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MULTILAYER REQUIREMENTS FOR NBI OF OPTICAL DOMAIN CONTROLLERS

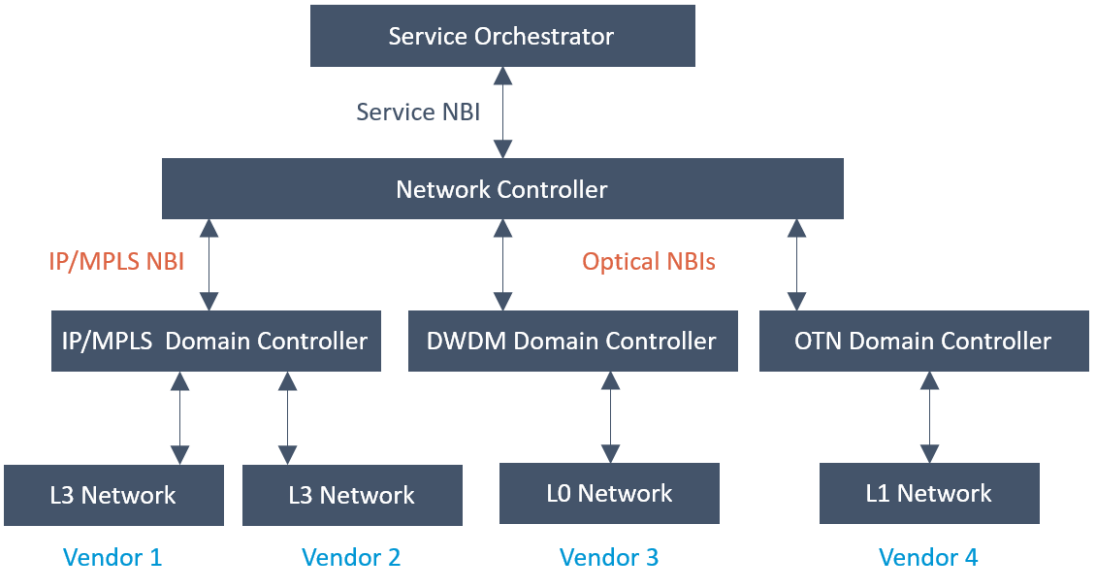
White Paper

Contents

Scope

The control architecture for multilayer networking typically comprises of technology-specific and layer-specific controllers for different optical domains and IP/MPLS domains, a network controller (network orchestrator), and a service orchestrator. This multilayer architecture places specific requirements on the NBI between layer-specific domain controllers and the network controller (shown in orange in the following figure). This paper focuses on requirements for the NBI of optical domain controllers in a multilayer architecture.

While standardization of this NBI is in progress both via IETF and ONF, and while there seems to be consensus on the RESTful format, the industry has not yet agreed on the actual data model. This paper does not dictate a particular data model, although an implementation of a subset of the ONF model in YANG is preferred. Instead, it defines the functional requirements for the NBI of optical domain controllers and leaves the implementation of these functions open for the vendor.



NBI Requirements for Optical Domain Controller

The NBI of the optical domain controller has four main functions: topology discovery, monitoring, provisioning, and path computation. These requirements generally apply to both DWDM and OTN systems, with the obvious omission of feasibility limitations that only apply to the DWDM layer.

Topology Discovery Requirements

The NBI of the optical domain controller must support the following functions to properly discover the network. All information must be provided on demand, as well as via unsolicited notifications within seconds of when changes occur.

- Provide a list of sites, including their names and geographical locations. Typically, the desired resolution is one or a few sites per city. (This information usually does not reside on the network elements, but can exist on the domain controllers.)

- Provide optical topology.
  - Optical NEs and their assignment to sites
  - Type of each optical NE, such as amplifier, regenerator, OTN switch, fixed multiplexer/OADM, basic ROADM, and add-drop properties of the ROADM (C, D, CD or CDC)
  - Fiber links between optical NEs, and the length (in km) of each fiber link; amplifiers are optional
  - SRLGs reflecting ducts, offices, and other passive elements that are configured on a link or optical NE
  - Optical client ports and their capabilities (Ethernet and/or OTN) and line ports per optical NE
  - Multiplexing hierarchy (such as which ports are supported by muxponders versus transponders, OTN switch capabilities)
  - Spare (unused) transponders that are connected to ROADMs and can be activated by the domain controller
  - Number of regenerators per site
- Provide optical connections (light paths and OTN subnetwork connections) and their properties.
  - The routing of each optical connection in the optical topology
  - The multiplexing hierarchy of the connection (which lower layer connections is it using, such as 10GE over an ODU2 supported by a series of 100G wavelengths that are multiplexed into fibers between ROADMs)
  - The wavelength of the connection
  - Protection path
  - Regenerators used by the connection
- Optical port attributes that are used for manually documenting connectivity to the IP/MPLS layer (for example, a port description or a TTI string).

Monitoring Requirements

The NBI of the optical domain controller must support the following functions to properly monitor the network.

- Provide notifications for link failures and equipment failures, including both a summary of current alarms and unsolicited messages when conditions change within two seconds of the event.
- Provide indication if the domain controller loses contact with one or more optical NEs, along with a timestamp of the last data collection. Ideally, a timestamp is identified for every object (such as for each node, link, and connection).
- Turn on and off the client side port of an optical NE port (towards the router). When off, the laser towards the router is not emitting light and no alarms are emitted towards management systems.
- Send a notification if the client-facing port senses loss of light from the connected device (router or other transport gear). The notification should be sent within one second of the event.
- Mark an optical path and its endpoints as down for maintenance. During this time, no critical alarms are issued to management systems.

- Upon request, get current packet statistics for a port, including packet count and/or byte count. The resulting measurement must be accurately relayed within one to two seconds from the time of the request.
- Send alarms for optical restoration failures and the reason for the failure within three seconds after the event.

Provisioning Requirements

The NBI of the optical domain controller must support the following functions to properly provision the network.

- Create an optical path by defining its endpoints (no constraints are specified).
- Create a loose or strict explicit optical path between two client ports. This explicit path is either defined by the network controller or returned by a PCEP query from the Optical layer or its domain controller.
- Create an implicit path with a combination of constraints, where the constraints are as follows.
  - Exclude one or more SRLGs
  - Include a specified link or optical NE
  - Exclude a specified link or optical NE
  - Maximum latency
- Specify the reason for failure if the path creation fails.
- Predefine an explicit or implicit restoration path for a given working path.
  - Verify feasibility of the restoration path and return an error if it is not feasible.
  - Share the capacity of the restoration path with other restoration paths provided their respective working paths are diverse.
- Define a restoration priority for the path that indicates when restoration should be attempted for the path.
- Restore paths with higher restoration priority before paths that have a lower restoration priority (for example, by introducing a delay that is a function of the priority before attempting restoration).
- Change the optical restoration path and its attributes for a connection without taking down the working path and without affecting traffic.

Path Computation Requirements

The NBI of the optical domain controller must support the following functions to properly compute optical paths.

- Compute a feasible optical path between two endpoints.
  - The path can be constrained, for example in terms of its latency, risk diversity (excluding SRLGs), fate sharing with other paths (including SRLGs), and capacity (for systems supporting flexible modulation format).
  - The path can be constrained to a specific loose or strict explicit path.

    - The response must include the explicit path, the path's wavelength, and regenerators.
- If a feasible optical path does not exist, the domain controller must return the reason for there being no such path.
- Compute a feasible optical restoration path between two endpoints, given the properties of the working path.
    - The returned restoration path must be feasible when the working path fails.
    - The restoration path must be diverse from the working path.
    - The restoration path can share capacity with other restoration paths provided that their working paths cannot fail at the same time.

Acronymns

Acronym	Description
C	colorless
CD	colorless and directionless
CDC	colorless, directionless, and contentionless
D	directionless
DWDM	dense wavelength division multiplexing
IETF	Internet Engineering Task Force
IP	Internet Protocol
MPLS	Multiprotocol Label Switching
NBI	north-bound interface
NE	network element
OADM	optical add-drop multiplexer
ODU	optical data unit
ONF	Open Networking Foundation
OTN	Optical Transport Network
PCEP	Path Computation Element Protocol
REST	Representational State Transfer

Acronym	Description
ROADM	reconfigurable optical add/drop multiplexer
SRLG	shared-risk link group
TTI	transmission time interval

About Sedona Systems

Sedona Systems has created the market's first multivendor control platform for the Optical and IP/MPLS layers (L0-L3) of service provider core and metro networks. Enabling both optically-aware IP/MPLS routing and IP/MPLS-informed optical switching, it doubles effective WAN capacity, boosts agility and flexibility, and saves up to 50% of network costs.

For further details, contact us at mailto:info@sedonasys.com or visit http://sedonasys.com.

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