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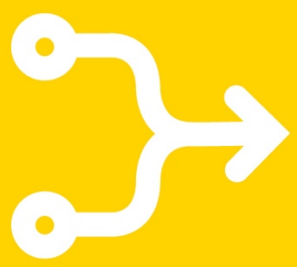

Creating The Intelligent Edge

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CommScope

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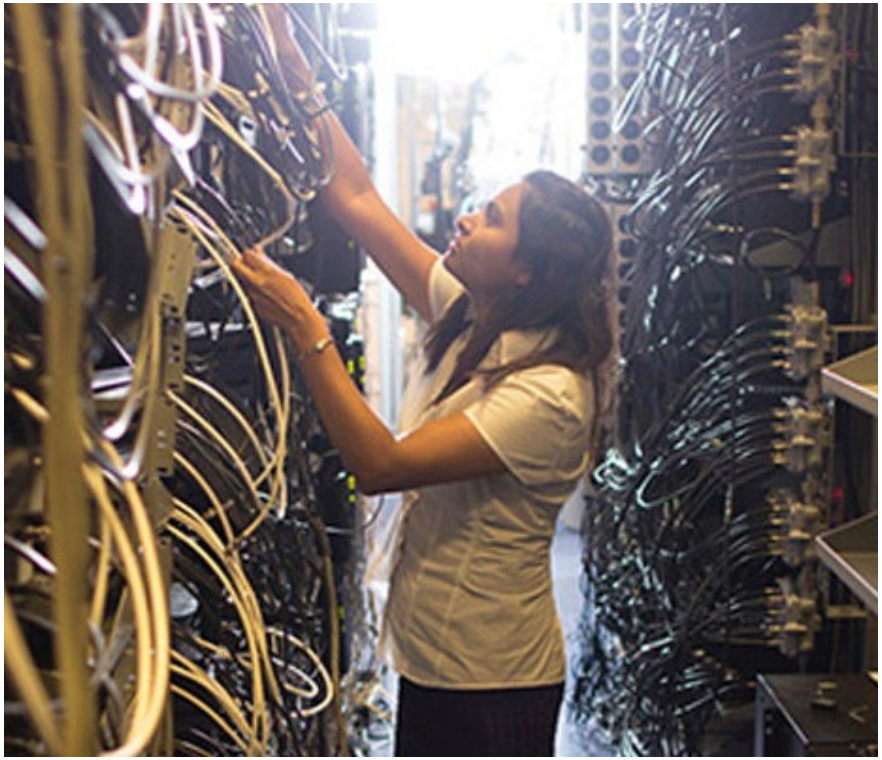


People of ARRIS

What is an Intent?

Declaration of the Business Goal

Service to be delivered

Lifecycle that is monitored

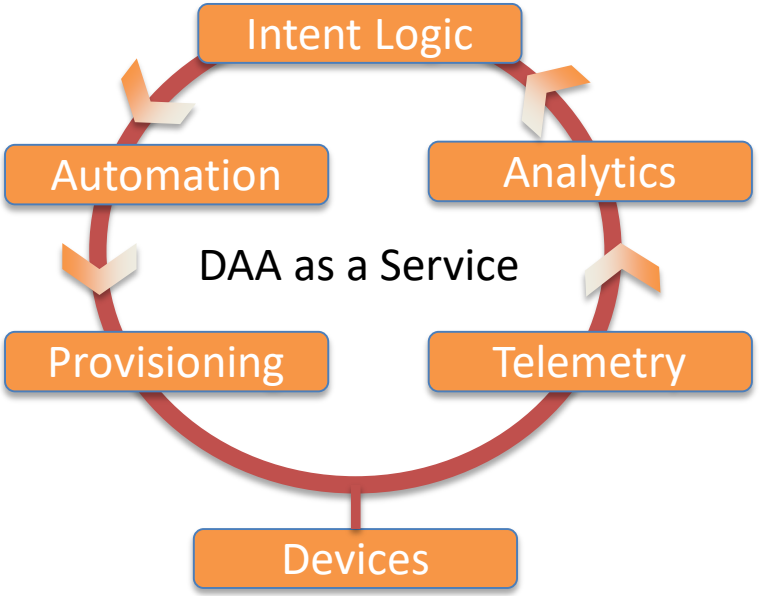
Automation of multi-vendor ‘things’

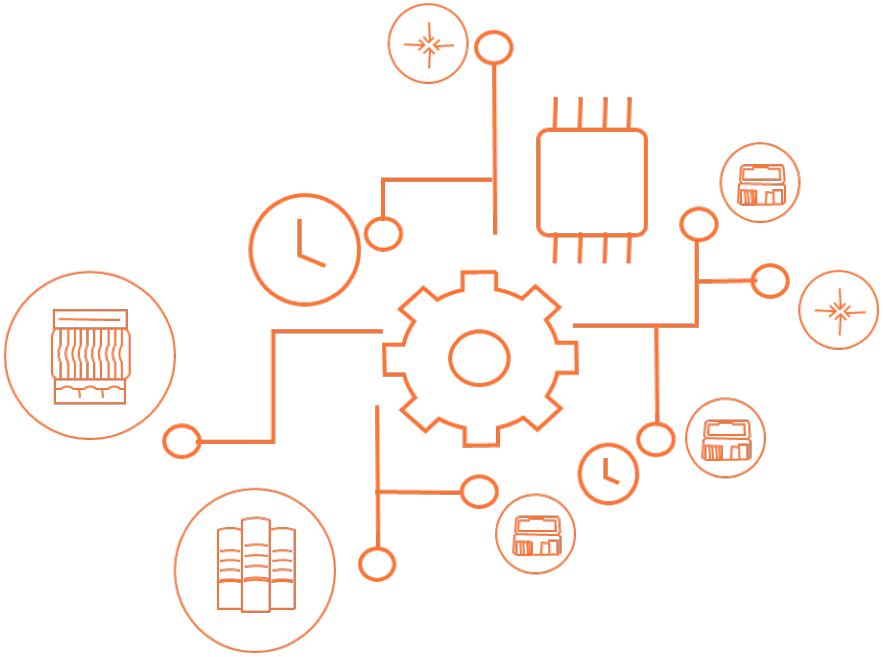
Activation / Fulfilment in End to End terms

Intent Based Networks

The new term to encapsulate general idea that ‘Services’ are the focus of the business not networks

- Modeling a service
- Execution of the service
  - Autonomously (ML)
  - On Demand (Human or Workflow)
- Ask Orchestration & Automation to satisfy the demands of the service model
- Monitor to assure the service quality





Orchestrating many systems

What is Orchestration?

Service co-ordination

- Among Virtualized Actors
- Among Physical Actors

Workflow

- Transactional Business Execution

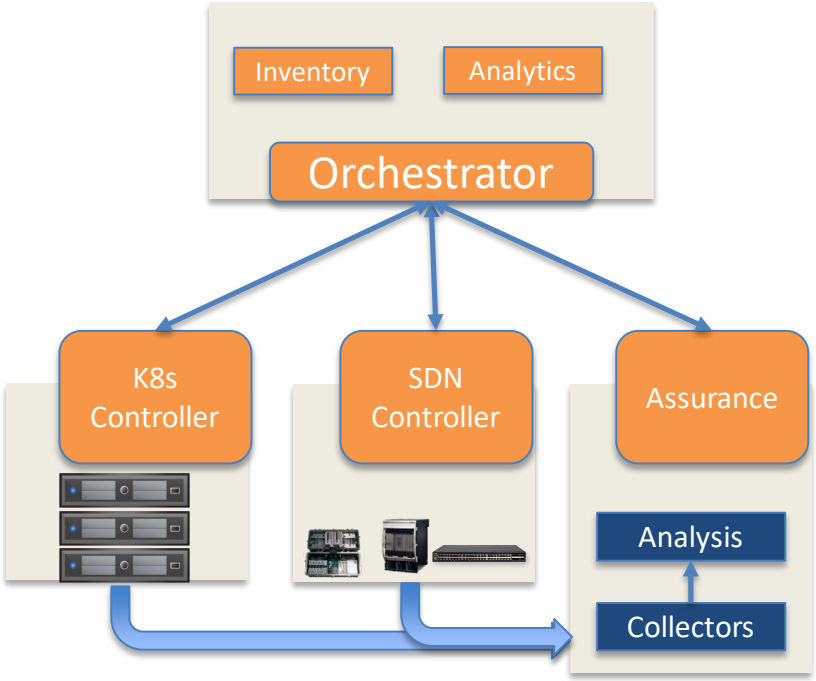
Abstraction

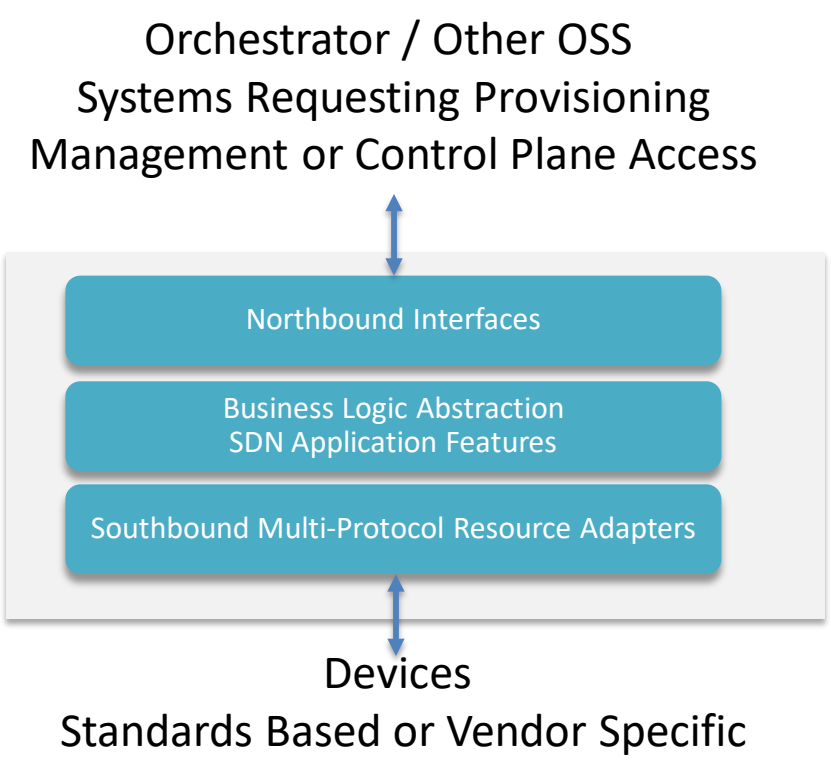
- Domains of concern
- Actors of responsibility
  - Network Controllers
  - Compute Controllers

Orchestration

Service co-ordination

- Communicates with a ‘controller’ of a function
- Function examples
  - Network element
    - SDN Controller able to speak to vendor device
  - Compute element
    - Cloud controller i.e.: Kubernetes able to speak to compute cluster resources
  - External element
    - A system requiring updates for service events i.e.: Assurance





Common view of SDN Application System

What is SDN?

Enriched OSS Management Planes
Optional OSS Control Planes

Enabler of

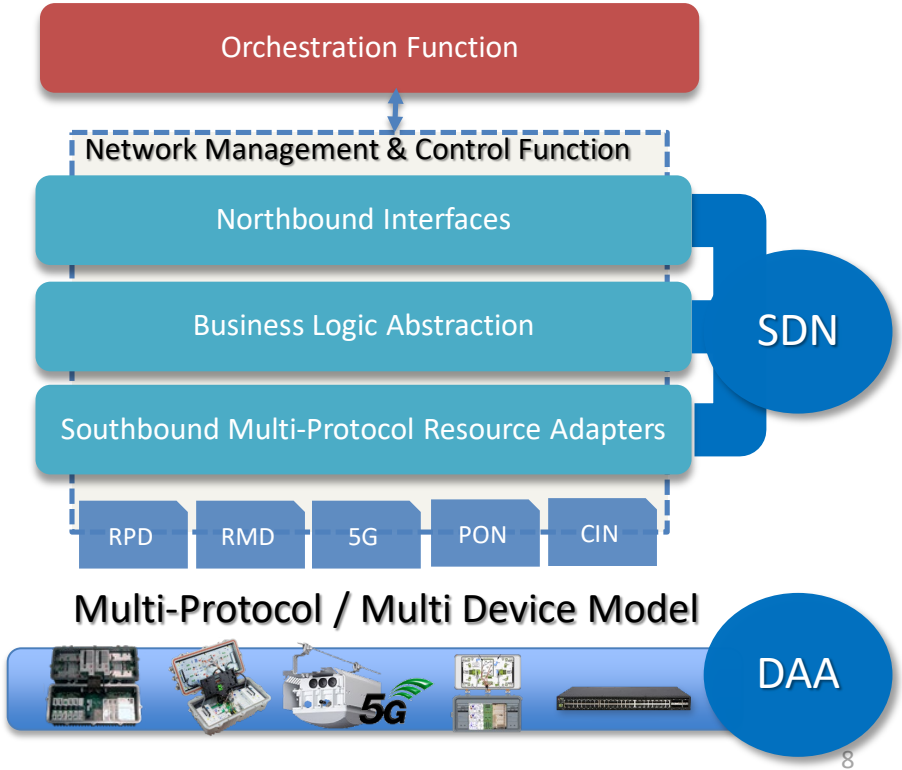
- Automation
- Assurance
- Disaggregation

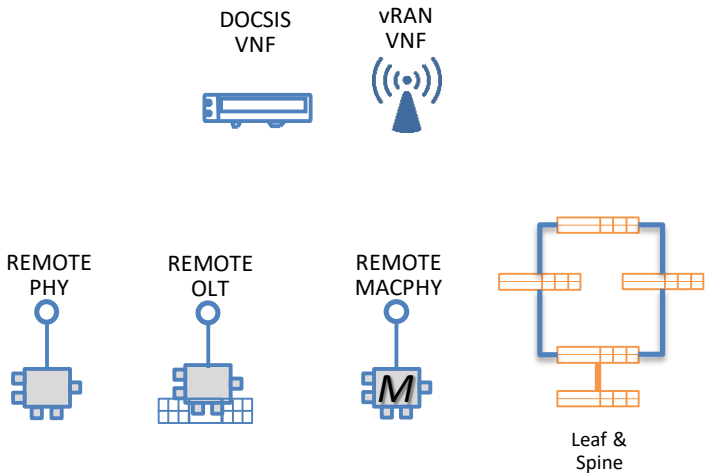
Facilitation of 'Model Driven' Networks

Brings an API to the Network

SDN Functions of Intelligent Edge

- Offers Northbound API
  - CRUD for DAA
    - Create Device
    - Read Device
    - Update Device
    - Delete Device
  - Assurance for DAA
    - Telemetry of device state
- Southbound Abstraction
  - Multi-protocol and Device Model
    - Speaks the language of the device





What is Provisioning?

Configuration at some level

Virtualized

Physical

Standards and Non Standards

Many DAA Provisioning Actors

DOCSIS

CableLabs

- CableLabs coverage for data model
  - Standard TLVs
- CableLabs coverage for interface
  - Standard SNMP MIBs to return OID
- CableLabs coverage for DPoE
  - Standard vCM TLVs (DOCSIS CM)
  - Standard SNMP vCM MIBs for subscribers

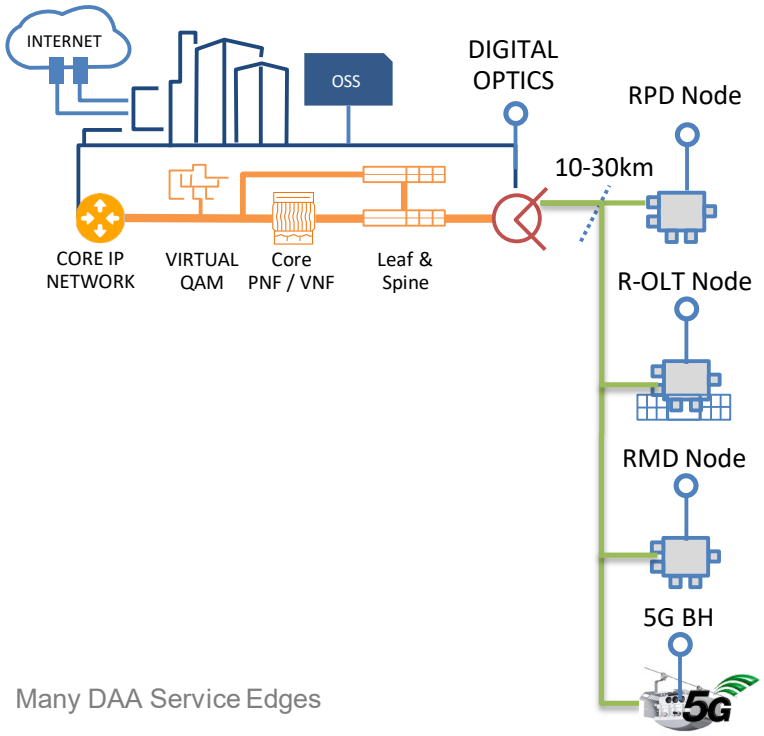
Network

Mixed

- CableLabs coverage for Remote PHY device itself
  - Standard TLVs over GCP
- IETF & Vendor coverage for CIN devices
  - Leaf and Spine switches from adjacent verticals
- PON DPoE coverage from CableLabs
  - No standard for the OLT
- P2P Ethernet services has certain MEF attributes + Leaf/Spine objects per IETF + others

Multiple Protocols in DAA Today and Going Forward

RPD	RMD	R-OLT	5G BH
CORE Provisioning Vendor API Other  RPD Provisioning GCP	Network Provisioning NETCONF, SNMP, RESTCONF, gRPC	Network Provisioning NETCONF, SNMP, RESTCONF, gRPC	Network Slicing NETCONF, SNMP, RESTCONF, gRPC
 CIN Provisioning NETCONF, SNMP, RESTCONF, gRPC	 CIN Provisioning NETCONF, SNMP, RESTCONF, gRPC	 CIN Provisioning NETCONF, SNMP, RESTCONF, gRPC	 CIN Provisioning NETCONF, SNMP, RESTCONF, gRPC
RPD Provisioning GCP 	RMD Provisioning FMA -RESTCONF 	ROLT Provisioning  Vendor API	RAN Provisioning 3GPP 



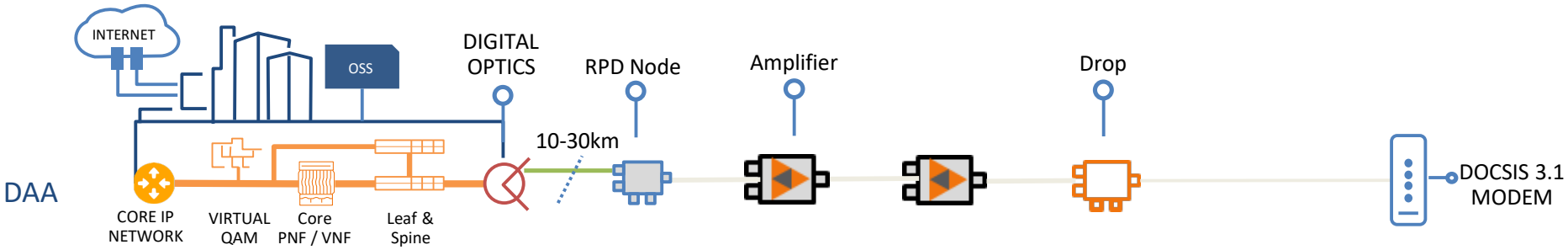
Many DAA Service Edges

How to begin?

Distributed Access Architecture

- ‘Onboard’ Remote CableLabs devices
  - Remote PHY
  - Remote MACPHY
  - Remote OLT
- ‘Onboard’ Remote non-CableLabs devices
  - 5G BH
  - P2P Ethernet

DAA Remote PHY Without Intelligent Edge

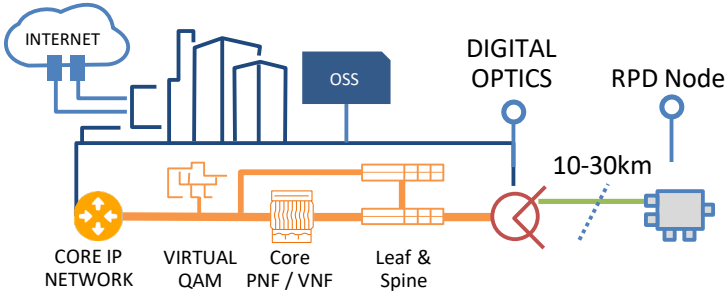


High Level Outside Plant to Headend view

DAA Remote PHY Without Intelligent Edge

RPD Onboarding Minimum Function

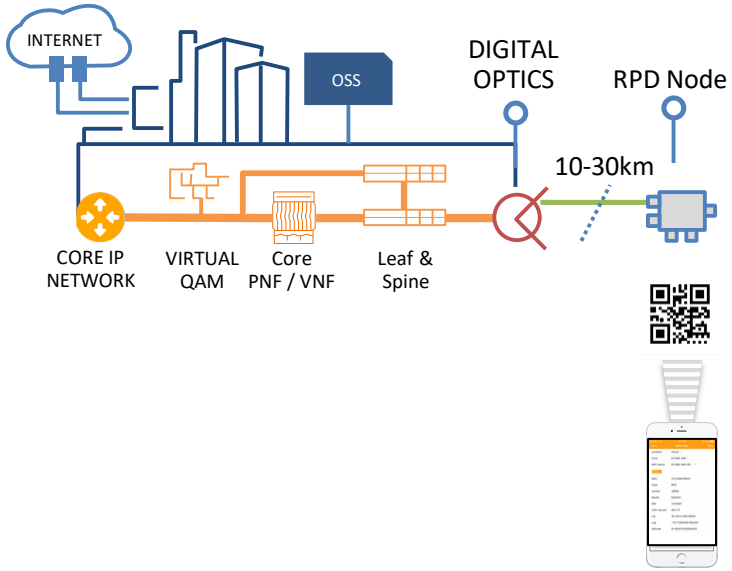
- DHCP/DHCPv6 must return Principle Core in Lease to Remote PHY Device
- Principle Core must have Service Group
- Remote PHY must be associated with Service Group
- IP Reachability
- 802.1x Authentication
- 1588 PTP Timing



DAA Remote PHY Without Intelligent Edge

Converged Interconnect Network

- If only Remote PHY Service
  - Not much to be done
    - Ensure IP Reachability
    - Configure DHCP/DHCPv6 Relay
    - Configure for 802.1x
    - Ensure 1588 Timing
  - Minimize Field Technician Time
    - Mobile App
      - Location & Inventory Update
      - Activation Information – Service Group Info

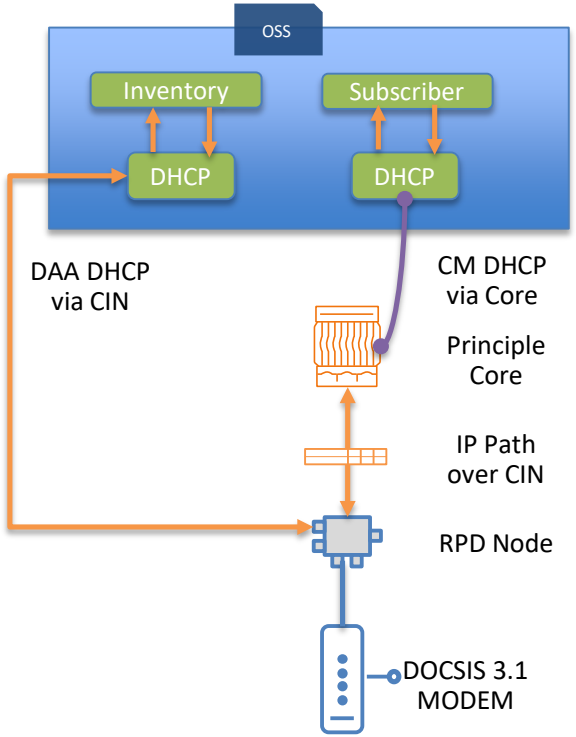


Current OSS for Remote PHY

DHCP Systems

- Identify RPD by Client Option string RPD*
- Associate by GiAddr & Client Option to an IP Space
- Enable Discovery for Principle Core
  - DHCPv6 Option 17.61
  - DHCP Option 43.61

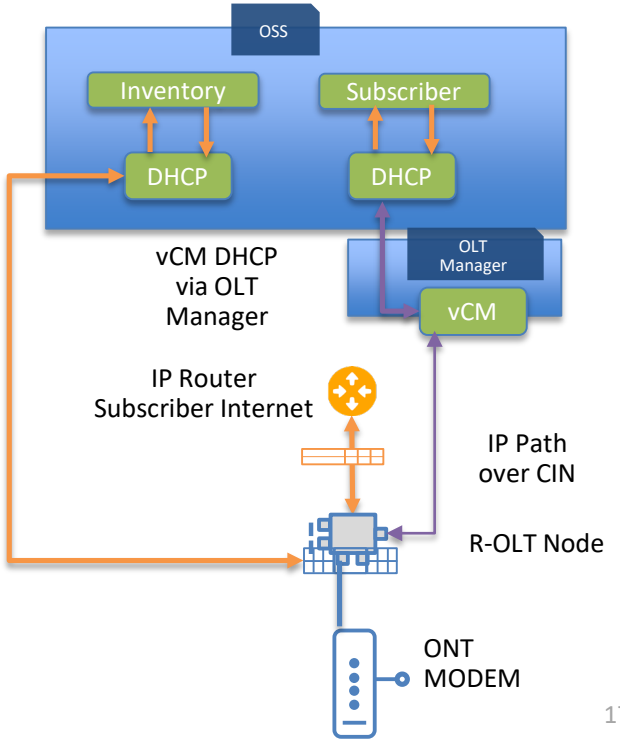
  - Hopefully the Principal Core contents are requested from Inventory not hard configured within DHCP!



Current OSS for Remote OLT

DHCP Systems

- Identify R-OLT by Client Option string ROLT*
- Associate by GiAddr & Client Option to an IP Space
- EPON DPoE
  - vCMs exist for subscribers
  - Either in an SDN based OLT Manager
  - Or in the R-OLT Node itself
- North side of R-OLT
  - Network for DAA Management
  - Network for vCM Internet to Subscriber Router
  - Possibly many Subscriber Networks Business Services

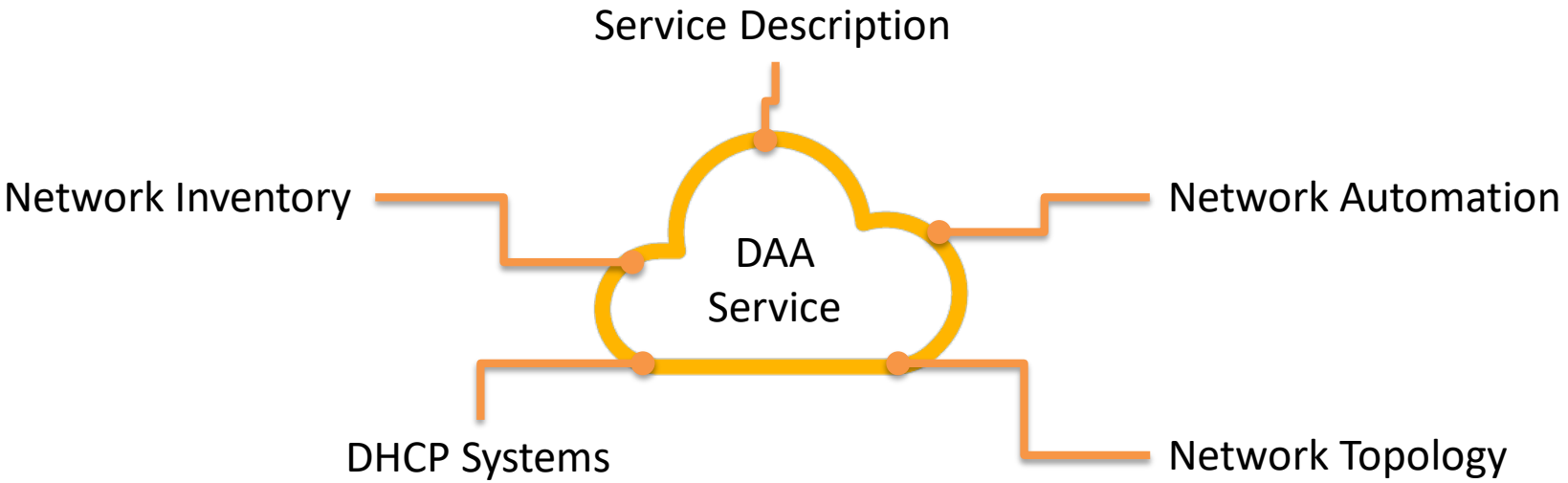


Many Forms of Remote DAA Services

How does the Remote PHY DAA investment deliver for multiple Remote enabled services?

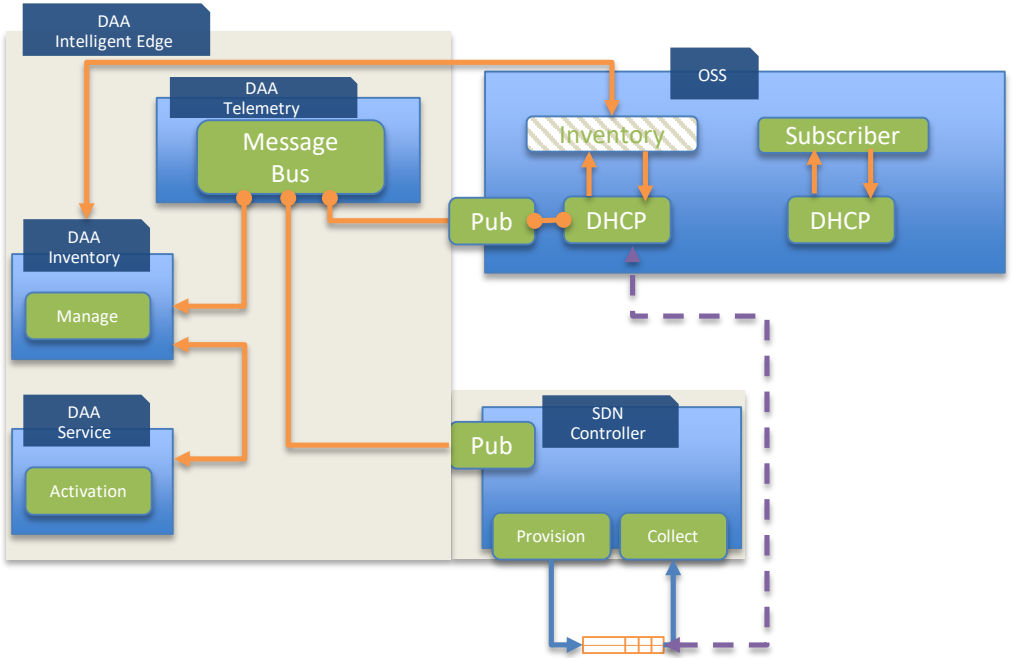
- The CIN Itself
  - S-Leaf and Spine device roles & locations
- Remote OLT PON
  - Has a MAC function in the Remote
  - Completely different IP reachability needs compared with Remote PHY
- Remote MACPHY
  - Similar to OLT PON
  - Could be Layer 2 or Layer 3
  - Residential and Business service separation over the network
- P2P Ethernet and 5G Backhaul Services?

Creating the DAA as a Service Model



Automated DAA CIN

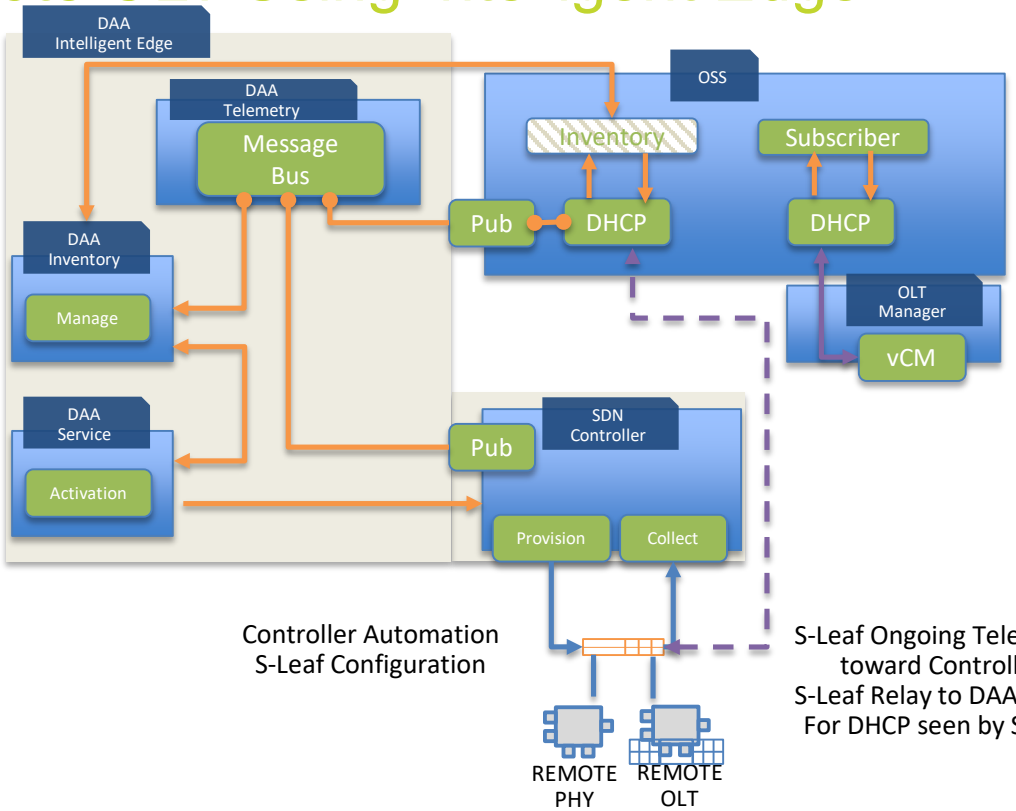
- Switch cabled in rack
- Management VLAN to DHCP
- Incoming DHCP
  - Inventory Lookup by uniqueID
  - Return Golden config by role
    - S-Leaf
    - Spine
  - Activate telemetry
    - Ongoing LLDP
  - All Pluggable Optics ports
    - DAA Services Management VLAN to DHCP access



DAA Remote PHY + Remote OLT Using Intelligent Edge

Enhance edge visibility at the S-Leaf

- Inventory Assigned S-Leaf Role
  - Automated Provisioning
- S-Leaf advertises LLDP to Controller
- Controller Publishes to Bus
- Activation Port Config by Service
- Provision Port Service
- S-Leaf Relay to DHCP
- DHCP Publishes to Bus
- DHCP DAA Inventory Lookup
- Remote is provisioned in-service

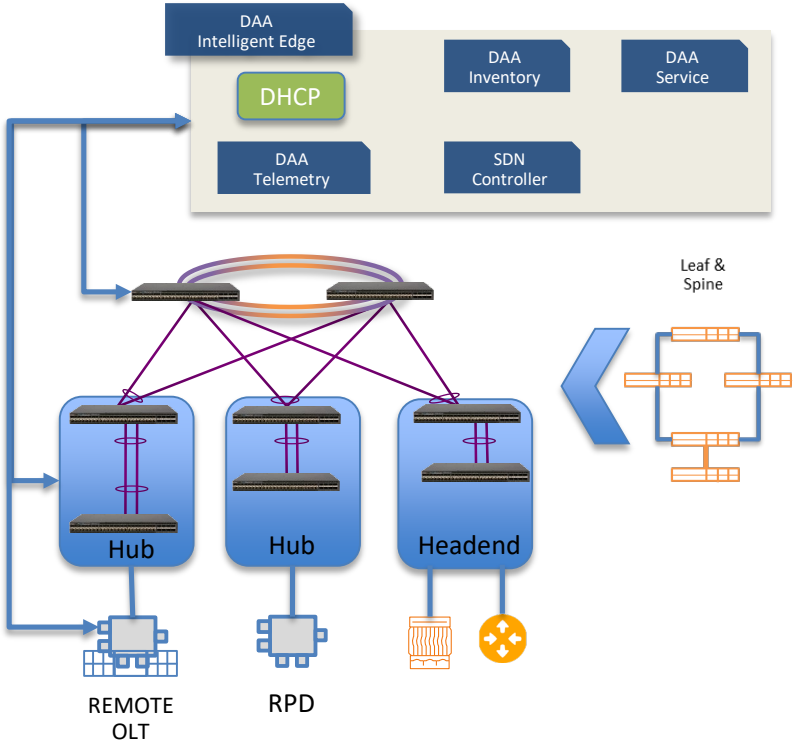


Discovery and Operations

Must provide visibility to Topology

LLDP is everywhere for CIN

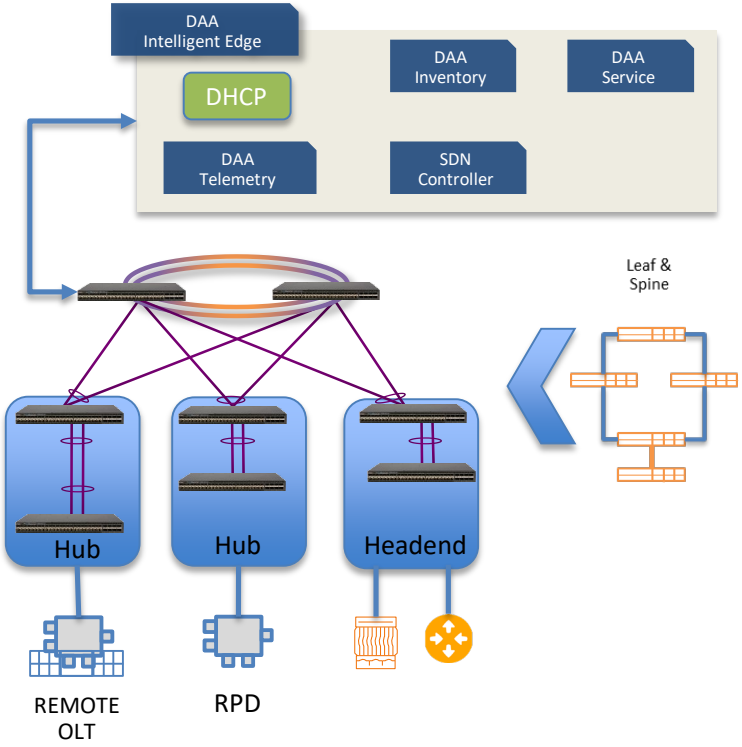
- Exposing to Intelligent Edge
  - Asynchronously (preferred)
    - NETCONF/RESTCONF Streaming
    - OpenFlow
    - sFlow
  - On Demand
    - Vendor API



Discovery and Operations

Topology Onboarding

- CIN Element is added to Inventory
  - Inventory assigns a ‘Role’ (s-Leaf or Spine)
- Device cabled to Management Network & Powered
- DHCP receives request
- Inventory Lookup
- Spine configuration file sent to device
- Inventory record updated



Discovery and Operations

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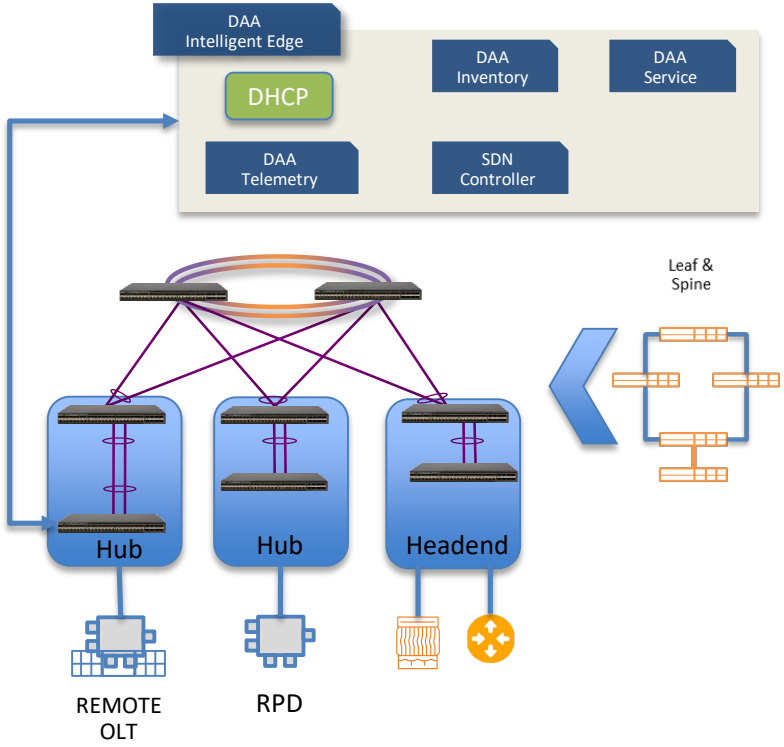
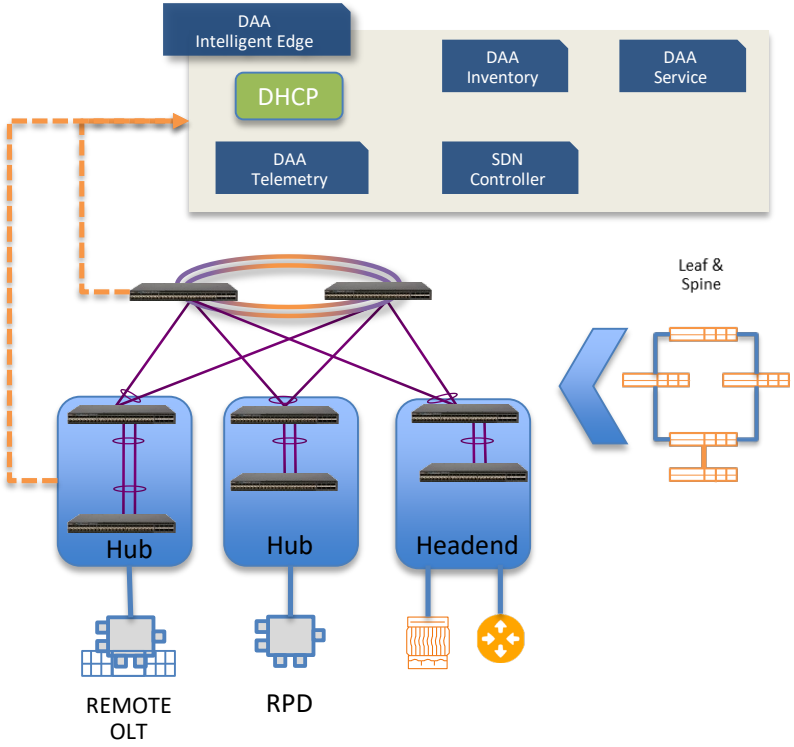
- Inventory Lookup
- S-Leaf configuration file sent to device
- Inventory record updated
- In this CIN design
  - EVPN design using VxLAN and VLAN Services
    - Spine offers Prefix Forwarding (Isolation from MAC learning)
    - Edges offer simple Multiple VLAN into VxLAN constructs



Discovery and Operations

Topology Discovery

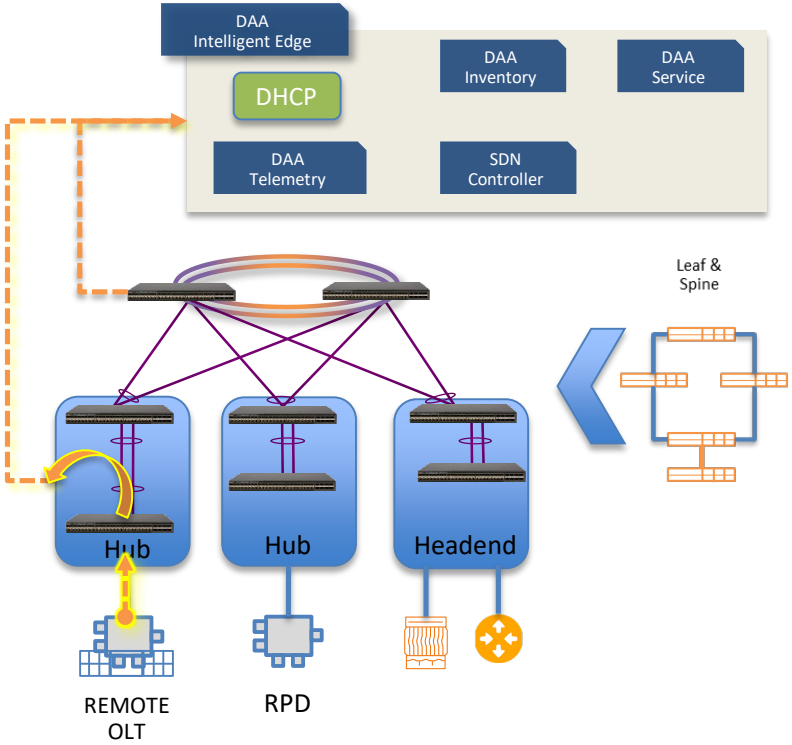
- Spine and s-Leaf sending to Intelligent Edge
  - LLDP information
  - Attached device reports per port
  - In our setup we used OpenFlow
    - Other options exist based on vendor device
  - Goal was asynchronous streaming from entire topology of device associations
  - SDN Controller computes the topology graph
    - Emits to message bus (Telemetry)
    - Inventory updates are now a closed loop



DAA Edge Attachment

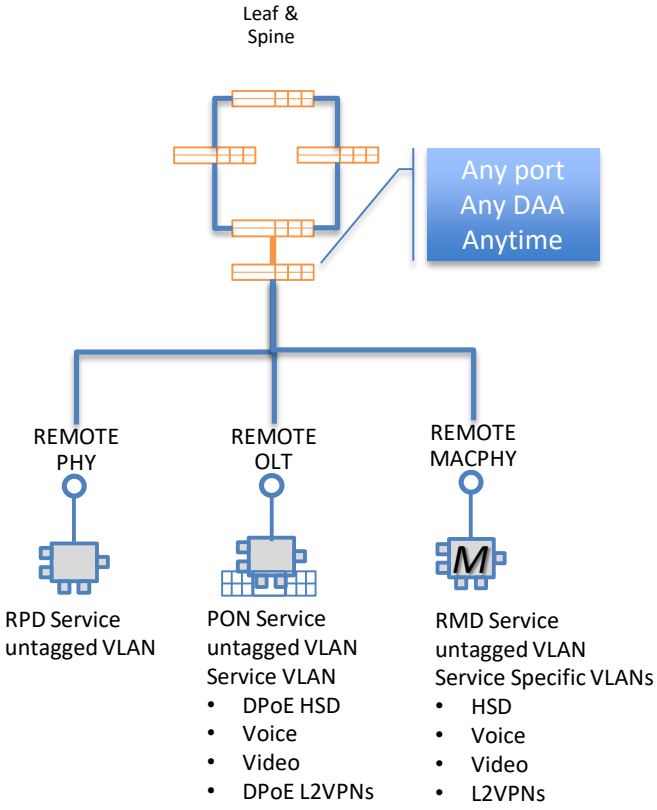
Topology Discovery & Onboarding for DAA Remotes

- Remote device cabled into s-Leaf port
  - S-Leaf sends LLDP update Intelligent Edge Controller
  - Emitted to Telemetry
  - Consumed by DAA Service
    - Updates Inventory
    - Sends ‘Profile’ to Controller for Port Update
  - SDN Controller
    - Updates Port config to match DAA Service type
- Remote Device emits DHCP
  - Device lease indicates its Manager such as :
    - Principle Core or OLT Manager or a MAC Manager
    - Device is provisioned



What does the Intelligent Edge Give Us?

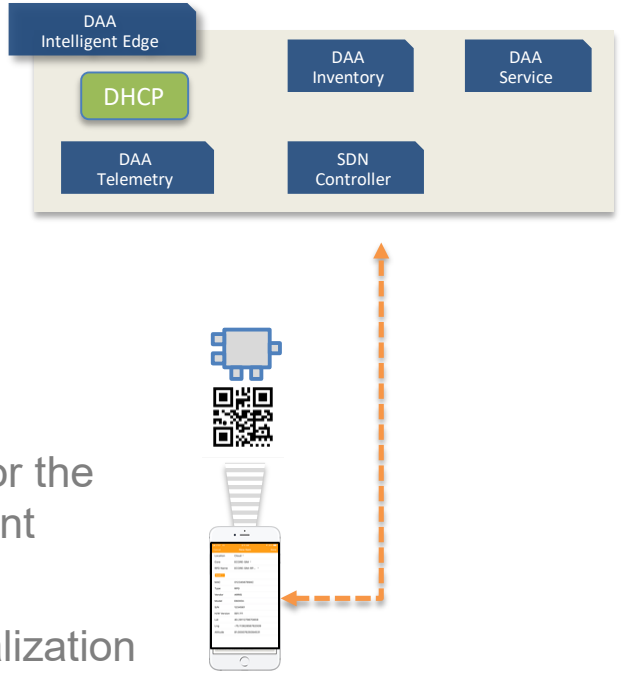
- Dynamically discovered DAA service per S-Leaf Port
  - S-Leaf ports no longer require manual provisioning
  - S-Leaf easily supports many service networks dynamically
  - S-Leaf ports no longer require tracking for role
    - RPD likely have a basic config for IP Reach to Core
    - R-OLT may have multiple VLAN or VxLAN config
    - RMD will have multiple VLAN or VxLAN config
    - P2P & 5G can also be automated



Intelligent Edge Inventory with Field

For the Field

- Remote exists in Inventory
- During Install
  - QR Code Scan at Truck
  - App communicates with Intelligent Edge
    - Update with Geo Lat/Long
    - Associate to ‘Service Group’
      - Intelligent Edge attaches logic for the ‘Manager or Principle’ at this point
    - Power on device
    - App returns indication of remote initialization process and success or fail status

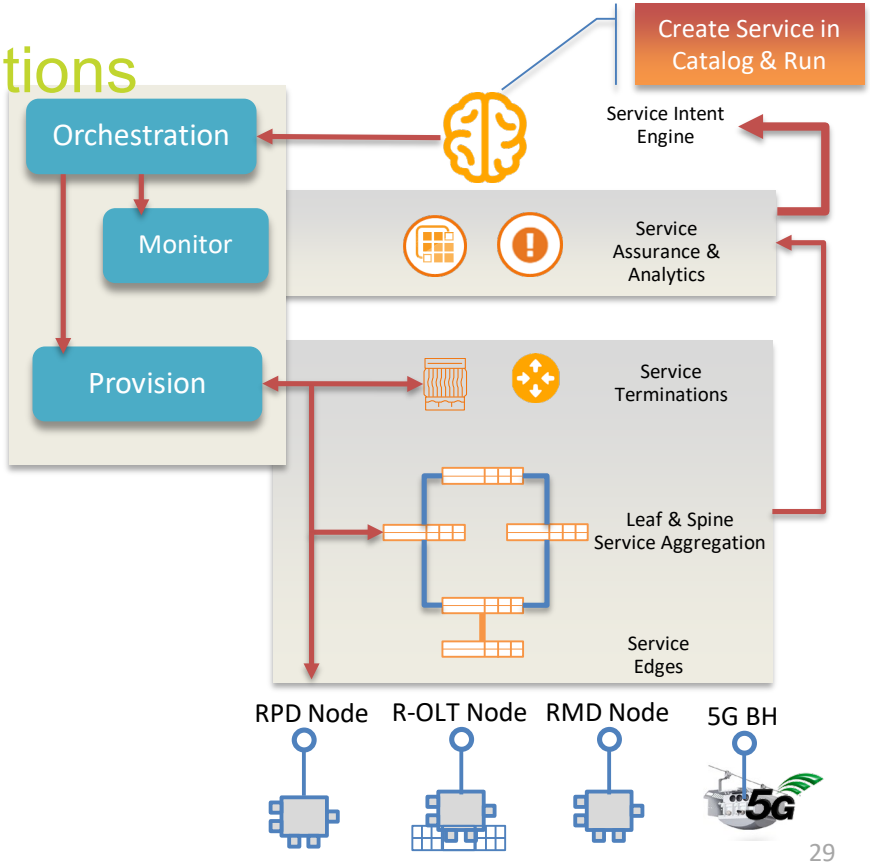


Forward Looking Stating our Intentions

Having solved for ‘Bottom-Up’

Solve for ‘Top-Down’ & make End-to-End

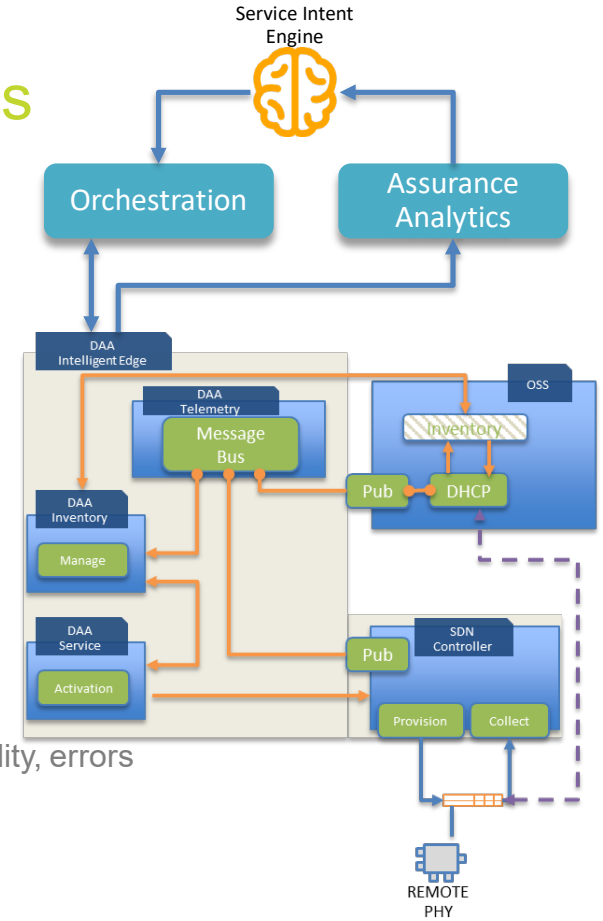
- Intent API to Orchestration
  - ‘RPD Service’
    - Bandwidth value
    - QoS value
    - Overlay value
  - Location ‘Hub1’
  - Action
    - Create ‘RPD Service-X’ in ‘Hub 1’
    - Send to Orchestrator



Forward Looking Acting on our Intentions

RPD Service Assigned to Hub1

- Inherits Bandwidth demand of 6GB/s & QoS DSCP Value
- Inherits Overlay Network
  - Association or Create New
- Action
  - Orchestrator to Inventory
    - Action Core Setup
  - Orchestrator to SDN Controller
    - Core – Network Overlay & Contract
  - Send to Assurance
    - Service Create Event
  - When RPD is attached
    - Update association to Service, Monitor for Bandwidth, availability, errors
  - When Assurance identifies violation of Service
    - Sends to Intent Engine for logic decision



Thank You!

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