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Cable Access Evolution with Remote PHY

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BRKSPG-2505

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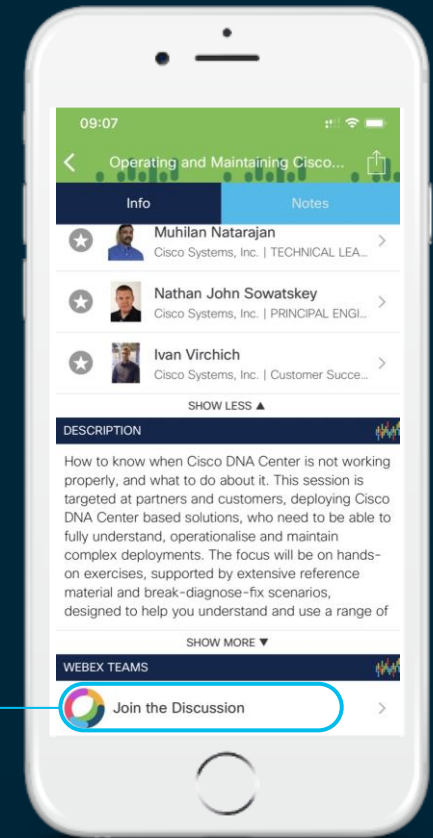
Cisco Webex Teams

Questions?

Use Cisco Webex Teams to chat with the speaker after the session

How

- 1 Find this session in the Cisco Events Mobile App
- 2 Click “Join the Discussion”
- 3 Install Webex Teams or go directly to the team space
- 4 Enter messages/questions in the team space

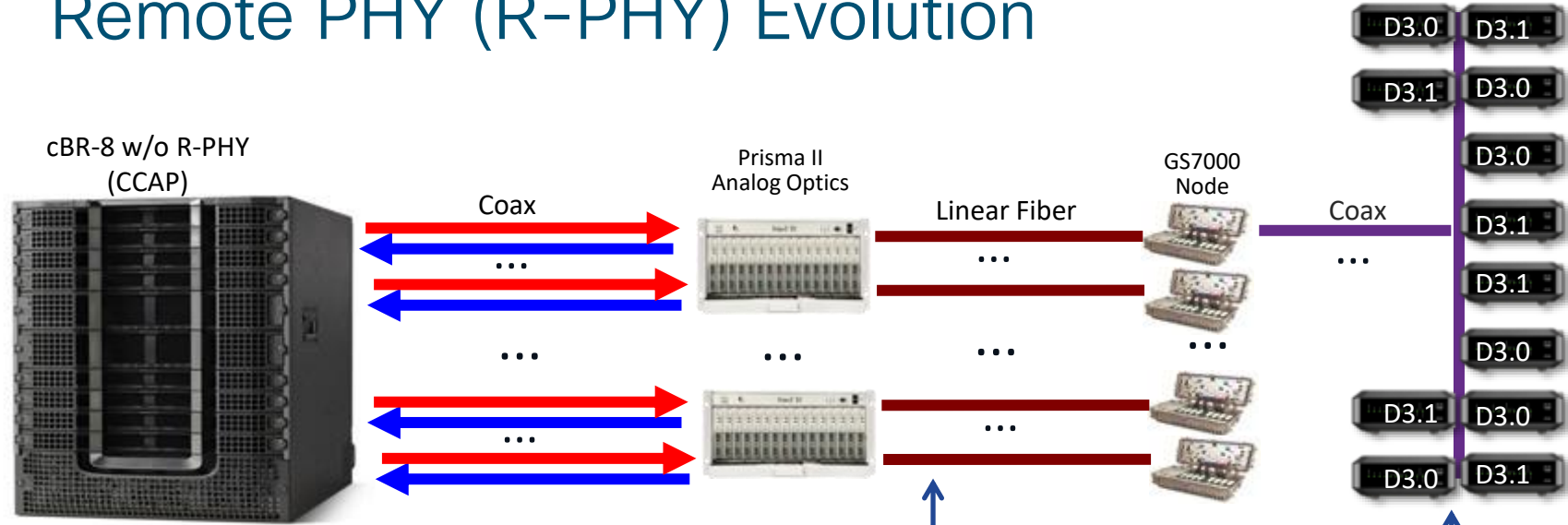


Agenda

- 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

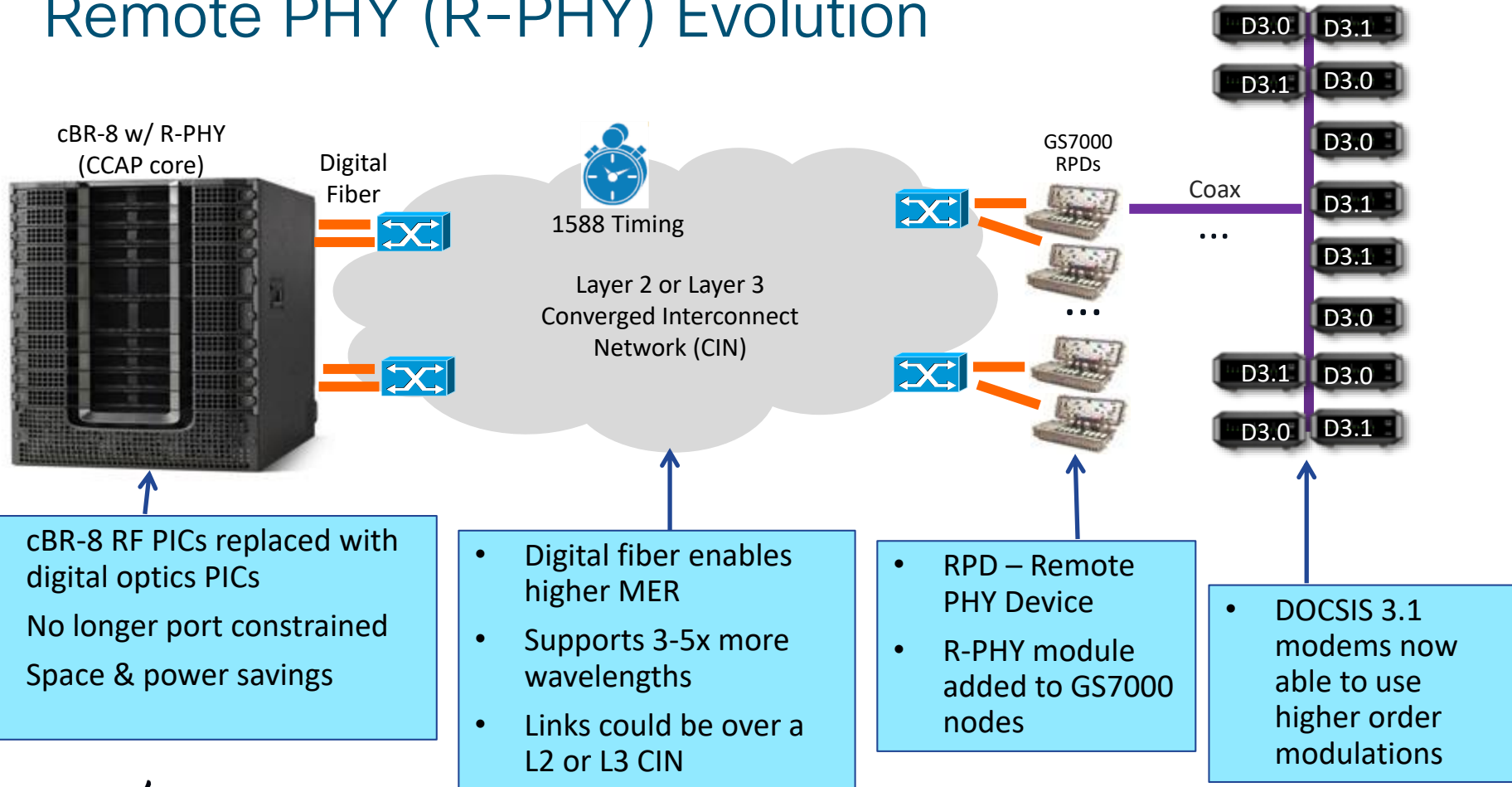


- With HA limited to 56 SGs due to limit of 56 DS ports and 112 US ports

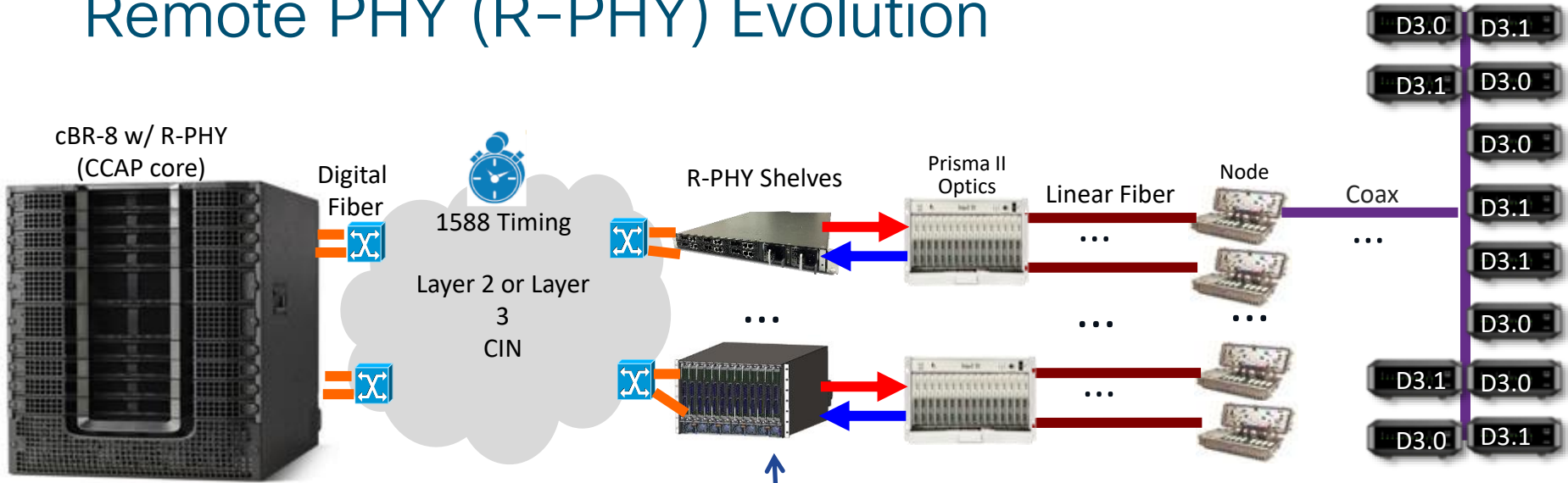
- Linear fiber limits achievable MER (max 35-38 dB)
- Linear fiber distance limited and supports fewer usable wavelengths

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

Remote PHY (R-PHY) Evolution



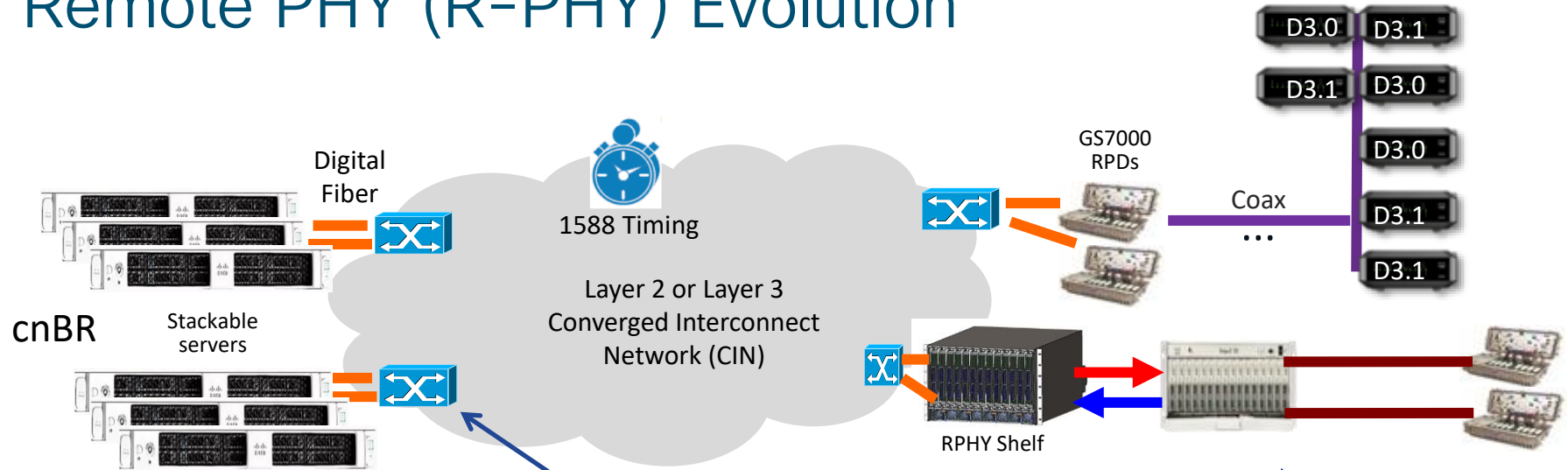
Remote PHY (R-PHY) Evolution



- 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

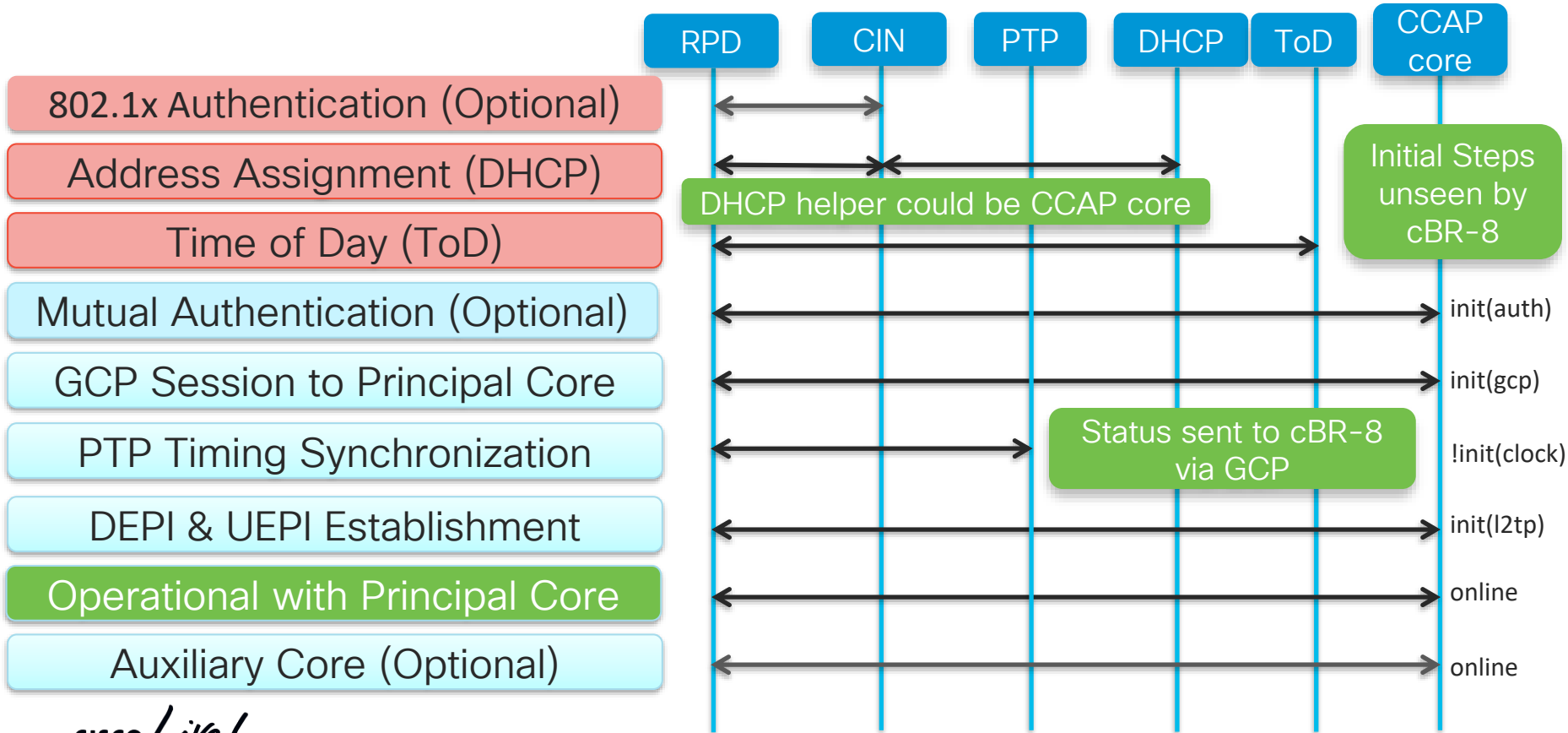


- Physical CMTS chassis replaced (or augmented) with Cloud Native Broadband Router (cnBR)

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

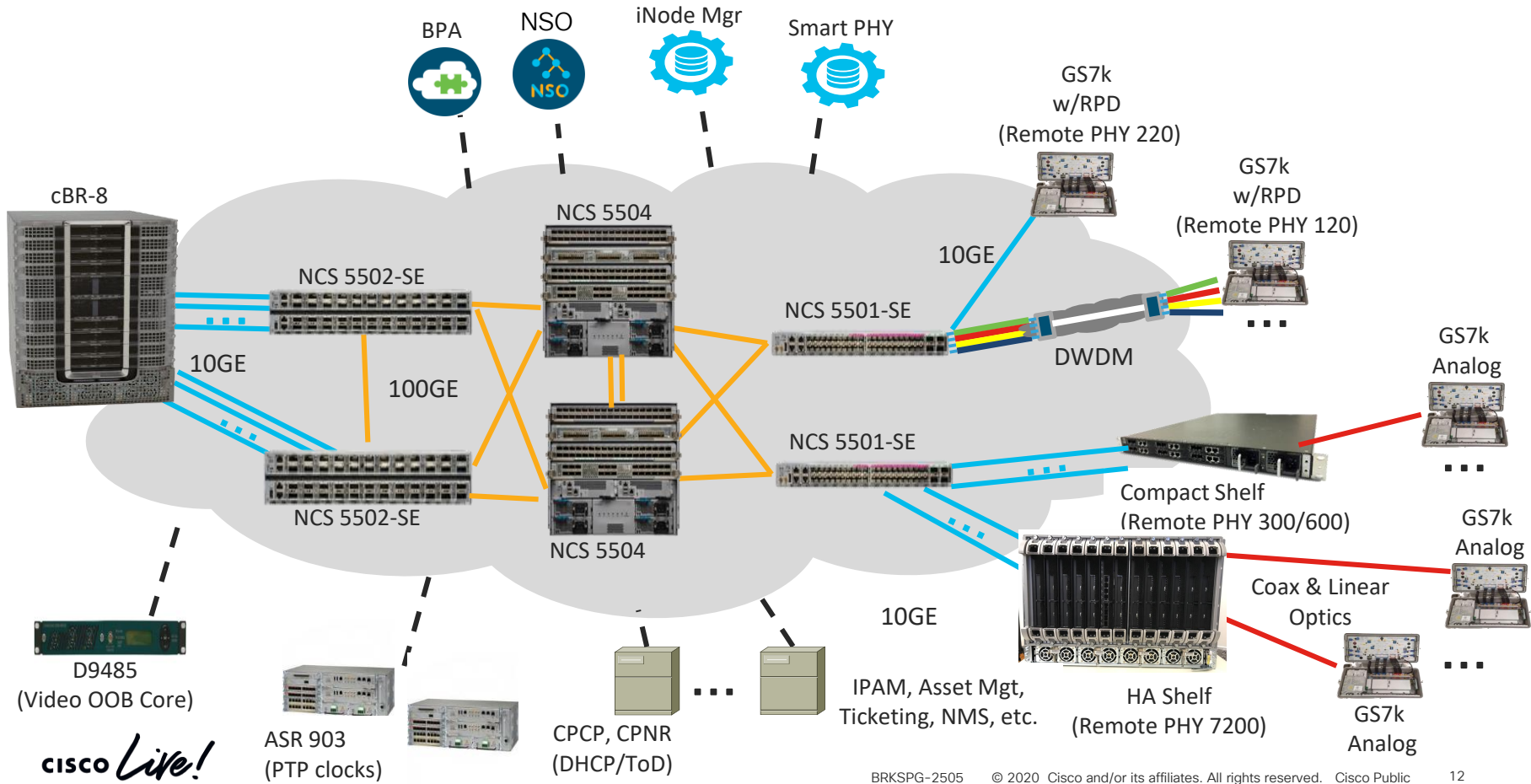
- cnBR can be used with R-PHY nodes and/or shelves to provide versatile & scalable networks

RPD Initialization



Remote PHY Components

Remote PHY Architecture Components

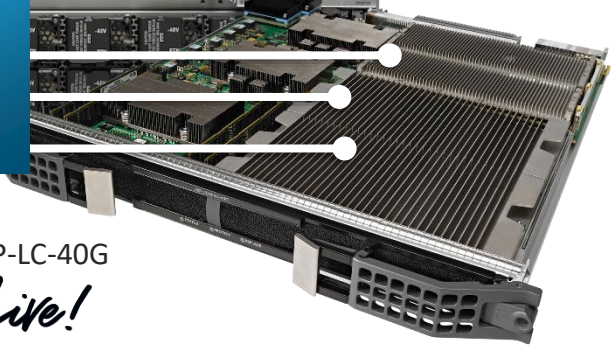


cBR-8 Remote PHY PIC (Digital PIC)

- 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)




DPIC
CBR-DPIC-8x10G
8x10G SFP+



PHY Modules
on Line Card
no longer
used

CBR-CCAP-LC-40G

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Air Baffle in
place of PHY
modules to
maintain airflow

CBR-CCAP-LC-40G-R

Second Generation Cable Line Card

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

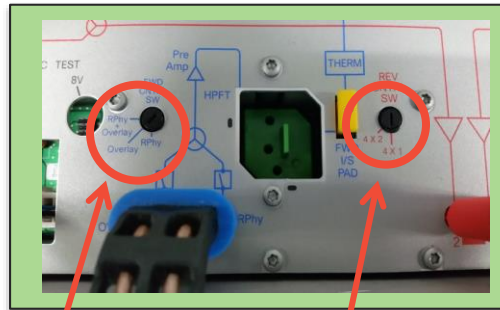


Cable LC Comparison

	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

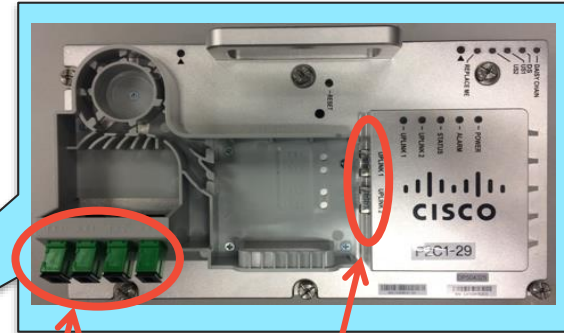
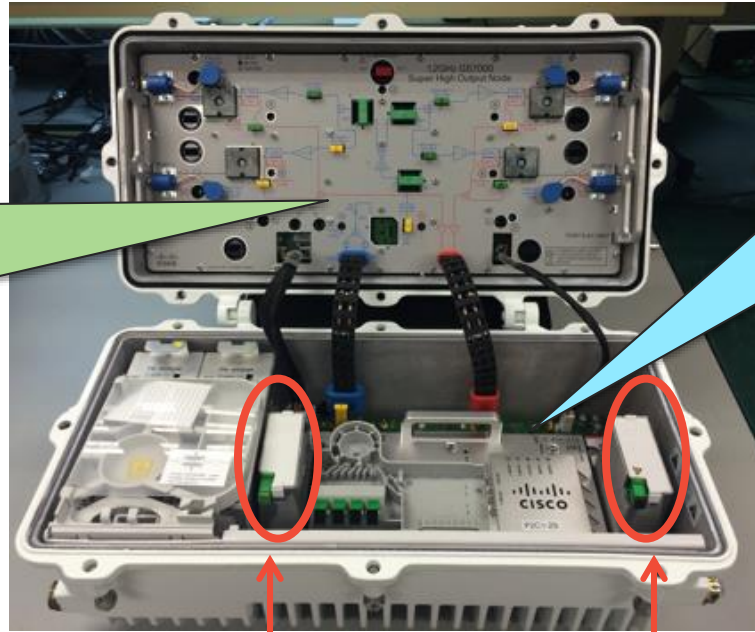
Remote PHY Device in a GS7000 Node

- 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

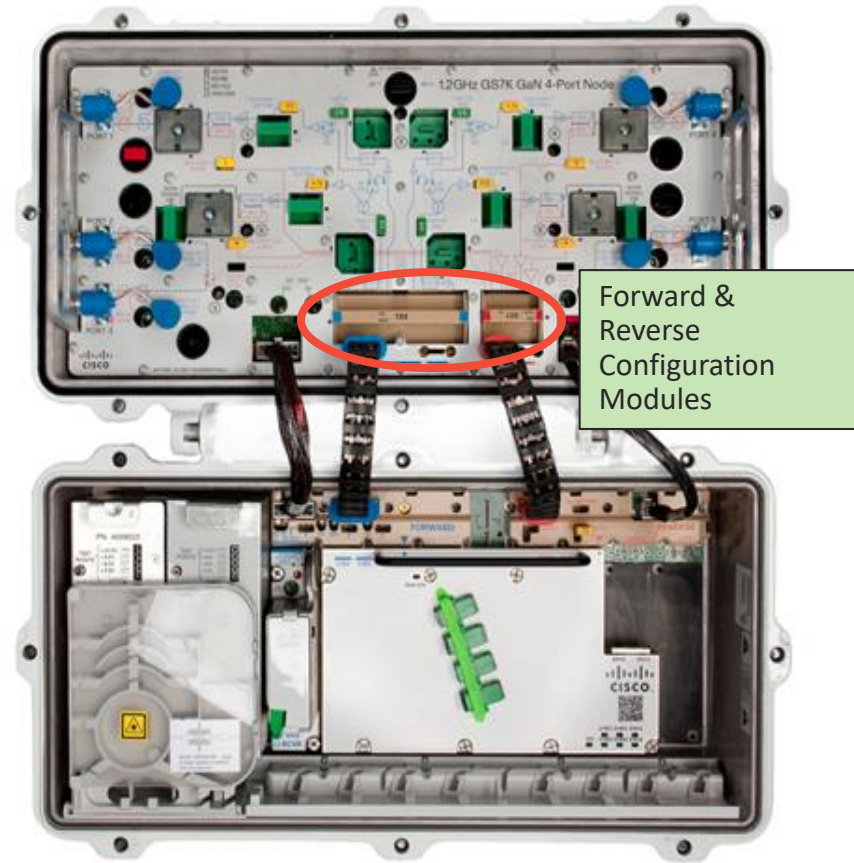


Pair of 10GE interfaces
Adapters for SC connectivity

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

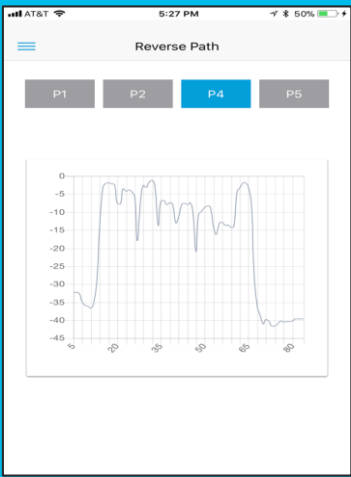
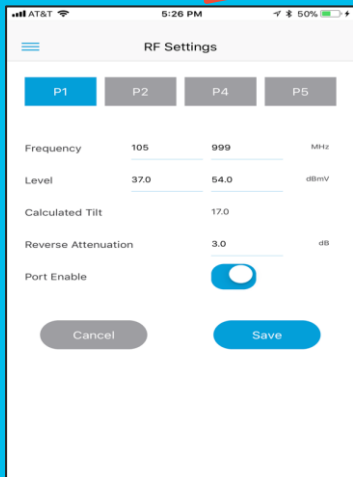
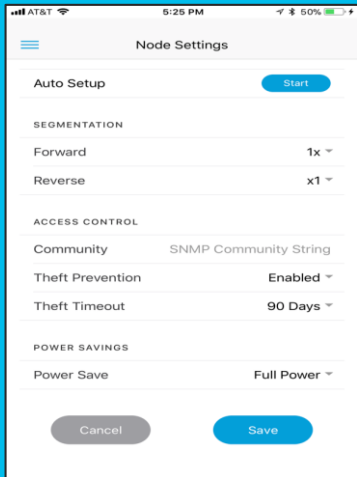
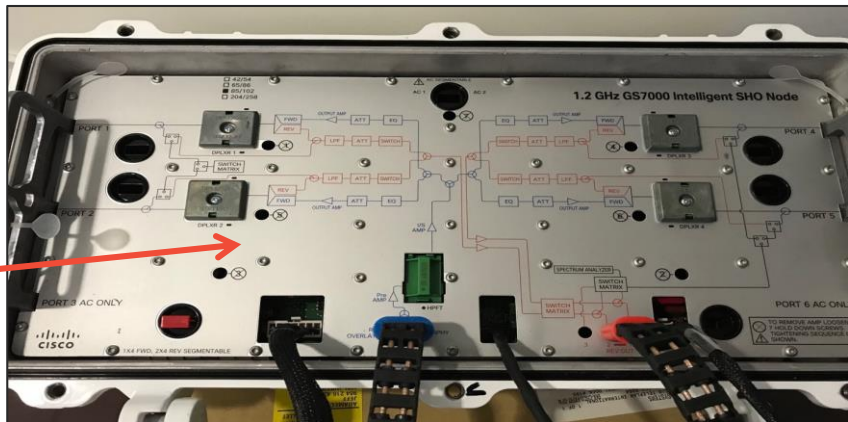
- Supports 2 Service Groups (2x2)
- Can only be used in 2x2 mode in a BAU GS7K node
- Designed for BAU deployment:
 - 384 MHz of narrowcast DS (e.g. 64 Annex B or or 48 Annex A/C SC-QAMs) per port
 - 1 OFDM channel up to 192 MHz
 - 96 QAMs of broadcast video to both DS ports & OOB support
 - 5 ATDMA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



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iNode Manager

iNode Manager v1.1.1

Overview Node Config Alarms

Nodes

Inventory

Status iNode

1

Overview Node Config Alarms

iNode : unknown - 2001:db8:daa:4:7a72:5dff:fed9:5c1d

Dashboard

SubModules

Settings

Forward and Reverse Path

Forward Spectrum Reverse Spectrum

Port1 / Port2 / Port4 / Port5

Frequency: 271 MHz

Amplitude (dBmV)

Frequency (MHz)

Overview Node Config Alarms

4 Total Alarms

0 Critical

4 Major

0 Minor

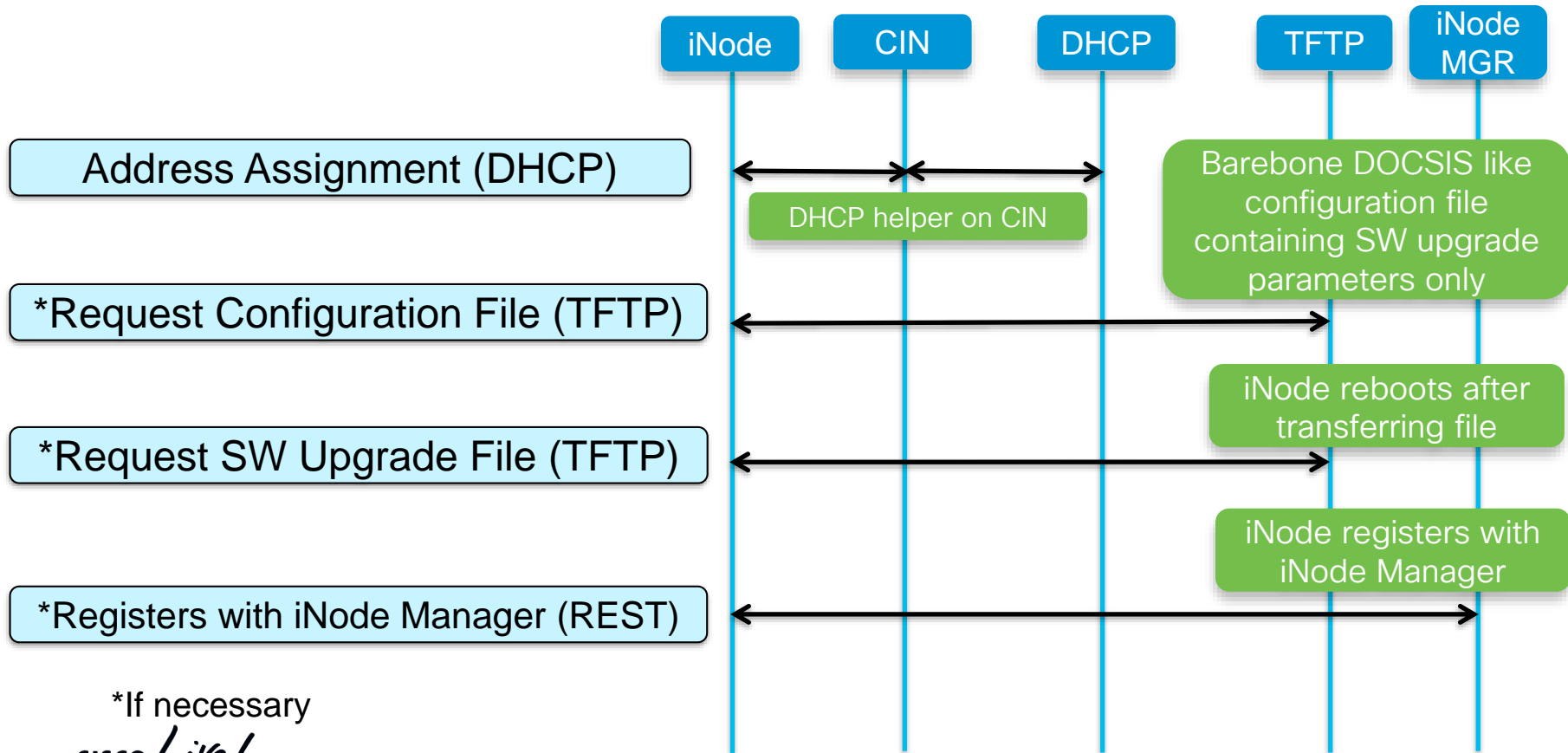
Alarms 0

Number of Rows : 10 Search...

Time Stamp (Eastern Standard Ti...	IP Address	Node Name	Severity	Alarm Message
2018-10-29 02:27:59 PM	2001:db8:daa:4:7a72:5dff:f...	unknown	Major	PS 2 -6V output voltage is high. Current value is: 0.0 Volts DC.
2018-10-29 02:27:59 PM	2001:db8:daa:4:7a72:5dff:f...	unknown	Major	PS 2 +24V output voltage is high. Current value is: 0.1 Volts DC.
2018-10-29 02:27:59 PM	2001:db8:daa:4:7a72:5dff:f...	unknown	Major	PS 2 +5.5V output voltage is high. Current value is: 0.0 Volts DC.
2018-10-29 02:27:59 PM	2001:db8:daa:4:7a72:5dff:f...	unknown	Major	PS 2 +8.5V output voltage is high. Current value is: 0.0 Volts DC.



iNode Initialization



*If necessary
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Compact (1RU) Remote PHY Shelf

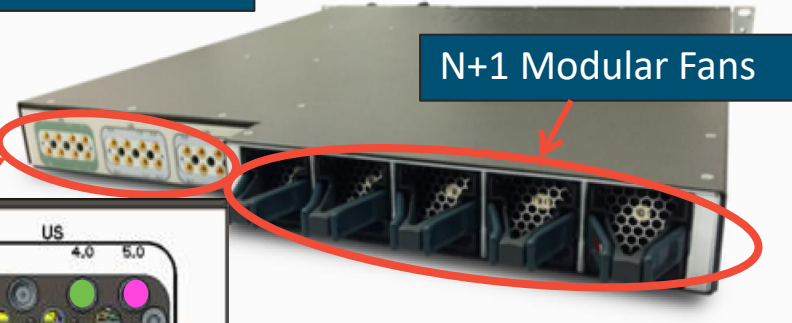
- Remote PHY 600 – 6 (1x2) SG support
Remote PHY 300 – 3 (1x2) SG support
- Packages 6 (or 3) 1x2 RPDs
- Total Power Budget:
480W max
- Stackable for greater SG densities



1+1 Modular Power Supplies (AC or DC)

Pair of 10GE Interfaces (SFP+) per RPD

Front



N+1 Modular Fans

Rear

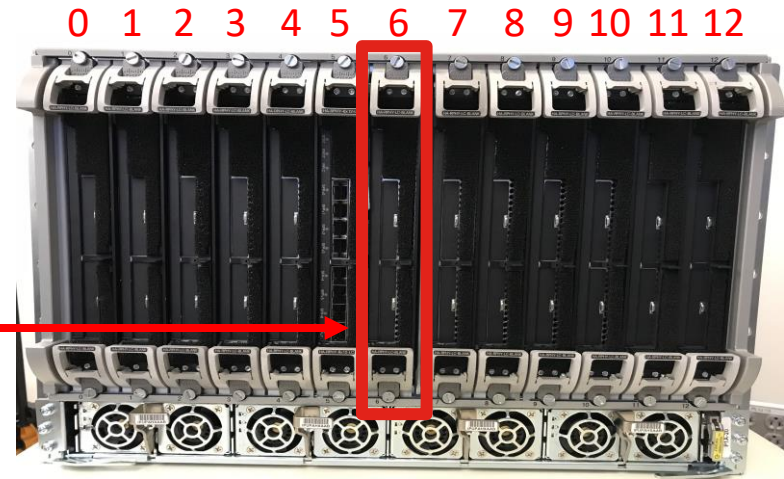
Similar UCH8 header blocks (1 DS & 2 US) as cBR-8 RF PIC



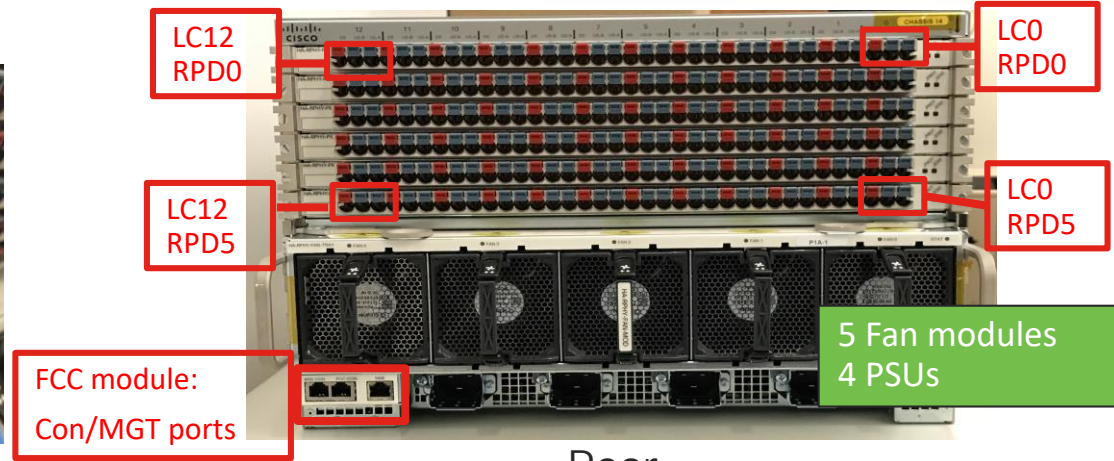
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High Availability Shelf (Remote PHY 7200)

- 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

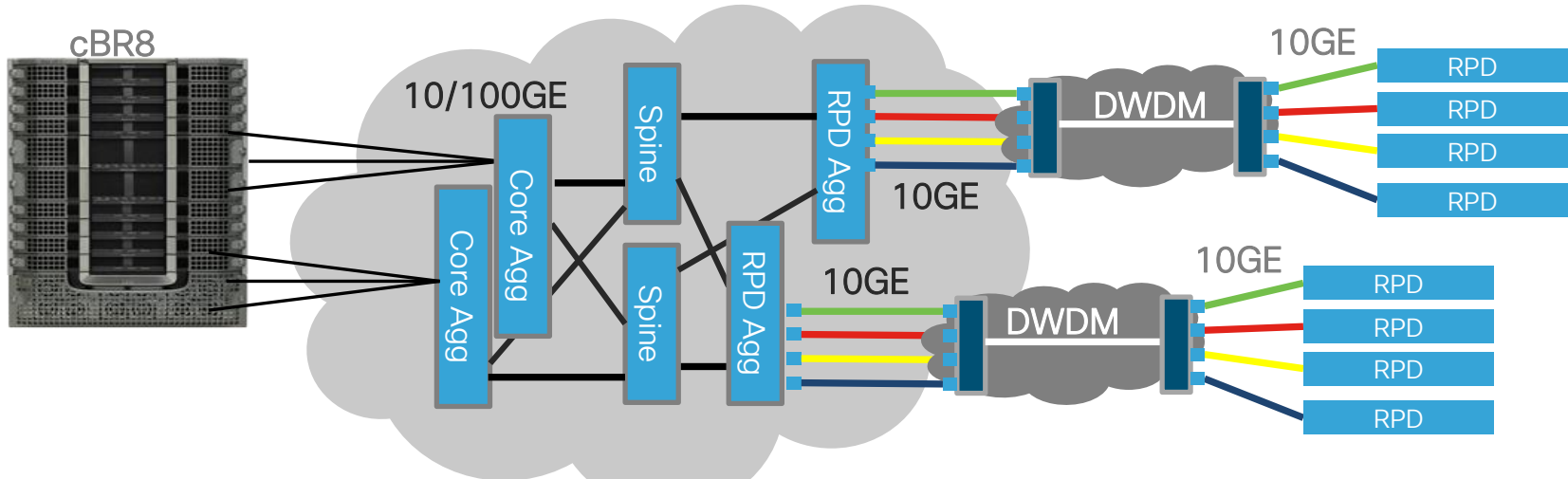


Rear

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



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

RPD Aggregation, Services Leaf

R-PHY Core, Spine

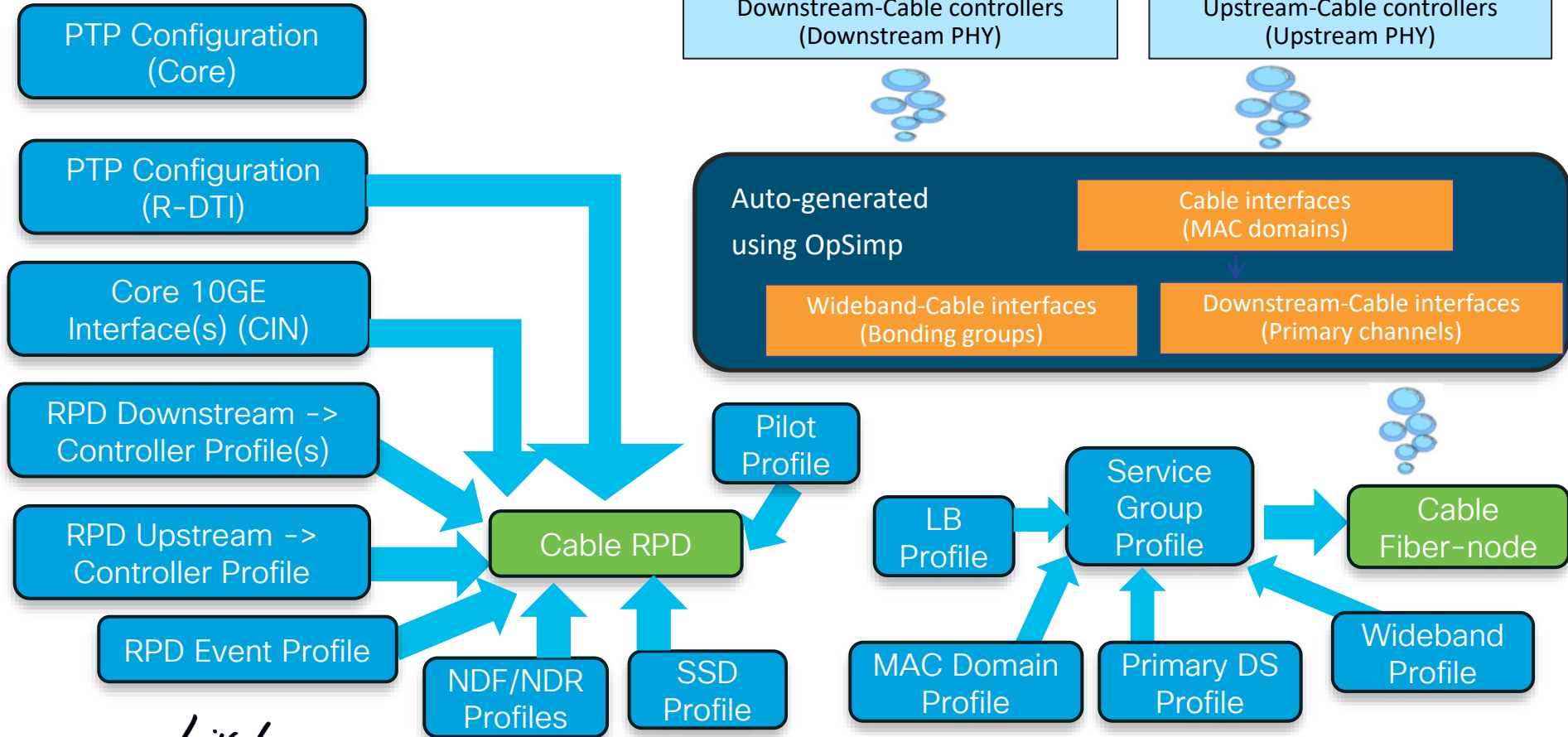
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A few points about CIN design ...

- 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
```

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

- 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

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
```

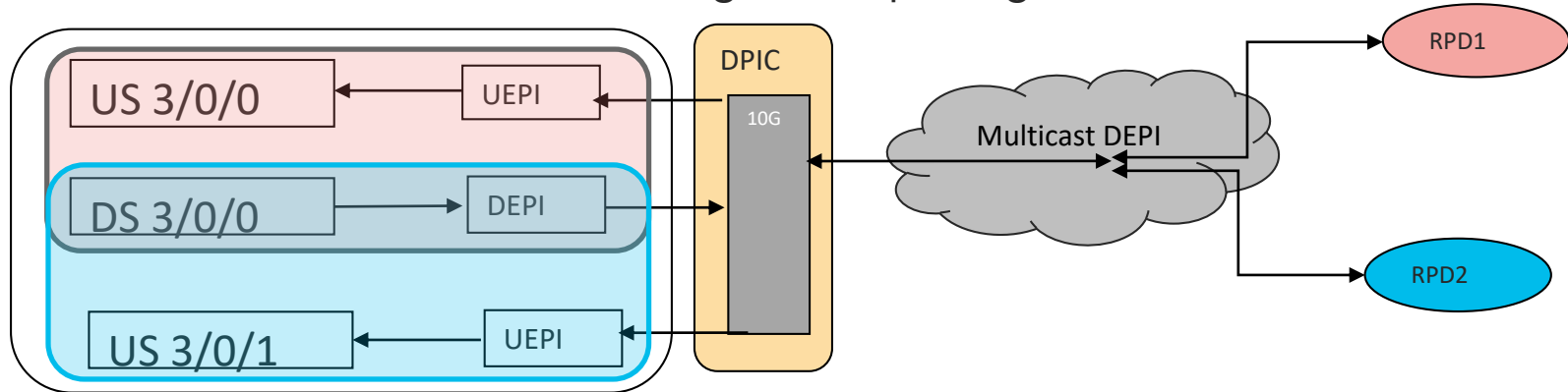
Requires
distinct US
channels for
each fiber
node defined
in the SG
profile

```
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

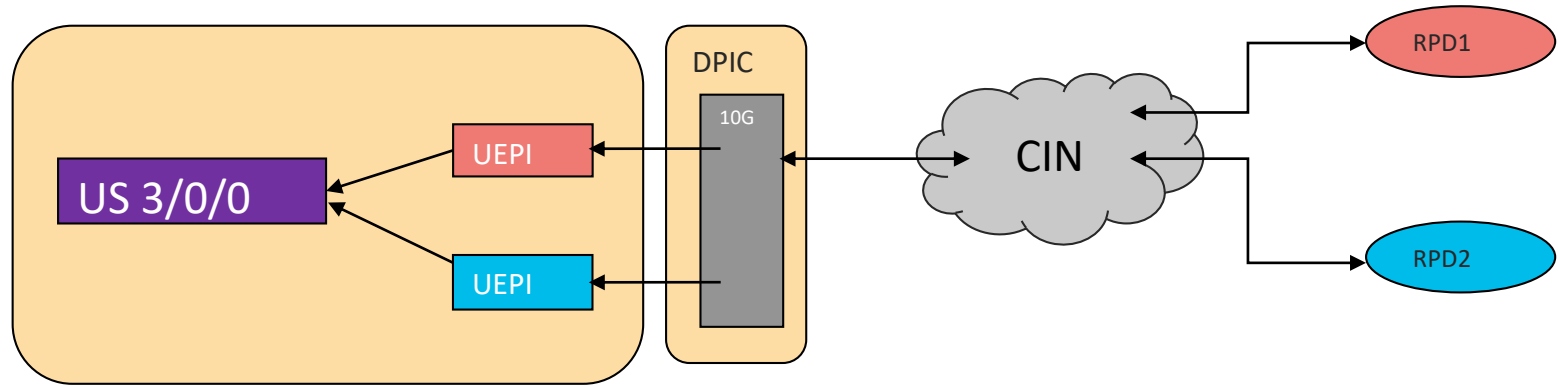
Downstream Virtual Splitting

- 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



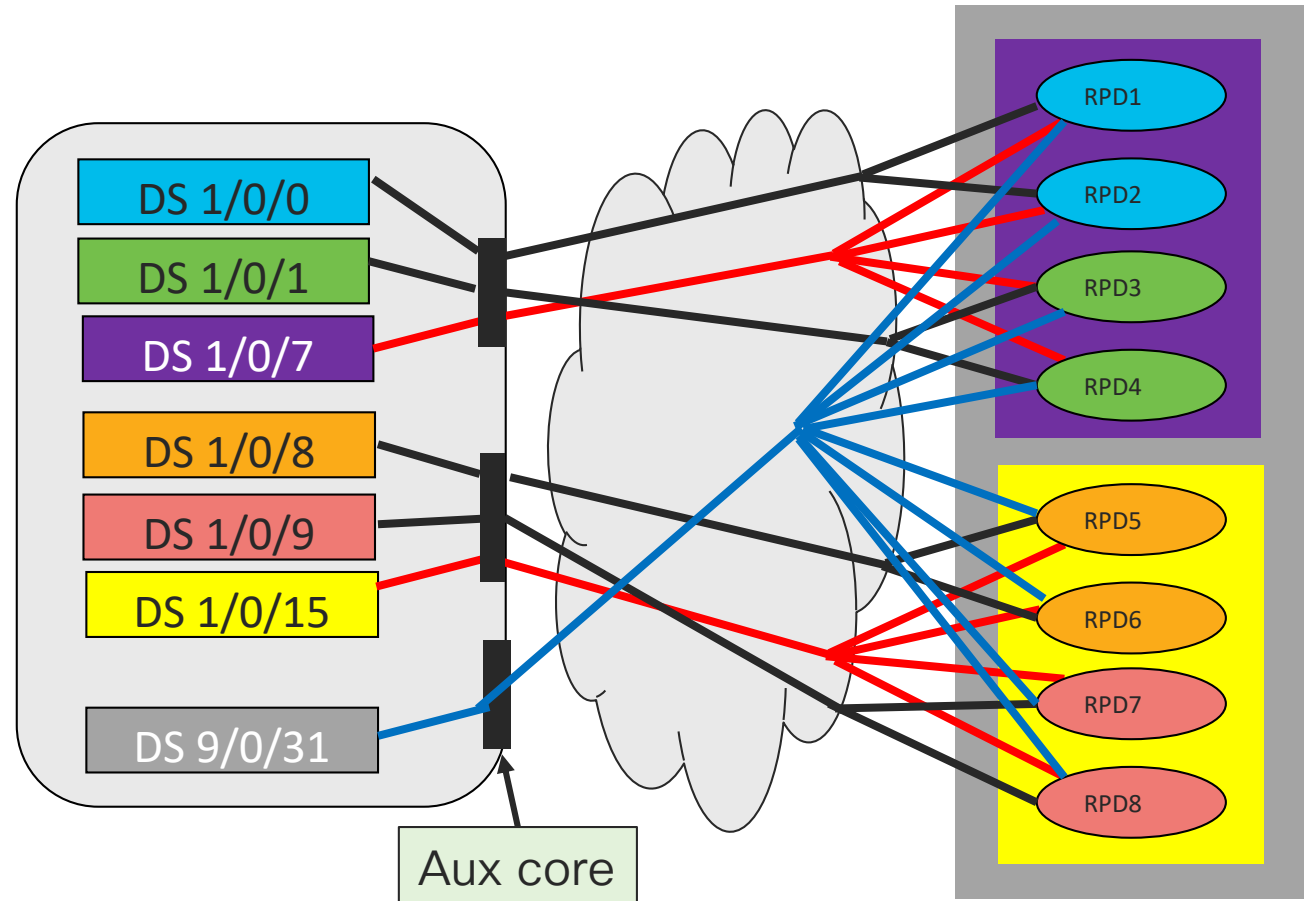
Upstream Virtual Combining

- 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



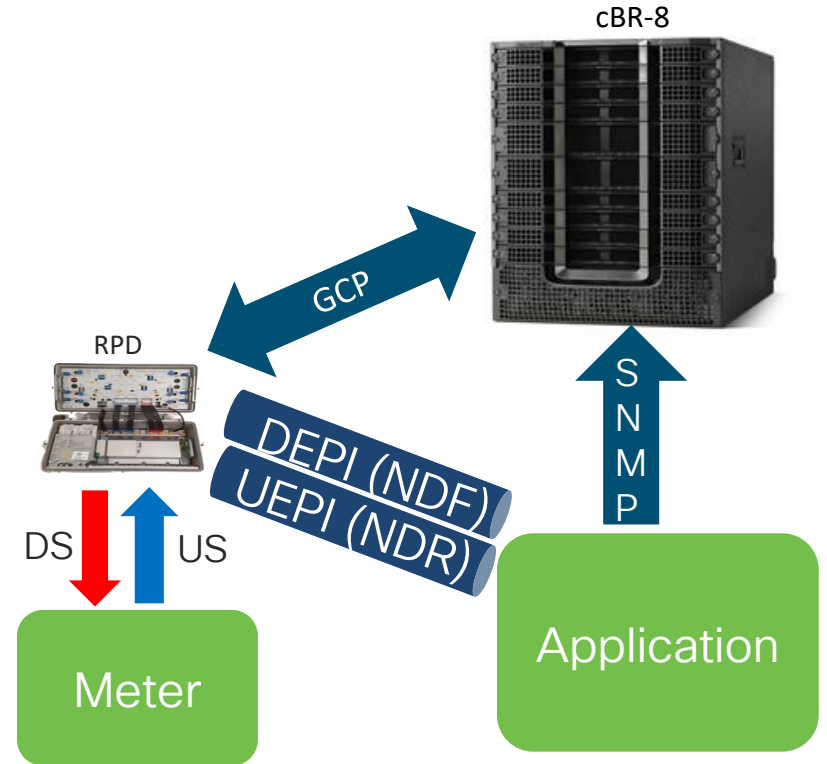
R-PHY Video & Auxiliary Cores

- 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



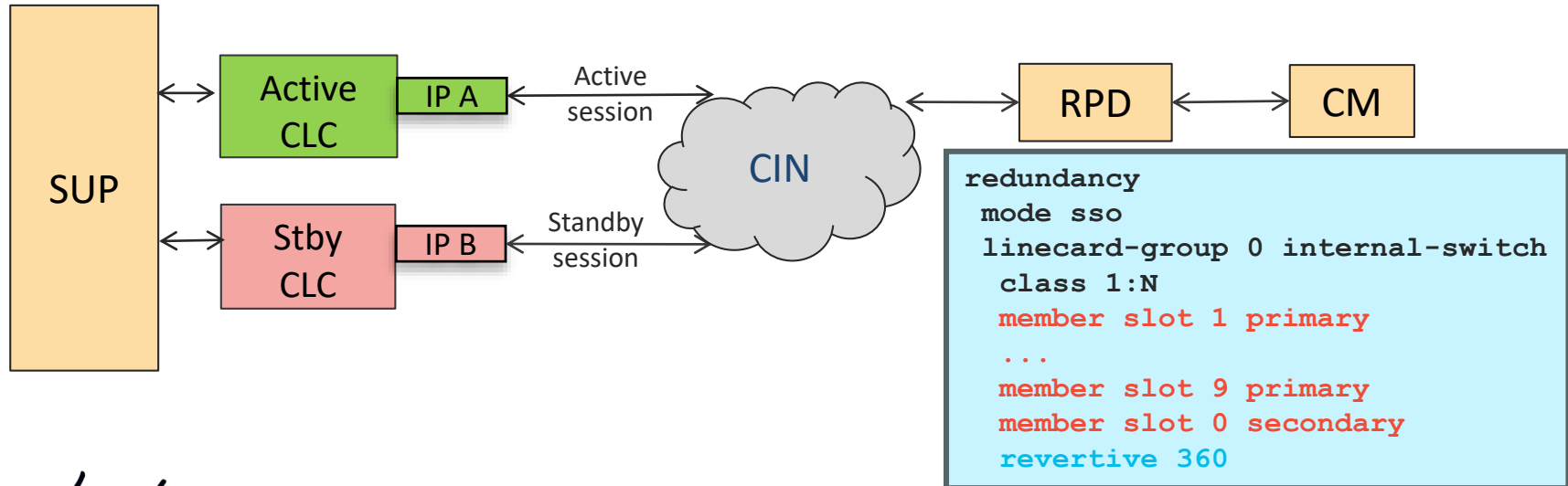
Pilot Tones

- 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
```

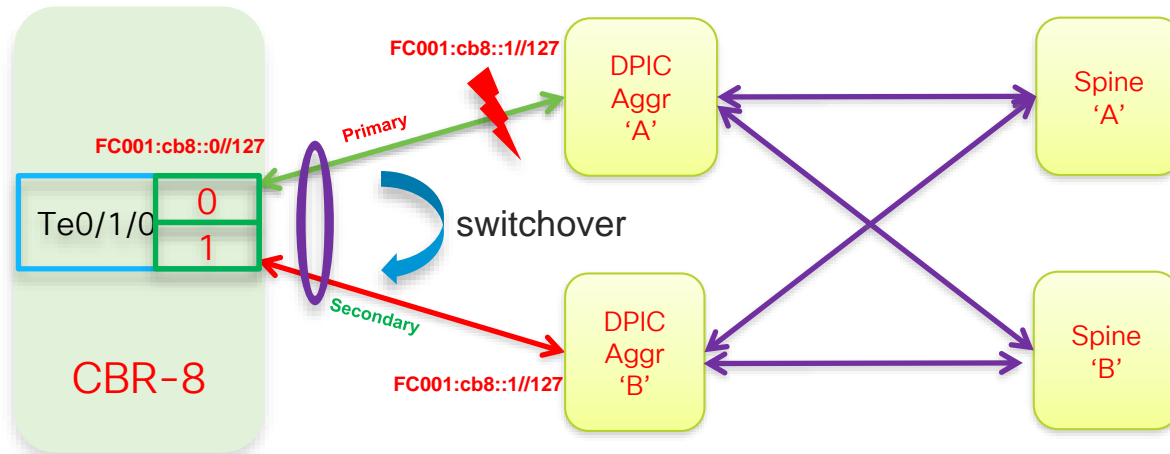
Line Card High Availability (LCHA)

- 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



DPIC Link High Availability

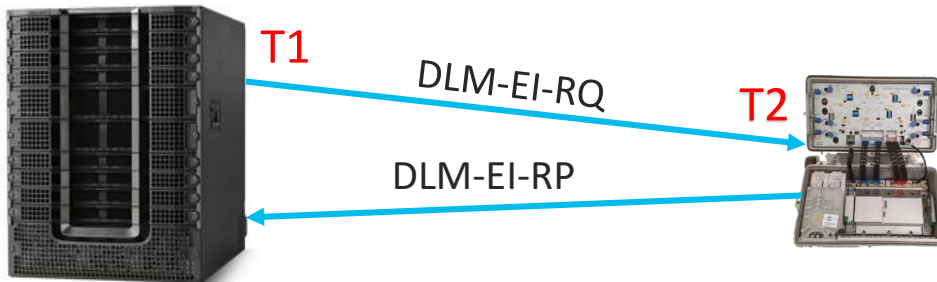
- DPIC link HA is disabled by default and is enabled globally in either hot or cold mode
- If enabled adjacent DPIC ports share the same MAC & IP
- Cold mode is recommended for layer 3 CINs where the standby transceiver is off
- Both upstream CIN interfaces should configure the same MAC and IP. Otherwise 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

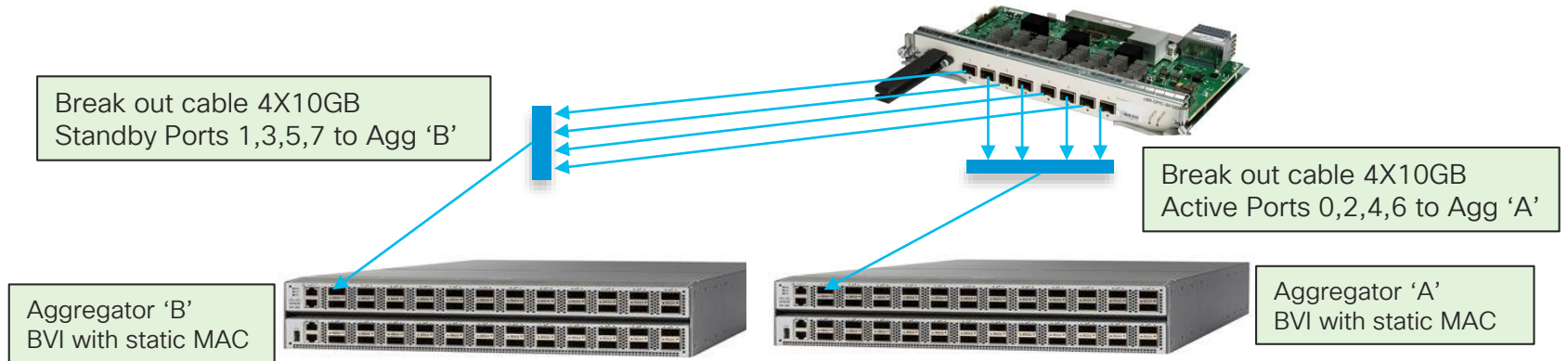


RPD inserts DTI timestamp (T2) in
the DOCSIS Timestamp End field

```
cable rpd GS7K-LWR
description remote RPD
identifier badb.ad13.1476
core-interface Tel1/1/2
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

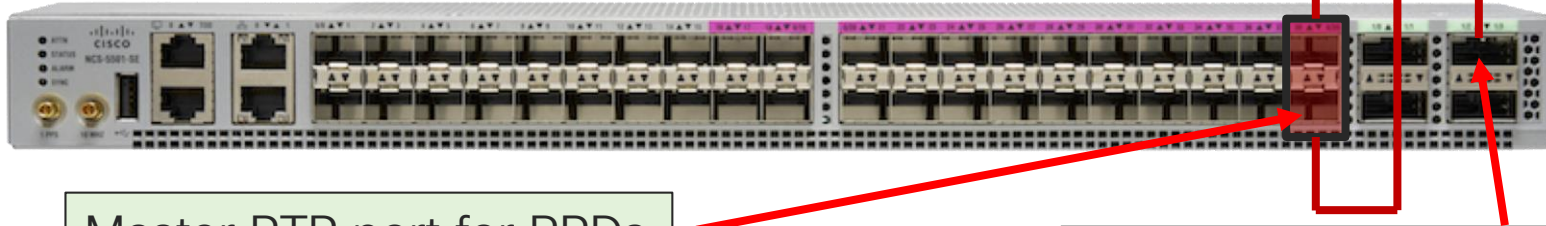


```
interface TenGigE0/0/0/0/0
  description DPIC0/0/0
  l2transport
!
interface BVI10
  description DPIC010
  ipv6 address fc00:0:302::3d/127
  ipv6 enable
  mac-address 10.583.7c4
!
```

```
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

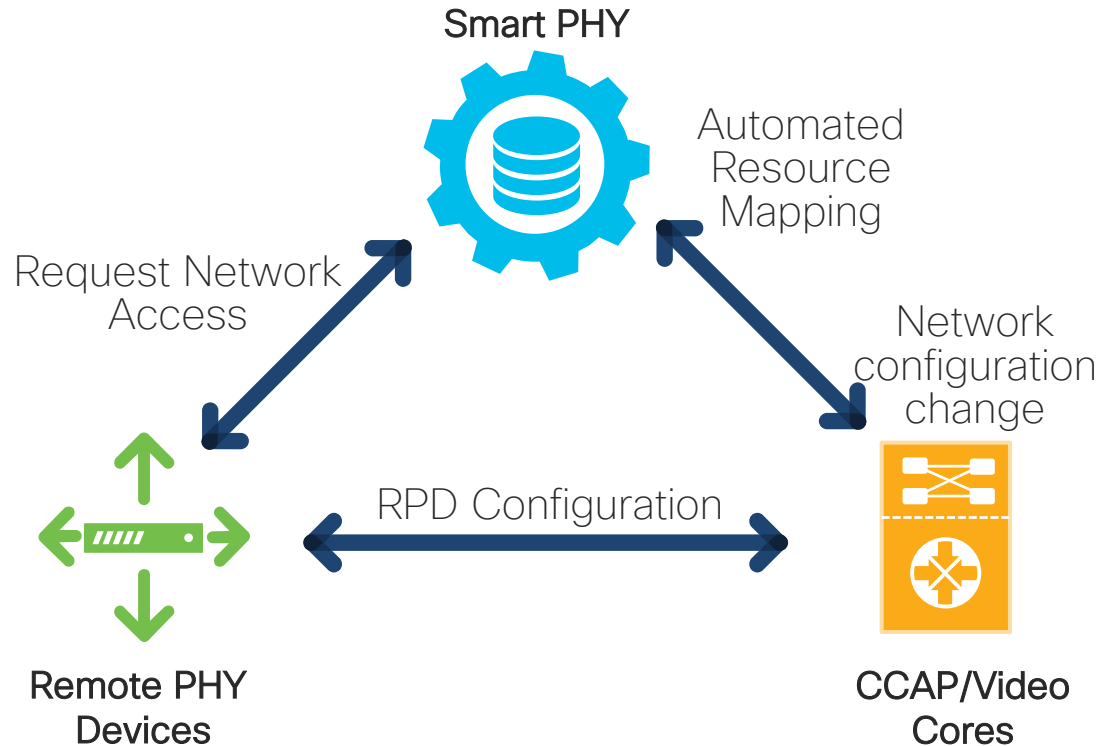


Cloud Native Platform

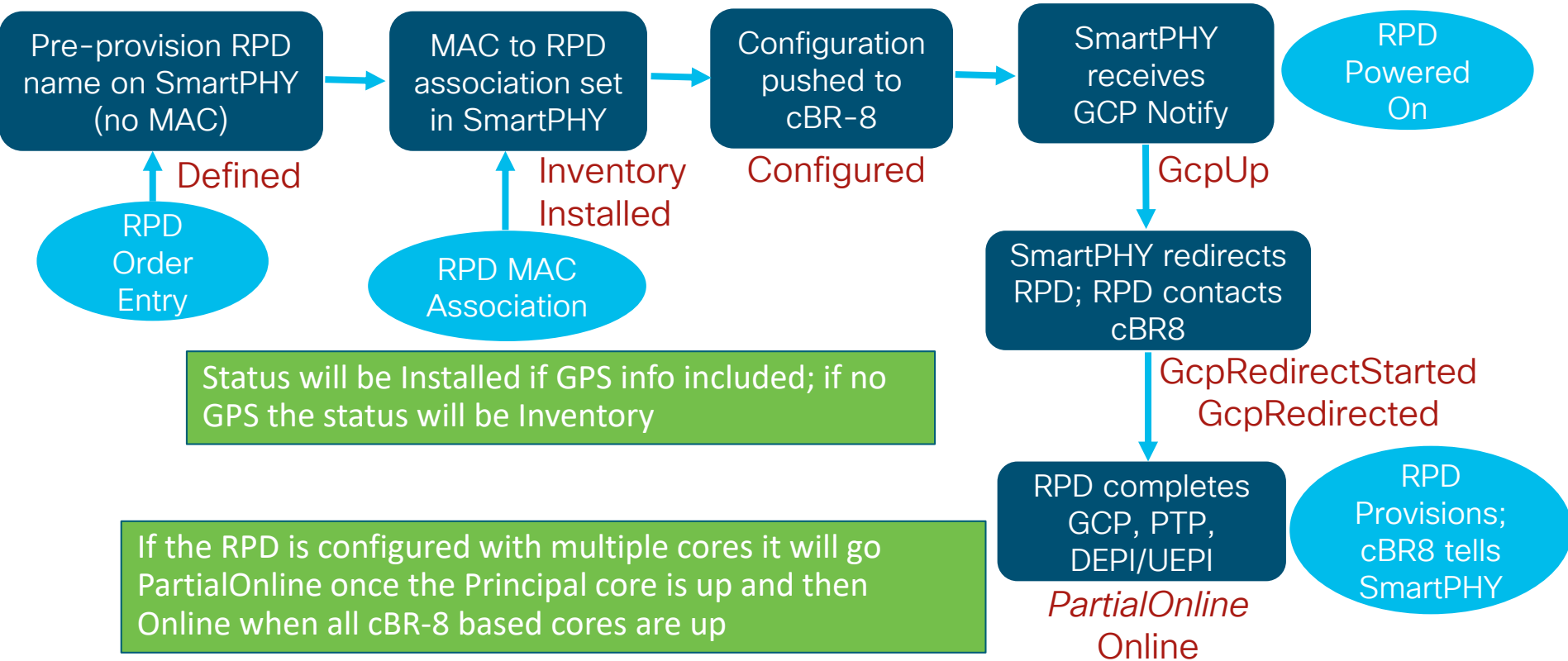
- Common Infrastructure
- API-Centric Design



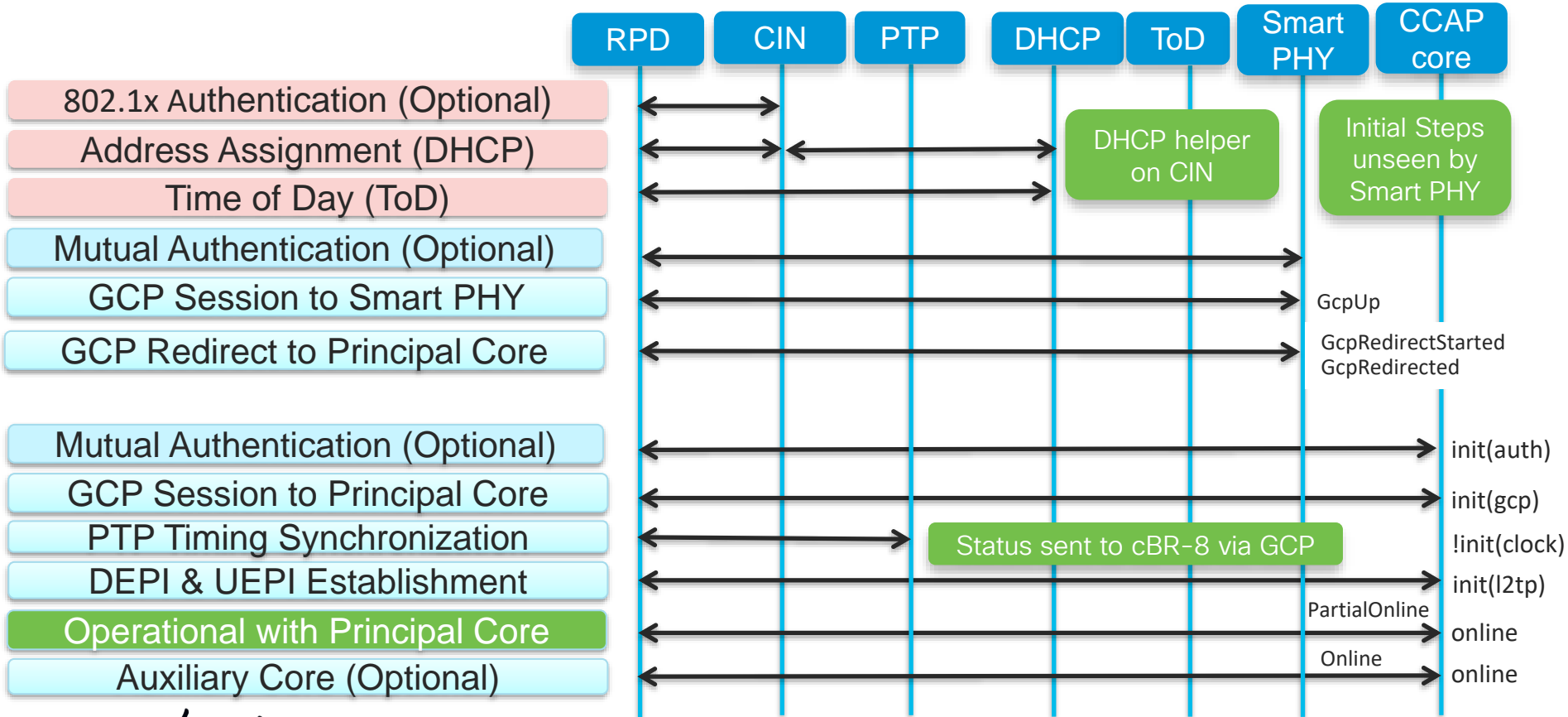
Advanced Monitoring & Troubleshooting



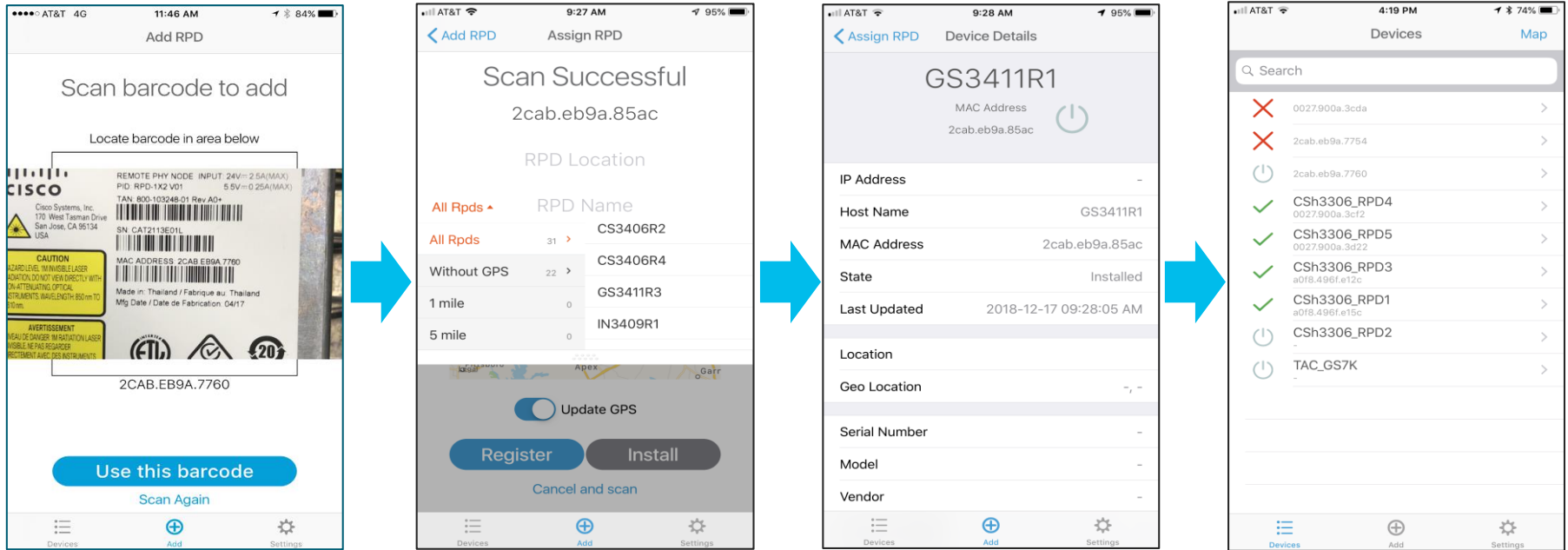
SmartPHY RPD States



RPD Initialization with Smart PHY



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

cisco *Live!*

Smart PHY Service Definition

Service Definitions

+ Create New

SystemTemplate (Default) Data only	0 Assigned
32x4_192OFDM_IPv4 Data only	29 Assigned
33x4_192OFDM Data , OOB	1 Assigned
96x4_192OFDM Data only	6 Assigned
96x4_192OFDM_BC Data only	1 Assigned
96x4_192OFDM_MDS lit Data only	4 Assigned
LB_Template Data only	0 Assigned

33x4_192OFDM

Selected 1 / Total 8

Name * 33x4_192OFDM Set as Default Search...

Description 32x4 SC-QAM, 192 OFDM

Event Profile * 1

R-DTI Profile * 1

Pilot Tone Profile 2

Cable DSG TGs Range from 1 to 65535. Separated by ',' semicolon

Primary Service Enable MAC Domain

Service Group Profile * 33x4

Downstream Controller Profile * 1

Upstream Controller Profile * 1

Network Delay (optional)

Network Delay

Out Of Band (optional)

Downstream VOM ID Range from 1 to 10

Downstream VOM Profile Range from 1 to 511

Upstream VARPD ID Range from 1 to 32

Upstream VARPD Profile Range from 1 to 511

Parameters include:

- RPD event profile
- RPD R-DTI profile
- Pilot tone profile
- Service group profile
- Primary service RPD DS controller profile
- Primary service RPD US controller profile
- Network Delay (DLM)
- Video out-of-band DS & US profiles (55-1)
- NDF/NDR PWs & profiles

Smart PHY RPD Assignment

Overview **RPD Assignment** Service Definitions Global Settings

Assign Service Definitions

Associate RPDs

Selected 0 / Total 46

Search...

RPD Name	MAC	Segmentation	Service Definition	CCAP...	CCAP Interface	DS Port	US Port	DS Data Ser...	US Data Servi
CS3306R5	0027.900a.3d22	1x1	96x4_192OFDM_MDSplit	F186-A9-CBR...	TenGigabitEthernet9/1/0	0	0	SG0	SG1

RPD to CCAP core pairings and service template associations can be imported via CSV file or manually added

Video Service G...	Video Interfaces	OOB Interface	D.	D	U	U	S	SSD Profile	C..	A.	D...	La...	Lon...	Description
BCVideo;NCVideo710	TenGigabitEthernet1/1/6;Te...										no			Compact Shelf in 33
BCVideo;NCVideo710	TenGigabitEthernet1/1/6;Te...										no			Compact Shelf in 34
BCVideo;NCVideo610	TenGigabitEthernet1/1/6;Te...										no			Compact Shelf in 34

- 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

Overview **RPD Assignment** Service Definitions Global Settings

Assign Service Definitions

Associate RPDs Selected 0 / Total 46

Assign Clear Details

Search...

Import CSV File

Browse

Download sample 'Associate RPDs template (*.csv)' file

Import Cancel

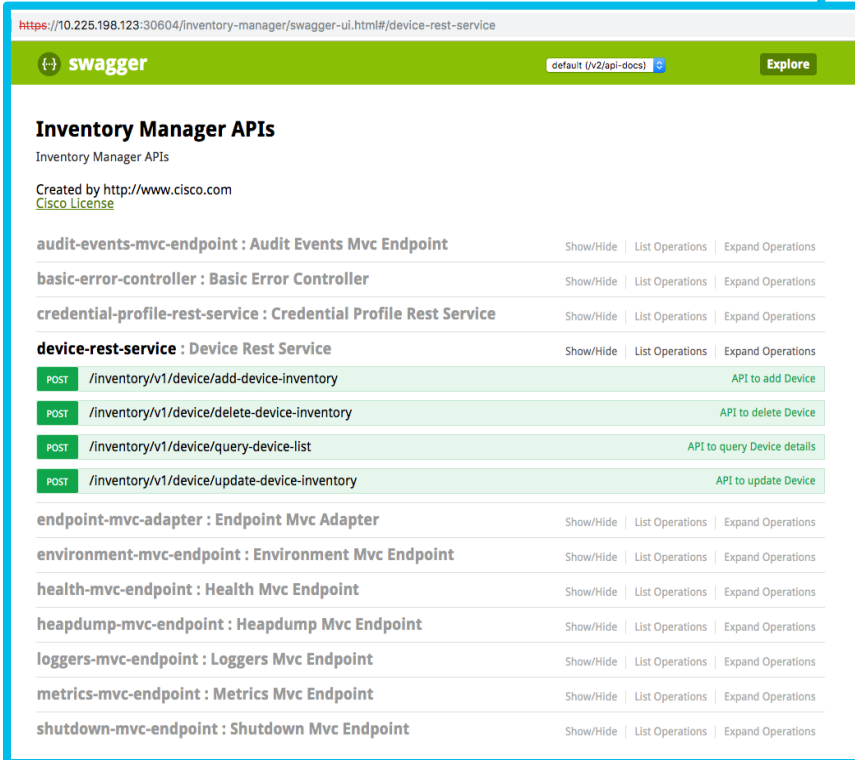
Sample file

Import from PC; can also get a sample template CSV file

J1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	RPD Name	RPD MAC	Service Definition	CCAP Core	SSD Profile	CCAP Core Interface	Downstream	Upstream D	Video Interfaces	Out	Data Prior	OC	Video Service Groups	Adc	RPD Latitude	RPD L
2	CS3306R5	0027.900a.3d22	96x4_192OFDM_MDSplit	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet9/1/0	SG0	SG1	-	-	0	-	-	-	-	
3	CS3406R5	a0f8.496f.ae5a	96x4_192OFDM_MDSplit	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet9/1/0	SG0	SG1	-	-	0	-	-	-	-	
4	CS3406R4	a0f8.496f.ae86	96x4_192OFDM_MDSplit	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet9/1/0	SG0	SG0	-	-	0	-	-	-	-	
5	CS3306R4	0027.900a.3cf2	96x4_192OFDM_MDSplit	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet9/1/0	SG0	SG0	-	-	0	-	-	-	-	
6	CS3306R0	a0f8.496f.e570	TLC_OFDMA	F186-A9-CBR8-01.ascable.cisco.com	-	2 TenGigabitEthernet2/1/0	-	-	-	-	0	-	-	-	-	
7	CS3403R3	a0f8.496f.ae20	32x4_192OFDM_IPv4	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet8/1/6	-	-	-	-	0	-	-	-	-	
8	CS3406R3	0027.900a.3cda	96x4_192OFDM_BC	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet7/1/0	DS701	DS701	TenGigabitEthernet1/1/6;TenGig	-	0	-	BCVideo;NCVideo710	-	-	
9	IN3409R1	7872.5dd5.e292	33x4_192OFDM	F186-A9-CBR8-01.ascable.cisco.com	-	1 TenGigabitEthernet1/1/2	DS120	US120	TenGigabitEthernet1/1/6	-	1	-	BCVideo	-	-	
10	CS3403R5	0027.900a.0c4a	32x4_192OFDM_IPv4	F241-36-05-CBR8-02.cisco.com	-	HundredGigE2/1/8	-	-	-	-	0	-	-	-	-	
11	CS3402R2	0027.900a.0632	32x4_192OFDM_IPv4	F186-A9-CBR8-01.ascable.cisco.com	-	1 TenGigabitEthernet2/1/4	-	-	-	-	0	-	-	-	-	
12	CS3406R0	a0f8.496f.ae98	96x4_192OFDM	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet2/1/0	DS201	US201	TenGigabitEthernet1/1/6;TenGig	-	0	-	BCVideo;NCVideo210	-	-	
13	CS3402R0	-	32x4_192OFDM_IPv4	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet1/1/4	-	-	-	-	0	-	-	-	-	
14	CS3402R3	0027.900a.0cf2	32x4_192OFDM_IPv4	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet3/1/2	-	-	-	-	0	-	-	-	-	
15	CS3403R2	a0f8.496f.adba	32x4_192OFDM_IPv4	F186-A9-CBR8-01.ascable.cisco.com	-	TenGigabitEthernet7/1/4	-	-	-	-	0	-	-	-	-	

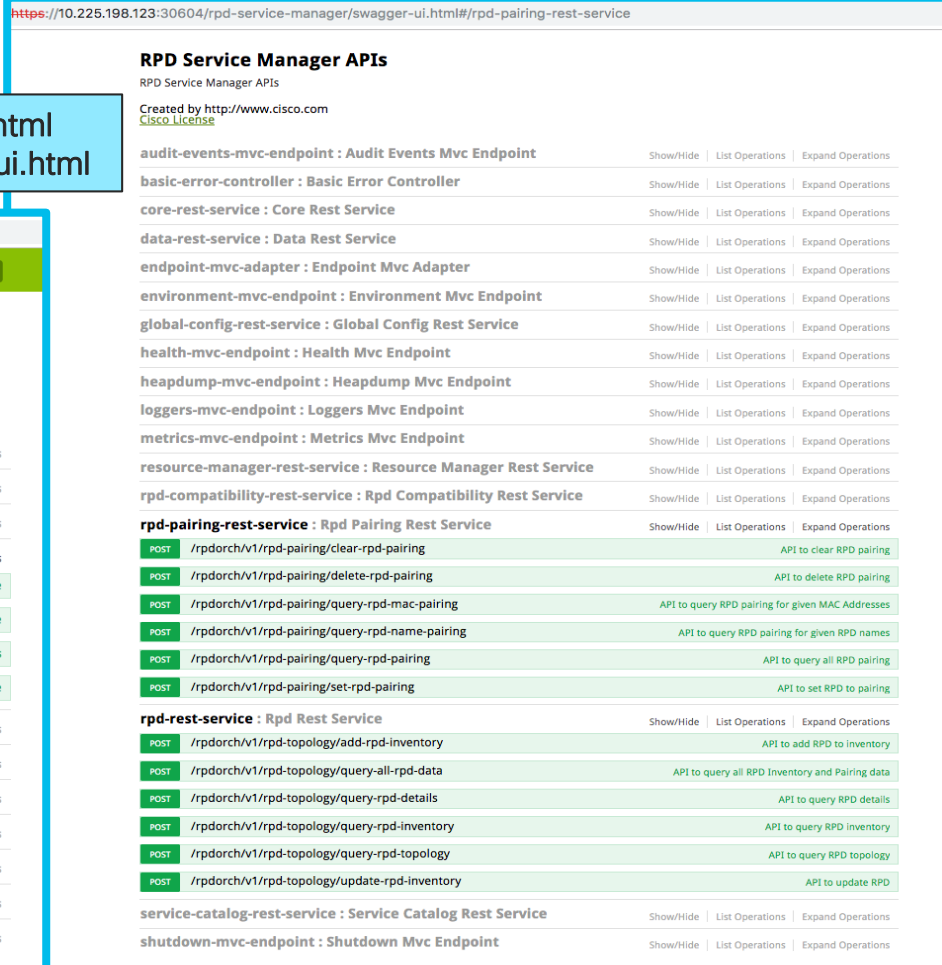
Smart PHY REST APIs

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



The screenshot shows the Swagger UI for the Inventory Manager APIs. The URL is <https://10.225.198.123:30604/inventory-manager/swagger-ui.html#/device-rest-service>. The interface includes a 'swagger' logo, a 'default (v2/api-docs)' dropdown, and an 'Explore' button. The main content area is titled 'Inventory Manager APIs' and lists various endpoints with their methods and descriptions.

Endpoint	Method	Description
audit-events-mvc-endpoint : Audit Events Mvc Endpoint		
basic-error-controller : Basic Error Controller		
credential-profile-rest-service : Credential Profile Rest Service		
device-rest-service : Device Rest Service		
POST /inventory/v1/device/add-device-inventory	API to add Device	
POST /inventory/v1/device/delete-device-inventory	API to delete Device	
POST /inventory/v1/device/query-device-list	API to query Device details	
POST /inventory/v1/device/update-device-inventory	API to update Device	
endpoint-mvc-adapter : Endpoint Mvc Adapter		
environment-mvc-endpoint : Environment Mvc Endpoint		
health-mvc-endpoint : Health Mvc Endpoint		
heapdump-mvc-endpoint : Heapdump Mvc Endpoint		
loggers-mvc-endpoint : Loggers Mvc Endpoint		
metrics-mvc-endpoint : Metrics Mvc Endpoint		
shutdown-mvc-endpoint : Shutdown Mvc Endpoint		



The screenshot shows the Swagger UI for the RPD Service Manager APIs. The URL is <https://10.225.198.123:30604/rpd-service-manager/swagger-ui.html#/rpd-pairing-rest-service>. The interface includes a 'RPD Service Manager APIs' title and a 'Created by http://www.cisco.com Cisco License' note. The main content area lists various endpoints with their methods and descriptions.

Endpoint	Method	Description
audit-events-mvc-endpoint : Audit Events Mvc Endpoint		
basic-error-controller : Basic Error Controller		
core-rest-service : Core Rest Service		
data-rest-service : Data Rest Service		
endpoint-mvc-adapter : Endpoint Mvc Adapter		
environment-mvc-endpoint : Environment Mvc Endpoint		
global-config-rest-service : Global Config Rest Service		
health-mvc-endpoint : Health Mvc Endpoint		
heapdump-mvc-endpoint : Heapdump Mvc Endpoint		
loggers-mvc-endpoint : Loggers Mvc Endpoint		
metrics-mvc-endpoint : Metrics Mvc Endpoint		
resource-manager-rest-service : Resource Manager Rest Service		
rdp-compatibility-rest-service : Rdp Compatibility Rest Service		
rdp-pairing-rest-service : Rpd Pairing Rest Service		
POST /rpdorch/v1/rpd-pairing/clear-rpd-pairing	API to clear RPD pairing	
POST /rpdorch/v1/rpd-pairing/delete-rpd-pairing	API to delete RPD pairing	
POST /rpdorch/v1/rpd-pairing/query-rpd-mac-pairing	API to query RPD pairing for given MAC Addresses	
POST /rpdorch/v1/rpd-pairing/query-rpd-name-pairing	API to query RPD pairing for given RPD names	
POST /rpdorch/v1/rpd-pairing/query-rpd-pairing	API to query all RPD pairing	
POST /rpdorch/v1/rpd-pairing/set-rpd-pairing	API to set RPD to pairing	
rdp-rest-service : Rpd Rest Service		
POST /rpdorch/v1/rpd-topology/add-rpd-inventory	API to add RPD to inventory	
POST /rpdorch/v1/rpd-topology/query-all-rpd-data	API to query all RPD Inventory and Pairing data	
POST /rpdorch/v1/rpd-topology/query-rpd-details	API to query RPD details	
POST /rpdorch/v1/rpd-topology/query-rpd-inventory	API to query RPD inventory	
POST /rpdorch/v1/rpd-topology/query-rpd-topology	API to query RPD topology	
POST /rpdorch/v1/rpd-topology/update-rpd-inventory	API to update RPD	
service-catalog-rest-service : Service Catalog Rest Service		
shutdown-mvc-endpoint : Shutdown Mvc Endpoint		

API Example #1 using CURL

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

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

```
{"status":"Success","nextFrom":null,"deviceKey":  
"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,"modelName":""}
```

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

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The screenshot displays the Postman interface with a REST client request for 'query RPD Pairing'. The URL is `https://110.225.198.123:30604/.../rpd-service-manager/rpdorch/v1/rpd-pairing/query-rpd-pairing`. The request method is POST. The Headers tab is active, showing three headers: Content-Type (application/json), Accept (application/json), and Authorization (Basic YWRtaW46YWRtaW4=). The Body tab is also active, showing a JSON response in Pretty view. The response is a success message with a list of RPD pairing details.

```
POST https://110.225.198.123:30604/.../rpd-service-manager/rpdorch/v1/rpd-pairing/query-rpd-pairing
```

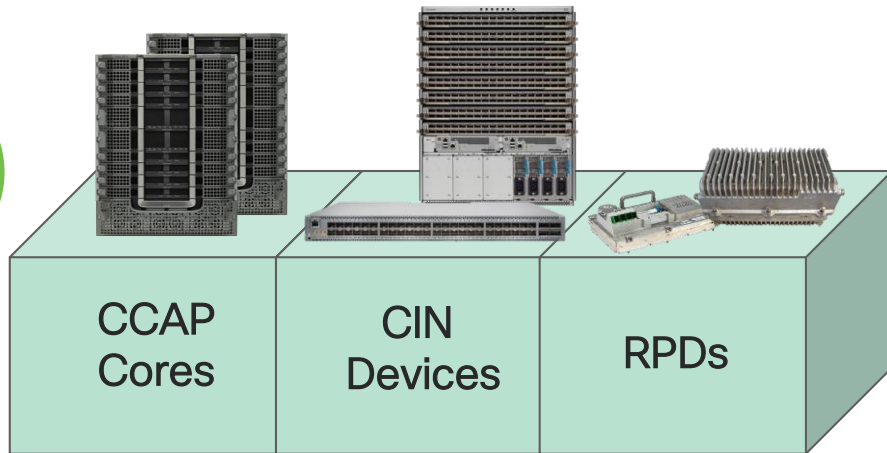
Headers (3)

KEY	VALUE
Content-Type	application/json
Accept	application/json
Authorization	Basic YWRtaW46YWRtaW4=

Body

```
1 {
2   "status": "Success",
3   "rpdPairingRspList": [
4     {
5       "macAddress": "484d412b1325",
6       "name": "H53303L0R5",
7       "serviceTemplate": "32x4_1920FDM_IPv4",
8       "approvalState": "Approved",
9       "assignedCores": [
10        {
11          "serviceType": "Data",
12          "mgmtCore": "F241-36-05-cBR8-02.cisco.com",
13          "rpdConnectionInterface": "TenGigabitEthernet1/1/2",
14          "primaryUsPort": 0
15        }
16      ],
17       "pairingChangeTimestamp": 1553182138129,
18       "description": "HA Shelf in 33-3 LC 0 RPD 5",
19       "state": "Online",
20       "gpsLocation": {
21         "genericLocation": ""
22       }
23     }
24   ]
25 }
```

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

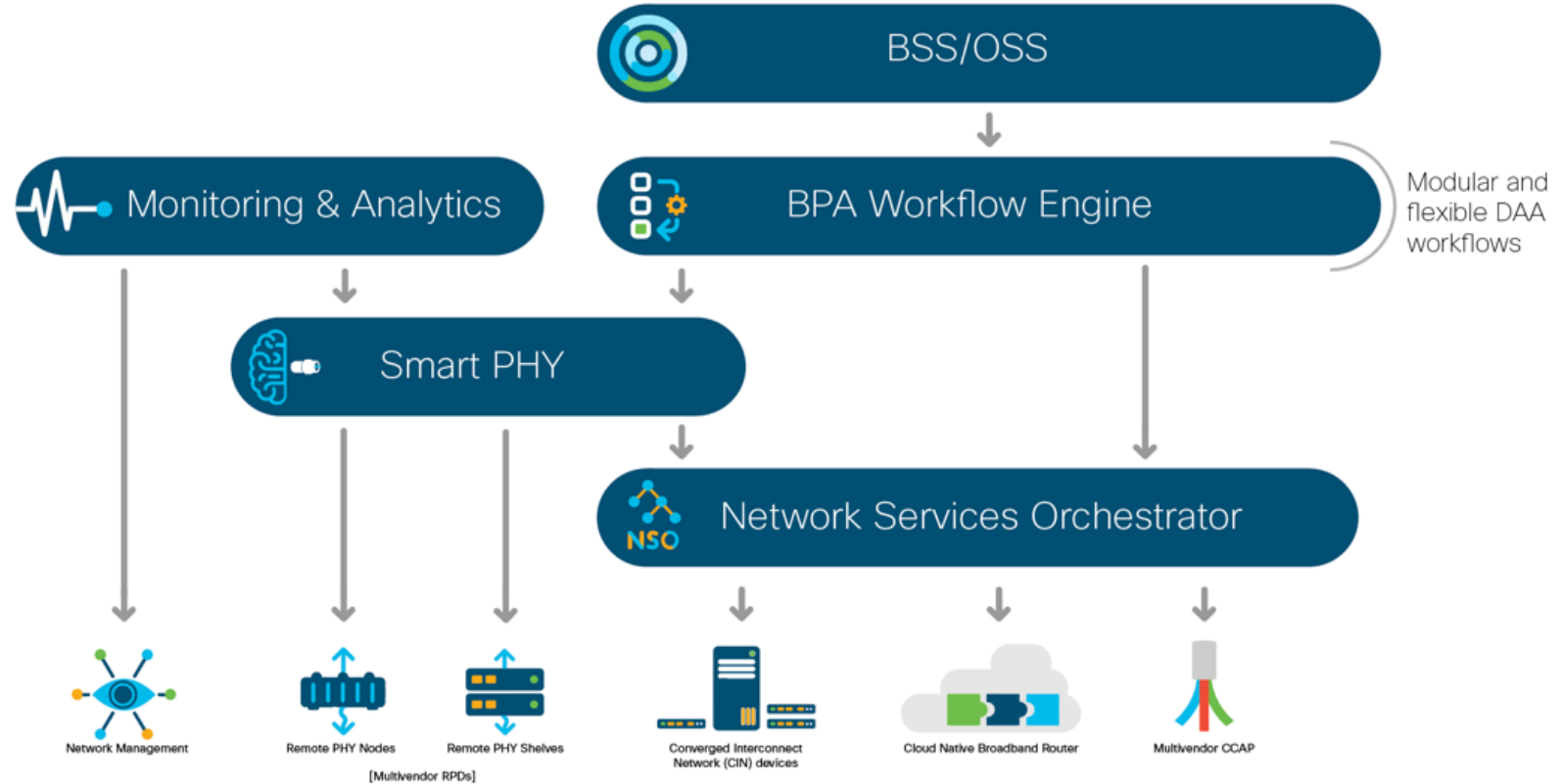


Increased
Deployment
Success Rate

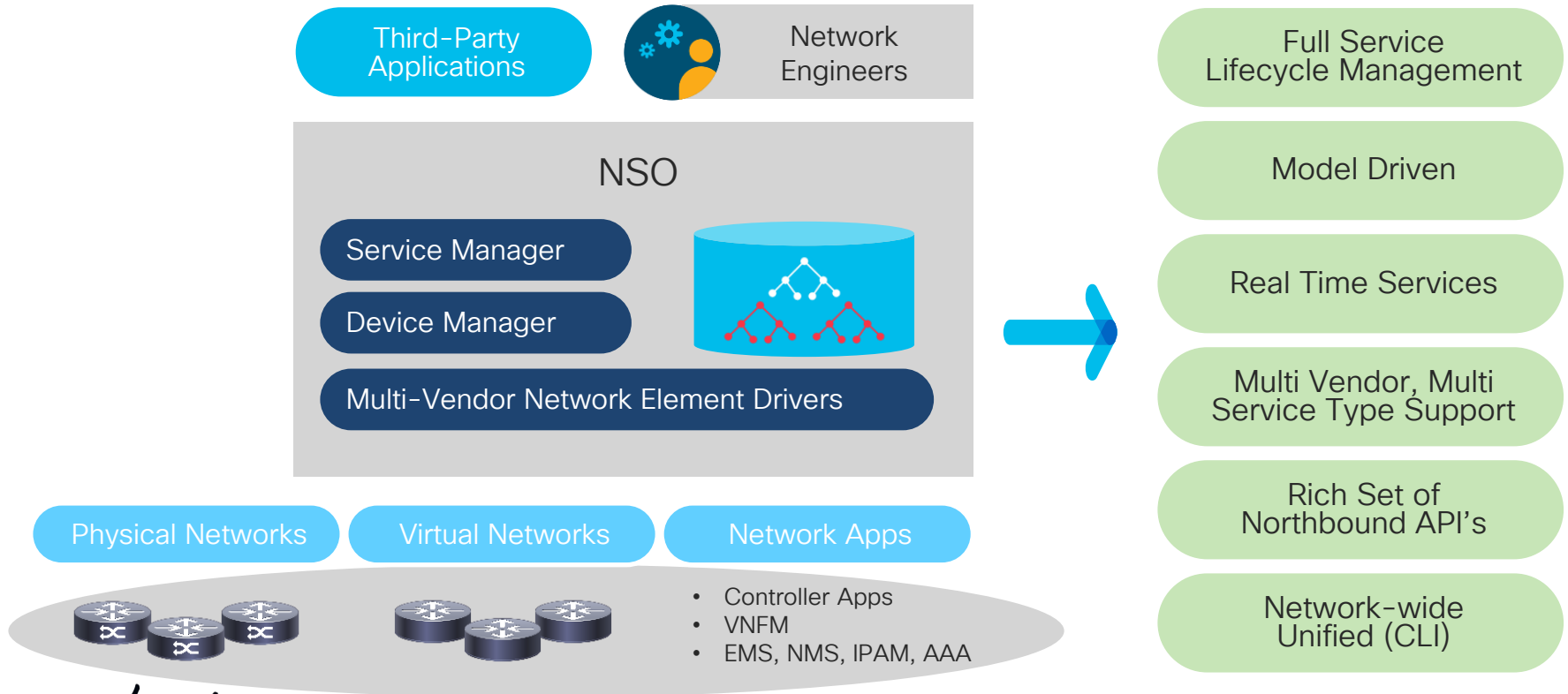


Guarantee network standardization

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



Dashboard



Service Center



Form Builder



Device Manager



OS Upgrade



Process Templates



Golden Config Templates



Config Validator



Workflows



Service Topology



Network Topology



Market Variances



Device Activation



Migration



Service Catalog



Commit Manager



Smart PHY Manager



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						initRC	initD	initIO	initO	Description
	Total	Reg	Oper	Unreg	Offline	Wideband					
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

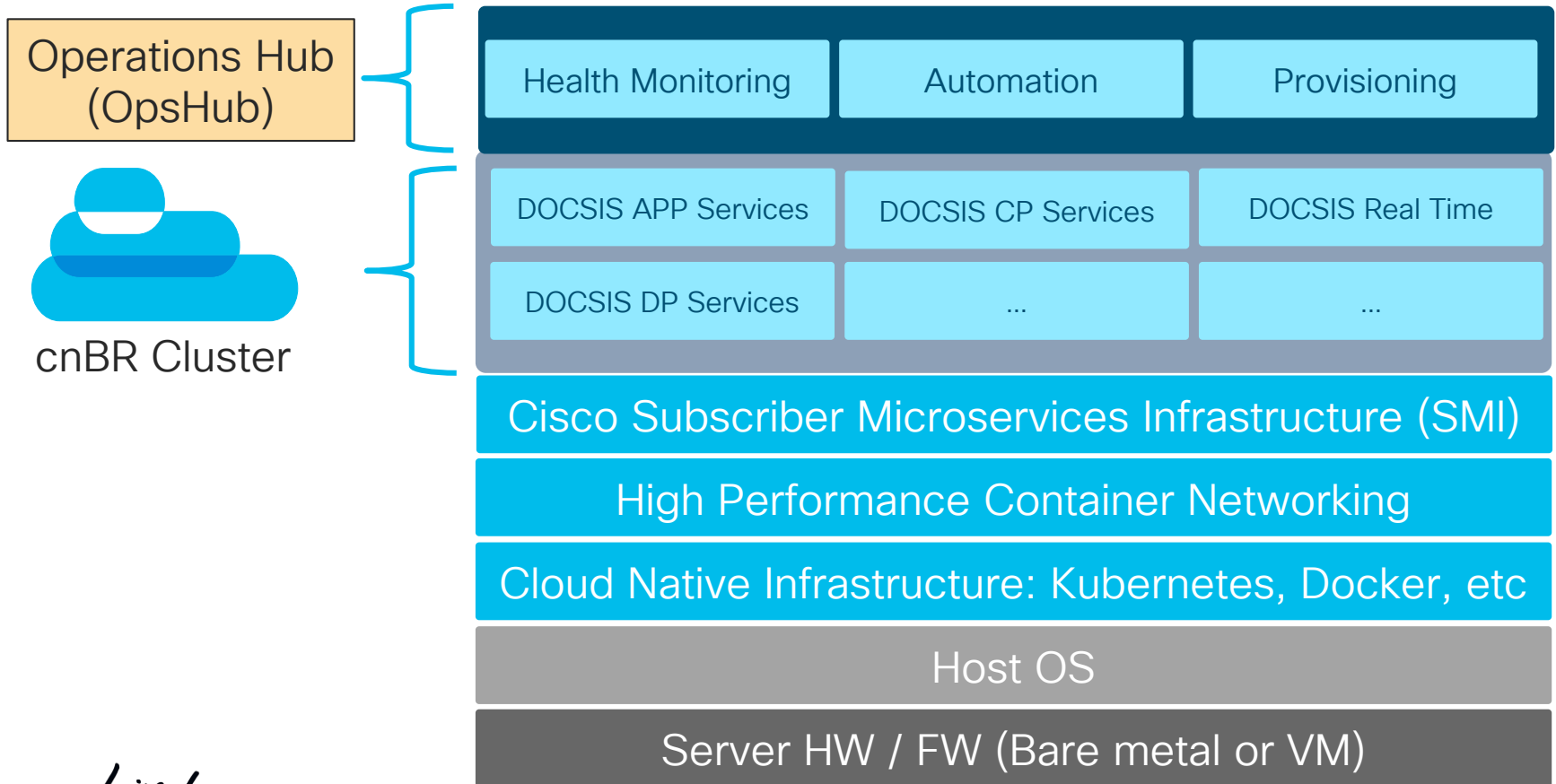
Microservices architectural pattern for high portability, scalability, and elasticity. Moving from SNMP and CLI to API and dashboard driven architecture.



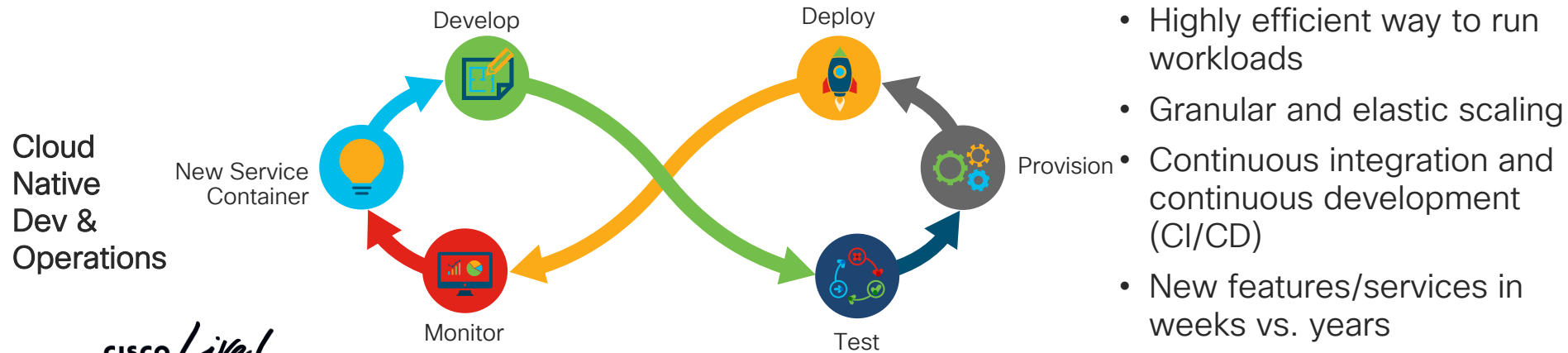
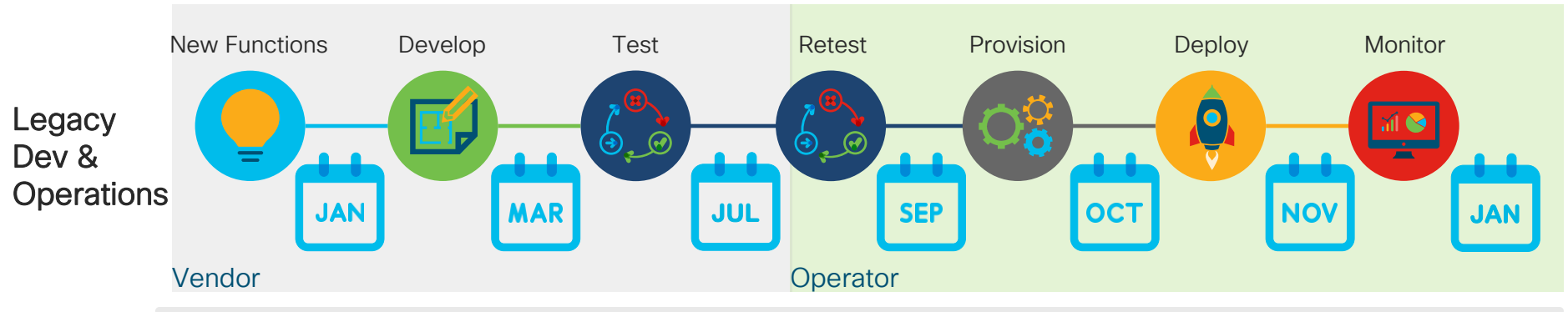
Automation & API Driven

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

cnBR Layered Architecture



Legacy vs. Cloud Native Broadband Router



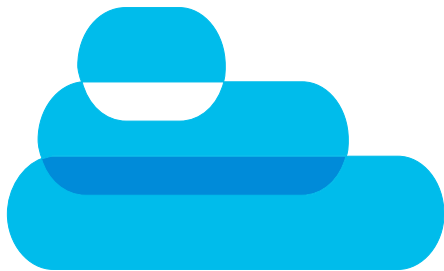
- Highly efficient way to run workloads
- Granular and elastic scaling
- Continuous integration and continuous development (CI/CD)
- New features/services in weeks vs. years



cnBR Operations Hub (OpsHub)

TODAY

- 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



cnBR

CISCO *Live!*

- 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

OpsHub Applications

Health Monitoring	Configuration	Accounting	Performance	Controllers	Security
<ul style="list-style-type: none">• Service Health• Network Health• System Health• CCAP health• CIN Health• RPD Health	<ul style="list-style-type: none">• cnBR Deployer• RPD Configuration• CIN Configuration• iNode Manager• RPD Move• SmartPHY• Image Management• Software Upgrade• Ops Automation	<ul style="list-style-type: none">• Inventory• Usage metrics• Fault metrics• Audit metrics• Analytics	<ul style="list-style-type: none">• D3.1 Profile Optimization• RF Optimization• Capacity Planning• CIN optimization• End to End optimization	<ul style="list-style-type: none">• GCPP Core• GCP Redirect• Aux Core• Cross Domain Orchestration (SmartPHY 2.0)	<ul style="list-style-type: none">• Authentication• Infra security• Application security

Summary

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- 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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Thank you





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