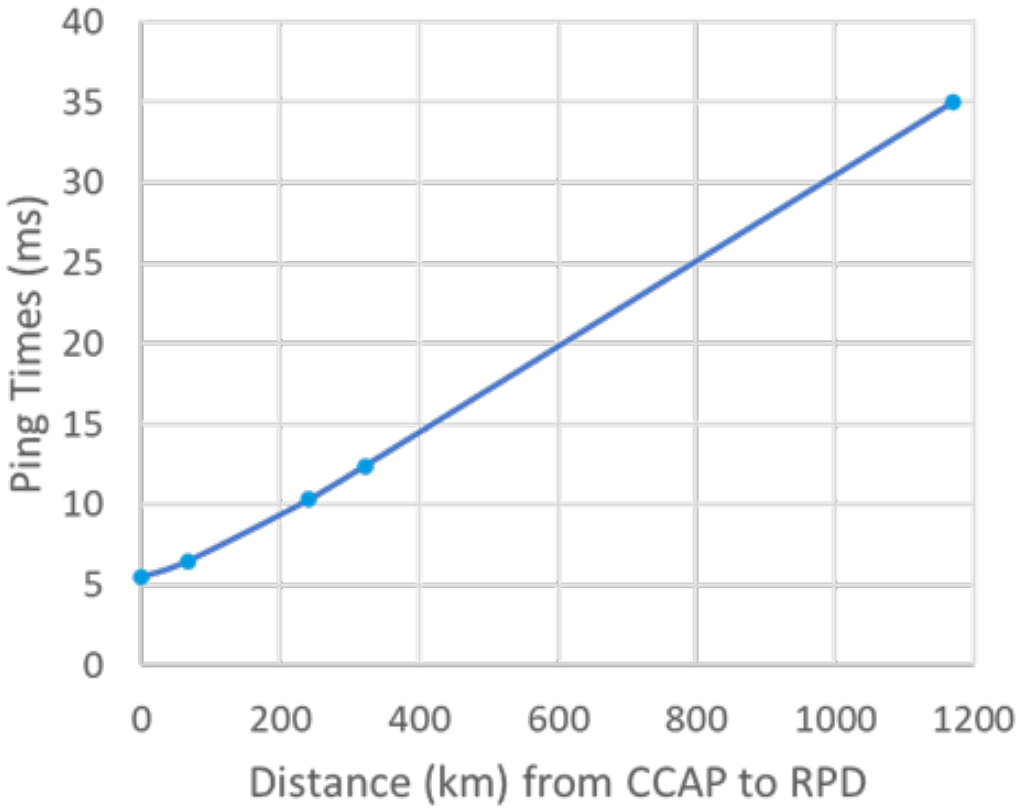


Legend:
RPC = Remote Phy Core
RPA = Remote Phy Aggregator
RPD = Remote Phy Device
CM = Cable Modem
CPE = Customer Premises Eqpt



Latency, Throughput, Distance

- Full downstream and upstream throughput, even on the Gigabit tier, up to 320km
- Exact distance limitation to preserve full Gigabit downloads is still TBD
- During path failover, worst-case at 1200km, downstream throughput inconsistent, not gigabit-class. RPDs and modems remain online and providing service in a degraded state



It is essential to maintain optimization - preferring the shortest path (in steady state) and ensuring symmetrical (forward & return) traffic flow

Capacity Planning

A $max(Td_H + TCIN_R/2\ , M * (Tu_H/2 + TCIN_R/2))]$

B $[Td_H/2 + M * TCIN_R]$

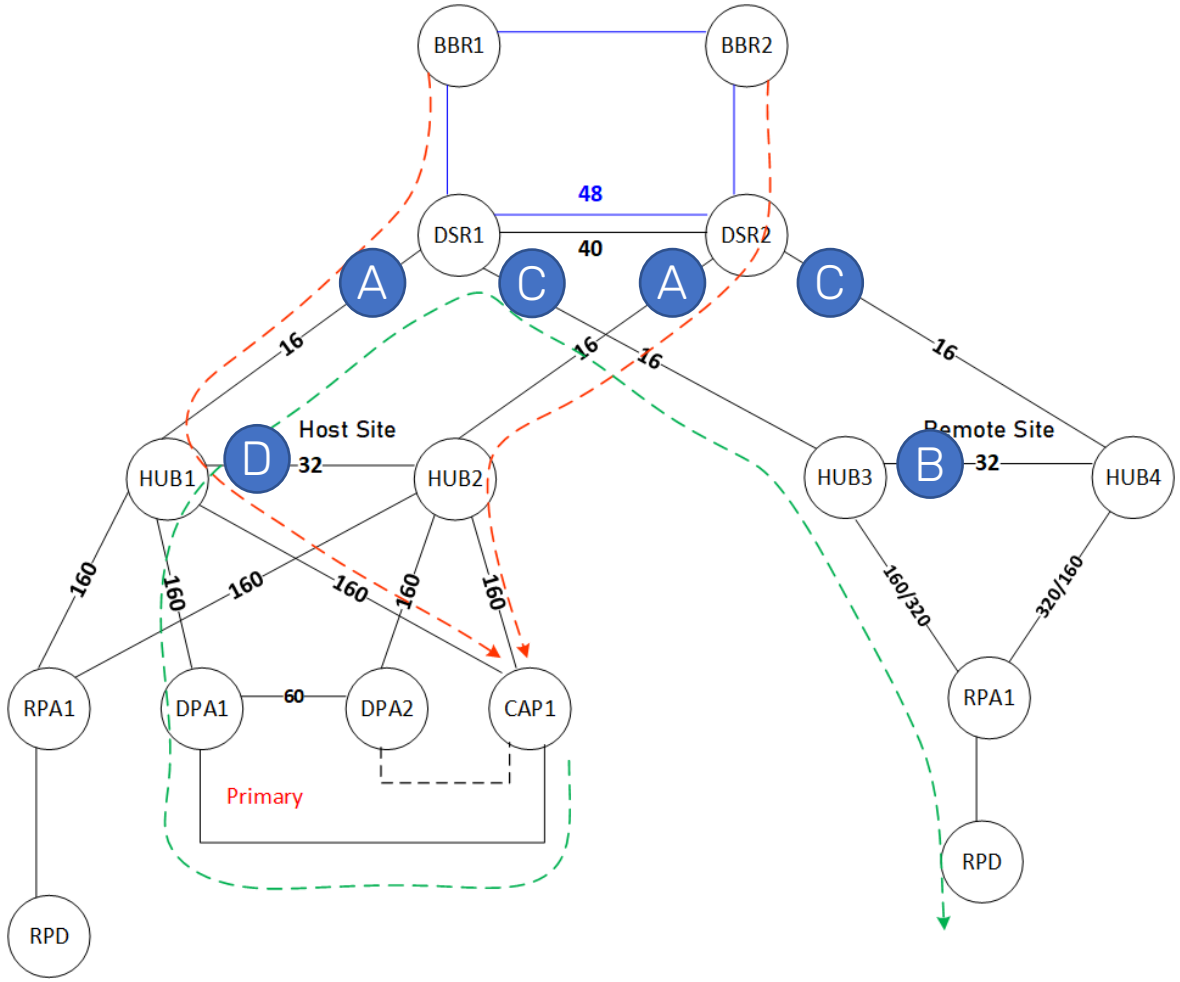
C $[max(Td_R\ , \frac{M}{2} * (Td_R + TCIN_R))]$

D $[Td_R + TCIN_R]$

Tx_y : Total x-stream traffic at y-site

M: Bandwidth margin on the router uplinks, required for heathy tunneled traffic flow

M = 1.5 ensures steady state below 66.66%



Conclusion

- E-CIN is novel to geographically de-couple Remote PHY core from edge
- Useful in reducing footprint at a facility and consolidating resources
- Cost benefit from deferred facility augments and shared core resources

- Unique challenges with reliability, latency, and operational complexity
- Cost expenditure on additional metro-core augments

- Apply E-CIN only where optical separation is low (< 320 Km) and cost benefit is high.
- Pending evaluation within the context of Remote MAC-PHY and virtual CCAP

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Thank You!

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