Network Services Interface

NSI Topology

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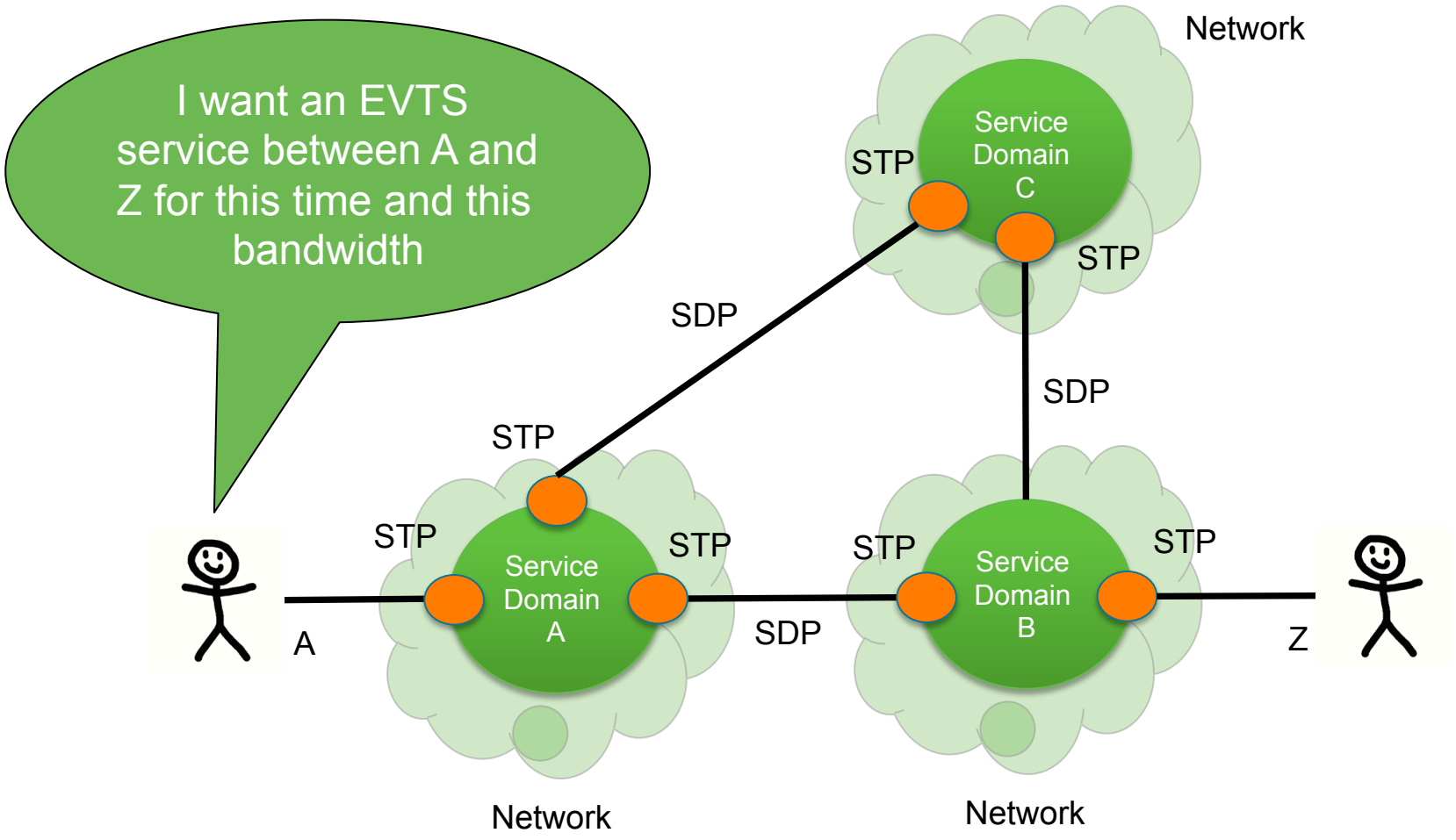
A Pictorial



NSI to NML mapping

NSI Term	NML Term
STP	Port, PortGroup, BidirectionalPort
Service Domains	SwitchingService
SDP	Relationship on Port
Service Definition	Annotation on SwitchingService + independent XML definition
Service Type	Attribute of Service Definition
Adaptation	Adaptation (slightly modified)
Service	N/A

NSI uses NML to model NSI topology concepts, not to build a physical view of the equipment.

Terminology

Network

- A group of network resources managed by a single network provider and a single NSA.
- A network exposes a set of defined service types representing the services offered to a user by the network.

Intra-Network Topology

- Refers to the topology of resources within a network, and the services offered by that network.

Inter-Network Topology

- Refers to the topology of interconnected Networks and the common services offered across these interconnected Networks.
- Inter-Network Topology is concerned with describing the way in which Networks are statically interconnected by treating each Network as an aggregated set of Network capabilities and Edge Points.

Terminology

Service

- A service is a “connection” between two points in a Network with certain predefined and dynamically specified characteristics that will deliver a “payload” from Network ingress to Network egress unmodified.

Service Type

- A predefined type of service offered by a network and specified by a Service Definition.

Service Definition

- A document that describes the predefined characteristics and requestable elements associated with a service being offered by a Network.

Terminology

Service Termination Point (STP)

- An STP names a topological location that is the ingress/egress point of a Network and is defined by a single Service Type.
- An STP can be fully specified representing a single termination point, or under specified representing a set or bundle of STP.

Service Domain (SD)

- A group of STP within a Network described by a single Service Type and can be fully interconnected without restriction.

Service Demarcation Point (SDP)

- SDP are formed when a pair STPs of matching capabilities are considered adjacent (and connectable) between two Service Domains.

Adaptation (Service Interworking)

- By definition, Service Domains of different Service Types cannot be directly connected due to the differing Service Definitions, however, an Adaptation can be defined that permits interconnection of STP from two different Service Domains using the concepts of encapsulation and adaptation.
- An Adaptation defines the (de)encapsulation or (de)adaptation of one service type into another service type if the Network is capable of offering the service.
- An Adaptation has directionality (adaptation and de-adaptation).
- Unidirectional and bidirectional Adaptations are supported, with bidirectional Adaptations containing a symmetric pair of adaptation and de-adaptation functions.
- An Adaptation can also be defined between STP of the same service type in the case where encapsulation/adaptation of the input service type results in the same output service type.
- An Adaptation has an associated Service Definition describing the Service Adaptation, parameters of the service, attributes of the service, and specifically any restrictions/limitations.

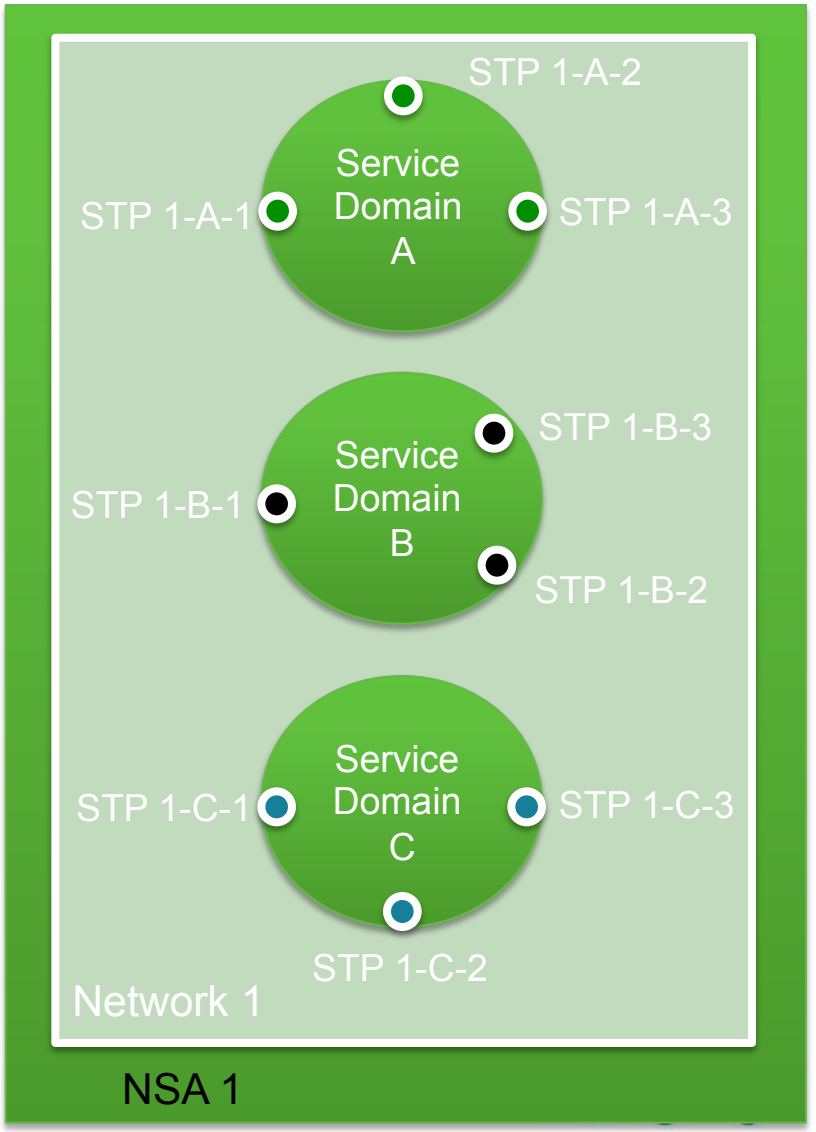
Service Domain

In a Service Domain any STP can be connected to any other STP.

A Service Domain has an associated Service Definition (SD) describing the service being offered.

Service Domains are grouped into Network topologies that can be advertised by at most one NSA.

An NSA can advertise multiple Network topologies.



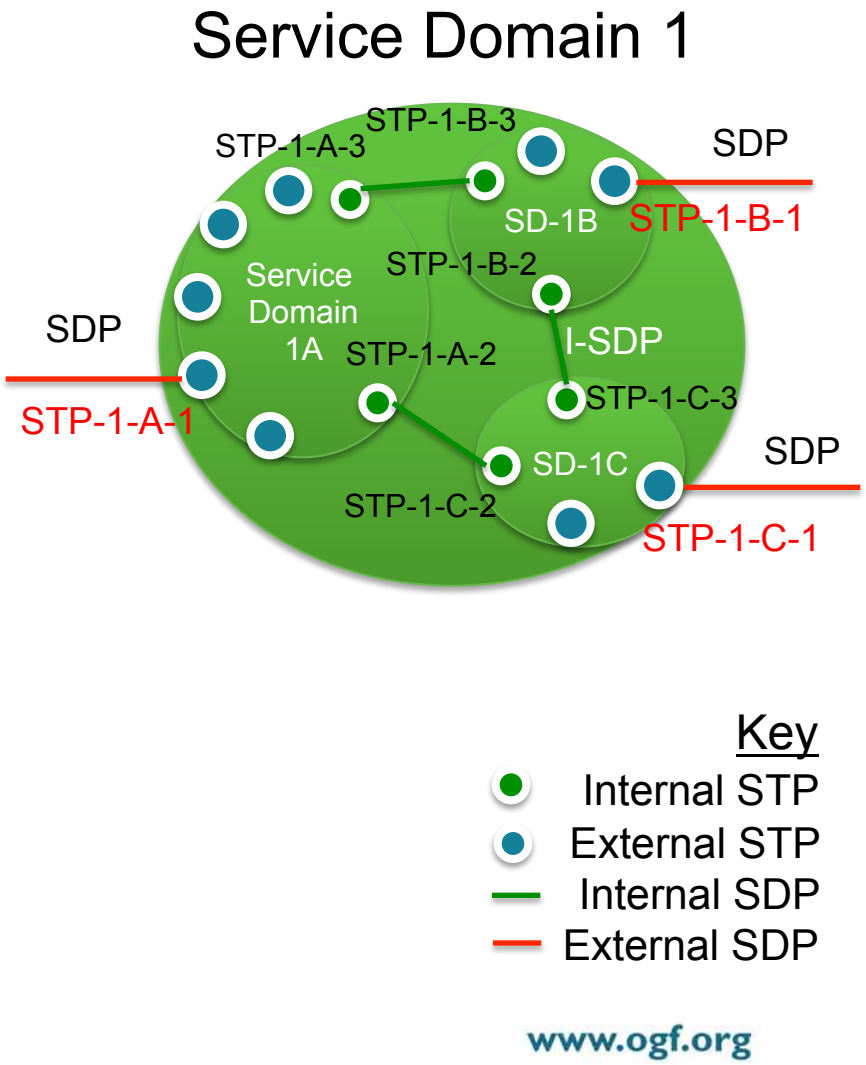
Service Domain

Service Domains can be nested to model internal structure.

Externally visible STP are used for inter-domain interconnection to peer networks.

Internal STP are used to connect the internal Service subdomain as well as to the Domain's external STP points.

An external path finder could issue a request to connect STP-1-A-1 to STP-1-C-1 and delegate internal path finding to the uPA, or if the path finder would like to provide additional guidance, it could specify a more detailed path such as (STP-1-A-1, STP-1-A-3), (STP-1-B-3, STP-1-B-2), and (STP-1-C-3, STP-1-C-1).



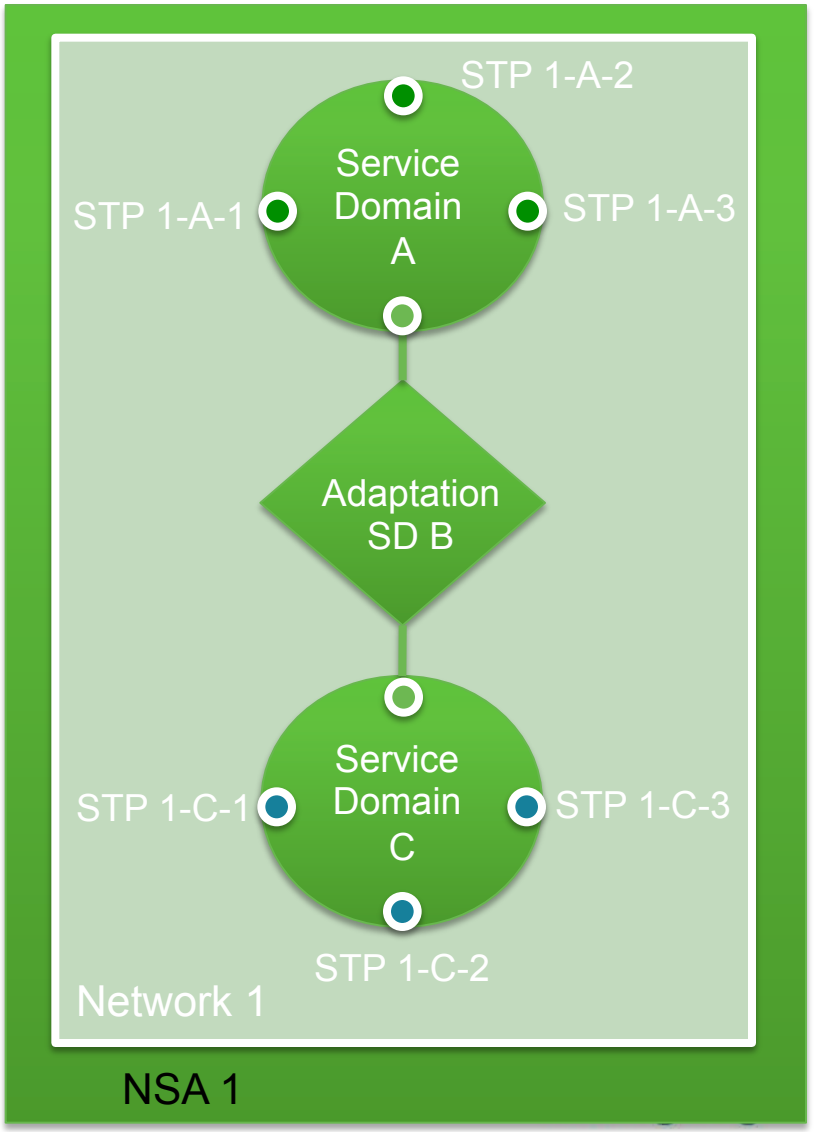
Adaptation

Service Domains contain a set of STP of the same Service Type that are capable of being interconnected.

Adaptations are used to connect STP from two Service Domains within the same Network, essentially allowing a path finder to determine if it is possible to “enter” an STP in one Service Domain and “exit” an STP on a different Service Domain.

Adaptation STP are added to each Service Domain to anchor the transitional SDP associated with the Adaptation. This transitional SDP is not used in connections, and is only present to enable path finding between the domains.

Adaptations are defined with their own Service Definition, describing the capabilities of the adaptation, and the service specific parameters needed to make the reservation requests across the Adaptation.



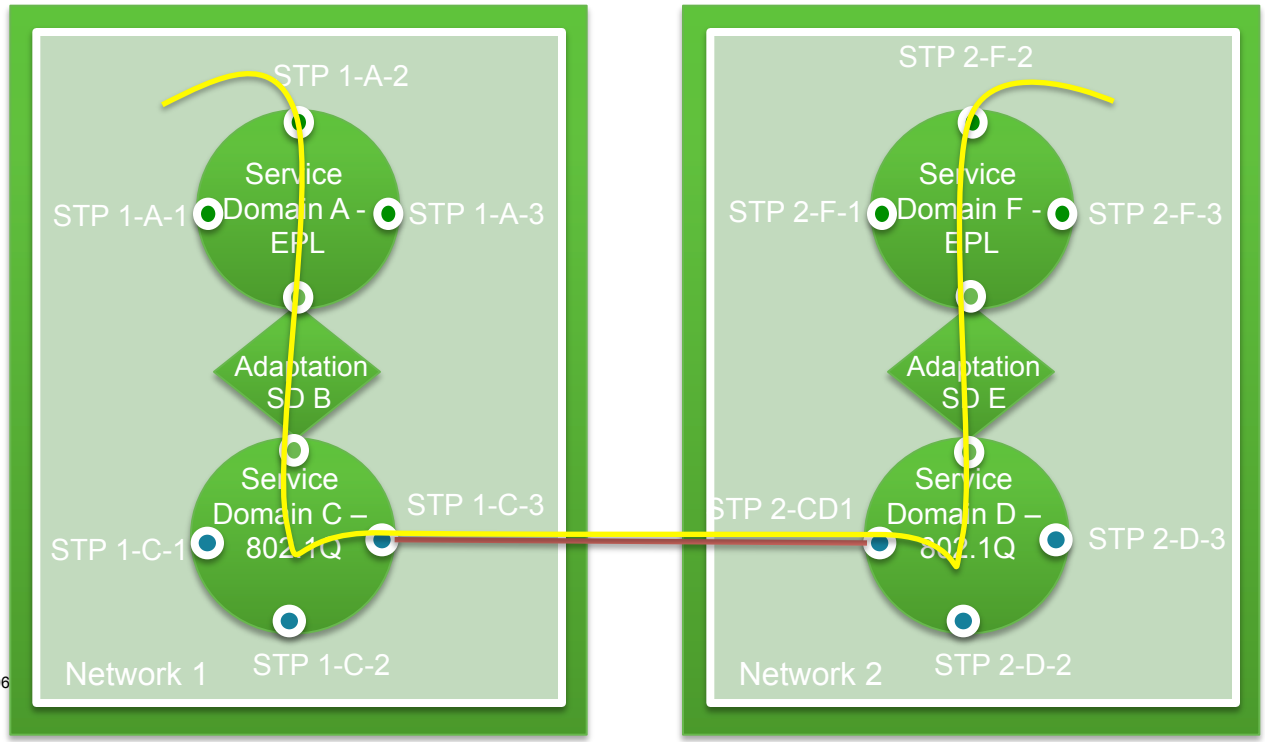
Adaptation in action

In this example we have an EPL service offered in Service Domain 1 defined by Service Description A, and an 802.1Q Trunk service in Service Domain 2 defined by Service Description C.

The EPL service offered in Service Domain 1 could be implemented using a number of technologies, however, from an end user perspective this is not important as they are interested in the service being offered, and not the technology behind the service.

For adaptation between Service Domain 1 (Service Definition A) and Service Domain 2 (Service Definition C) in Network 1 we require a transform from the EPL service to the 802.1Q Trunk compliant service. For this example, we define an Adaptation (Service Definition B) that interconnects STPs in Service Domain 1 to STPs in Service Domain 2 through encapsulation of the original EPL service Ethernet frames using 802.1AH. The 802.1AH frame is compatible with Service Domain 2, using the S-TAG from the 802.1AH frame as the switching VID. Where this encapsulation occurs in the network is irrelevant from a path finder perspective, and is left up to the supporting NSA to worry about the details.

Similarly, in Network 2 we must reverse the encapsulation performed in Network 1 to get back the original service type to deliver to the end user. In this case the paired Adaptation (Service Definition B) in Network 2 is used to remove the 802.1AH header allowing an STP in Service Domain 3 (Service Definition C) to be connected to an STP in Service Domain 4 (Service Definition A) getting us back to the original Service Type.



NSI Service Termination Points

The Port element maps to a unidirectional STP.

```
<!-- The hasOutboundPort relationship models a single outbound unidirectional
     port that is mapped to the NSI unidirectional STP object. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
    <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:666:out"/>
</Relation>

<!-- The hasInboundPort relationship models a single inbound unidirectional
     port that is mapped to the NSI unidirectional STP object. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
    <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:666:in"/>
</Relation>
```

From these two port definitions we would generate the following unidirectional STP identifiers:

urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:666:out
urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:666:in

Unidirectional STP from Port and Label

The Port element maps to a unidirectional STP.

```
<!-- This hasOutboundPort relationship models a single outbound
     unidirectional port that maps to the NSI unidirectional STP object. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
    <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:out">
        <Label labeltype="http://schemas.ogf.org/nml/2013/05/ethernet#vlan">1799</Label>
    </Port>
</Relation>

<!-- This hasInboundPort relationship models a single inbound
     unidirectional port that maps to the NSI unidirectional STP object. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
    <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:in">
        <Label labeltype="http://schemas.ogf.org/nml/2013/05/ethernet#vlan">1799</Label>
    </Port>
</Relation>
```

The Label elements contains a single value that is used to fully qualify an STP. From these two port definitions we would generate the following STP identifiers:

urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:out?vlan=1799
urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:in?vlan=1799

Unidirectional STP from PortGroup and LabelGroup

The PortGroup element is a summary mechanism used to specify a mapping to one or more unidirectional STP.

```
<!-- This hasOutboundPort relationship models a series of outbound
     unidirectional ports by specifying a list of vlan labels.  This
     will map to multiple NSI unidirectional STP objects. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
    <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:out">
        <LabelGroup labeltype="http://schemas.ogf.org/nml/2013/05/ethernet#vlan">1779-1799</LabelGroup>
    </PortGroup>
</Relation>

<!-- This hasInboundPort relationship models a series of inbound
     unidirectional ports by specifying a list of vlan labels.  This
     will map to multiple NSI unidirectional STP objects. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
    <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:in">
        <LabelGroup labeltype="http://schemas.ogf.org/nml/2013/05/ethernet#vlan">1779-1799</LabelGroup>
    </PortGroup>
</Relation>
```

The LabelGroup elements can contain a range of values that are used to generate fully qualify STP or underspecified STP. From these two port definitions we would generate the following underspecified STP identifiers:

urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:out?vlan=1779-1799
urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:in?vlan=1779-1799

For fully qualified STP we would get 20 of each inbound and outbound built as on the previous slide.

NSI Service Demarcation Points

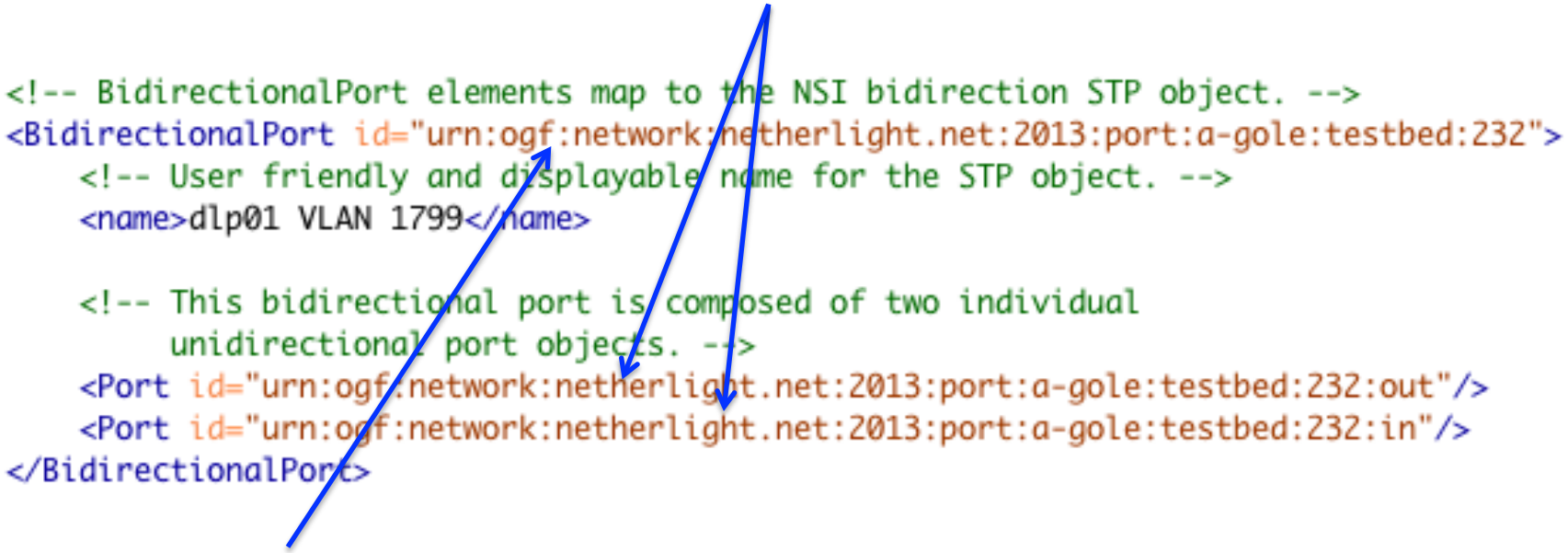
The Port and PortGroup elements may contain an isAlias relationship indicating connectivity to another Port or PortGroup. We use this isAlias relationship to create an SDP between the adjacent STP generated from the Port or PortGroup elements.

```
<!-- This hasOutboundPort relationship models a series of outbound
     unidirectional ports by specifying a list of vlan labels.  This
     will map to multiple NSI unidirectional STP objects. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
    <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:out">
        <LabelGroup labeltype="http://schemas.ogf.org/nml/2013/05/ethernet#vlan">1779-1799</LabelGroup>

        <!-- This isAlias relationsip identifies the inbound unidirectional
             port connected on the far end of this port. In this specific
             case the port is hosted in a different network. -->
        <Relation type="http://schemas.ogf.org/nml/2013/05/base#isAlias">
            <PortGroup id="urn:ogf:network:manlan.internet2.edu:2013:netherlight:in"/>
        </Relation>
    </PortGroup>
</Relation>
```

Bidirectional STP

The BidirectionalPort element groups a pair of inbound and outbound Port or PortGroup elements to create a bidirectional STP.



```
<!-- BidirectionalPort elements map to the NSI bidirection STP object. -->
<BidirectionalPort id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232">
    <!-- User friendly and displayable name for the STP object. -->
    <name>dlp01 VLAN 1799</name>

    <!-- This bidirectional port is composed of two individual
         unidirectional port objects. -->
    <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:out"/>
    <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:in"/>
</BidirectionalPort>
```

The BidirectionalPort id is used as the root for the bidirectional STP identifier, but we must also navigate to the unidirectional Port/PortGroup definitions to determine any labels being used. The following bidirectional STP identifier would be created based on the unidirectional Port specification:

urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232?vlan=1799

NSI CS Services

```
<!-- NSI CS Services offered by this Network. -->
<sd:ServiceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EVTS.A-GOLE">
    <name>GLIF Automated GOLE Ethernet VLAN Transfer Service</name>
    <serviceType>http://services.ogf.org/nsi/2013/07/definitions/EVTS.A-GOLE</serviceType>
    <schema xmlns="" name="p2ps" required="true"
            namespace="http://schemas.ogf.org/nsi/2013/07/services/point2point"
            type="{http://schemas.ogf.org/nsi/2013/07/services/point2point}P2PServiceBaseType">

    </schema>
</sd:ServiceDefinition>

<sd:ServiceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EPL.A-GOLE">
    <name>GLIF Automated GOLE Ethernet Private Line Service</name>
    <serviceType>http://services.ogf.org/nsi/2013/07/definitions/EPL.A-GOLE</serviceType>
</sd:ServiceDefinition>

<sd:ServiceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EPL-to-802.1Q">
    <name>Service adaptation from EPL-to-802.1Q</name>
    <serviceType>http://services.ogf.org/nsi/2013/07/definitions/EPL-to-802.1Q</serviceType>
</sd:ServiceDefinition>
```

Full service definition can be included.

Reference to Service Definition type

Adaptation Service Definition type

NSI Service Domain

The SwitchingService element is used to model NSI Service Domains. A single SwitchingService declaration can expand into many NSI Service Domains depending if label swapping is supported. Inbound and outbound Port/PortGroup elements are specified as members.

```
<!-- We define a hasService relationship to hold our definitions of
     NSI Service Domains and Adaptations. -->
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasService">
    <!-- We use the SwitchingService element to define NSI Service Domains
         for the A-GOLE-EPL service. -->
    <SwitchingService id="urn:ogf:network:netherlight.net:2013:ServiceDomain:A-GOLE-EPL"
        encoding="http://schemas.ogf.org/nml/2013/05/ethernet">

        <!-- The standard EPL ports. -->
        <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
            <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:666:in"/>
            <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:668:in"/>
        </Relation>

        <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
            <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:666:out"/>
            <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole-epl:testbed:668:out"/>
        </nml:Relation>

        <!-- NSI CS Services supported by this Service Domain. -->
        <sd:ServiceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EPL.A-GOLE"/>
    </SwitchingService>
</Relation>
```

The ServiceDefinition element identifies the services supported in this Service Domain.

Label Swapping

The SwitchingService supports the concept of label swapping. If the labelSwapping attribute is set to true then any port within the SwitchingService can be connected to any other port independent of label. If set to false, then only ports with equivalent labels can be interconnected.

```
<SwitchingService id="urn:ogf:network:netherlight.net:2013:ServiceDomain:A-GOLE-EVTS"
    encoding="http://schemas.ogf.org/nml/2013/05/ethernet"
    labelSwapping = "true"
    labelType="http://schemas.ogf.org/nml/2013/05/ethernet#vlan">

    <!-- Port relations have to be specified separately from PortGroups as defined
         in the NML schema. -->
    <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
        <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:in"/>
    </Relation>

    <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
        <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:out"/>
    </nml:Relation>

    <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:241:in"/>
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:in"/>
    </Relation>

    <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:241:out"/>
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:out"/>
    </nml:Relation>

    <!-- NSI CS Services supported by this Service Domain. -->
    <sd:ServiceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EVTS.A-GOLE"/>
</SwitchingService>
```

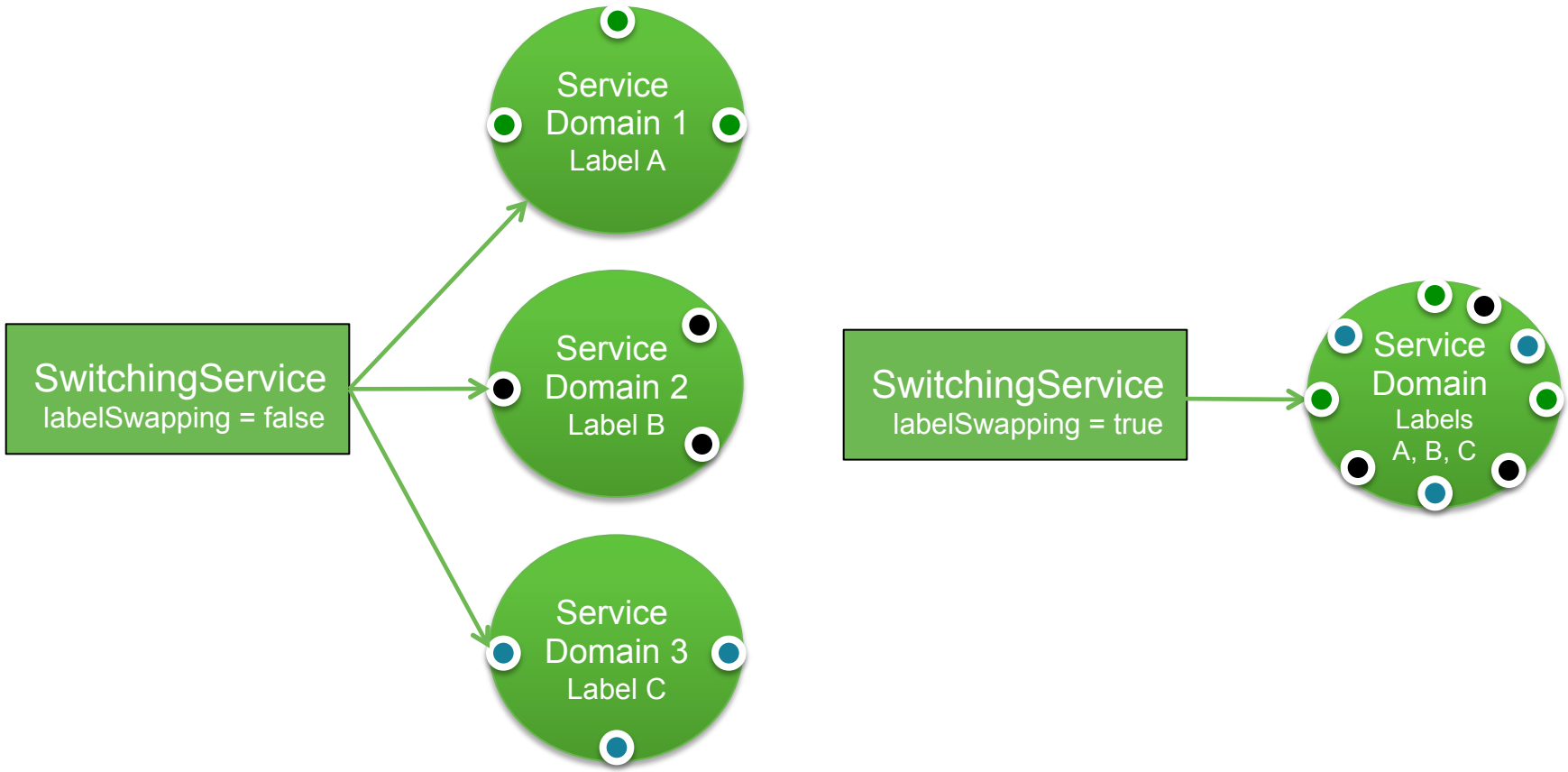
labelSwapping set to “true” indicates that ports can be connected with different label values.

labelType indicates the label that could be switched.

Port elements can be members of SwitchingService.

PortGroup elements can also be members of SwitchingService.

Service Domain Mappings



Adaptation Port Definition

Adaptation is port based in NML, so to model an adaptation between NSI Service Domains, we must create special STP for referencing within the Adaptation. In our specific case, we create four unidirectional ports per adaptation. The outbound port from the source Service Domain #1 references the AdaptationService, and the AdaptationService references the inbound port of the destination Service Domain #2. Similarly, for deadaptation the outbound port in Service Domain #2 references the DeadaptationService, and the DeadaptationService references the inbound port on Service Domain #1.

```
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
    <!-- This port is on the sending end of the EPL-to-802.1Q adaptation
         within the EPL Service Domain. -->
    <Port id="urn:ogf:network:netherlight.net:2013:adaptation:a-gole:testbed:EPL-to-802.1Q:out">
        <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasService">
            <AdaptationService id="urn:ogf:network:netherlight.net:2013:AdaptationService:EPL-to-802.1Q"/>
        </Relation>
    </Port>
</Relation>

<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
    <!-- This port is on the receiving end of the EPL-to-802.1Q adaptation within the EPL Service Domain. -->
    <Port id="urn:ogf:network:netherlight.net:2013:adaptation:a-gole:testbed:EPL-to-802.1Q:in"/>
</Relation>

<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
    <!-- This port is on the sending end of the 802.1Q-to-EPL adaptation
         within the 802.1Q Service Domain. -->
    <Port id="urn:ogf:network:netherlight.net:2013:adaptation:a-gole:testbed:802.1Q-to-EPL:out">
        <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasService">
            <DeadaptationService id="urn:ogf:network:netherlight.net:2013:DeadaptationService:EPL-to-802.1Q"/>
        </Relation>
    </Port>
</Relation>

<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
    <!-- This port is on the receiving end of the EPL-to-802.1Q
         adaptation within the 802.1Q Service Domain. -->
    <Port id="urn:ogf:network:netherlight.net:2013:adaptation:a-gole:testbed:EPL-to-802.1Q:in"/>
</Relation>
```

Outbound Port elements reference the (De)AdaptationService.

Adaptation Service Definition

Adaptation Id is referenced by source port.

Service Definition for adaptation is referenced by Id.

```
<Relation type="http://schemas.ogf.org/nml/2013/05/base#hasService">
    <!-- The AdaptationService element describes a unidirectional adaptation. In this case we are describing an
         adaptation from an EPL to an 802.1Q Trunk service where we take input Ethernet frames, encapsulate
         them in an 802.1AH header, and allocate an S-TAG for transfer over a switch 802.1Q Trunk service. We
         place the Service Definition id in the adaptationFunction attribute to allow for adaptation details
         to be discovered. -->
    <nml:AdaptationService id="urn:ogf:network:netherlight.net:2013:AdaptationService:a-gole:testbed:EPL-to-802.1Q"
            adaptationFunction="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EPL-to-802.1Q">
        <name>EPL-to-802.1Q Adaptation</name>
        <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#providesPort">
            <nml:Port id="urn:ogf:network:netherlight.net:2013:adaptation:a-gole:testbed:EPL-to-802.1Q:in"/>
        </nml:Relation>
    </nml:AdaptationService>

    <!-- The DeadaptationService element describes a unidirectional deadaptation. In this case we are describing
         a deadaptation from an 802.1Q Trunk to an EPL service where we are removing an 802.1AH header from
         original Ethernet fame. We place the Service Definition id in the adaptationFunction attribute to
         allow for deadaptation details to be discovered. -->
    <nml:DeadaptationService id="urn:ogf:network:netherlight.net:2013:AdaptationService:a-gole:testbed:802.1Q-to-EPL"
            adaptationFunction="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EPL-to-802.1Q">
        <name>802.1Q-to-EPL Adaptation</name>
        <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#providesPort">
            <nml:Port id="urn:ogf:network:netherlight.net:2013:adaptation:a-gole:testbed:802.1Q-to-EPL:in"/>
        </nml:Relation>
    </nml:DeadaptationService>
</Relation>
```

Target port of adaptation.

Target port of deadaptation.

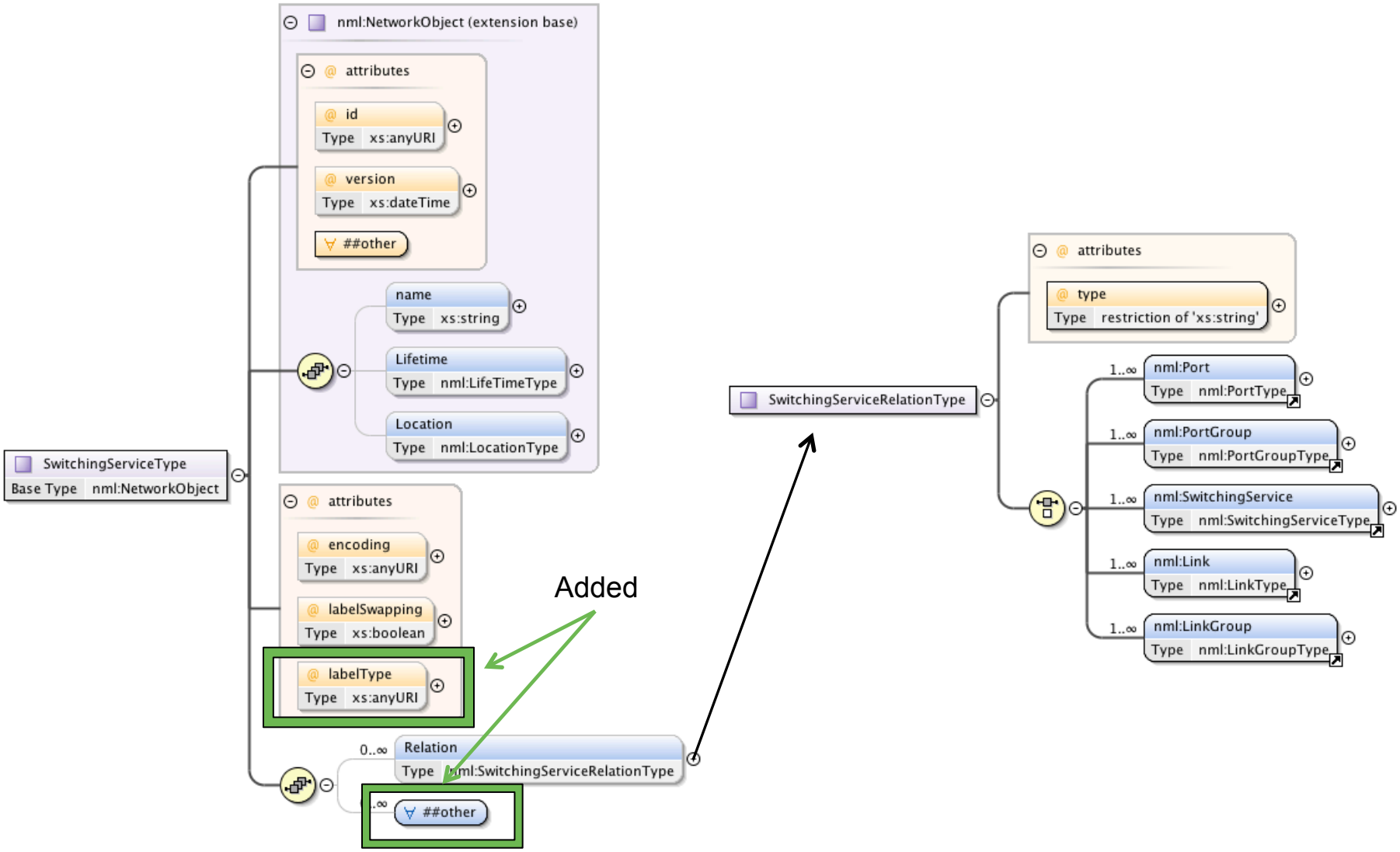
Service Definition for deadaptation must be same reference Id as adaptation.

SWITCHING SERVICE DETAILS

Switching Service

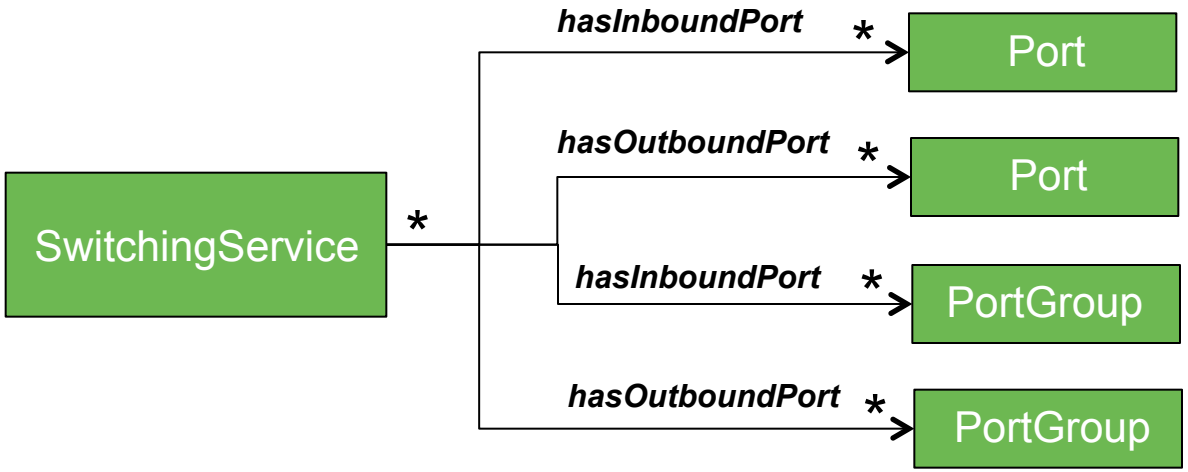
- A *SwitchingService* describes the ability to create new Links from any of its inbound Ports to any of its outbound Ports.
- A *SwitchingService* may have the following attributes:
  - ***id*** is assign a persistent globally unique URI.
  - ***encoding*** is assign a data encoding identifier associated with the *SwitchingService.*
  - ***labelSwapping***. A value of **false** adds a restriction to the *SwitchingService*: it is only able to create cross connects from an inbound *Port* to an outbound *Port* if the *Label* of the connected *Ports* has the same value. The default value is **false**.
  - ***labelType*** is assign the label type identifier associated with a *Port* that is switched by the *SwitchingService*.
  - ***other*** and *anyAttributes* allowing for the inclusion of attributes from other namespaces.
- A *SwitchingService* may have the following element members:
  - ***name*** to assign a human readable string.
  - ***Relation*** describe how the *SwitchingService* relates to other defined NML objects.
  - ***other*** an *ANY* definition allowing for the inclusion of element from other namespaces.
- Other attributes and elements inherited from *NetworkObject* and *Service* are available for use.

SwitchingService Definitions



Relations

- A *SwitchingService* may have the following relations:
  - ***existsDuring*** to one or more Lifetimes
  - ***hasInboundPort*** to one or more *Ports* or *PortGroups*
  - ***hasOutboundPort*** to one or more *Ports* or *PortGroups*
  - ***isAlias*** to one or more *Switching Services*
  - ***providesLink*** to one or more *Links* or *LinkGroups*. The *providesLink* relation points to *Links* which describe the currently configured cross connects in a *SwitchingService*.



Label Swapping

- The *SwitchingService* supports the concept of label swapping.
- If the ***labelSwapping*** attribute is set to true then any port within the *SwitchingService* can be connected to any other port independent of label value.
- If set to false, then only ports with equivalent labels can be interconnected.
- The ***labelType*** attribute identifies the type of label the *SwitchingService* will switch.
- A *Port* or *PortGroup* may have at most one ***labelType***.

Example

The SwitchingService supports the concept of label swapping. If the labelSwapping attribute is set to true then any port within the SwitchingService can be connected to any other port independent of label. If set to false, then only ports with equivalent labels can be interconnected.

```
<SwitchingService id="urn:ogf:network:netherlight.net:2013:ServiceDomain:A-GOLE-EVTS"
        encoding="http://schemas.ogf.org/nml/2012/10/ethernet"
        labelSwapping = "true"
        labelType="http://schemas.ogf.org/nml/2012/10/ethernet#vlan">

    <!-- Port relations have to be specified separately from PortGroups as defined
         in the NML schema. -->
    <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
        <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:in"/>
    </Relation>

    <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
        <Port id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:232:out"/>
    </nml:Relation>

    <Relation type="http://schemas.ogf.org/nml/2013/05/base#hasInboundPort">
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:241:in"/>
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:in"/>
    </Relation>

    <nml:Relation type="http://schemas.ogf.org/nml/2013/05/base#hasOutboundPort">
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:241:out"/>
        <PortGroup id="urn:ogf:network:netherlight.net:2013:port:a-gole:testbed:manlan:1:out"/>
    </nml:Relation>

    <!-- Services supported by this SwitchingService (NSI Service Domain). -->
    <sd:ServiceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EVTS.A-GOLE"/>
</SwitchingService>
```

labelSwapping set to “true” indicates that ports can be connected with different label values.

labelType indicates the label that could be switched.

Port elements can be members of SwitchingService.

PortGroup elements can also be members of SwitchingService.

ServiceDefinition associated with this SwitchingService.

Ethernet

- We are using the following Ethernet namespace for our NML documents:

  http://schemas.ogf.org/nml/2012/10/ethernet

- The ***encoding*** attribute on both the *SwitchingService* and *Port/PortGroup* elements will use the following URL if they support Ethernet:

  http://schemas.ogf.org/nml/2012/10/ethernet

- The ***labeltype*** attribute in the *SwitchingService* and *Label/LabelGroup* elements will use the following URL if they support IEEE 802.1Q Ethernet:

  http://schemas.ogf.org/nml/2012/10/ethernet#vlan

Ethernet (continued)

- A Label element associated with an Ethernet port will contain a single VLAN value and have the "*labeltype*" set to http://schemas.ogf.org/nml/2012/10/ethernet.
- A LabelGroup element associated with an Ethernet port will contain one or more VLAN values and have the "*labeltype*" set to http://schemas.ogf.org/nml/2012/10/ethernet.
- A LabelGroup supports comma and hyphen separated ranges such as "1-1770,1780-2000,2002,2006".

Default behavior no SwitchingService

- If no *SwitchingService* is specified within the NML *Topology* element then this implies a single *SwitchingService* for each supported ***labelType/encoding*** pair, containing all unidirectional ports of that ***labelType*** and ***encoding*** specified using the "has*Port" relations, all defined *ServiceDefinitions* supporting the ***encoding***, and the ***labelSwapping*** attribute set to false.
- Ports defined with no labels are matched on ***encoding*** type only and placed in a *SwitchingService* defined with no ***labelType*** or ***labelSwapping*** attributes.
- Ports defined with no ***encoding*** are matched on ***labelType*** only (if available) and placed in a *SwitchingService* defined with no ***encoding*** attribute, however, ***labelType*** and ***labelSwapping*** attributes can be present if used as a matching criteria.

Specifying a wildcard SwitchingService

- When a specific default behavior is required, a *SwitchingService* can be specified in the NML *Topology* element with wildcard behaviors.
- All ports matching the wildcard specification of the defined *SwitchingService* are included in that *SwitchingService*.
- When a wildcard *SwitchingService* is defined the default *SwitchingService* behavior is no longer used.
- A wildcard *SwitchingService* is specified within the NML *Topology* element similar to a normal *SwitchingService* specification except no *Relation* elements are included.
- The lack of *Relation* elements implies the *SwitchingService* includes any *Port/PortGroups* that match the specified ***labelType*** and ***encoding*** of that *SwitchingService*.

Continued…

- For example, the following wildcard *SwitchingService* is defined that includes all ports using a "vlan" ***lableType*** and an "ethernet" ***encoding***. This *SwitchingService* is defined with ***labelSwapping*** set to "true" and with the "EVTS.A-GOLE" *ServiceDefinition*:

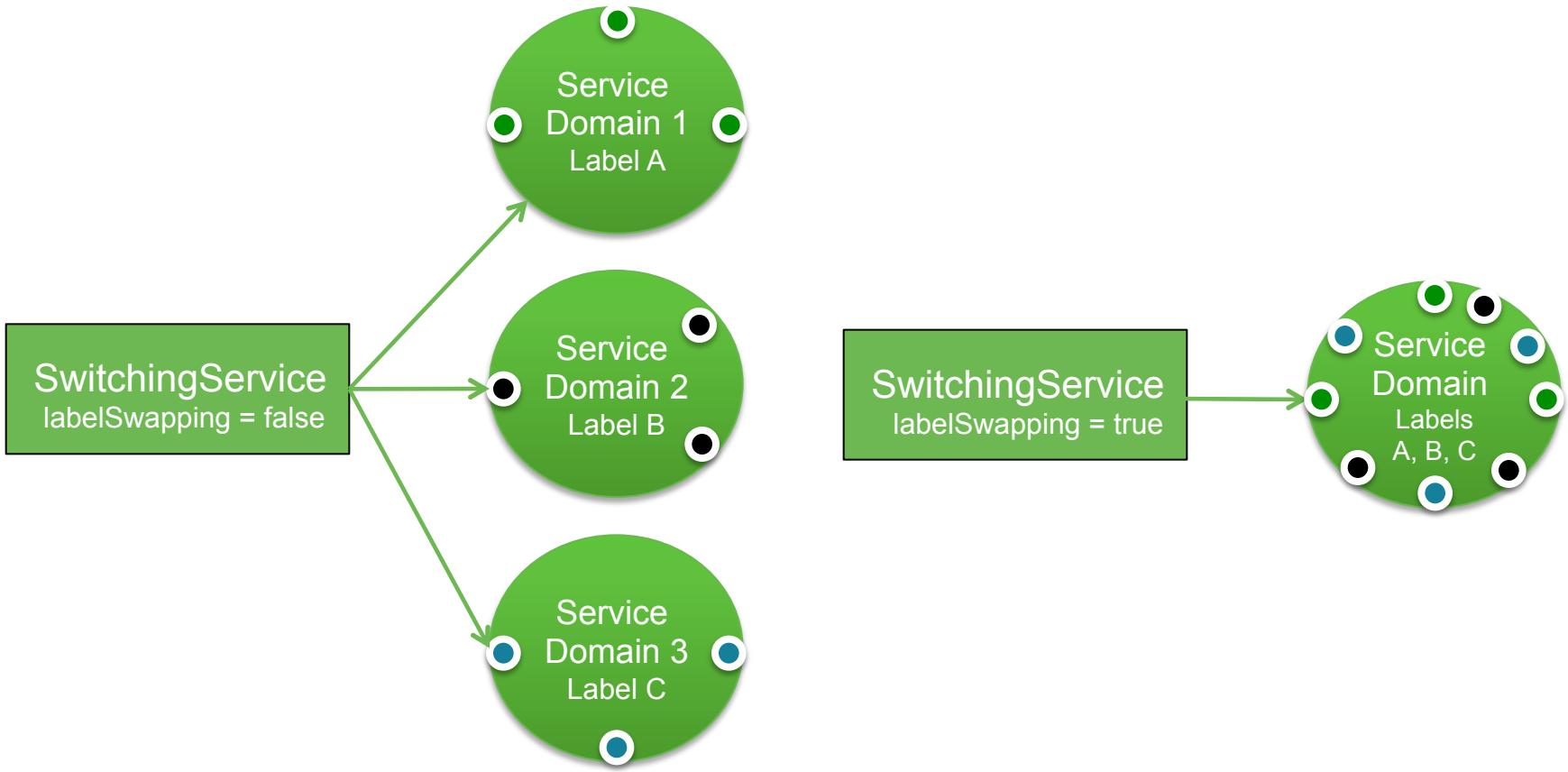
```
<SwitchingService id="urn:ogf:network:netherlight.net:2013:ServiceDomain:a-gole:testbed:A-GOLE-EVTS"
        encoding="http://schemas.ogf.org/nml/2012/10/ethernet"
        labelSwapping = "true"
        labelType="http://schemas.ogf.org/nml/2012/10/ethernet#vlan">
    <sd:serviceDefinition id="urn:ogf:network:netherlight.net:2013:ServiceDefinition:EVTS.A-GOLE" />
</SwitchingService>
```

- If there are ports defined within the NML *Topology* element that do not match a defined *SwitchingService* then these ports are not connectable.

NSI Service Domain

- In a Service Domain any STP can be connected to any other STP with the following constraints:
  - Unidirectional inbound STP can only be connected to unidirectional outbound STP.
  - Bidirectional ports can only be interconnected to other bidirectional ports.
- A Service Domain has an associated Service Definition (SD) describing the service being offered.
- Service Domains are grouped into Network topologies that can be advertised by at most one NSA.
- An NSA can advertise multiple Network topologies.
- The SwitchingService element is used to model NSI Service Domains.
- A single SwitchingService declaration can expand into many NSI Service Domains depending if label swapping is supported or not (a domain per label value).

Service Domain Mappings



Next Steps

- Need to get an official designation for modified NML (errata, new version, etc.)
- NSA implementations need to incorporate new NML schema (in current form it is backwards compatible).
- Network deployments need to advertise their *SwitchingService* elements in NML topology documents.
- Path finders start utilizing the information to better model *ServiceDomains* within a network.