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Cable Access Evolution with Remote PHY

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BRKSPG-2505

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Barcelona | January 27–31, 2020

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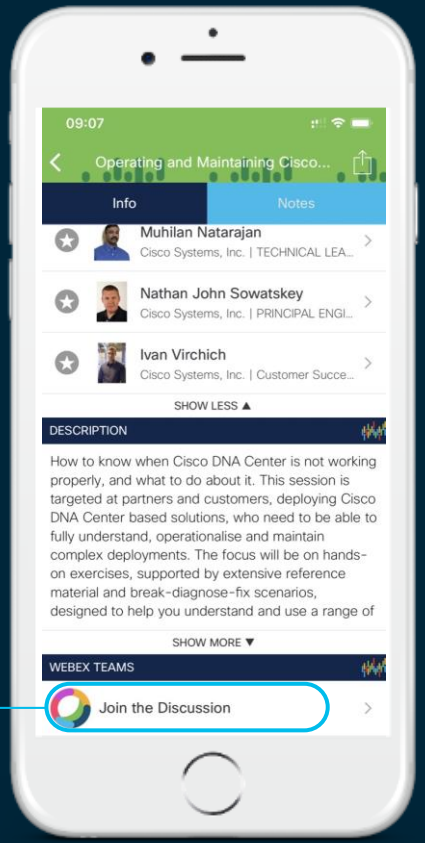
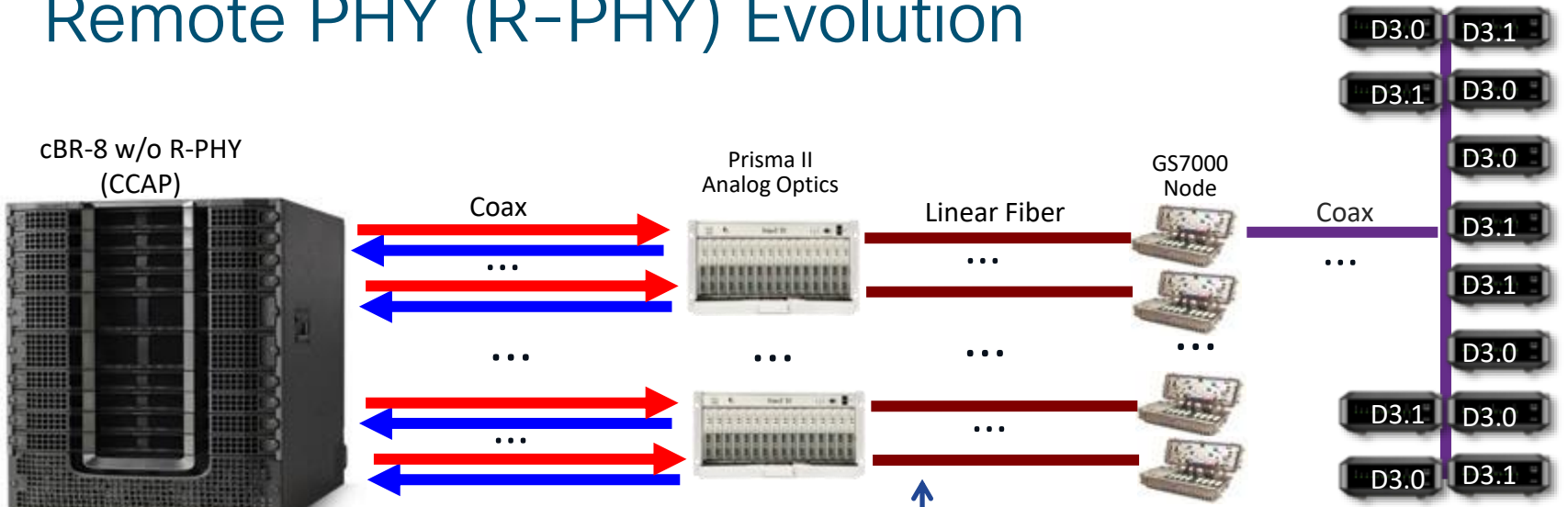


Agenda

- Remote PHY (R-PHY) Motivation & Protocols
- R-PHY Components
- R-PHY Implementation & Case Studies
- R-PHY Automation
- R-PHY Assurance
- Cloud Native Broadband Router (cnBR) Overview
- Summary

Remote PHY Motivation & Protocols

Remote PHY (R-PHY) Evolution

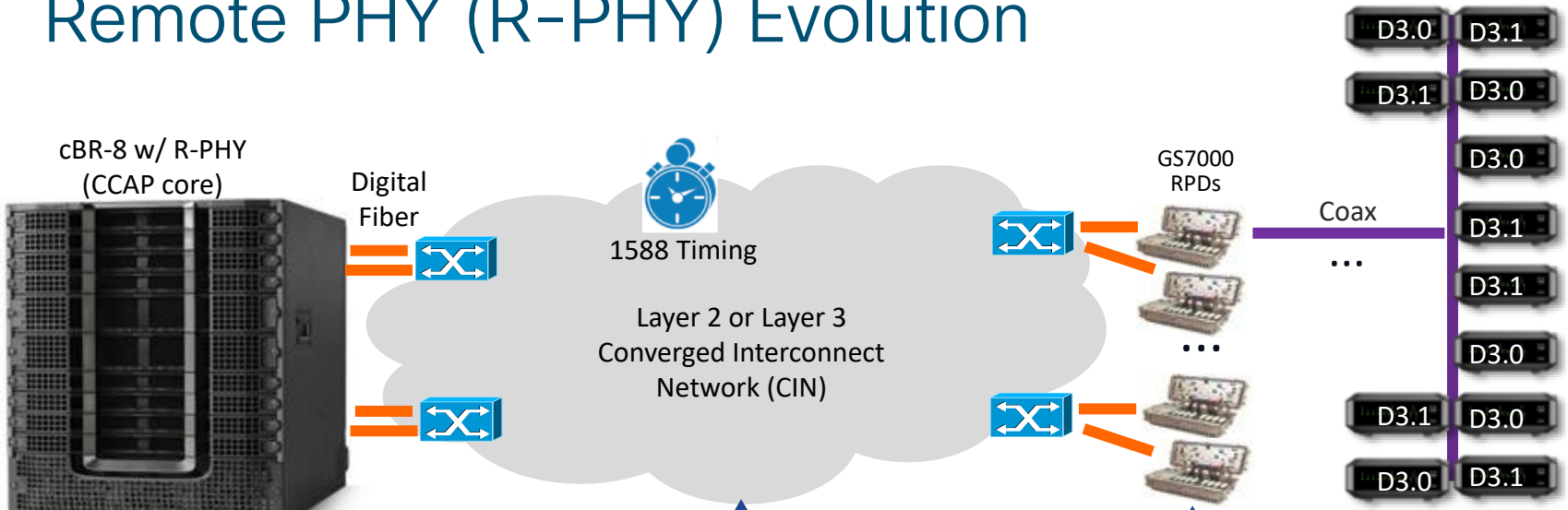


- With HA limited to 56 SGs due to limit of 56 DS ports and 112 US ports

- Linear fiber limits achievable MER (max 35-38 dB)
- Linear fiber distance limited and supports fewer usable wavelengths

- DOCSIS 3.1 modems may be unable to use higher order modulations

Remote PHY (R-PHY) Evolution



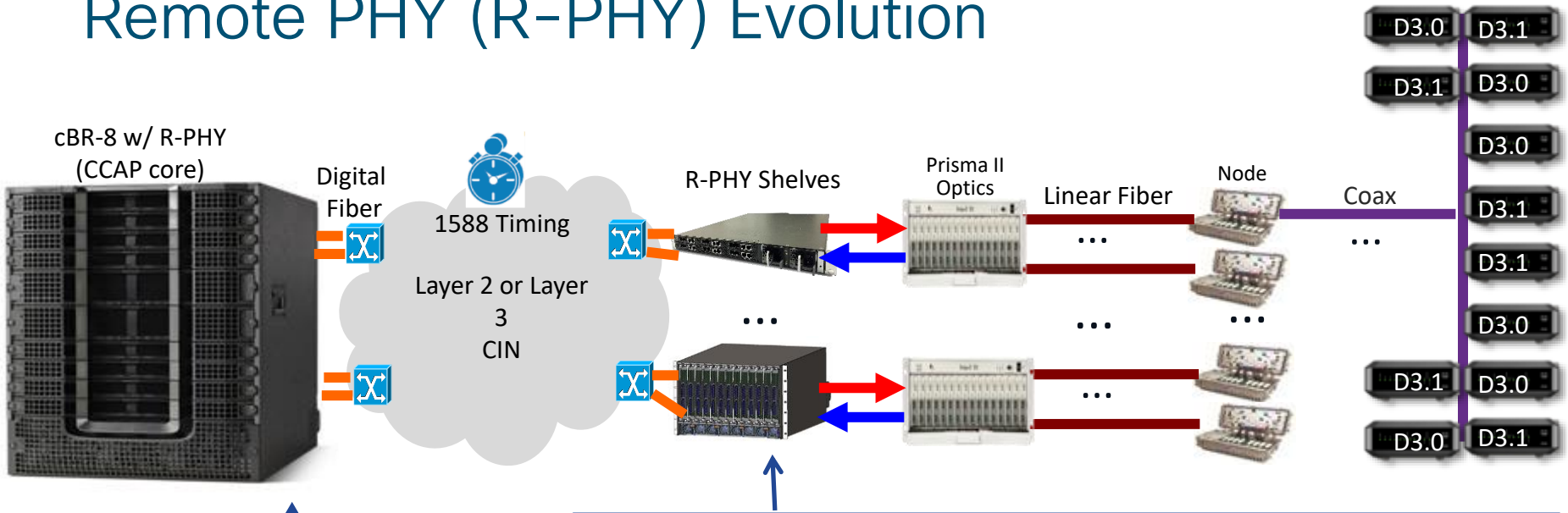
- cBR-8 RF PICs replaced with digital optics PICs
- No longer port constrained
- Space & power savings

- Digital fiber enables higher MER
- Supports 3-5x more wavelengths
- Links could be over a L2 or L3 CIN

- RPD – Remote PHY Device
- R-PHY module added to GS7000 nodes

- DOCSIS 3.1 modems now able to use higher order modulations

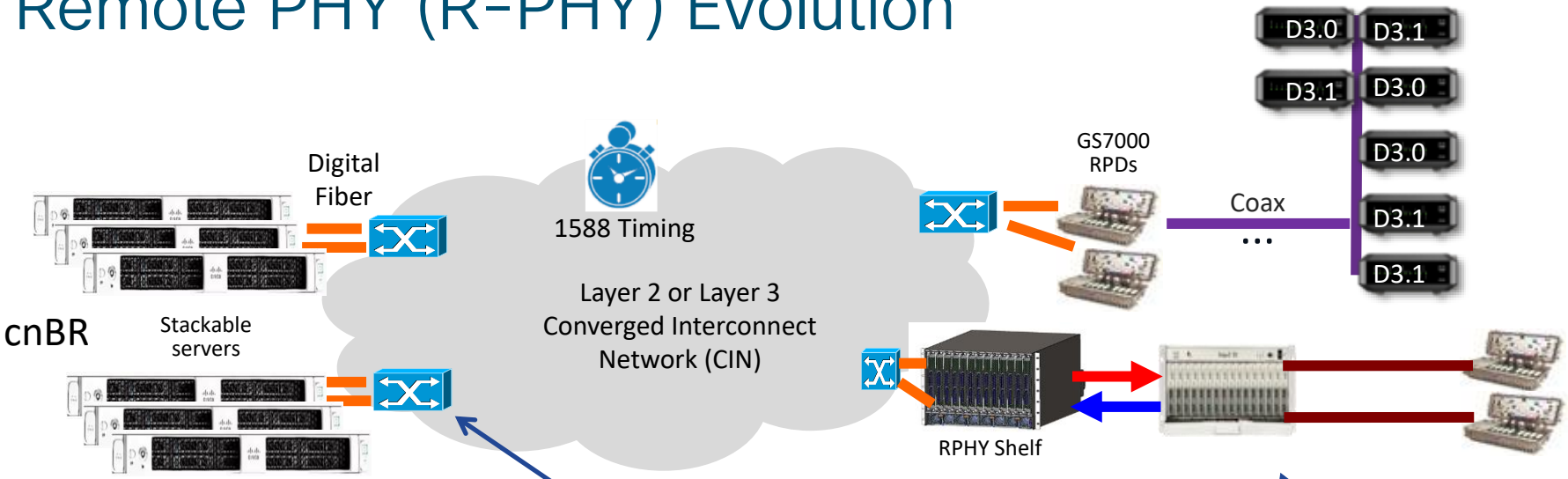
Remote PHY (R-PHY) Evolution



- Digital optics PICs used to enable 2x – 4x SG scaling

- R-PHY Shelf enables cBR-8 port capacity increase while keeping existing outside plant equipment
- Could be used in smaller sites for hub consolidation or co-located with cBR-8 to augment capacity

Remote PHY (R-PHY) Evolution



- Physical CMTS chassis replaced (or augmented) with Cloud Native Broadband Router (cnBR)

- cnBR communicates with a Service Provider Router (SPR) which constructs the equivalent of the CMTS Bundle interface

- cnBR can be used with R-PHY nodes and/or shelves to provide versatile & scalable networks

RPD Initialization

802.1x Authentication (Optional)

Address Assignment (DHCP)

Time of Day (ToD)

Mutual Authentication (Optional)

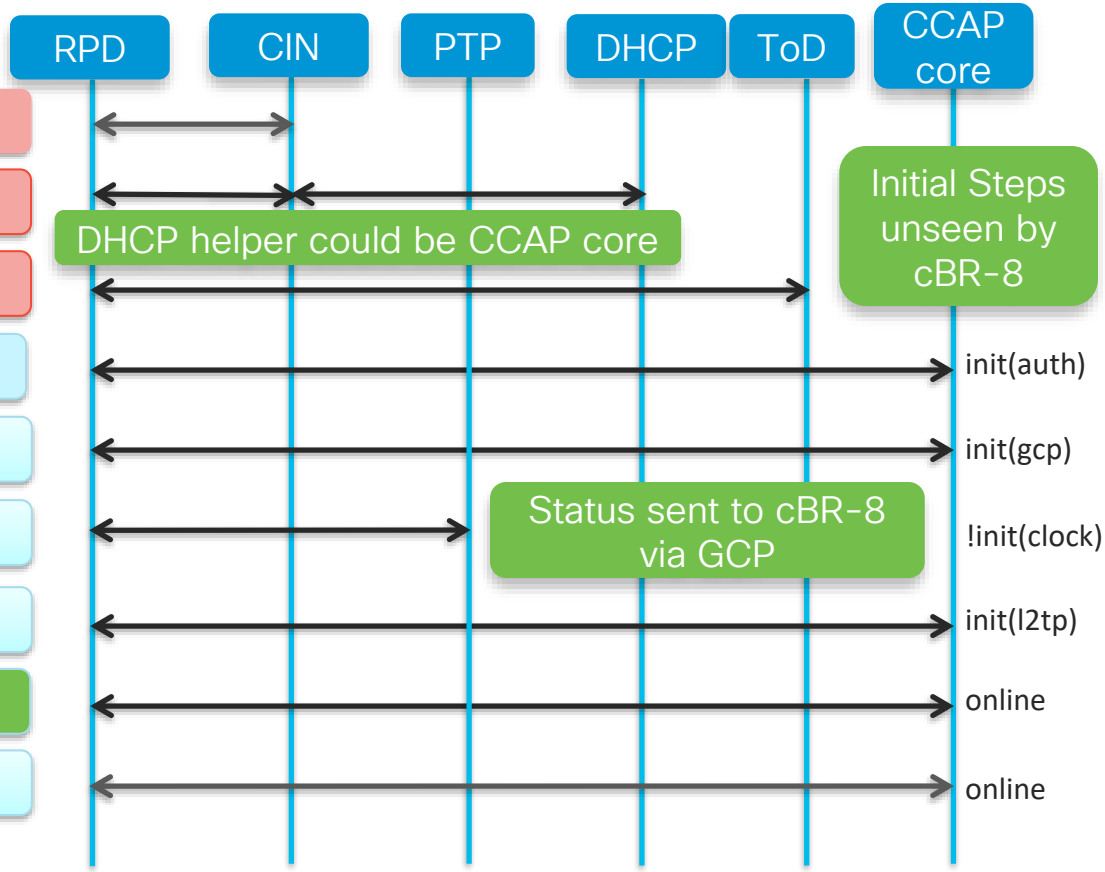
GCP Session to Principal Core

PTP Timing Synchronization

DEPI & UEPI Establishment

Operational with Principal Core

Auxiliary Core (Optional)



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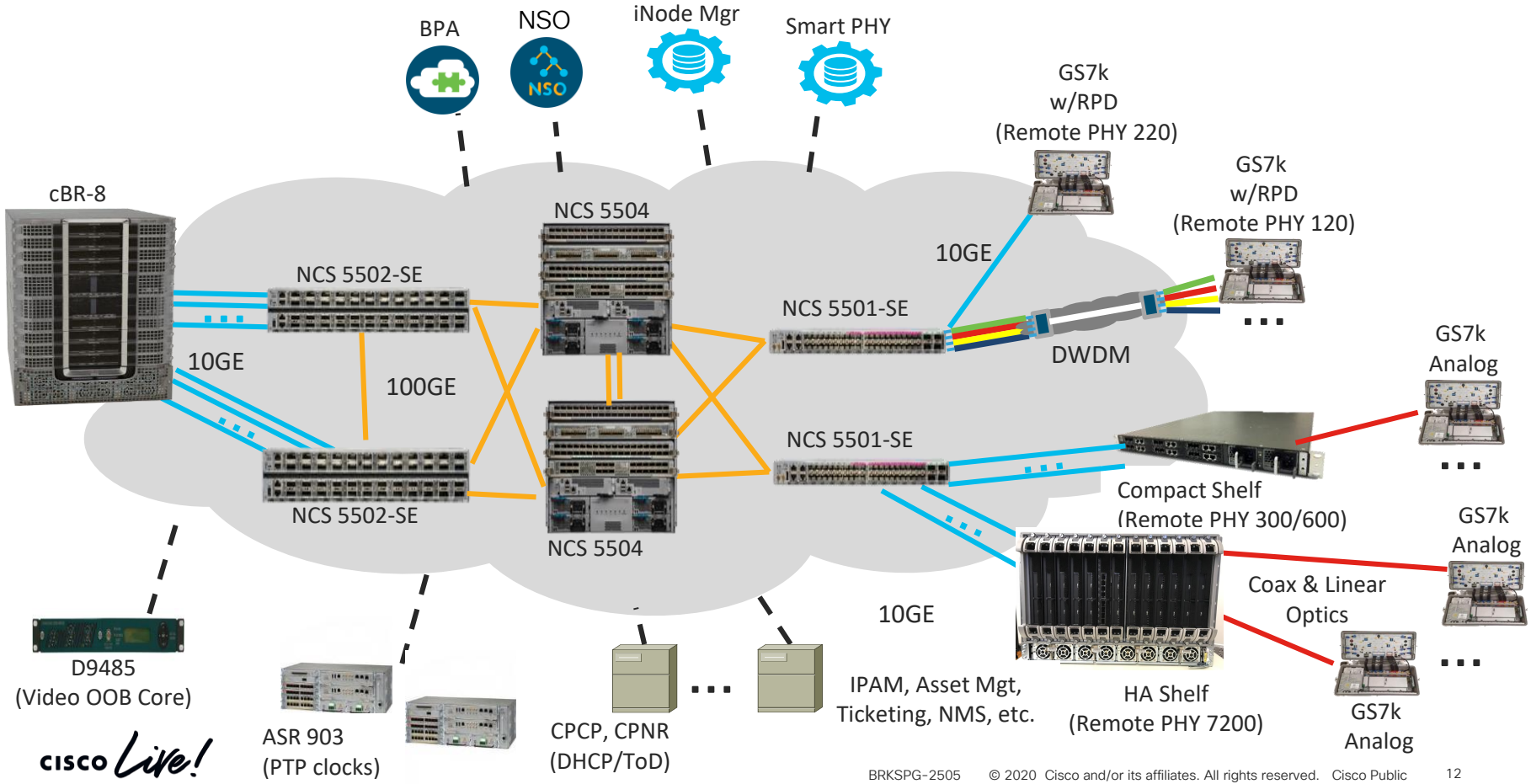
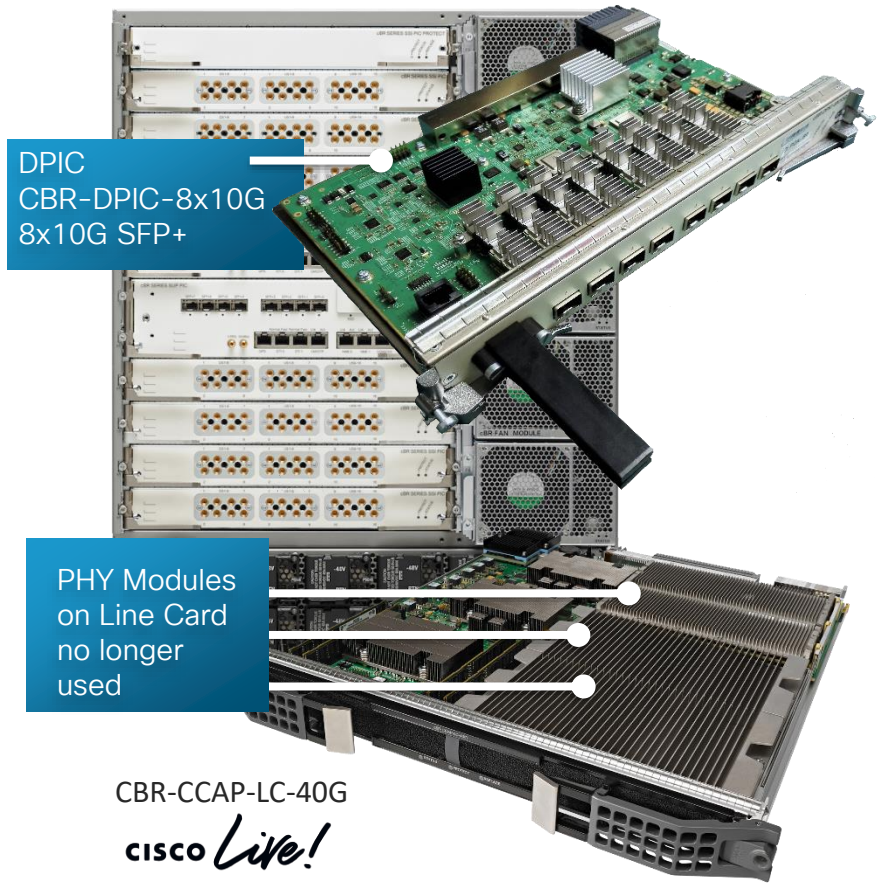
Remote PHY Components

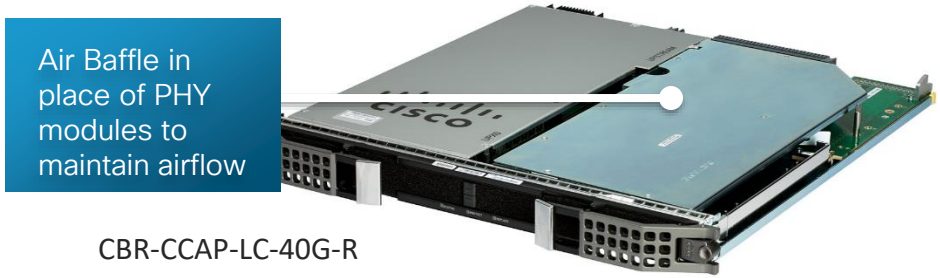
Remote PHY Architecture Components



cBR-8 Remote PHY PIC (Digital PIC)



- DPIC can work with an integrated CCAP Line Card (CBR-CCAP-LC-40G)
- Or R-PHY CCAP LC w/o PHY modules (CBR-CCAP-LC-40G-R)
- DPICs used with active & standby CCAP LCs (no special Protect DPIC)



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Second Generation Cable Line Card

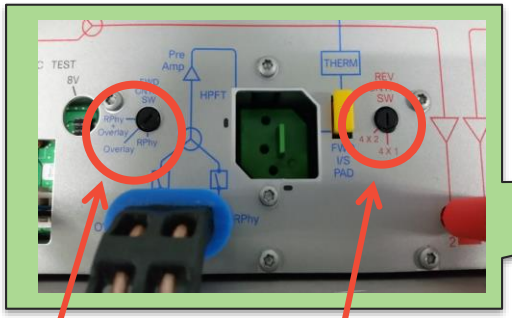
- Faster CPU, more memory, more advanced MAC FPGAs (CBR-CCAP-LC-G2-R)
- Works with 8x10G or 2x100G DPIC

Cable LC Comparison

	G1 LC	G2 LC (today)
# DS SC-QAMs (6 MHz)	768	1024
# US ATDMAs	128	256
# Video QAMs (6 MHz)	384	512
# Video QAMs (> 6 MHz)	288	384
# Active Video Sessions	5,760	7,680
# Encrypted Video Sessions	1,920	2,560

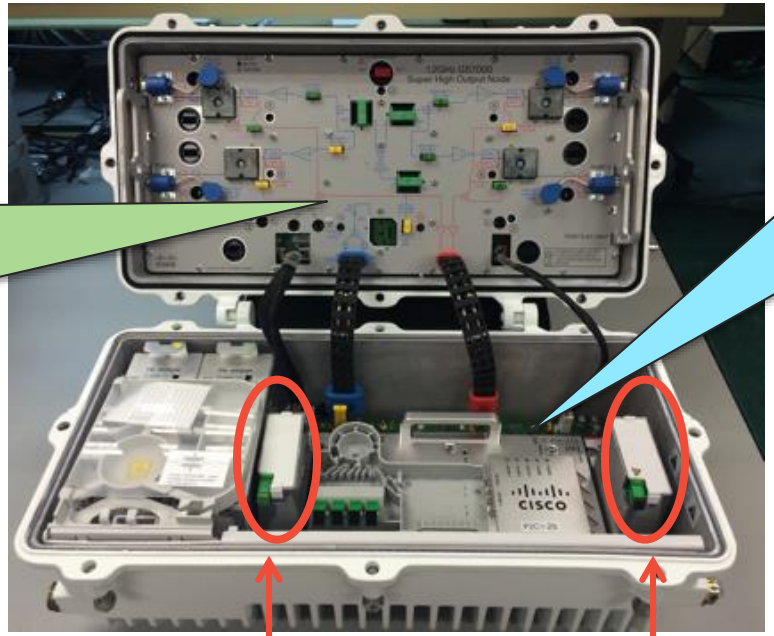
Remote PHY Device in a GS7000 Node

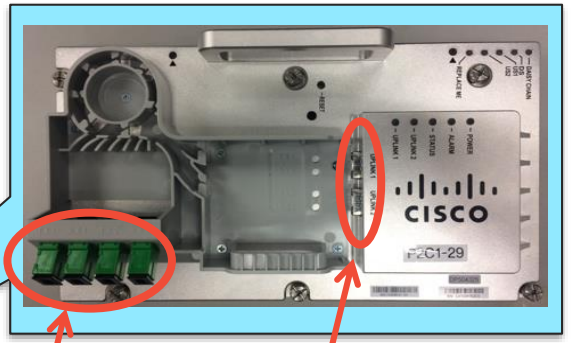
- The RPD occupies the middle 6 slots in the GS7000 lid



Forward Control SW:
RPhy or RPhy + Overlay options

Reverse Control SW:
4x1 or 4x2 options





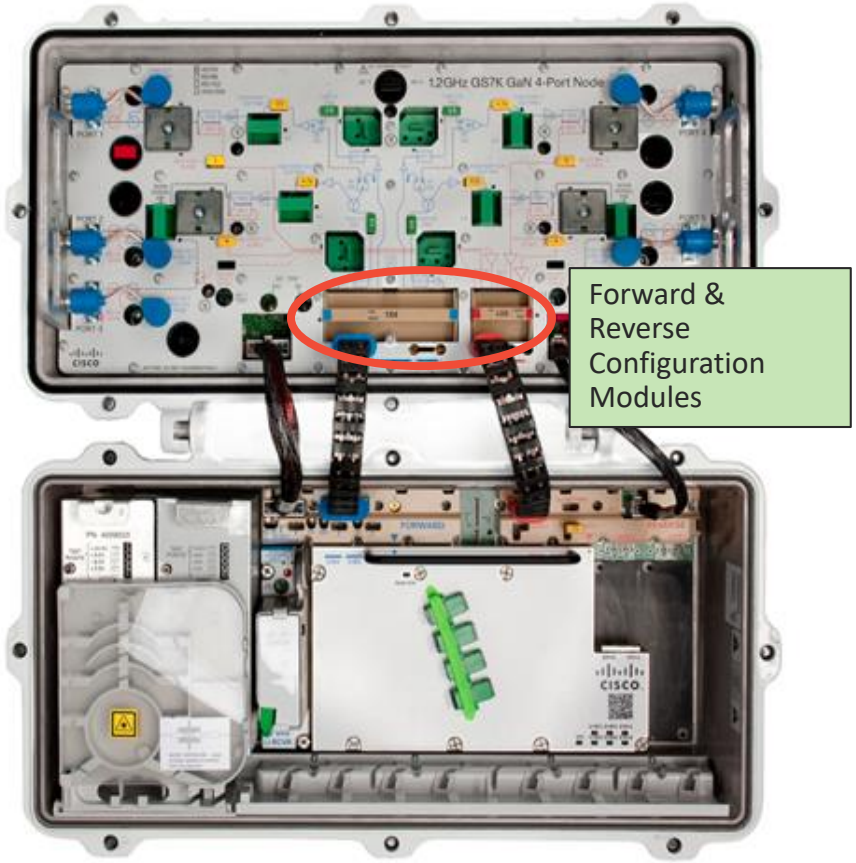
Pair of 10GE interfaces

Adapters for SC connectivity

Ability to include Optical Transmitter & Receiver for Overlay

GS7000 SHO & BAU nodes

- Initial GS7000 node supporting the RPD is the SHO (Super High Output) node capable of supporting fiber deep deployments with longer coaxial runs without amplification
- Can also use a BAU (Business As Usual) GS7000 RPD capable node supporting traditional deployments with amplifier cascades
- The BAU node requires new Forward & Reverse Configuration Modules (FCM/RCM) installed to be usable with an RPD
  - GS7K-FCM-RPD-14= & GS7K-FCM-RPD-24=
  - GS7K-RCM-RPD-41= & GS7K-RCM-RPD-42=



Nodes & RPDs

Remote PHY 120 (1x2) RPD

- Supports 1 Service Group (1x1 or 1x2)
- Can be used in either SHO or BAU GS7K node
- Full Spectrum D3.0/D3.1 capable:
  - 160 SC-QAMs or 6 x 192 OFDMs or a mix on the DS port
  - 12 ATDMA or 2x96 OFMDA or a mix per US port
- Video, 55-1 & 55-2 OOB, NDF/NDR

Remote PHY 220 (2x2) RPD

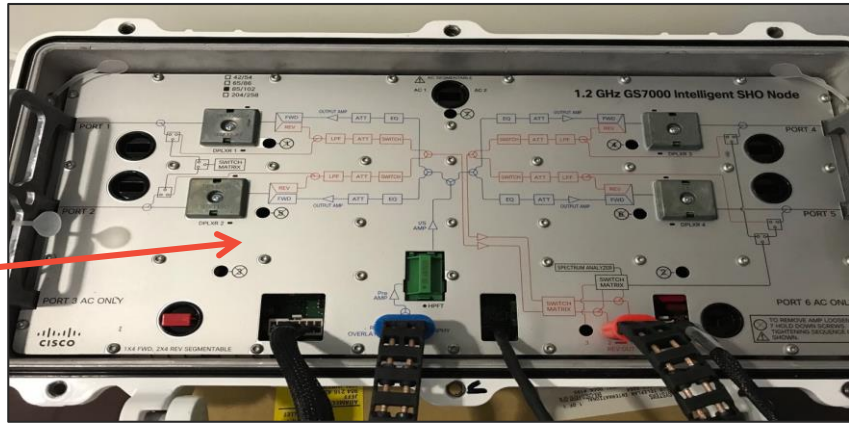
- Supports 2 Service Groups (2x2)
- Can only be used in 2x2 mode in a BAU GS7K node
- Designed for BAU deployment:
  - 384 MHz of narrowcast DS (e.g. 64 Annex B or or 48 Annex A/C SC-QAMs) per port
  - 1 OFDM channel up to 192 MHz
  - 96 QAMs of broadcast video to both DS ports & OOB support
  - 5 ATDMA US, 1x48 OFDMA per port
  - Video, 55-1 & 55-2 OOB, NDF/NDR

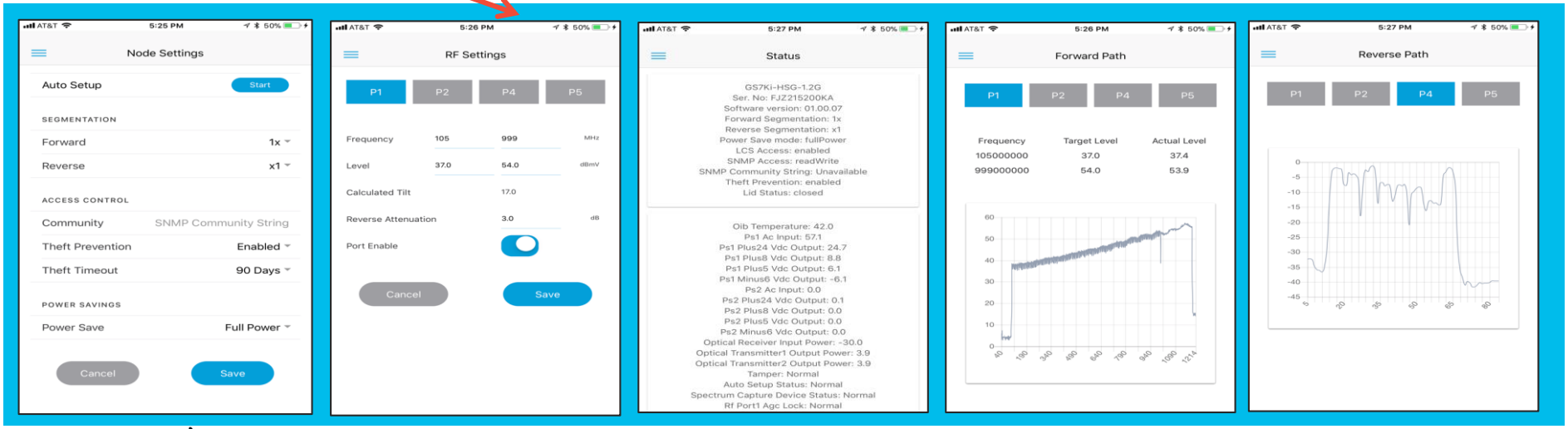
GS7000 Intelligent Node

GS7K iNode is a full-featured configurable node capable of touchless provisioning

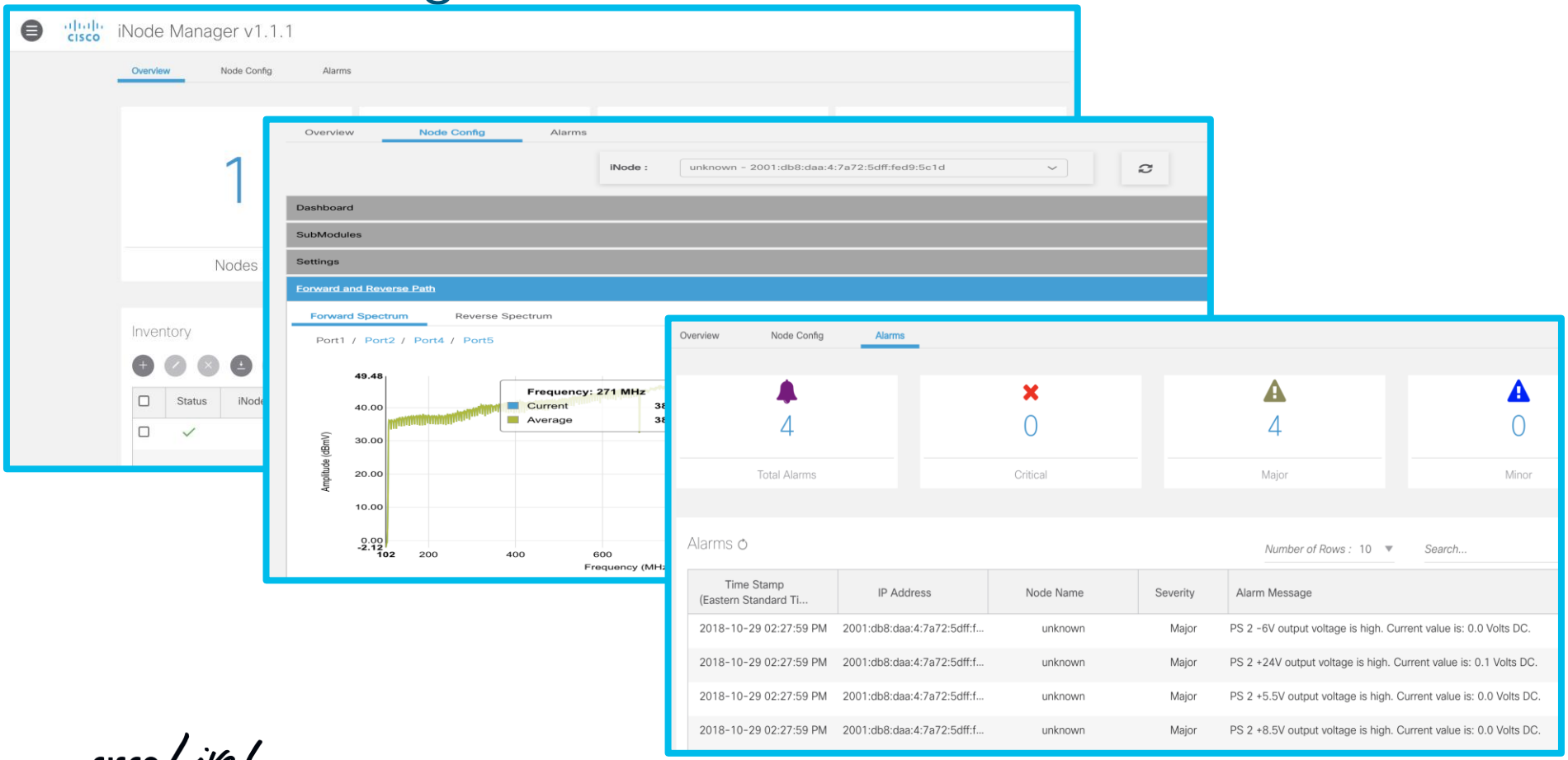
Streamlined setup (no pads, EQs, etc.)

Configure/Adjust/Measure parameters locally or remotely

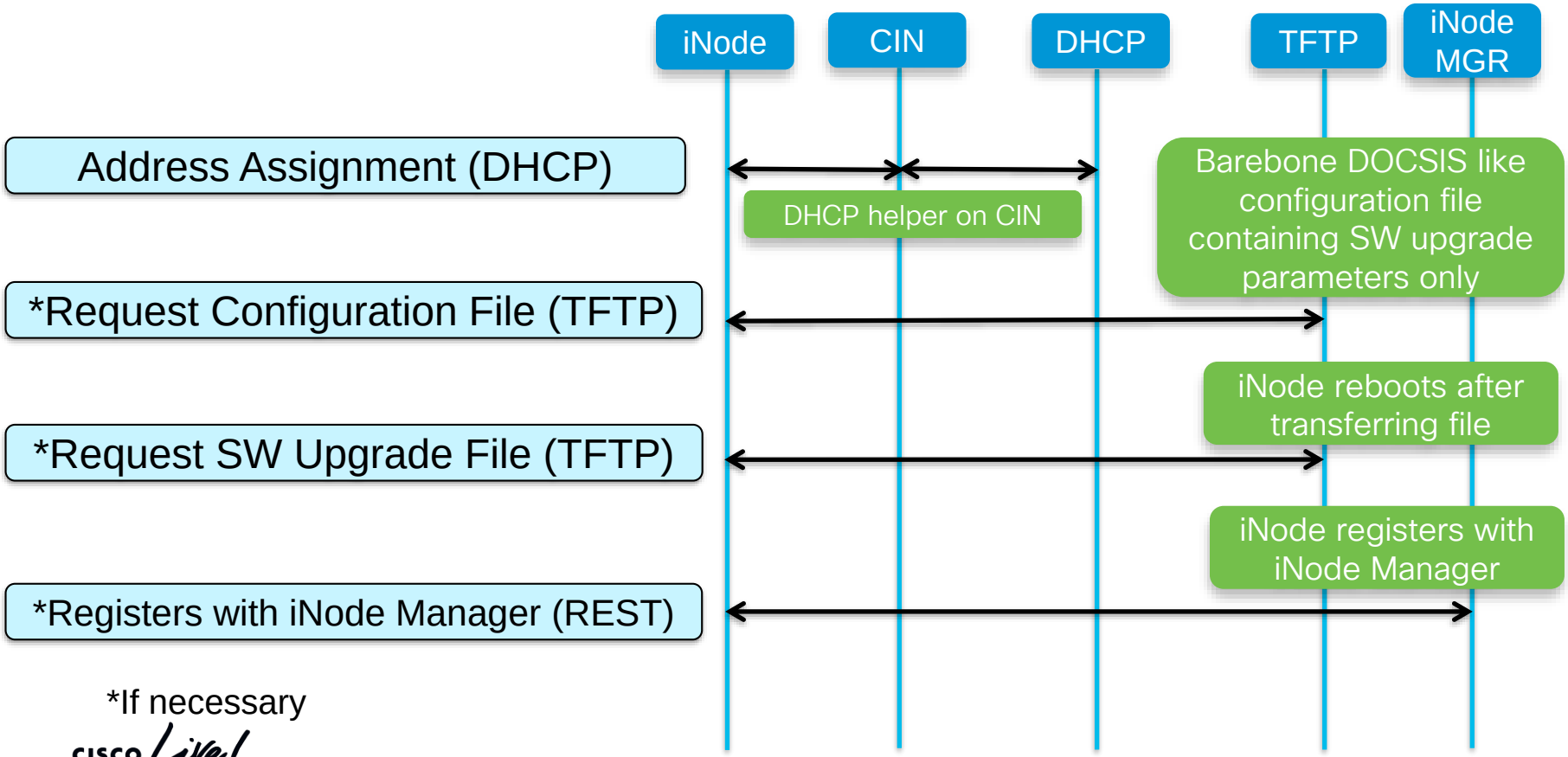




iNode Manager



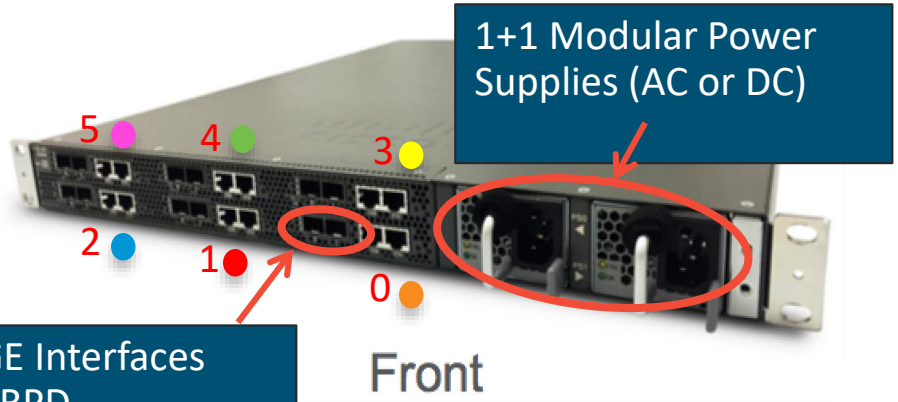
iNode Initialization



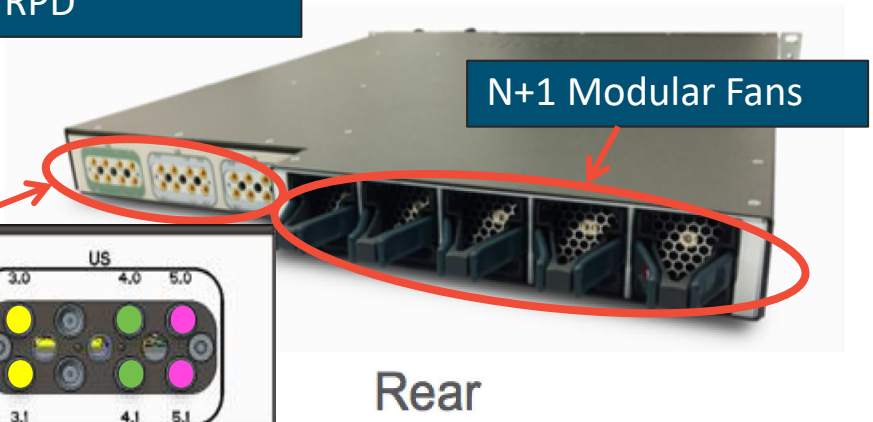
*If necessary

Compact (1RU) Remote PHY Shelf

- Remote PHY 600 – 6 (1x2) SG support
  Remote PHY 300 – 3 (1x2) SG support
- Packages 6 (or 3) 1x2 RPDs
- Total Power Budget:
  480W max
- Stackable for greater SG densities



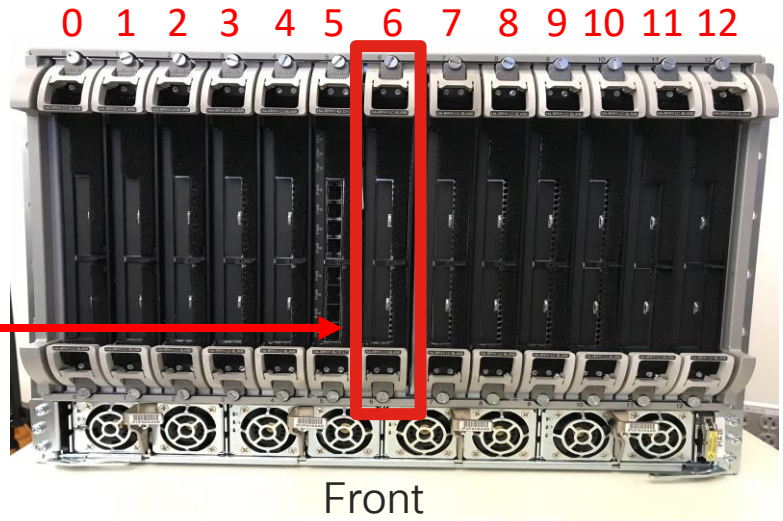
Pair of 10GE Interfaces (SFP+) per RPD



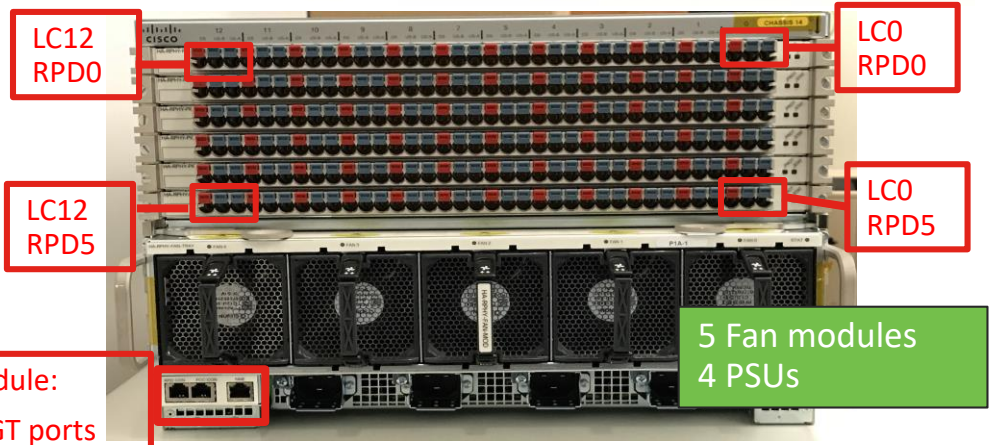
Similar UCH8 header blocks (1 DS & 2 US) as cBR-8 RF PIC

High Availability Shelf (Remote PHY 7200)

- 7RU, 19” rack mount chassis
- 13 linecards (12 active) – LC 6 is the protect
- Each LC has 8 SFP+ backhaul ports
- Each LC consists of 6 1x2 RPDs for a chassis capacity of 72 RPDs
- The back of the chassis has 6 RF PICs each supporting an eRPD from each front LC



Front

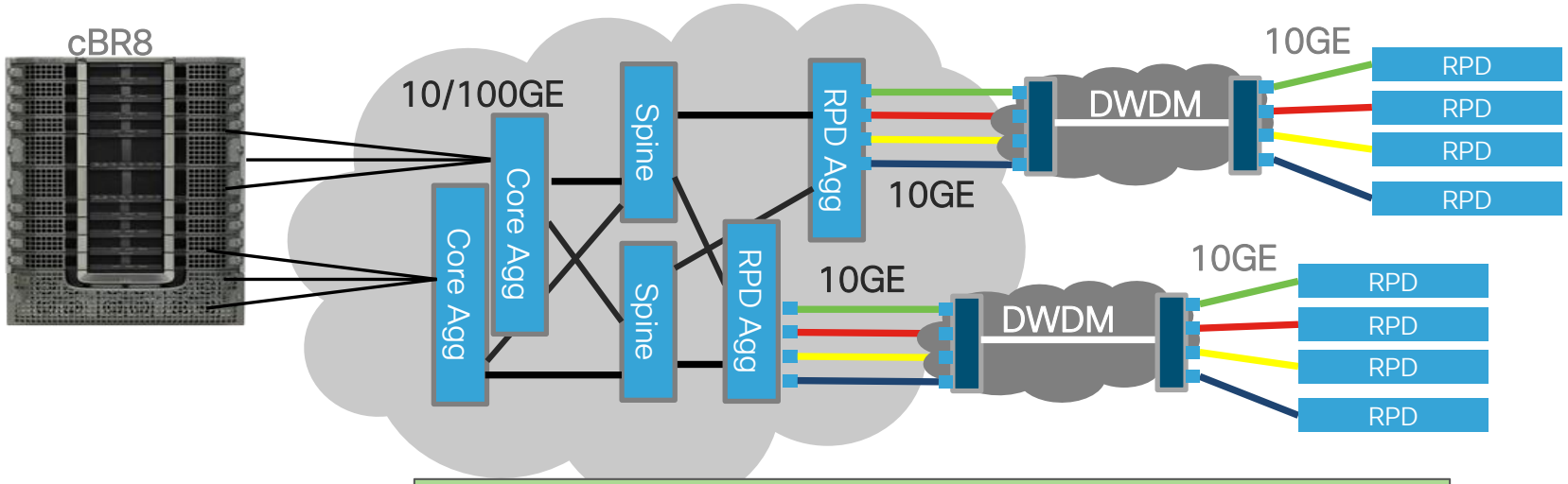


Rear

A few points about the RPHY 7200

- Supervisor-less design, no IOS
- Minimal configuration
  - login credentials
  - trunk/access mode
  - link redundancy mode
  - backhaul mapping
- No configuration required for LCHA other than revert behavior
- One PTP module per RPD LC; all 6 RPDs sync to this module
- 3 Link Redundancy modes: N/A, 6+2, 4+4 (global configuration)
- Embedded RPD (erpd) to backhaul port mappings are configurable

Converged Interconnect Network (CIN)



- High capacity / Low power?
- Optics used in CIN? DWDM support?
- Layer 3 or Layer 2? BVI, VRRP capabilities?
- Multicast Support? IPv6?
- PTP Support? CIN support for 802.1x? MACsec?
- CIN Provisioning? Automation capabilities?

NCS 5500 Product Family

- Modular and Fixed IOS-XR OS based platforms for high-scale WAN aggregation
- Flexible 10/25/40/100GE interface support
- Low power, high performance
- Automation, Telemetry, Programmability

NCS 55A1-24Q6H-S
24x1G/10G, 24x1G/10G/25G, 6x100G

NCS 540
24x10G + 2x100G

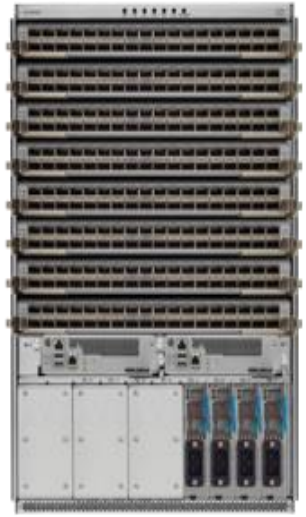
NCS 5501-SE
40x10G + 4x100G

RPD Aggregation, Services Leaf

NCS 55A1-36H
36x100G

NCS 5502-SE
48x100G

NCS 5504
3.6Tbps per slot
14.4 Tbps – 7 RU



NCS 5508
3.6Tbps per slot
28.8 Tbps – 13 RU

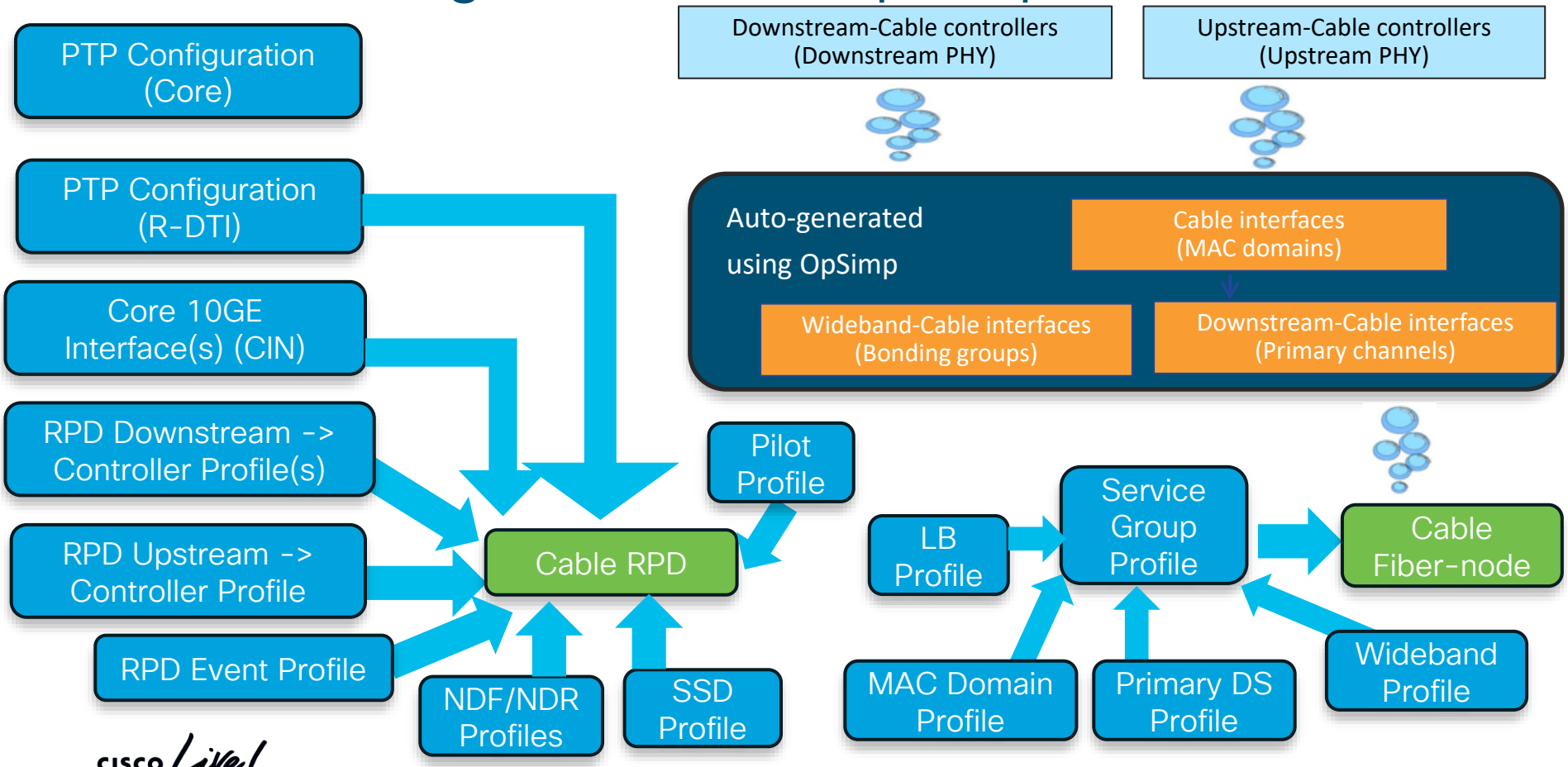
R-PHY Core, Spine

A few points about CIN design ...

- R-PHY demands “IP circuits” not just “IP paths”
- Path symmetry & latency stability are key
- Layer 3 preferred due to flexibility, scaling, well understood IGP/BGP control plane, resiliency, load balancing, ...
- If feasible use point-to-point subnets for each RPD versus bridge domains and integrated routing & bridging
- IS-IS recommended as IGP to carry CIN device loopbacks and BGP for RPD, DPIC, ..., subnets

R-PHY Implementation & Case Studies

R-PHY Configuration with OpSimp Flowchart



PTP & R-DTI Configuration

```
ptp clock boundary domain 44
 servo tracking-type R-DTI
 clock-port slave-from-GM1 profile g8275.2 local-
priority 80
  delay-req interval -5
  sync interval -5
  sync one-step
  transport ipv6 unicast interface Lo0 negotiation
  clock source 2001:DB8::1588
 clock-port slave-from-GM2 profile g8275.2
  delay-req interval -5
  sync interval -5
  sync one-step
  transport ipv6 unicast interface Lo0 negotiation
  clock source 2001:DB8:1:1588
```

- The “servo ..” configuration allows the cBR-8 clock to synch much faster
- Ensure the cBR-8 loopback has IP connectivity to the clock source
- The ”clock source” addresses could be from Grand Master or Boundary Clocks

- Ensure the domain number matches with the cBR-8 PTP configuration
- The “clock source” address(es) could be from Boundary Clock(s)

```
ptp r-dti 1
 ptp-domain 44
 clock-port 1
  transport ipv6
  clock source ipv6 2001:DB8::1588
  clock source ipv6 2001:DB8:1:1588 alternate
  transport dscp 46
  sync interval -4
  delay-req interval -4
```

MAC Domain (MD) Splitting

MD Splitting is when multiple fiber nodes share DS channels but use unique US channels

```
cable profile service-group 32x4_mdsplit
 cable bundle 1
 mac-domain 0 profile MD1
  downstream sg-channel 0 8 16 24 profile DS1
  upstream 0 sg-channel 0
  upstream 1 sg-channel 1
  upstream 2 sg-channel 2
  upstream 3 sg-channel 3
  upstream 4 sg-channel 4
  upstream 5 sg-channel 5
  upstream 6 sg-channel 6
  upstream 7 sg-channel 7
  us-bonding-group 1
   upstream 0
   upstream 1
   upstream 2
   upstream 3
  us-bonding-group 2
   upstream 4
   upstream 5
   upstream 6
   upstream 7
```

Requires distinct US channels for each fiber node defined in the SG profile

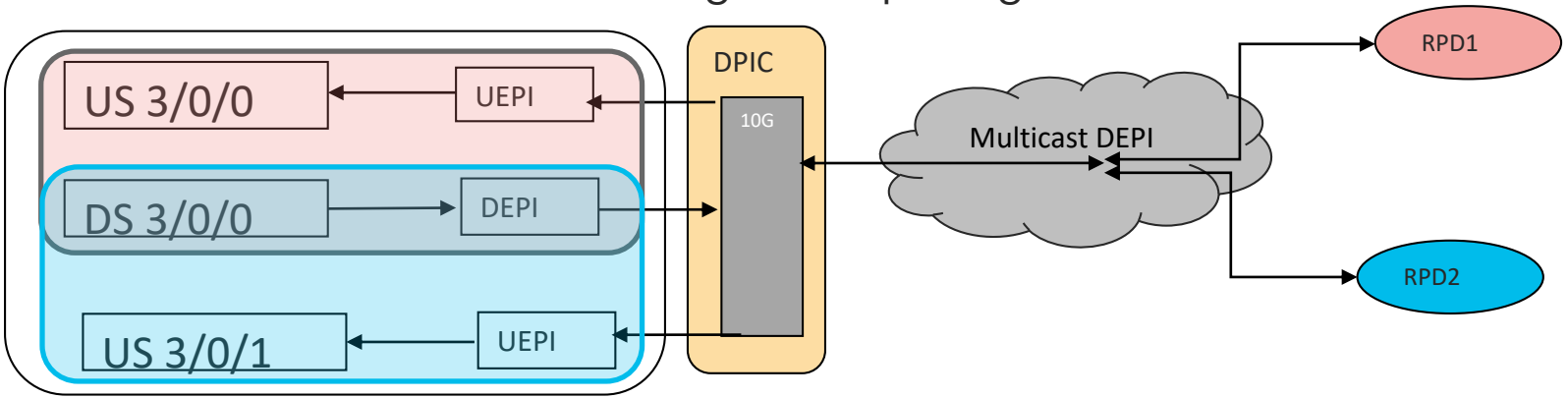
```
cable fiber-node 3
 downstream Downstream-Cable 9/0/0
 upstream Upstream-Cable 9/0/0
 downstream sg-channel 0 downstream-Cable 9/0/0 rf-channel 0
 downstream sg-channel 8 downstream-Cable 9/0/0 rf-channel 8
 downstream sg-channel 16 downstream-Cable 9/0/0 rf-channel 16
 downstream sg-channel 24 downstream-Cable 9/0/0 rf-channel 24
 upstream sg-channel 0 3 Upstream-Cable 9/0/0 us-channel 0 3
 upstream sg-channel 4 7 peer-node-us
 service-group managed md 0 Cable 9/0/0
 service-group profile 32x4_mdsplit

cable fiber-node 5
 downstream Downstream-Cable 9/0/0
 upstream Upstream-Cable 9/0/1
 downstream sg-channel 0 downstream-Cable 9/0/0 rf-channel 0
 downstream sg-channel 8 downstream-Cable 9/0/0 rf-channel 8
 downstream sg-channel 16 downstream-Cable 9/0/0 rf-channel 16
 downstream sg-channel 24 downstream-Cable 9/0/0 rf-channel 24
 upstream sg-channel 4 7 Upstream-Cable 9/0/1 us-channel 0 3
 upstream sg-channel 0 3 peer-node-us
 service-group managed md 0 Cable 9/0/0
 service-group profile 32x4_mdsplit
```

Association between fiber nodes must be defined

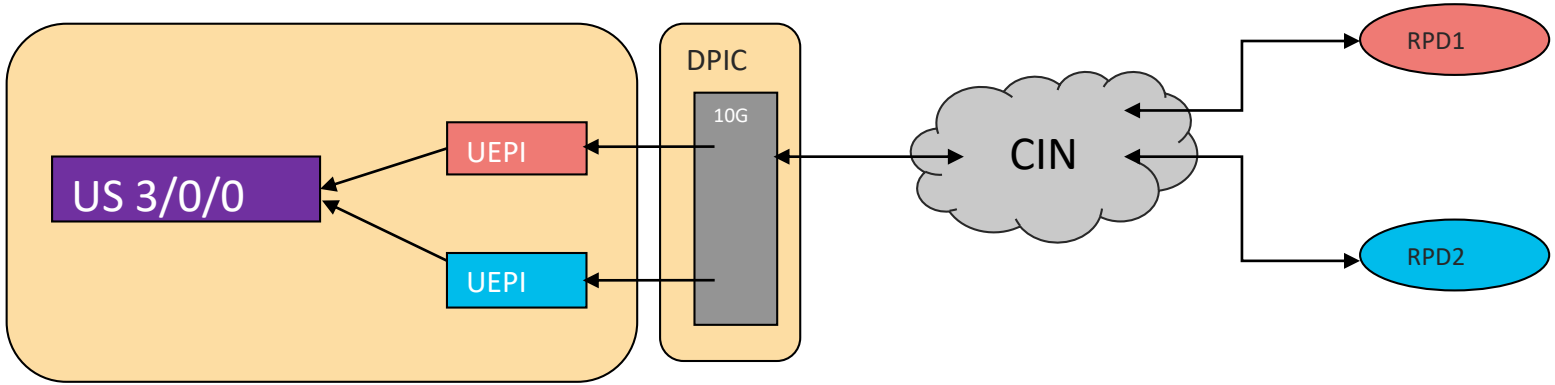
Downstream Virtual Splitting

- Does it make sense to dedicate Downstream Channels per RPD?
  - As fiber moves deeper the number of subs per node decreases
  - Inefficient use of CCAP core MAC layer resources
- Solution: DS Virtual Splitting via Multicast DEPI
- Recommendation is on average 4:1 splitting max



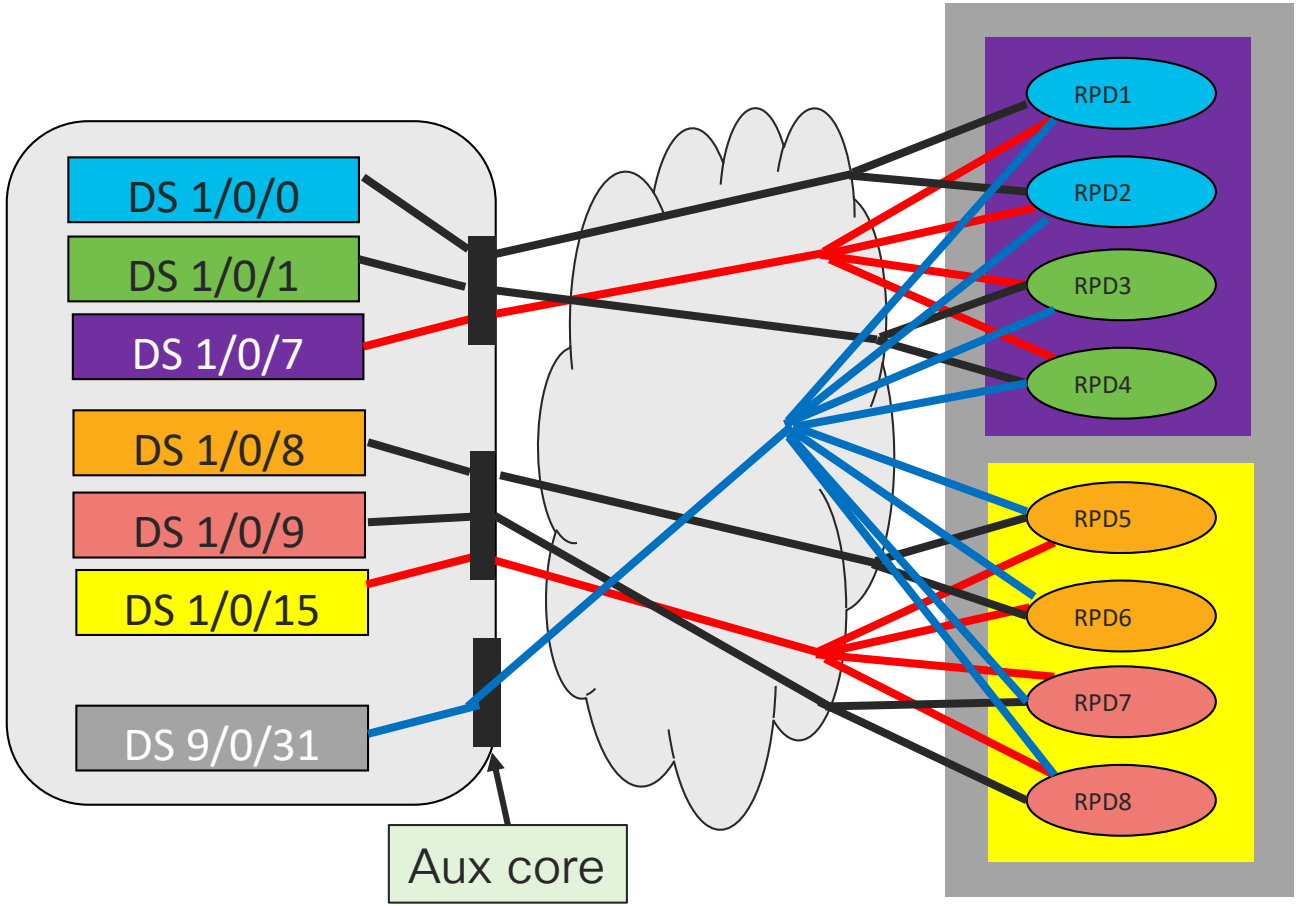
Upstream Virtual Combining

- Virtual Combining is the complimentary upstream feature to DS Splitting
- Multiple RPDs US ports are combined/shared by the same US controller MAC resources on the cBR-8
- cBR-8 MAC scheduler treats cable modems across these RPDs as if they were on common physical upstream channels



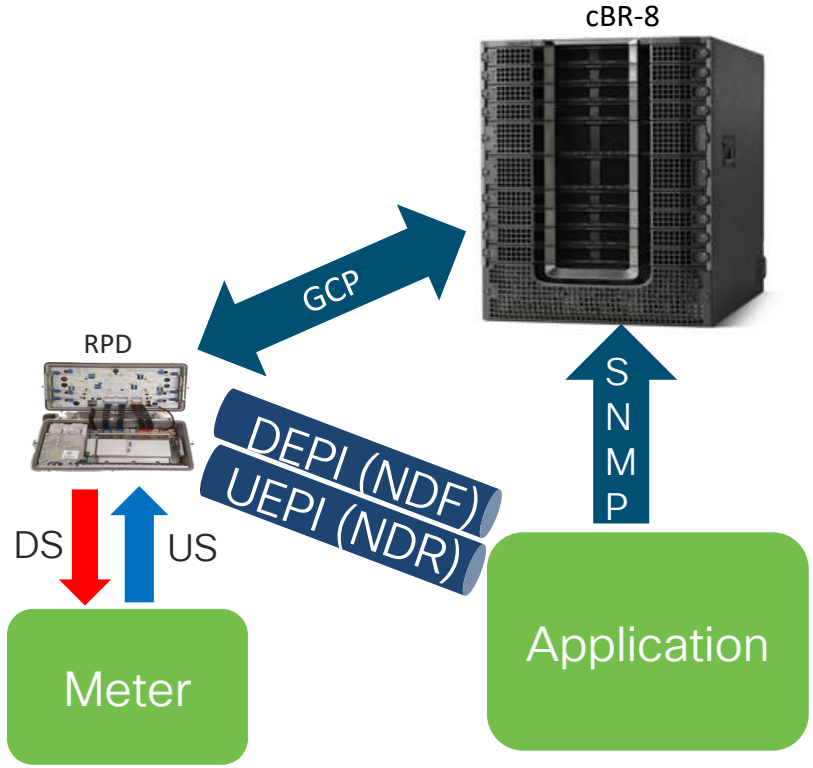
R-PHY Video & Auxiliary Cores

- With VS/VC DOCSIS SGs with 2 RPDs each
- 2 Narrowcast Video SGs with 4 RPDs each
- 1 Broadcast Video SG with 8 RPDs



NDF/NDR

- Narrowband Digital Forward/Return digitizes an analog portion of the spectrum and encapsulates it in DEPI/UEPI to support services such as FM Broadcast, Forward/Reverse Sweep, DS Leakage, Upstream Triggered Spectrum Capture, etc.
- NDF/NDR channels defined by channel width & center frequency
- DEPI/UEPI PWs statically defined



Pilot Tones

- The RPD supports generation of the following signals
  - CW alignment tones
  - CW carrier for legacy leakage detectors
  - Proprietary leakage test signals
  - CW carriers for AGC pilots
- Tones for AGC are usually 6 dBc higher than a general QAM channel

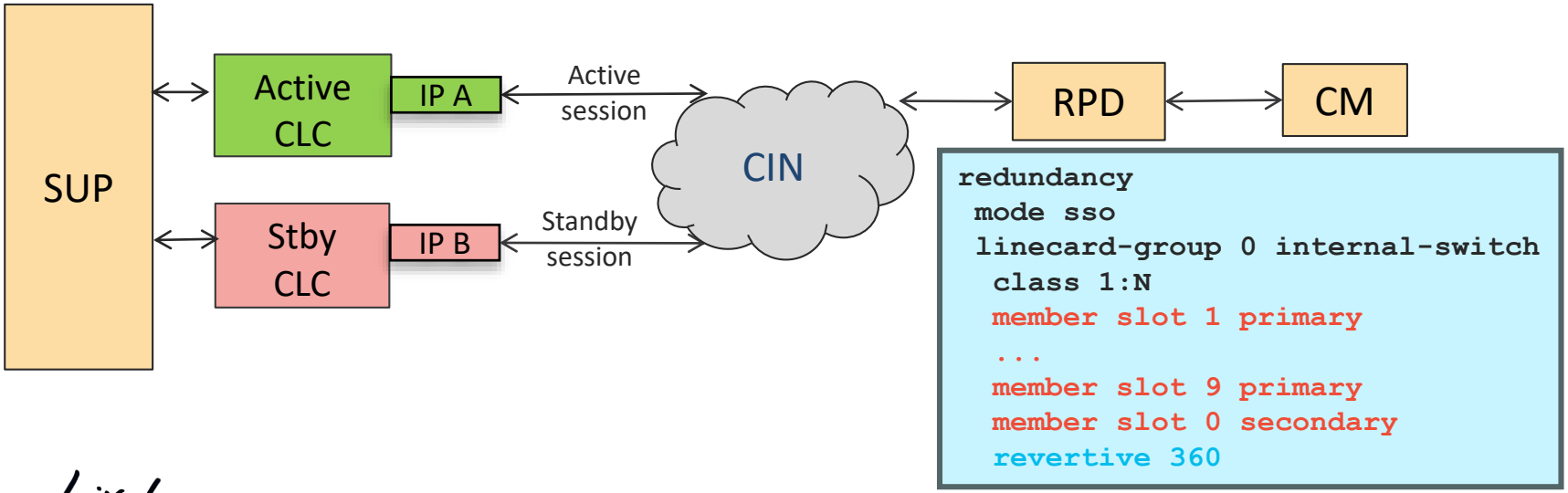
```
cable rpd RPD03
 description RPD03
 identifier 78bc.1a1f.a3fc
 rpd-ds 0 downstream-pilot-tone profile 1
 core-interface Te1/1/0
  rpd-ds 0 downstream-cable 1/0/15 profile 10
 core-interface Te1/1/4
  principal
  rpd-ds 0 downstream-cable 1/0/16 profile 1
  rpd-us 1 upstream-cable 1/0/2 profile 1
  rpd-ds 0 static-pseudowire NDF profile 1
  rpd-us 1 static-pseudowire NDF profile 1
 r-dti 3
 rpd-event profile 0
 ssd 1
 rpd-55d1-us-event profile 0
```

Line Card High Availability (LCHA)

RPDs connect to both the active LC and standby LC DPICs

Establish “active” and “standby” GCP and DEPI/UEPI sessions

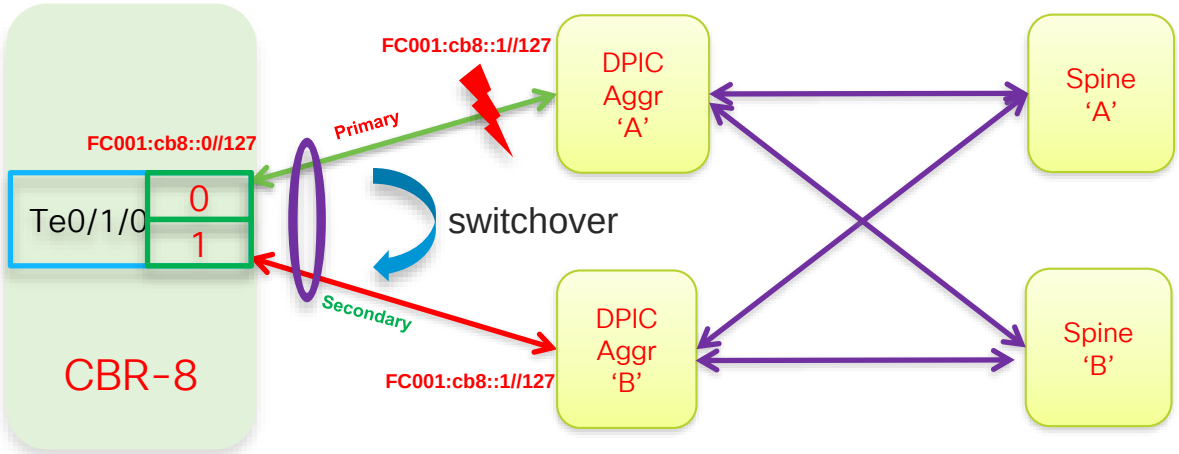
Core signals the RPD to switch-over its active connection




```
redundancy
 mode sso
 linecard-group 0 internal-switch
  class 1:N
  member slot 1 primary
  ...
  member slot 9 primary
  member slot 0 secondary
  revertive 360
```

DPIC Link High Availability

- DPIC link HA is disabled by default and is enabled globally in either hot or cold mode
- If enabled adjacent DPIC ports share the same MAC & IP
- Cold mode is recommended for layer 3 CINs where the standby transceiver is off
- Both upstream CIN interfaces should configure the same MAC and IP. Otherwise it will take seconds to refresh arp or ipv6 neighbors. The traffic loss time will be longer.



DEPI Latency Measurement (DLM)

- Measurement of the CIN latency between the CCAP Core and RPD enabling the DOCSIS scheduler to accurately adjust MAP advance

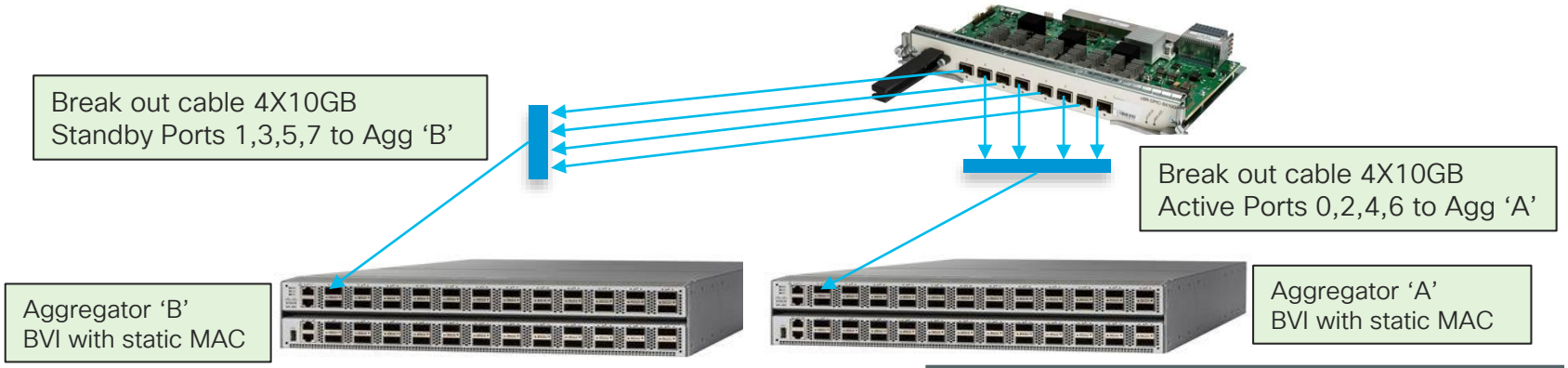
CCAP Core places current 32-bit DTI Timestamp the DOCSIS Timestamp Start field

RPD inserts DTI timestamp (T2) in the DOCSIS Timestamp End field

```
cable rpd GS7K-LWR
 description remote RPD
 identifier badb.ad13.1476
 core-interface Te1/1/2
  principal
  rpd-ds 0 downstream-cable 1/0/5 profile 2
  rpd-us 0 upstream-cable 1/0/5 profile 1
  network-delay dlm 1
 r-dti 2
 rpd-event profile 0
```

```
[no] network-delay dlm [interval in secs] {measure-only}
```

DPIC to NCS Connectivity

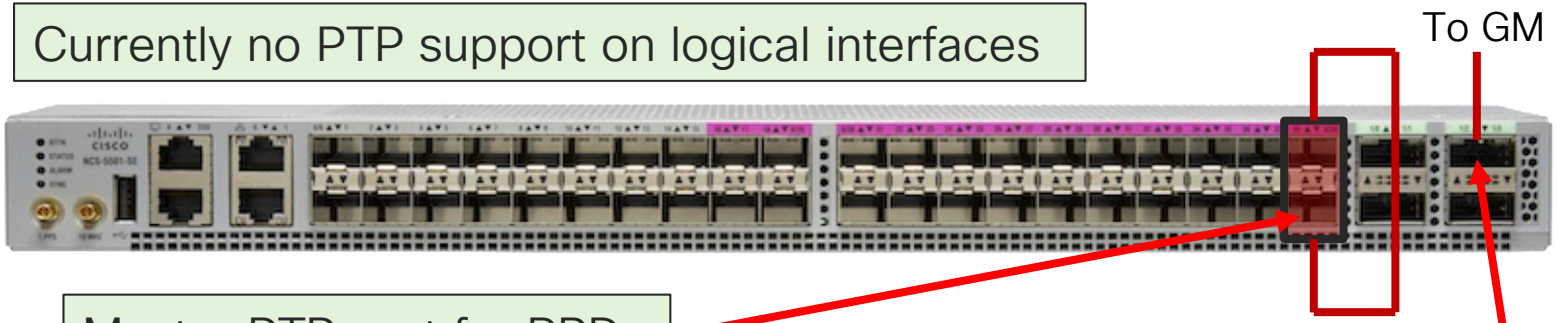



```
interface TenGigE0/0/0/0/0
 description DPIC0/0/0
 l2transport
!
interface BVI10
 description DPIC010
 ipv6 address fc00:0:302::3d/127
 ipv6 enable
 mac-address 10.583.7c4
!
```

```
l2vpn
 bridge group DPICs
  bridge-domain DPIC010
   interface TenGigE0/0/0/0
    !
   routed interface BVI1
   !
  bridge-domain DPIC012
   interface TenGigE0/0/0/1
    !
   routed interface BVI2
   !
...
```

NCS Boundary Clock Operation

Currently no PTP support on logical interfaces



Master PTP port for RPDs

```
interface TenGigE0/0/0/38
 description PTP loopback
  ipv6 address 2001:0500::FE/127
!
interface TenGigE0/0/0/39
 description PTP loopback-vrf
 ptp
  profile g82752_master_v6
 vrf forwarding ptp-loopback
 ipv6 address 2001:0500::FF/127
```

Slave PTP port towards GM

```
interface HundredGigE0/0/1/2.1000
 ptp
  profile g8275_2_slave_v6
  master ipv6 fc00:0:202:1::2
   priority 200
  !
 !
 vrf ptp-gm2
 ipv6 address fc00:0:302::83/127
 ipv6 enable
 encapsulation dot1q 1000
```

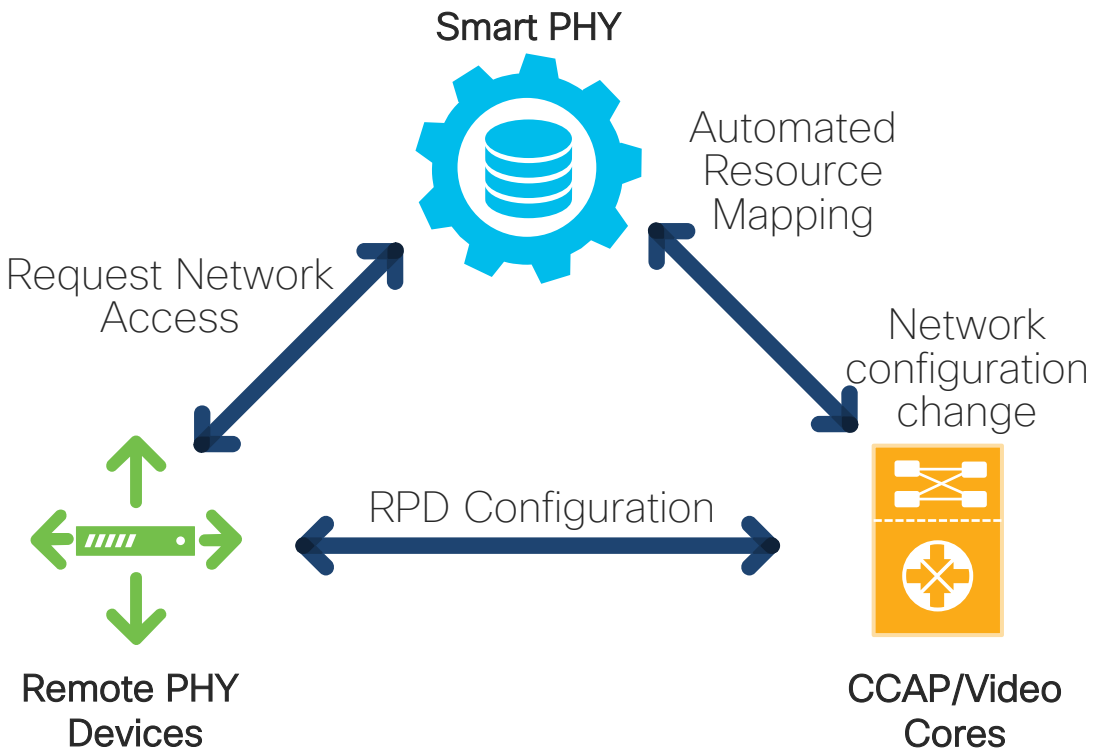
CIN QoS Markings

Traffic	Per-Hop-Behavior (PHB)	DSCP Value
DOCSIS data (L2TP)	Best Effort	0
PTP	Expediated Forwarding (EF)	46
GCP	Best Effort	0
MAP/UCD (L2TP)	EF	46
BWR and RNG-REQ	EF	46
Video	CS4	32
MDD (L2TP), voice	CS5	40

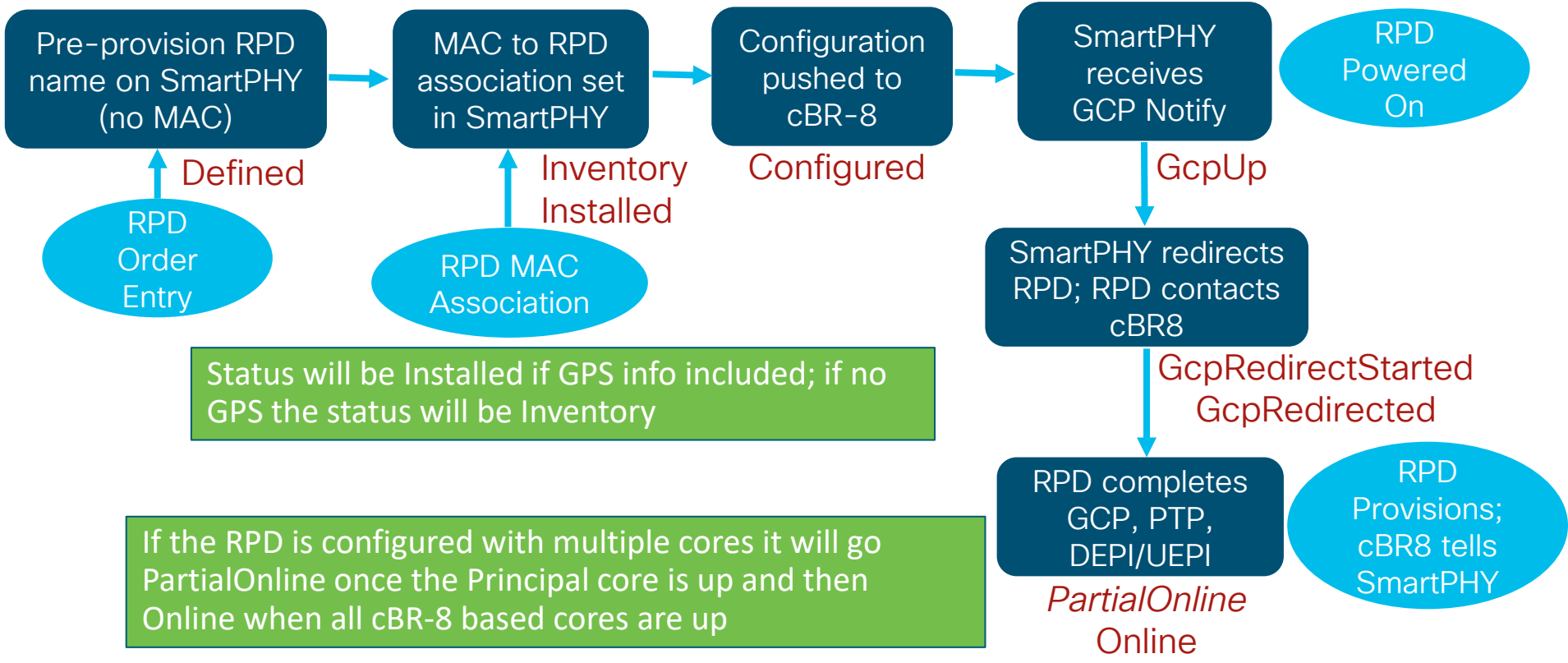
Remote PHY Automation

Smart PHY – RPD Deployment Automation

- **Deployment Simplified**
  - Resource Selection
  - DOCSIS & Video
  - cBR-8 and RPD orchestration
- **Unified Provisioning**
  - Common DHCP Policy
  - Flexible RPD to SG mapping without managing one-offs
- **Cloud Native Platform**
  - Common Infrastructure
  - API-Centric Design
- **Advanced Monitoring & Troubleshooting**



SmartPHY RPD States



RPD Initialization with Smart PHY

802.1x Authentication (Optional)

Address Assignment (DHCP)

Time of Day (ToD)

Mutual Authentication (Optional)

GCP Session to Smart PHY

GCP Redirect to Principal Core

Mutual Authentication (Optional)

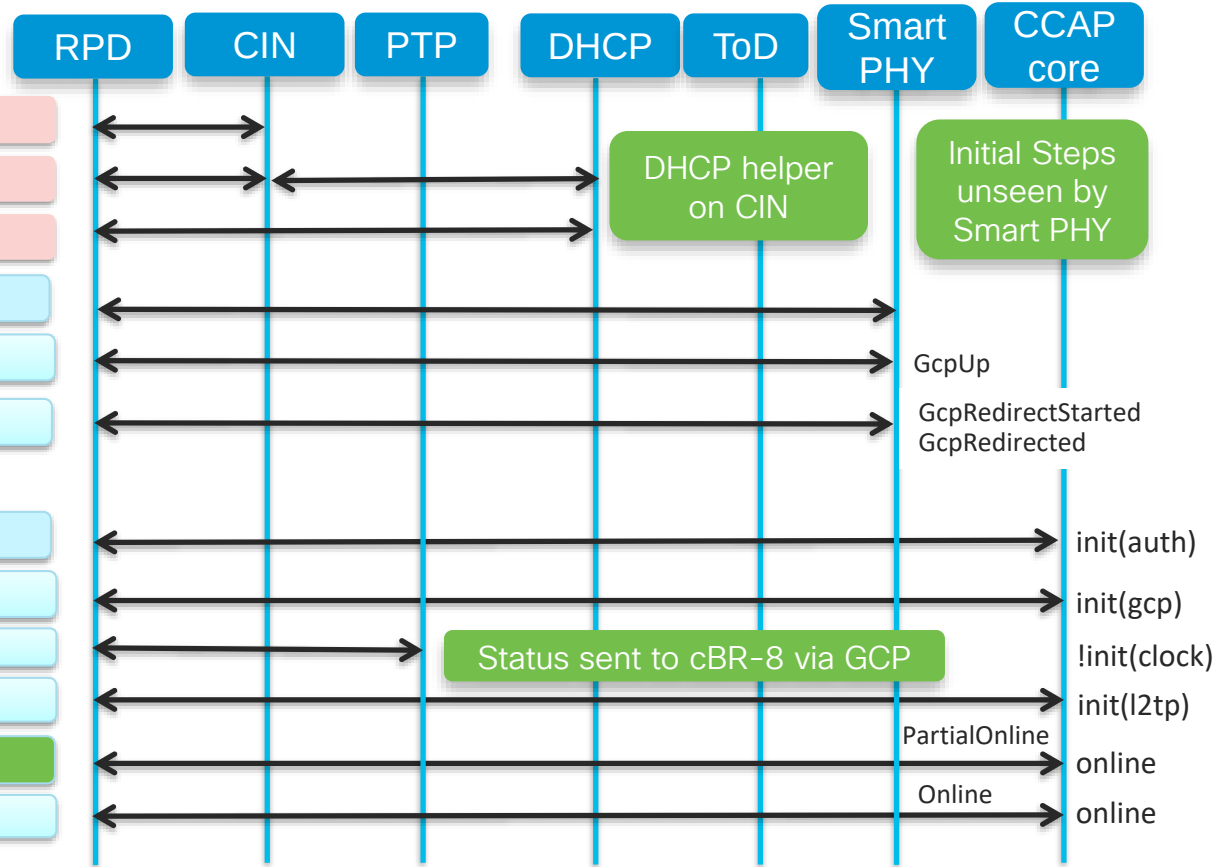
GCP Session to Principal Core

PTP Timing Synchronization

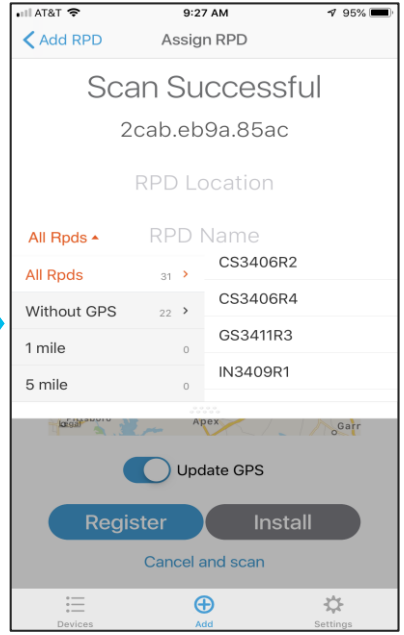
DEPI & UEPI Establishment

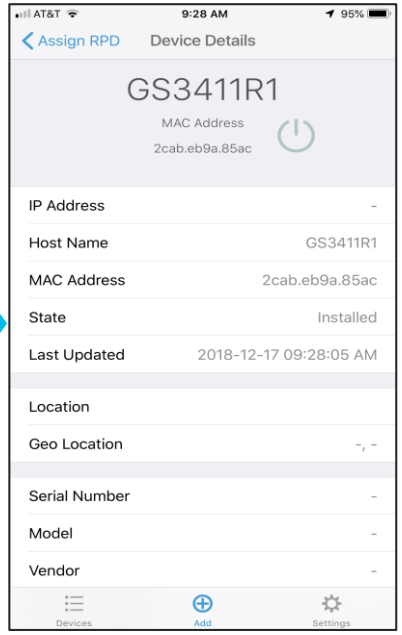
Operational with Principal Core

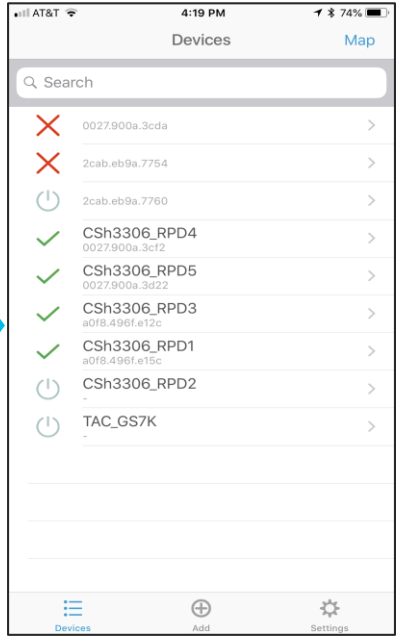
Auxiliary Core (Optional)



Smart Phone Application

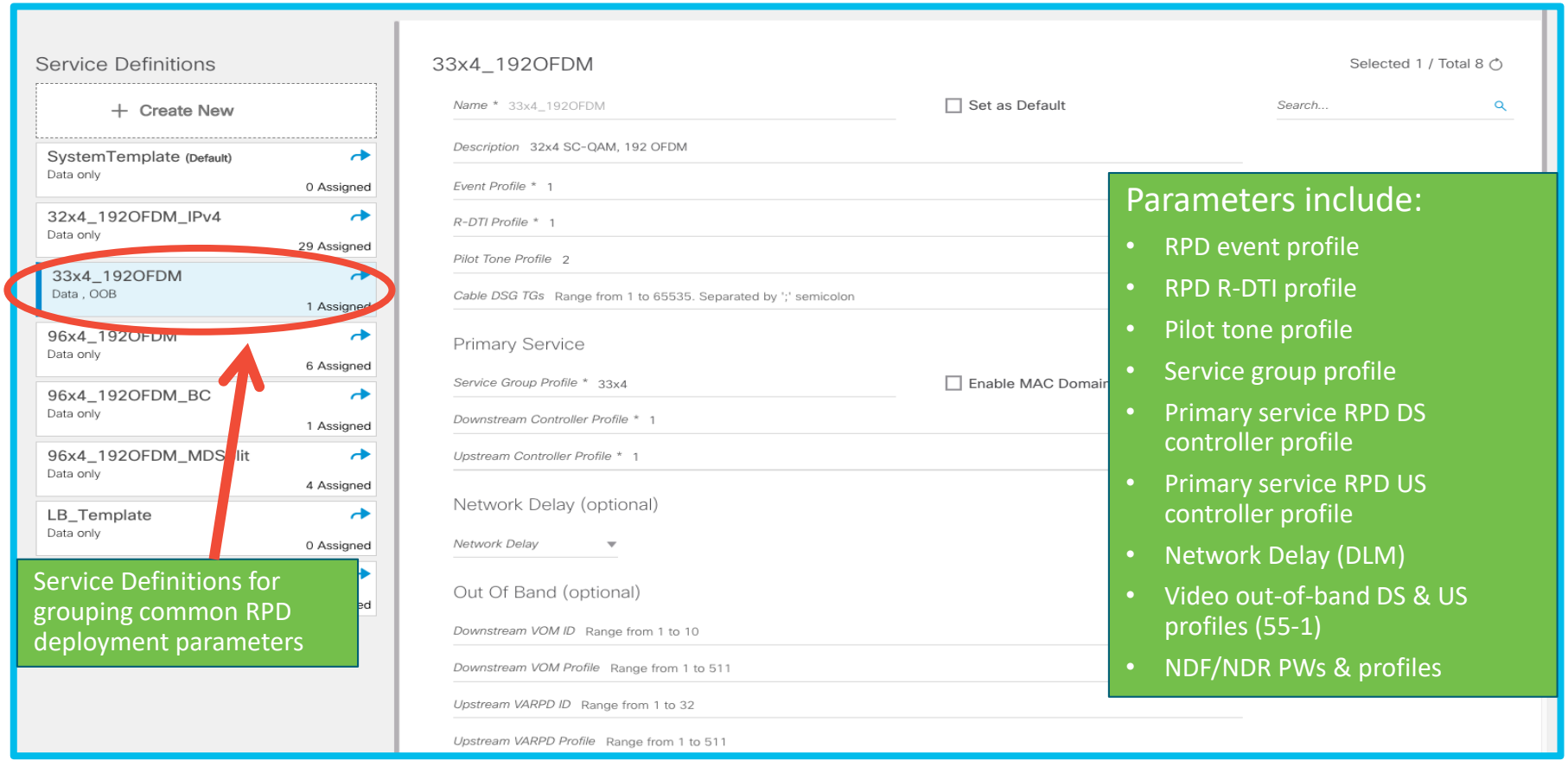




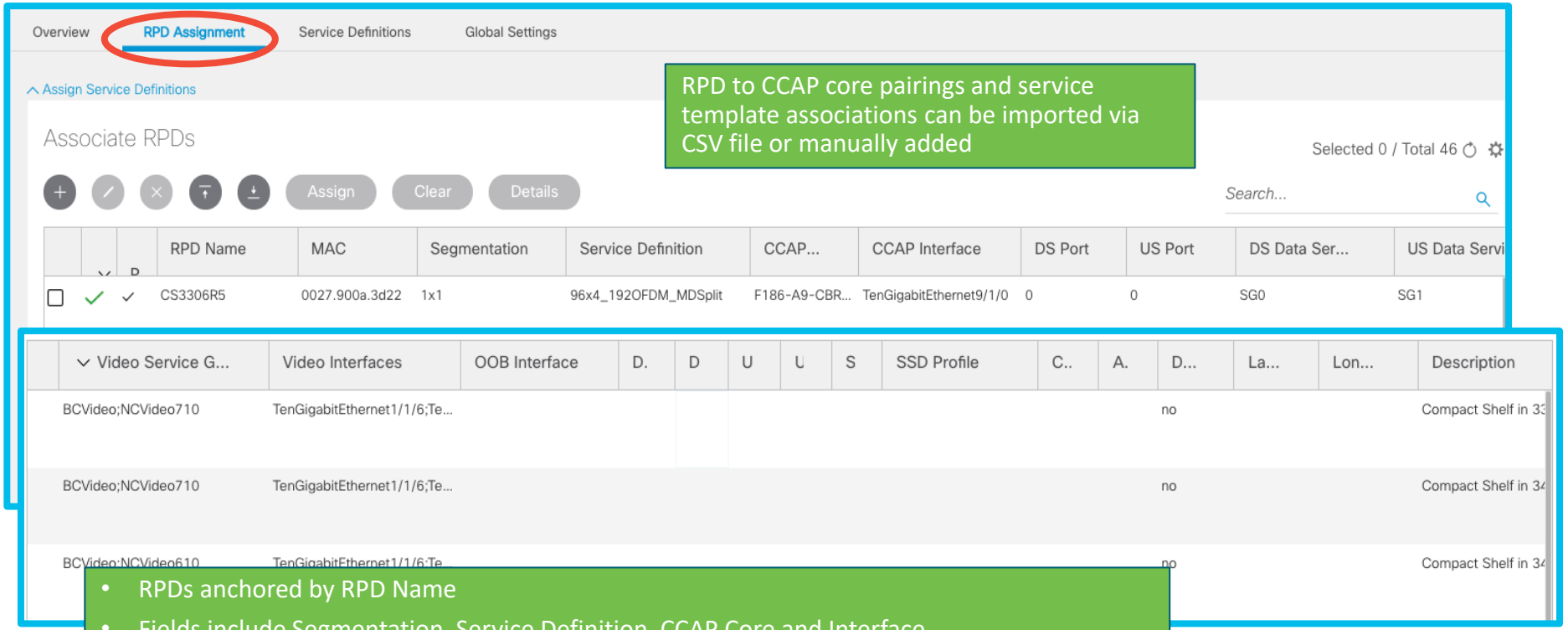


- RPD bar codes can be scanned via the Smart Phone App to automatically add the RPDs to the Smart PHY inventory
- Can also include the phone's GPS coordinates to automatically populate the RPD's location
- App can be used for both staging and installation workflows

Smart PHY Service Definition

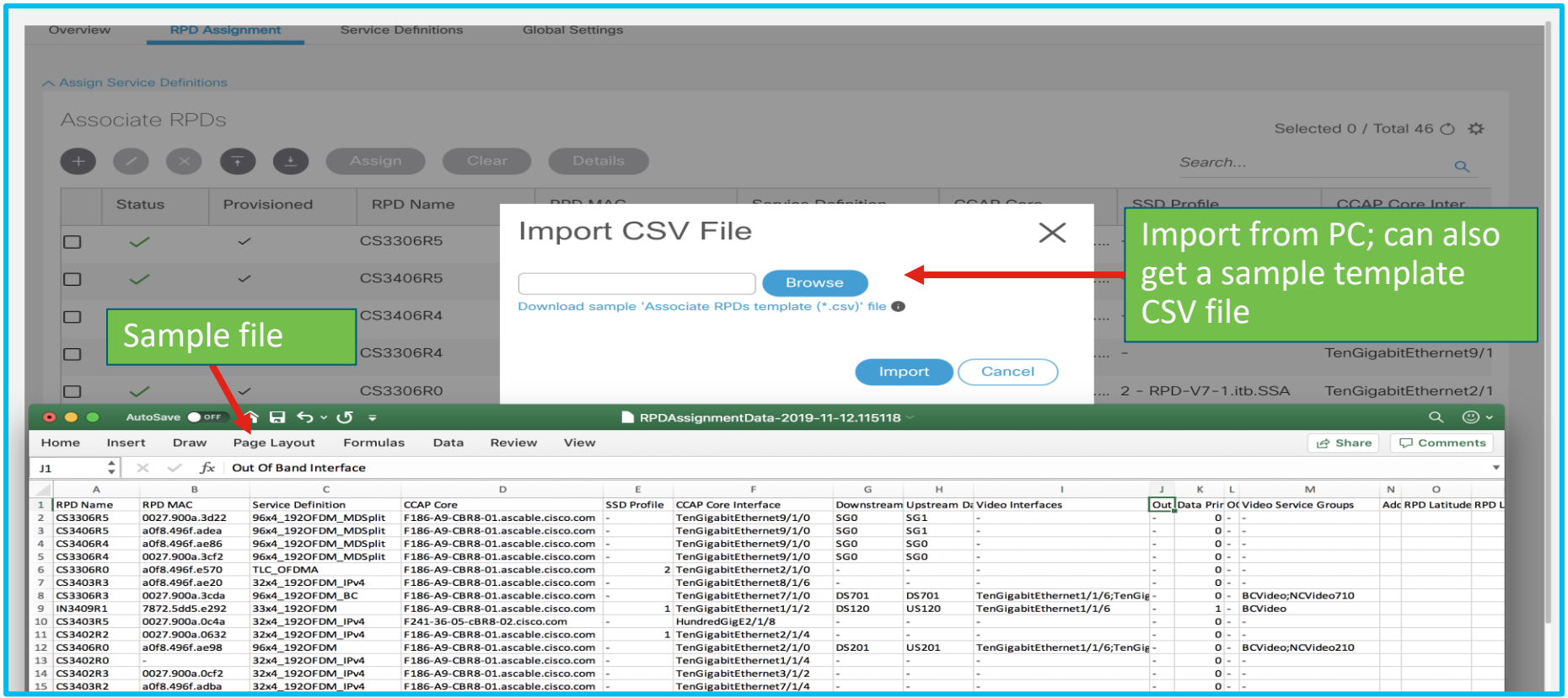


Smart PHY RPD Assignment



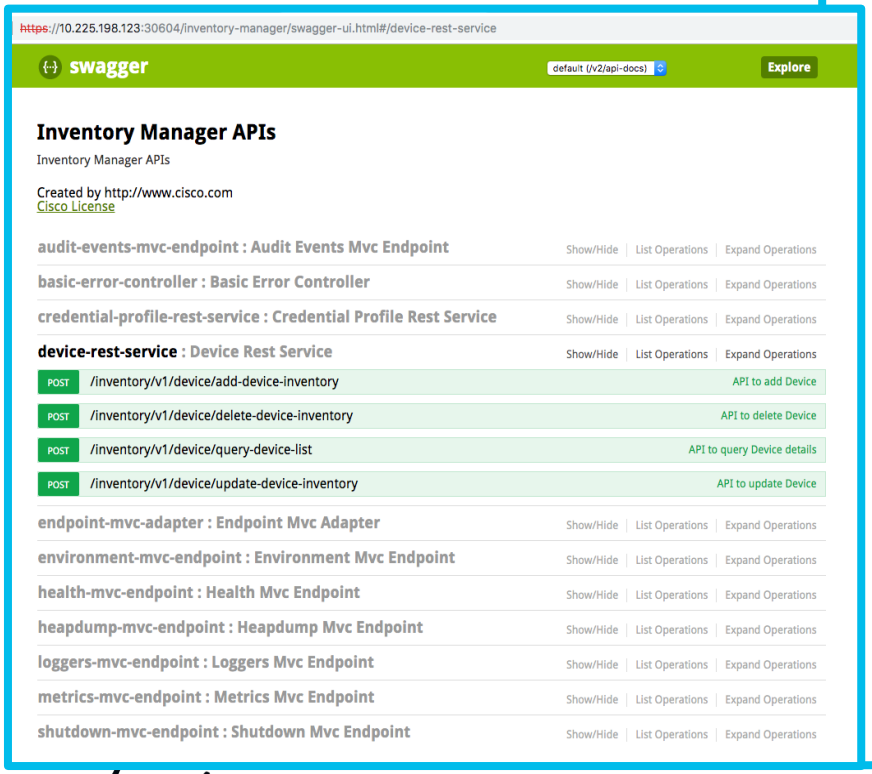
- RPDs anchored by RPD Name
- Fields include Segmentation, Service Definition, CCAP Core and Interface
- Data Service Group fields used to indicate Virtual Splitting & Combining
- Video Service Groups & Interfaces

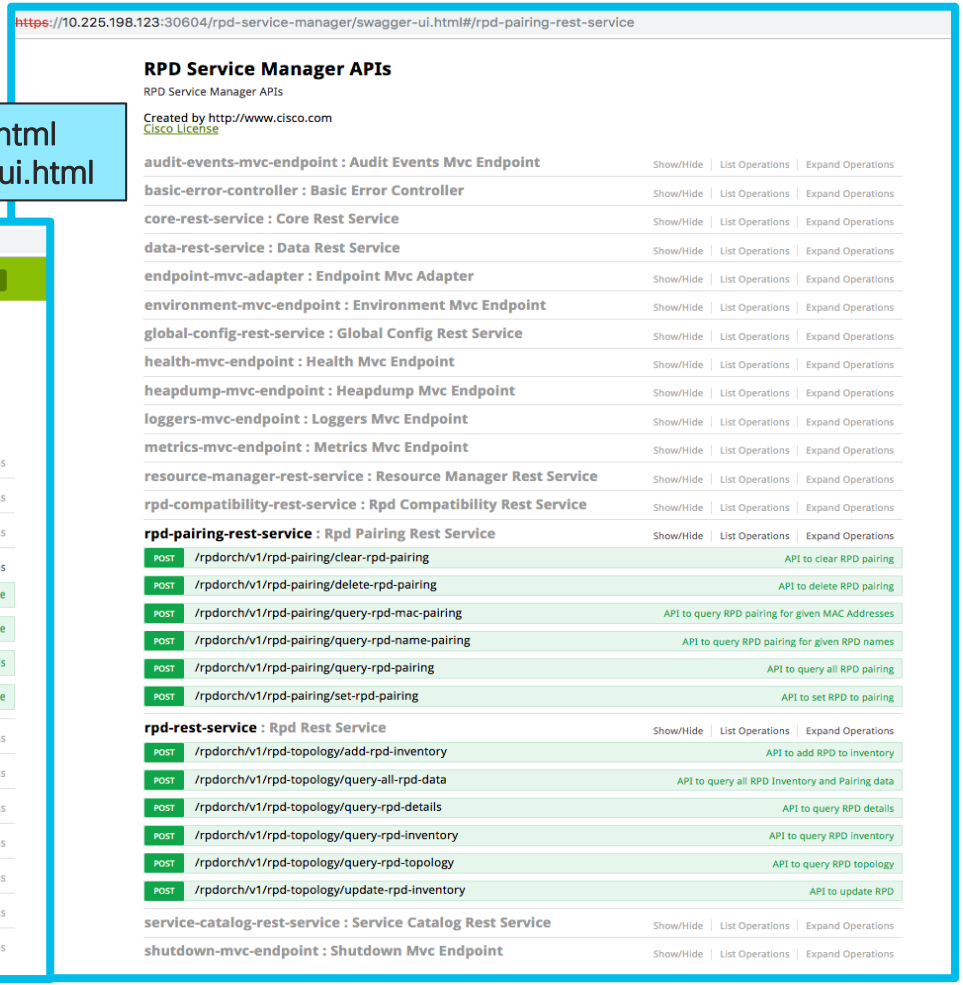
Importing RPDs



Smart PHY REST APIs

https://<SPHY IP>:30604/inventory-manager/swagger-ui.html
https://<SPHY IP>:30604/rpd-service-manager/swagger-ui.html





API Example #1 using CURL

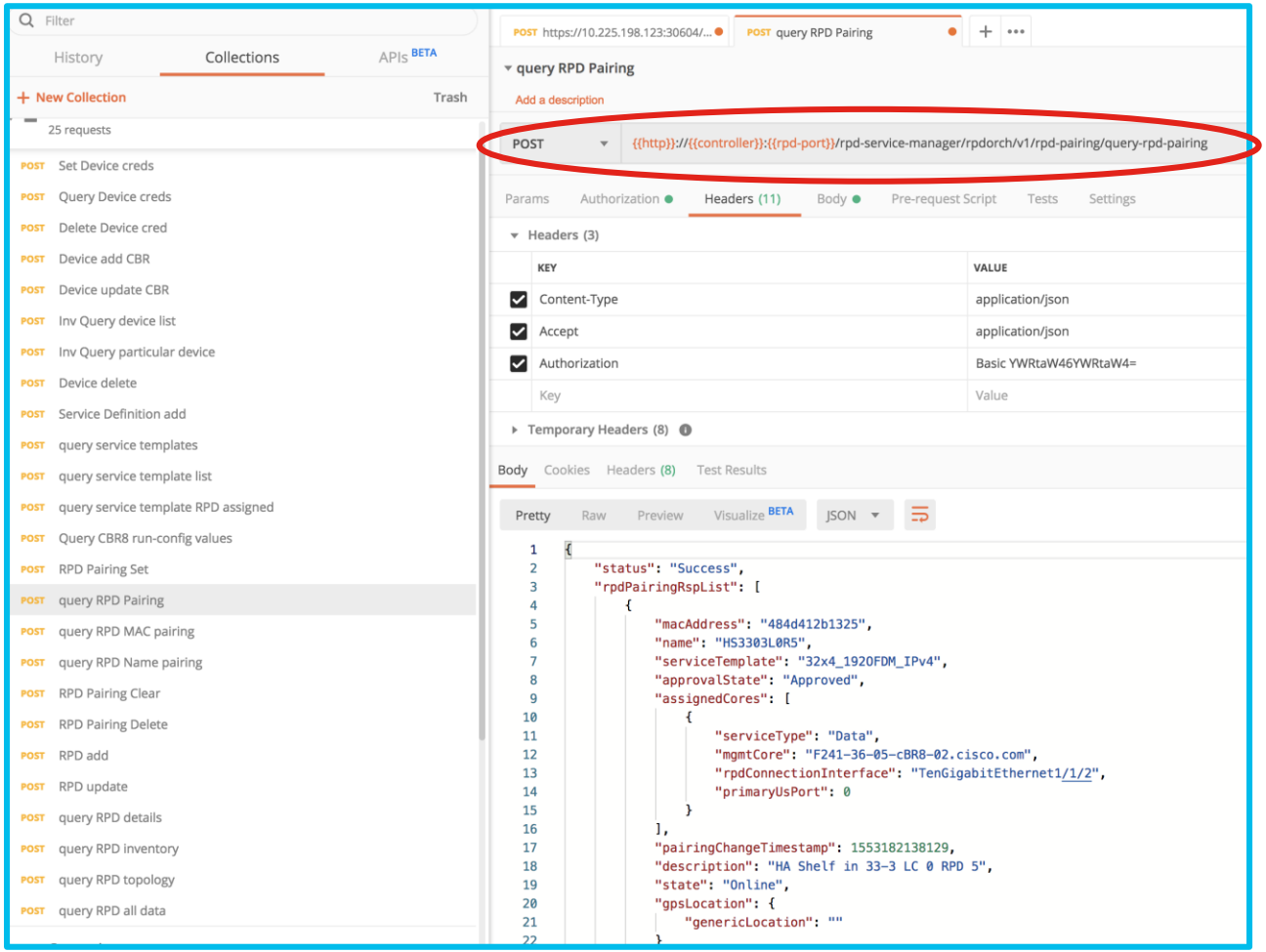
```
curl 'https://10.225.198.123:30604/inventory-
manager/inventory/v1/device/query-device-list'  -k -H 'Authorization:
Basic YWRtaW46U21AcnQ3Nzc=' -H 'Content-Type: application/json' -H
'Accept: application/json, text/plain,
data-binary '{}'

{"status":"Success","nextFrom":null,"de
00A3D22","deviceKeyType":"MACADDRESS","state":"ONLINE","stateChangeTi
mestamp":1573166774039,"macAddress":"0027900A3D22","ipAddressList":["
2001:db8:daa:9:227:90ff:fe0a:3d22"],"uuid":"_DEVICE_0027900A3D22","gp
sLocation":{"genericLocation":""},"hostName":"CS3306R5","description"
:"Compact Shelf in 33-6 RPD 5","productType":"RPHYSHELF-
CHASS","deviceInfo":{"serialNumber":"CAT2147E0JA","hwVersion":"1.0","
swVersion":"v6.6","bootRomVersion":null,"modelNumber":"
```

Base64 encrypted form of password
https://www.base64encode.org/
username:password
click encode

Postman

- Postman is a Collaboration Platform for API Development https://www.getpostman.com/
- Can be used to test Smart PHY APIs using API and environment variable libraries



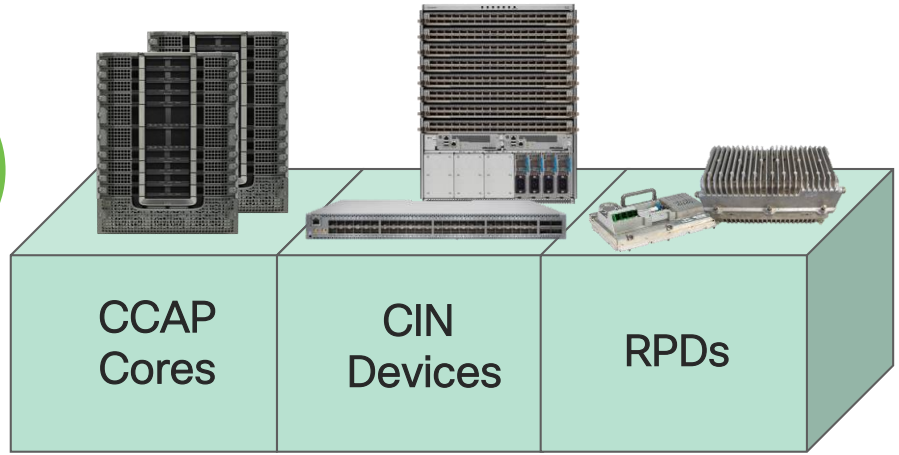
Automation Use Case Examples

CCAP & CIN Onboarding

Service Addition / Modification / Deletion

RPD Onboarding

Configuration Changes/Updates



Software Upgrades

Configuration Compliance

RMAs / Device Migration

Node Splits

Network / Service Health Checking

Disaster Recovery

Capacity Optimization

Security Policy Enforcement

Benefits of DAA Automation

Improve Team Coordination

Onboarding & activation of RPDs across operations, engineering, and inside/outside plant field teams

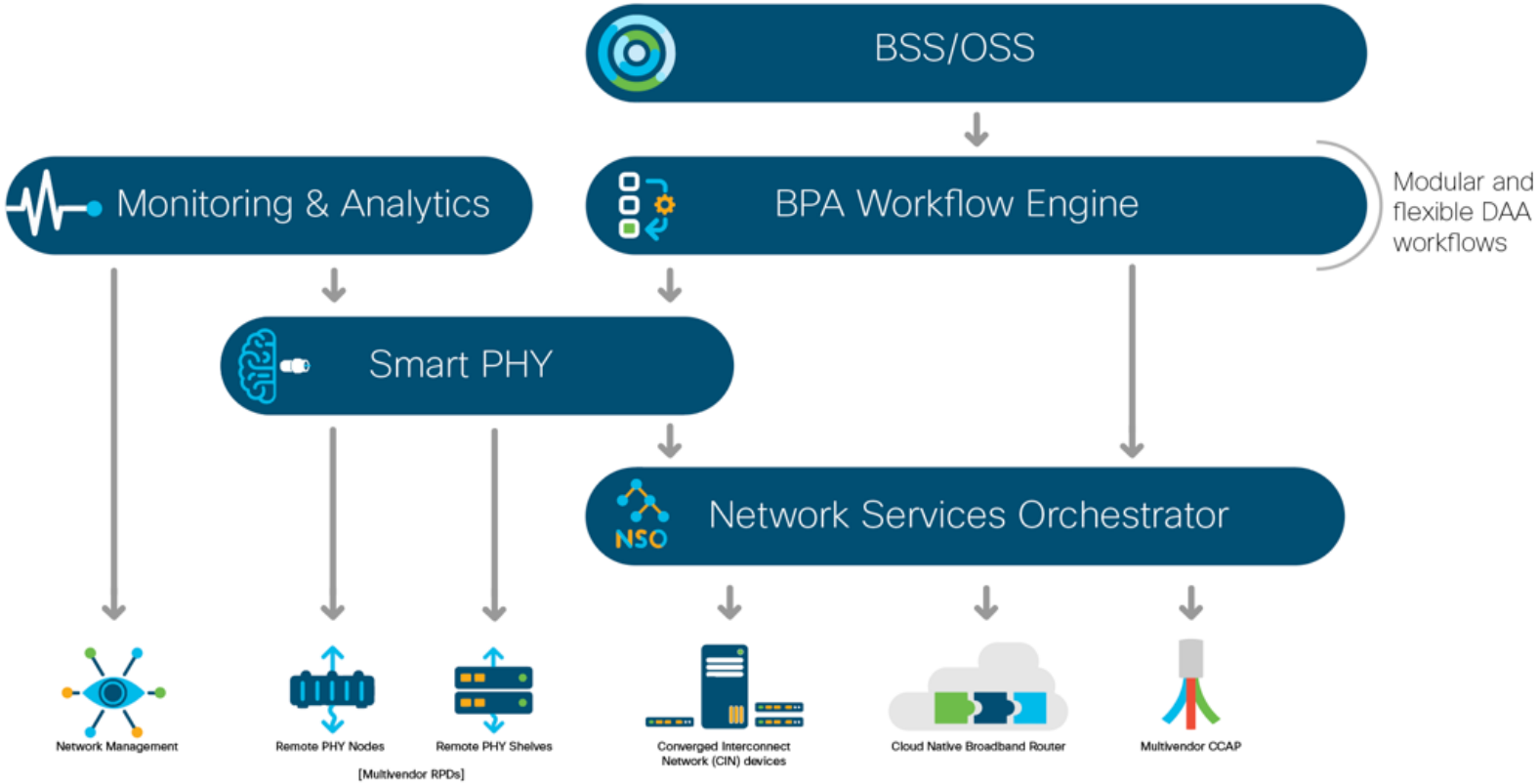
Faster Deployments

OS upgrade MOPs reduced manual steps by 10x factor

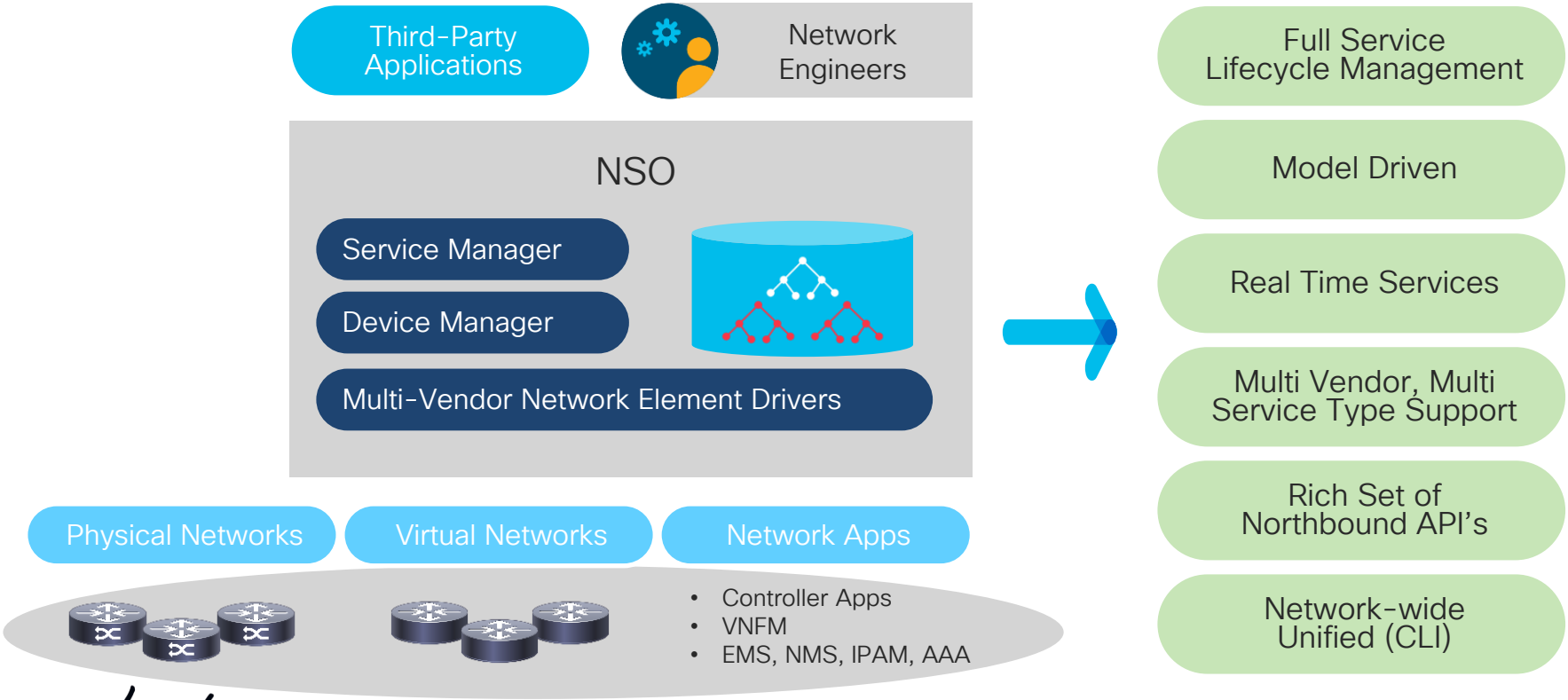
Increased Deployment Success Rate

Guarantee network standardization

DAA Automation Architecture



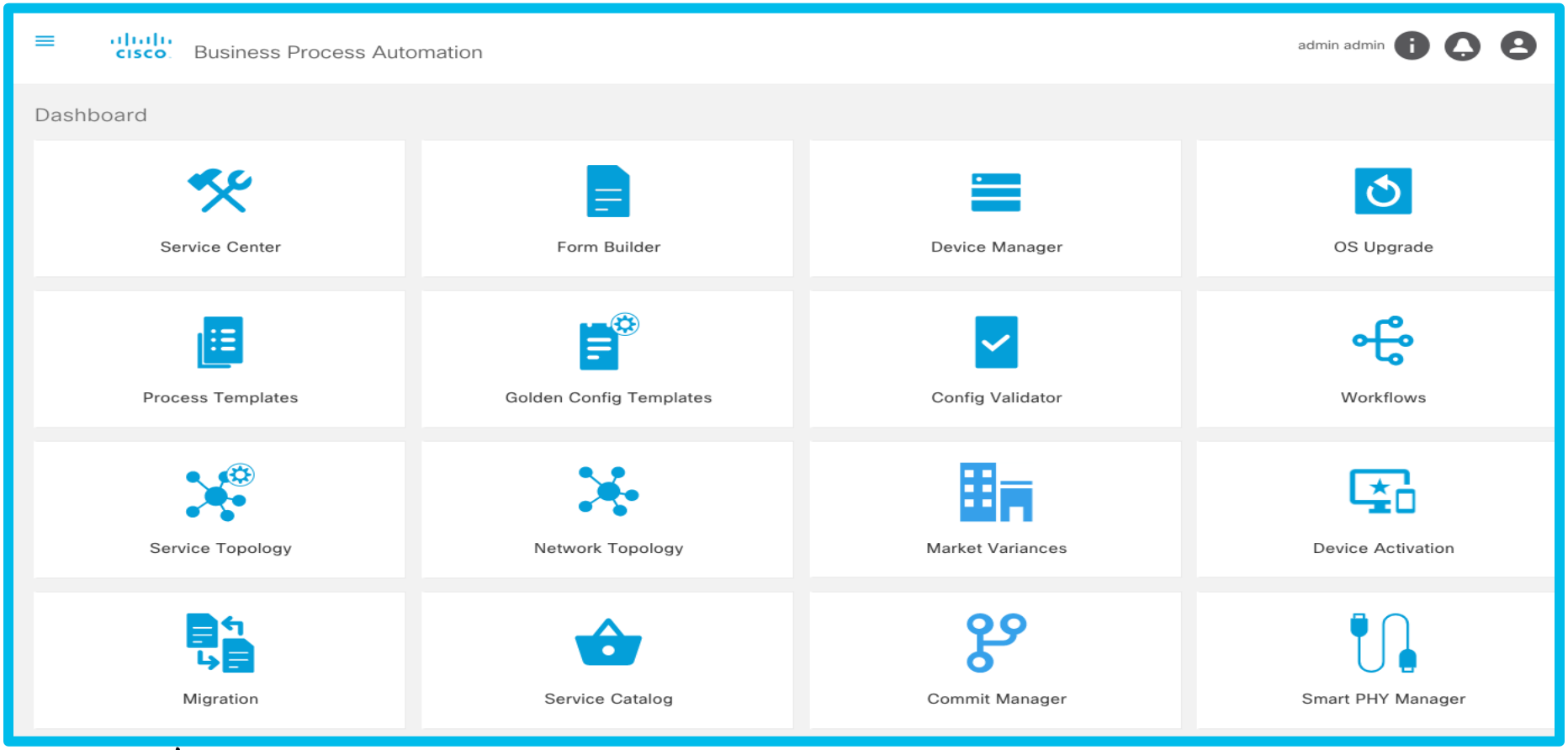
Network Services Orchestrator (NSO)



Business Process Automation (BPA)

- Scalable microservices based platform with embedded standards based workflow engine
- Workflows allow business processes to be defined by a series of tasks
- Pre-integrated with Cisco NSO (Network Services Orchestrator) but can integrate with other controllers (e.g. Ansible) as well
- Containerized application layer to host use cases
- Customized templates for MOP automation
- Configurable user/group to application access and API access

Business Process Automation Dashboard



Automation Demo(s)

R-PHY Assurance

RPD Port Descriptions

- Configure per RPD US descriptions under the RPD config
- Use CLI “show cable modem rpd all summary total” to see

```
cable rpd CS3306R3
 description Compact Shelf in 33-6 RPD 3
 identifier 0027.900a.3cda
 type shelf
 ,..
 rpd-us 0 description Jeff Test

cBR8#show cable modem rpd all summary total
...
RPD ID: 0027.900a.3cda
Interface                        Cable Modem                                                    Description
              Total Reg    Oper   Unreg Offline Wideband initRC initD initIO initO
C7/0/0/UB     7     7      7      0     0       7         0      0     0      0
C7/0/0/U0     1     0      0      1     0       0         0      0     0      0       Jeff Test
C7/0/0/U1     3     0      0      3     0       0         0      0     0      0       Jeff Test

Total:        11    7      7      4     0       7         0      0     0      0
```

RPD Offline Traps from cBR-8

- Enables cBR-8 to send an Event Trap when it detects RPDs going offline

```
cBR8(config)snmp-server enable traps ccap-core-event error
cBR8(config)snmp-server host 172.24.77.16 cisco123
```

- To see events

```
show cable rpd ccap-core-event
```

R-PHY MIBs

- Remote PHY MIBs available here:
  http:://mibs.cablelabs.com/MIBs/DOCSIS/
- DOCS-RPHY-MIB
- DOCS-RPHY-CTRL-MIB
- DOCS-RPHY-PTP-MIB
- DOCS-RPHY-STATS-MIB
- DOCS-RPHY-SEC-MIB

The docsRphyObjects part of the MIB is broken down into 5 main groups:

- docsRphyRpdDevMibObjects
- docsRphyRpdIfMibObjects
- docsRphyRpdIpMibObjects
- docsRphyCcapMibObjects
- docsRphyCmtsCmStatMibObjects

docsRphyCmtsCmStatMibObjects tables

docsRphyCmtsCmRegStatusTable – indexed by **docsIf3CmtsCmRegStatusId**; contains the object **docsRphyCmtsCmRegStatusRpdUniqueId** which reports the RPD the modem is connected; **docsIf3CmtsCmRegStatusId** is a value assigned by the CMTS to identify a CM MAC address

```
snmpwalk -v 2c -c cisco123 -Ob 10.225.240.96 docsIf3CmtsCmRegStatusMacAddr
DOCS-IF3-MIB::docsIf3CmtsCmRegStatusMacAddr.7083718 = STRING: 10:5f:49:1e:80:f0

snmpwalk -v 2c -c cisco123 -Ob 10.225.240.96 docsIfCmtsCmPtr | grep 7083718
DOCS-IF-MIB::docsIfCmtsCmPtr.16.95.73.30.128.240 = INTEGER: 7083718

snmpwalk -v 2c -c cisco123 -Ob 10.225.240.96 docsRphyCmtsCmRegStatusRpdUniqueId.7083718
DOCS-RPHY-MIB::docsRphyCmtsCmRegStatusRpdUniqueId.7083718 = STRING: a0:f8:49:6f:ae:86

F186-A9-CBR8-01#scm 105f.491e.80f0 ver | i RPD
RPD ID                              : a0f8.496f.ae86
```

DOCS-RPHY-CTRL-MIB

Object Name	Description
docsRphyCtrlRpdResetCtrlTable	Allows an RPD to be reset via GCP by the Principal Core
docsRphyCtrlRpdLogCtrlTable	Controls resetting a RPDs local log and/or pending event queue
docsRphyCtrlRpdSsdCtrlTable	Controls Secure SW Download (SSD) operations on the RPD
docsRphyCtrlRpdCrashDataFileCtrlTable	Control transferring/deletion of RPD crash files
docsRphyCtrlRpdCrashDataServerCtrlTable	Controls setting crash server info on the RPD
docsRphyCtrlRpdInitProvCtrlTable	Allows the asset ID, device alias, and RPD location to be updated by the operator

DOCS-RPHY-PTP-MIB

Tables
docsRphyPtpCcapCurrentDataSet
docsRphyPtpCcapParentDataSet
docsRphyPtpCcapTimeProperties
docsRphyPtpCcapPortDataSetTable
docsRphyPtpCcapClockStatus
docsRphyPtpCcapCorePtpPortStatusTable
docsRphyPtpCcapPortMasterClockStatusTable
docsRphyPtpRpdCurrentDataSetTable
docsRphyPtpRpdClockStatusTable
docsRphyPtpRpdPortDataSetTable
docsRphyPtpRpdPtpPortStatusTable
docsRphyPtpRpdPortMasterClockStatusTable

```
docsRphyPtpCcapClockStatusClockState.0 =
INTEGER: phaseAligned(5)
docsRphyPtpCcapClockStatusLastStateChange.0 =
Timeticks: (191055290) 22 days, 2:42:32.90
docsRphyPtpCcapClockStatusPacketsSent.0 =
Counter64: 529420725 Packets
docsRphyPtpCcapClockStatusPacketsReceived.0 =
Counter64: 1092047176 Packets
```

```
docsRphyPtpRpdClockStatusClockState.0.39.144.10
.60.218 = INTEGER: phaseAligned(5)
docsRphyPtpRpdClockStatusLastStateChange.0.39.1
44.10.60.218 = Timeticks: (182001) 0:30:20.01
docsRphyPtpRpdClockStatusPacketsSent.0.39.144.1
0.60.218 = Counter64: 143071 Packets
docsRphyPtpRpdClockStatusPacketsReceived.0.39.1
44.10.60.218 = Counter64: 296339 Packets
```

Cloud Native Broadband Router (cnBR) Overview

Cisco Cloud Native Broadband Router (cnBR)

A containerized, cloud native, CCAP, unifying multivendor solutions into a single, secure, standards-based architecture

Cloud native

NFV done right. Containerized software architecture that is elastic, resilient and composable simplifying the transition to CI/CD.

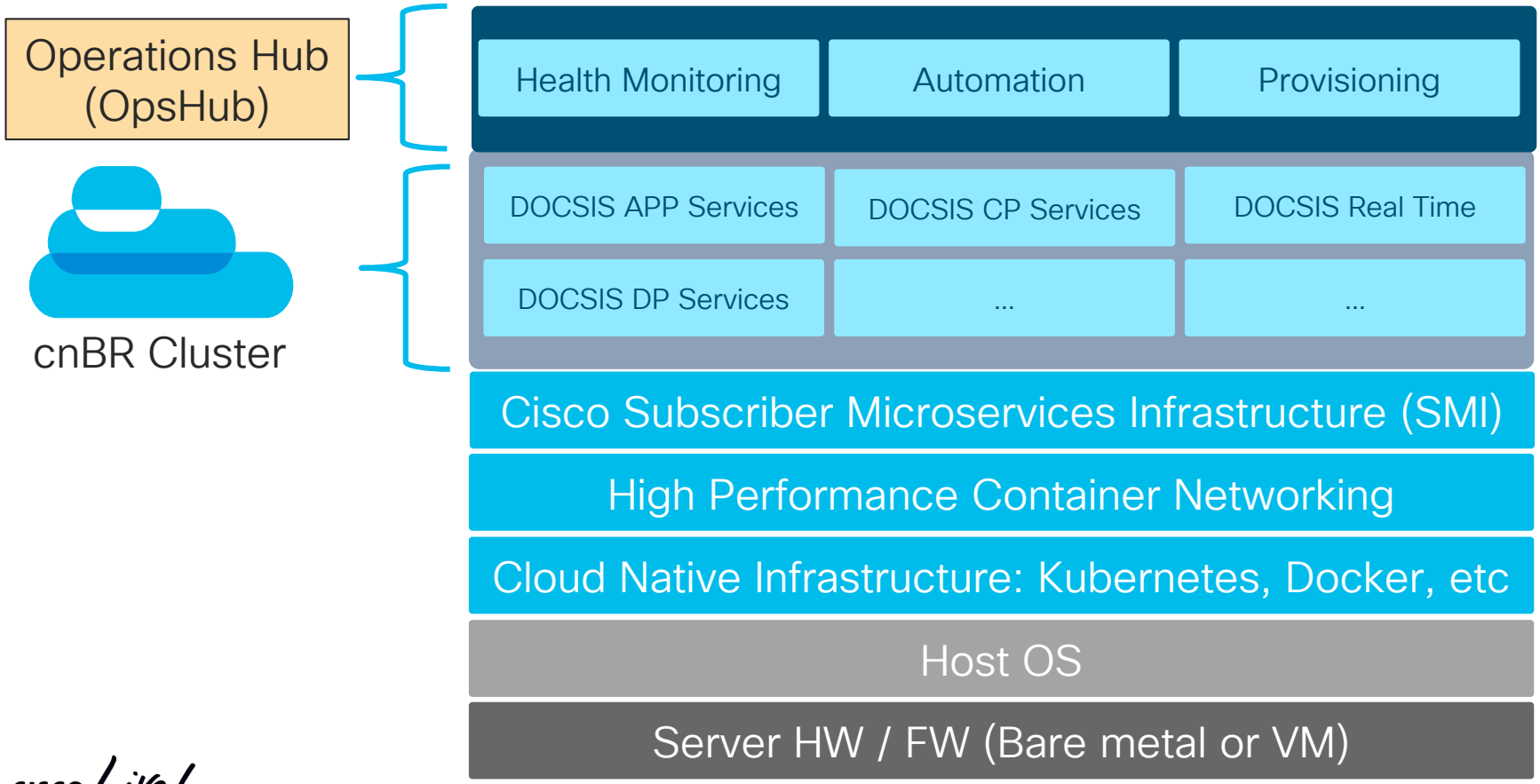
Operational Simplicity

Microservices architectural pattern for high portability, scalability, and elasticity. Moving from SNMP and CLI to API and dashboard driven architecture.

Automation & API Driven

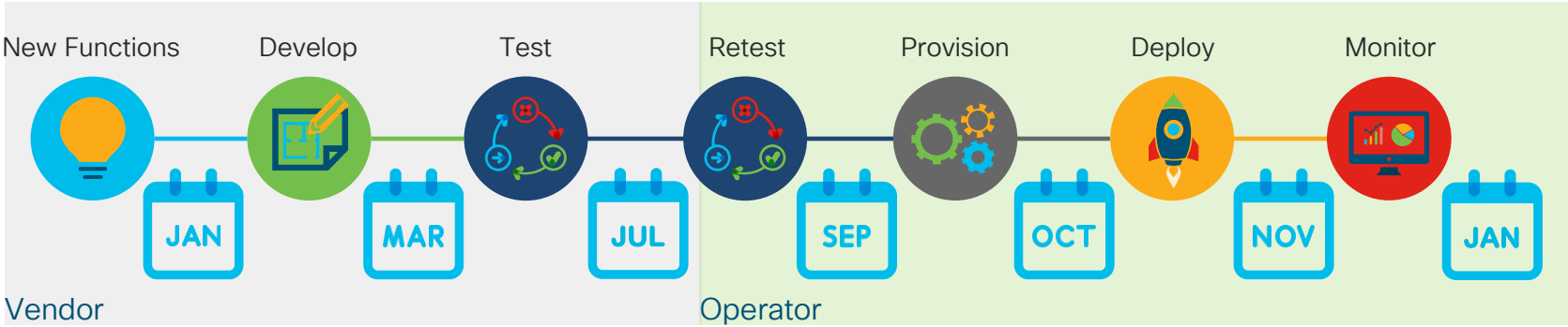
APIs enabling Intent driven networking. Transform network operations with closed-loop automation.

cnBR Layered Architecture

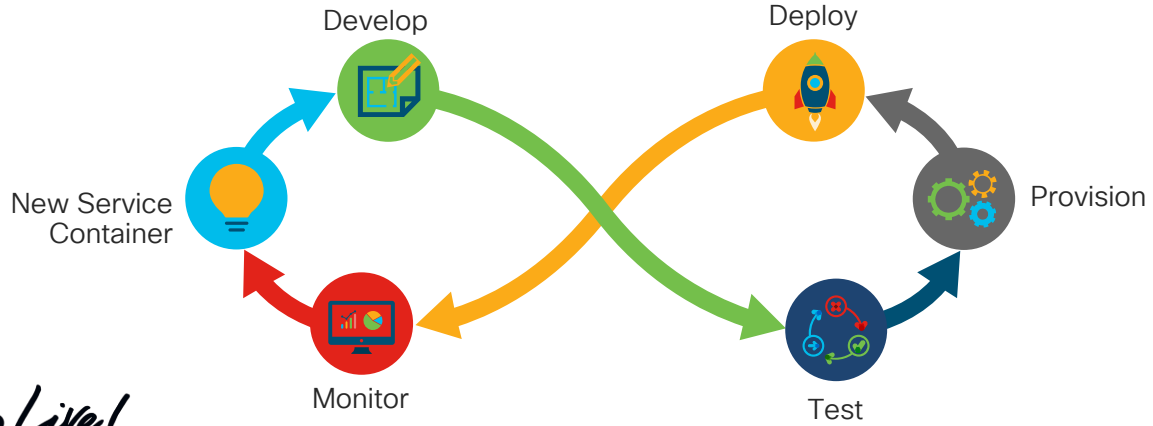


Legacy vs. Cloud Native Broadband Router

Legacy Dev & Operations



Cloud Native Dev & Operations



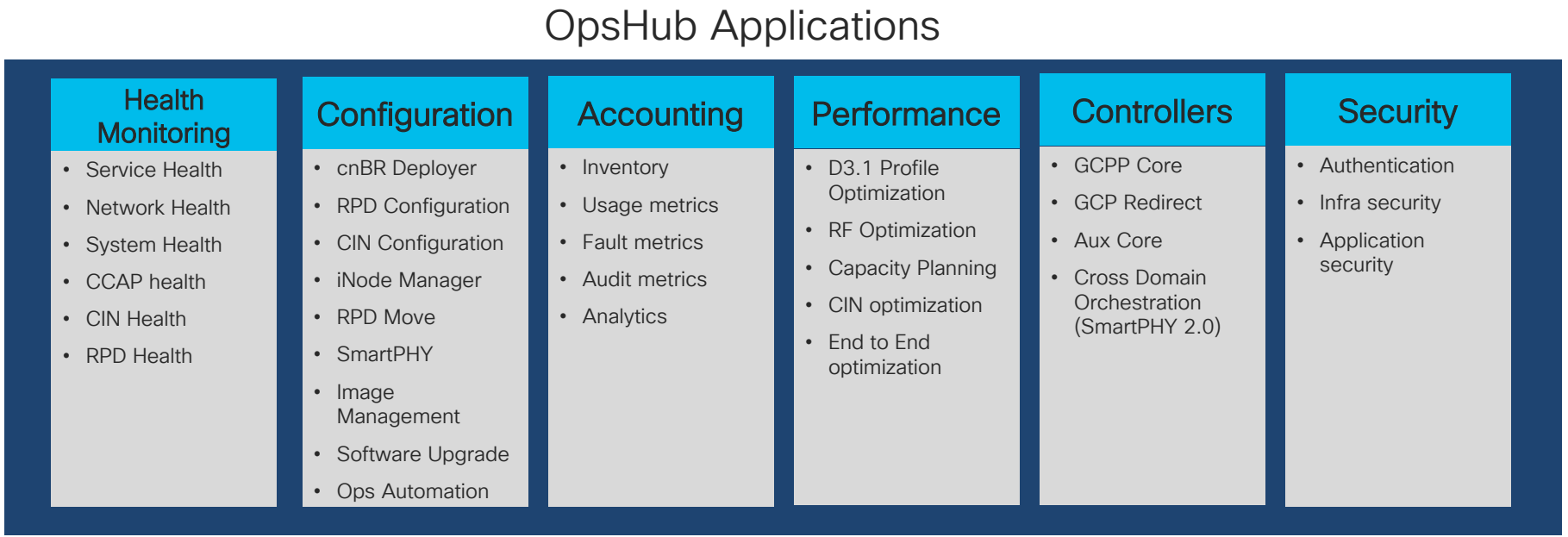
- Highly efficient way to run workloads
- Granular and elastic scaling
- Continuous integration and continuous development (CI/CD)
- New features/services in weeks vs. years

cnBR Operations Hub (OpsHub)

- The CMTS is the central point for a “small” segment of the cable plant
- Operations relies on direct CMTS interfaces (CLI, SNMP, IPDR) for data often with in-house tooling and scripting

- The Operations Hub (OpsHub) becomes the central point for potentially the entire cable access plant
- Operational data is now gathered via REST APIs, streaming telemetry, & dashboards

Operations Hub/OpsHub Functional Components



Summary

Summary

- Moving to a Remote PHY architecture enables hub consolidation, full benefits of D3.1, an improved usage of cBR-8 MAC resources, increased usability of DWDM wavelengths, service consolidation in the CIN, and innovative technologies such as Cloud Native Broadband Router (cnBR)
- Increase expertise by knowing the RPHY protocols (GCP/RCP, DEPI/UEPI, PTP) and components (CCAP cores, RPD nodes & shelves, CIN routers)
- Deploy full RPHY services and at scale via virtual splitting & combining, narrowcast & broadcast video services, out-of-band signaling, etc.
- Automation is vital to deploying Remote PHY at scale; solutions based on Smart PHY & BPA address this need
- cnBR is a transformational product bringing the best in cloud technology to the cable industry

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