Transforming the Cable Access Network with Remote PHY

Cisco Knowledge Network Webinar
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Remote PHY Overview and Market

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Polling Question

• When will your company begin RPHY deployments?
  • Already started
  • Next year (2019)
  • 2 to 5 years out
  • More than 5 years away
  • What is RPHY?
Distributed Access Drives Change

- RPHY distributes DOCSIS PHY across hubs and nodes
- Saves rack space and power with FD growth, reducing CAPEX and OPEX
- Makes an analog network, an IP network
- Provides the foundation for cloud native CMTS
• With HA limited to 56 SGs due to limit of 56 DS ports and 112 US ports

• Linear fiber may limit achievable MER (max 38-40 dB)
  • Linear fiber distance limited and supports fewer usable wavelengths

• DOCSIS 3.1 modems MAY be unable to use higher order modulations
Remote PHY Evolution

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

- Digital fiber enables higher MER (43-45db)
- Supports 3-4x more wavelengths
- Links could be over a L2 or L3 CIN

- RPD – Remote PHY Device
- R-PHY module can be added to existing nodes

- DOCSIS 3.1 modems now able to use higher order modulations
The Cisco Remote PHY Solution

• Open Standards compliant, the only Standard in town...
• First company to submit R-PHY Code for the RPD to Open Source
• Partnering and interoperability validation of Remote PHY
• First company to bring multiple Remote PHY Devices (RPDs) to market
  – GS-7000 1x2 and 2x2 BAU RPD
  – RPD Shelf in compact and Full HA modular form factors
• Minimal Core Changes
  – cBR-8 only requires a change to a DPIC, beyond that it’s just a software upgrade
  – Instantly doubles the number of Service Groups to 16 per LC
  – Virtual Splitting and Combining capabilities
Interoperability – Core and RPD

Cisco Core Interoperability

Cisco RPD Interoperability

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Market Status

• Comcast and Cox have publicly committed to RPHY
• Cisco has delivered over 10,000 RPDs to date
• Active rollout of RPD’s ongoing at Tier 1 MSOs in the US
• Dozens of shelf customers worldwide are replacing aging CMTS equipment
• Lab trials and field trials with almost every MSO WW
• OpenRPD worked, enabling RPD market particularly in EMEA & APJC
• Beginning to see conversation shift to ‘virtual’
Cisco Remote PHY Portfolio

1. **cBR-8**
   - Features:
     - RPHY Core
     - Enablement with D-PIC

2. **GS7000 / iNODE Remote PHY 120**
   - Features:
     - GS7000 SHO Node
     - iNODE
     - 1x2 RPD

3. **Remote PHY 300/600**
   - Features:
     - RPHY Compact Shelf
     - 1RU 3/6 SG
     - Small HUB

4. **GS7000 Remote PHY 220**
   - Features:
     - GS7000 BAU Node
     - 2x2 BAU RPD

5. **Remote PHY 7200**
   - Features:
     - RPHY High Availability Shelf
     - 7RU 72SG
     - 12+1 HA
     - Medium to large hub

6. **FDX Capable NODE / RPD**
   - Features:
     - FDX Capable Node
     - RPD Operates in Legacy or FDX Mode
     - Full Spectrum FDX

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cBR-8 Core and Remote PHY Module
Evolving Cable SP Network Architectures

Benefits

• Scaling service groups beyond the port capacity of the traditional CMTS

• Decoupling the scaling from dependency on the integrated PHY ports

• Allowing Digital Fiber / Ethernet to be driven deeper into the network

• Enabling migration to a cloud-centric ecosystem focused on service velocity and value creation
Why RPHY in the Node?

Consolidation to leverage CMTS Capacity
- Enables Cloud Native CMTS migration
- Enables Ethernet to the node which increase plant value
- Increased core scaling
- Enables hub site consolidation
- Lower hub power consumption
- Lower optics costs (10G)
- Linear fiber from headend or data center to node
Remote PHY 120 RPD

- Supported by GS7000 BAU, SHO nodes and iNODE
- Designed for fiber deep architectures
- 1x1 or 1x2 service group support
- Full Spectrum D3.0 and D3.1 capable HW
  - 160 DS QAMs
  - 6 blocks 192MHz OFDM
  - 12 US channels (12 ATDMA or 8 ATDAM + 4 SCDMA)
  - 2 blocks 96MHz OFDMA
- Video QAM and 55-1,2 support
- Integrated FFT enables advanced spectrum monitoring of entire 0 to 300 MHz upstream
- NDR/NDF support
- Shipping in volume!
Remote PHY 220 BAU RPD

- Supported by GS7000 BAU node
- Supports two 1x1 service groups
- Full legacy spectrum D3.0 and D3.1 support
- FPGA based PHY enables flexible channel plans for evolving networks
  - Deploy Day1 with 96 BC QAM, 32 DS NC QAM and 1 OFDM - migrate to 2 OFDM in the future via firmware upgrade
  - 4 US ATDMA channels per port
  - 1 block 48Mhz OFDMA per port
- Video QAM and 55-1,2 support
- Integrated FFT enables advanced spectrum monitoring of entire US spectrum on both ports
- NDR/NDF support
- Available NOW!
FDX Node & RPD

- Future proof node platform
- Common node platform as all GS7000
- Supports fiber deep applications
- New FDX capable RPD
  - Operates as RPHY 1x2 or FDX 1X1
  - DPD for reduced power
  - Full spectrum FDX
  - FDX EC
- Field characterization now!
- Node available mid-2019
- FDX RPD late 2019
Why RPHY in the Shelf?

Consolidation to leverage CMTS Capacity
- Enables Cloud Native CMTS
- Enables hub site consolidation
- Increased core scaling
- Lower hub power consumption and smaller footprint
- Increase in supported segments on the CMTS (2x/4x)
- Enables DOCSIS 3.1 for rural regions
- Linear fiber from headend or data center to node
Remote PHY 300/600 Compact Shelf

Features
- 3x6 and 6x12 SG Configurations
- Packages QTY 3 or 6 GS7000 (1x2) RPD Modules
- 1+1 modular power supplies (AC and DC Options)
- N+1 modular fans
- Total power budget: 320/530 W max
- Stackable for greater SG densities
- 1.75” (H) x 17.45” (W) x 23.6” (D)
- -40°C to 60°C, -200 to 13,700ft
- Shipping and deployed in production

Monitoring and Management
- Open RPD and standards compliant
- Managed as an extension of cBR-8 digital PIC port
- Power supply and fan status reported by cBR-8
- Local interfaces for connection faulty diagnosis
- Smart PHY integration
Remote PHY 7200
High Availability RPHY Shelf

Chassis Size:
• 7RU, 19" rack mount chassis (10.5" H x 17.3" W x 24" D)
• 13 slots for RPD line cards (6 DS x12 US, total 18 physical ports each)

Capacity:
• 72 DS SG (1x2 ratio) with redundancy
• Each RPD line cards contains six 1x2 RPD modules (6x12)
• 160 narrowcast QAMs or 6 x192 MHz OFDM blocks per service group
• 12 US channels or 2 OFDMA blocks (96 MHz) per port
• 96 broadcast QAMs per RPD line card (shared across ports)
• Downstream frequency range:54MHz – 1,218 GHz
• Upstream frequency range:5MHz – 204 MHz

Power Supplies:
• cBR-8 power supplies
• 2 + 2 redundancy for both AC and DC applications.
• Chassis power budget ~ 3800W

Fan Shelf:
• N+1 fan Configuration (4+1) – operates indefinitely with 1 fan failure
• System can operate during fan tray replacement

Supervisor-less Design

High Availability
High Density
Power Efficient
Standard Compliant
OSS Support

Leakage Detection and Pilot Tones
• 4 Dedicated Tone Generators
• Any QAM can be configured to generate a tone
• Integrated with CommsOnics, Trialithic and Arcomm leakage detection meters

SCTE55–1 and 2 OOB
• Supported in RPD PHY

Return Path Monitoring
• Support for narrowband monitoring via cBR-8 MIBs
• Wideband return path monitoring via triggered spectrum management
• Integrated with leading tool vendors

Modulated OOB (FM, HMS Transponders, DAB/Digital Radio)
• Supported by NDR/NDF
• Currently integrated with NDR/NDF Headend Converter Devices
Cable Automation and Orchestration

Ben Bekele
Director, Product Management
Core Cable Access Strategy

Digitize
- DAA/RPHY

Virtualize
- Cloud CCAP

Densify
- FDX & MBH

Crosswork

Automate
- Enabled by IP, Open Source and Data - Powered by Innovation

Cable Apps
Major Barrier To Transformation: Complexity
Time-consuming, rigid operations, high operations costs—cannot scale!

- Plan
- Design
- Procure
- Install
- Configure
- Secure
- Operate
- Optimize

Inhibits Innovation
Inhibits New Markets
Inhibits Business Agility
From Complexity to Simplicity with Automation
A Platform for Innovation

From Months to Minutes

Plan
Design
Automated Self-Service On-Demand
Optimize

Service Oriented
Self-Service Automated Provisioning
Elastic (Capacity on Demand)
Improved Customer Outcomes with Automation

**Time to Value**
- Configuration & Change Automation
  - Faster Customer Service Onboarding: 78%
  - Faster Execution of Change Requests: 81%

**Time to Remediation**
- Automated Fault Remediation
  - Faster Execution of Maintenance Procedures: 84%
  - Improvement in Mean Time to Repair: 70%

Specific improvements vary and depend on many factors
Source: Cisco Automation Benchmark of 5 SP Customers
Polling Question

- Where should operators focus their automation efforts when it come to DAA & Cloud?
  - Operations
  - Configuration
  - Optimization
  - Assurance
  - All of the above
Cable Automation Application Focus Areas
For DAA & Cloud CMTS Architecture

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Status Monitoring</th>
<th>Trending &amp; Reporting</th>
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</thead>
<tbody>
<tr>
<td>• Provisioning and activation</td>
<td>• Topology – Service and Network</td>
<td>• Network capacity</td>
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<td>• Software upgrade</td>
<td>• CCAP, RPD, CIN status/health</td>
<td>• SG/User BW utilization</td>
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<td>• Move, decommission RPDs</td>
<td>• Capacity utilization</td>
<td>• RF health</td>
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<td>• Node split</td>
<td>• RF – Upstream spectrum</td>
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<tr>
<th>Assurance</th>
<th>Planning</th>
<th>Insights &amp; Optimization</th>
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<tr>
<td>• Capacity</td>
<td>• Capacity planning</td>
<td>• MTTR improvement</td>
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<tr>
<td>• Network SLA</td>
<td>• Plant maintenance planning</td>
<td>• Bandwidth optimization</td>
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<tr>
<td>• Firmware management</td>
<td>• Node split planning</td>
<td>• Node cluster power management</td>
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<td>• Cloud CMTS migration planning</td>
<td>• OFDM profile management</td>
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Cable Automation Architecture

**Design time**
- Workflow Automation
  - BPMN Workflow Mgr
  - Asset Inventory
  - Controller
- Cable Automation Core Applications
  - SmartPHY
  - I-Node Mgr
  - Cloud CMTS Mgr

**Run time**
- Business Process Automation
  - Onboarding
  - SW Upgrade
  - Change Request
- Common Portal
  - Portal/UI
- Correlation and Insights
  - Monitoring & Assurance
    - Monitoring
    - Assurance
    - Service Topology
    - Network Topology

**External Application**
- API Manager or Kafka Bus for External Application

**Common Portal**
- SP BSS/OSS
- Remedy
- ServiceNow
- Granite

**Monitoring & Assurance**
- Monitoring Platform
- Network Optimization Engine
- Common Data Collector

**Correlation and Insights**
- ServiceNow
- Remedy
- Common Portal

**Service Topology**
- Change Request
- SW Upgrade
DAA & cnBR Automation Use Cases
Customized using the baseline use cases

Operations Automation
- Day 0, Day 1, Day 2, Day N Operations
- Device Onboarding – CCAP, CIN, RPD
- Device configuration – CCAP, CIN...
- Service onboarding
- MOP process automation
- Device Lifecycle Management
- Software upgrade process

Monitoring & Assurance
- Topology– Physical & Network
- Device visualization
- CCAP, RPD, CIN status/health
- Capacity utilization
- RF monitoring
- Upstream spectrum capture
- PNM
- Root cause analysis – MTTR improvement

Platforms
- BPA
- NSO

Platforms
- DataMiner
- Crosswork Situation Manager

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High Level DAA Onboarding Workflow – Day 0

**Elements** - RPD, CIN and CCAP Core

**Operation** - Install, configure and activate DAA

**Operations Flow**
CCAP and RPD Onboarding Automation
Cable Automation - Applications Dashboard

- Device Onboarding (RPD, CIN, CCAP...)
- Network Optimization
- Network Monitoring
- Capacity Planning
- cnBR Migration Analysis
- Workflows
- Config Audit/Golden Config
- Service Group Migration
- Network & service Assurance
- Node Split Planning
- Inventory Mgmt
- Device Lifecycle Mgmt
- cnBR Onboarding
- Software Upgrade
- Topology Mgmt
- Network/Plant Maintenance Planning
- Network Insights, Reporting and Trending
- Service Lifecycle Mgmt

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Smart PHY

Remote PHY Deployment Automation

Gitesh Shah
Product Manager
Cable Automation & Orchestration Suite

- Smart PHY
- iNode Manager
- cCMTS Manager

Applications

Physical and virtual network functions

- cBR-8
- RPHY
- Intelligent Node
- Cloud CMTS
- Resource Optimization

Cable Orchestration and Automation
Current RPD Deployment Challenges

• Manual Configuration
  – Error prone at scale
  – Difficult to keep track of resources used
  – Per RPD configuration

• Provisioning Requirements
  – DHCP Server must know the CCAP/Video Cores
    ▪ Inflexible load balancing
  – Validation and debugging manually
  – Monitoring based on Syslog messages

• Change Operations such as RMAs and Splits
Automated RPD Deployment

- In large scale RPD deployment, automation is a must
  - Dozens of steps per RPD
  - 250-500 RPDs per cBR-8
  - 100s of cBR8s in typical network / region

- Key steps for RPD deployment automation
  - Initial RPD Discovery
  - RPD grouping into SGs
  - SG to cBR MAC resource mapping
  - Config generation and application to cBRs
  - RPD deployment validation
  - Ongoing health Monitoring
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
- Cloud Infrastructure
- API-Centric Design

Advanced Monitoring & Troubleshooting

Request Network Access
Smart PHY
Automated Resource Mapping
Network configuration change (Yang Runtime)
RPD Configuration
CCAP/Video Cores
Remote PHY Devices
Cloud Native Software Architecture
Smart PHY 2.0 Architecture

- Common micro-service platform as cnBR and iNode Manager
- Kubernetes platform for micro-service orchestration
- Multi-node clustering for SW resiliency, HW redundancy and load-balancing
- Critical infrastructure (i.e. Cassandra DB) with multiple replicas across the cluster
Cable Automation & Orchestration Architecture

```
Smart PHY
  GCP
  Rpd SvcMg
  Zookeeper
  Cassandra
  Tric-UI
  Tric-BE
  Logstash
  Elastic search
  Kafka

iNode Manager
  iNode Mgr

API-GW
  UI

Inventory

Docker
K8
Host OS
```

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Transforming Cable with Automation
Executive Summary

- Element and Architecture Lifecycle Management
- Automate Network Operations
- Monitor and Optimize Network Performance
- Provide Real-Time Analytics and Insights

Operator Cross Domain Workflow Automation and Orchestration

End to End Network Monitoring and Optimization

Real Time Analytics, Insights and Correlation
Q&A