# IEEE 802.1Q YANG Interface Framework in support of Link Aggregation (802.1AX), Security (802.1X), and CFM (802.1ag)

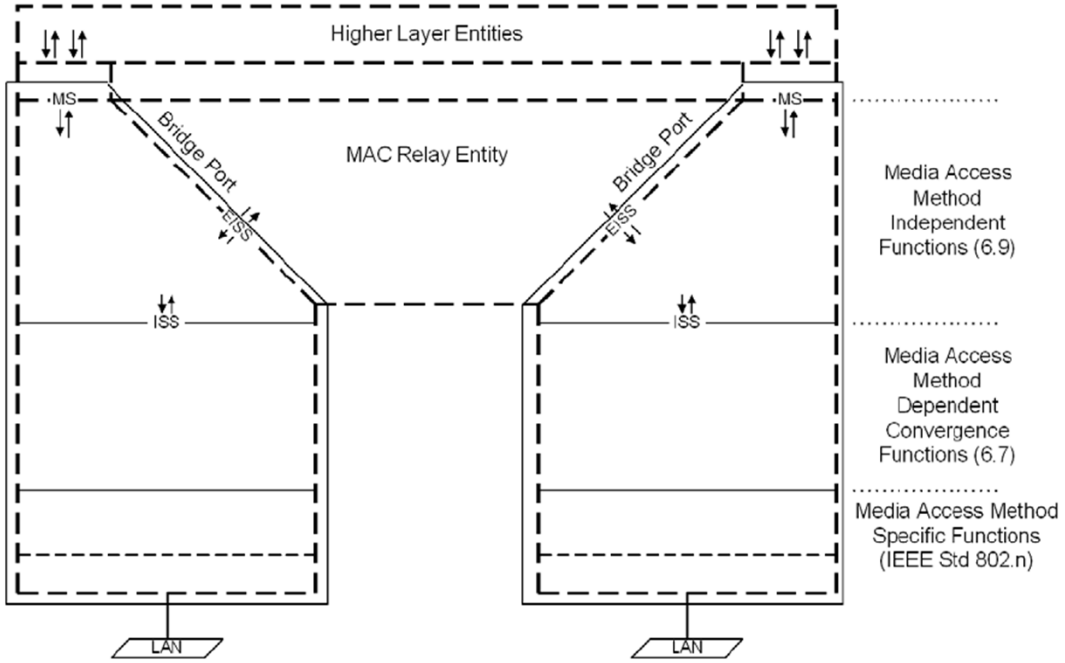
Marc Holness
Version 1.4
26 July 2016

# IEEE 802.1Q Bridge Port

- Each Bridge Port is associated with one Interface, and in most situations, each Bridge Port is associated with a different interface
- However, there are situations in which multiple Bridge Ports are associated with the same interface
  - For example, several Bridge Ports can each correspond one-to-one with several Ethernet private lines (or SDH virtual circuits) but all on the same Interface
  - Or multiple Bridge Ports can each correspond to a single internal LAN (I-LAN) port
- Alternatively, there is the Link Aggregation (IEEE Std 802.1AX) case where there are many physical Ports for one Bridge Port

# IEEE 802.1Q Bridge Port

- The MAC Relay Entity handles the media access method-independent functions of relaying frames among Bridge Ports. It uses the EISS (6.8, 6.9) provided by each Bridge Port
- Each Bridge Port also functions as an end station and shall provide the MAC Service to an LLC Entity that operates LLC Type 1 procedures to support protocol identification, multiplexing, and demultiplexing, for PDU transmission and reception by the Spanning Tree Protocol Entity and other higher layer entities

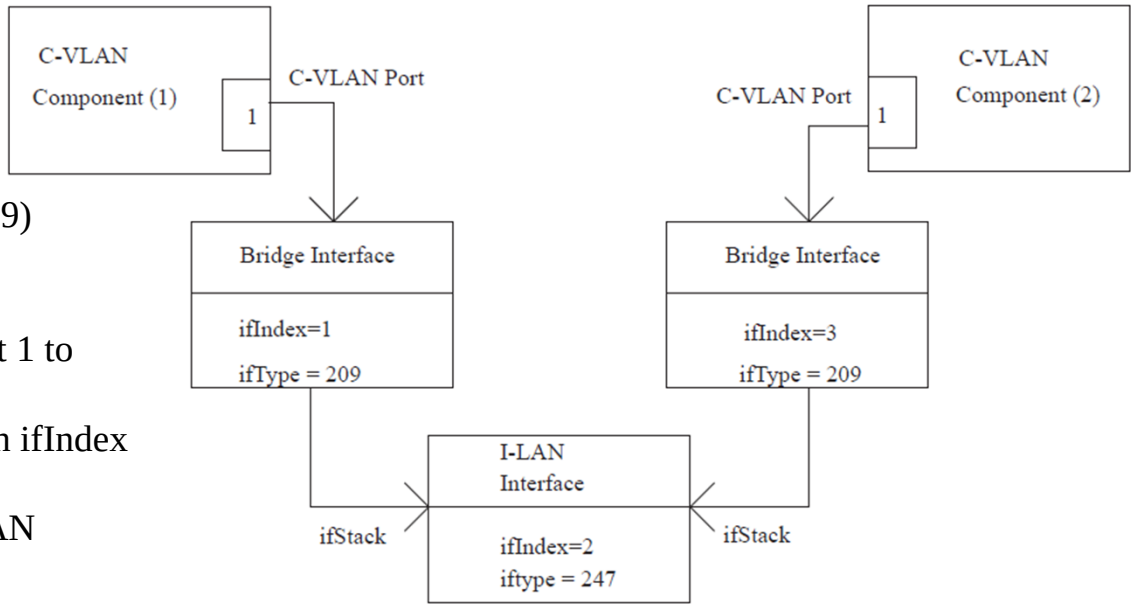


# IEEE 802.1Q-2014 References

- From 802.1Q-2014, Clause 17.3.2.2 “Relationship to the IF-MIB”

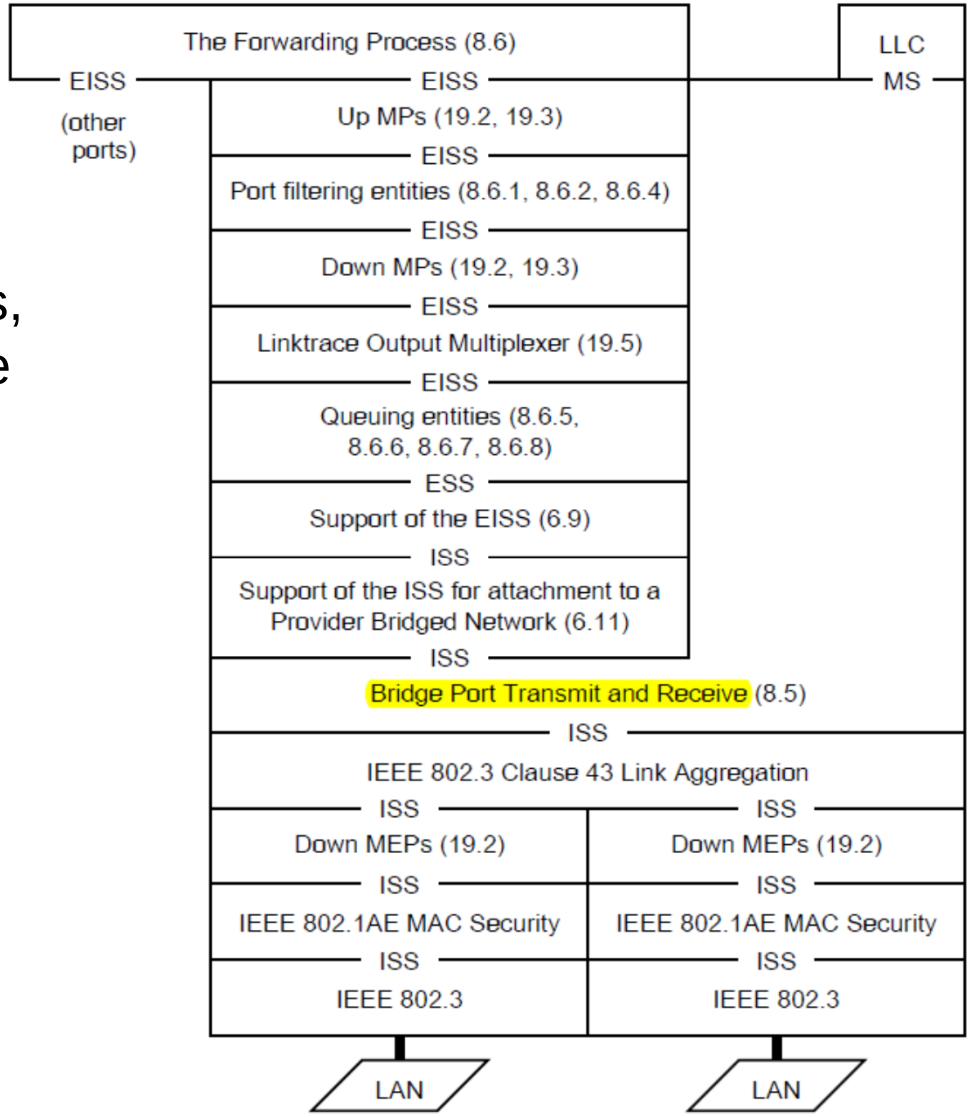
The following steps are required

1. Create C-VLAN component 1.
2. Create C-VLAN Port 1 on component 1.
3. Create a Bridge Port interface (ifType 209) identified by ifIndex 1 using a external mechanism.
4. Associate C-VLAN Port 1 on component 1 to Bridge Port interface 1.
5. Create an I-LAN interface identified with ifIndex 2.
6. Stack Bridge Port interface 1 on the I-LAN interface 2.
7. Create C-VLAN component 2.
8. Create C-VLAN Port 1 on component 2.
9. Create a Bridge Port interface (ifType 209) identified by ifIndex 3 using a external mechanism.
10. Associate C-VLAN Port 1 on component 2 to Bridge Port interface 3.
11. Stack Bridge Port interface 3 on the I-LAN interface 2.



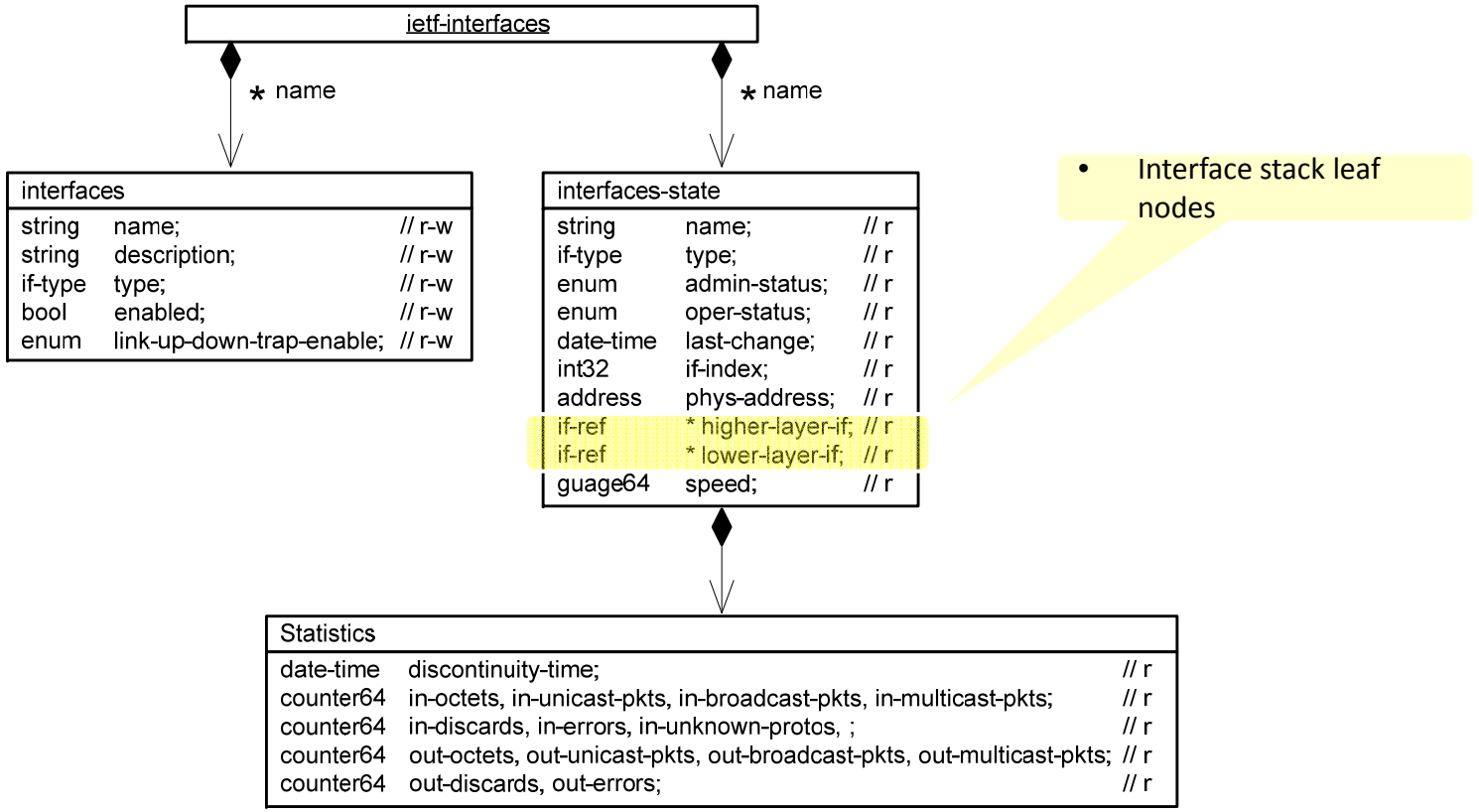
# CFM Maintenance Point Placement

- CFM entities are specified as shims that make use of and provide the ISS or EISSS at SAPs within the network
- The relationships among MPs, and between the MPs and the other entities in a Bridge, are configurable

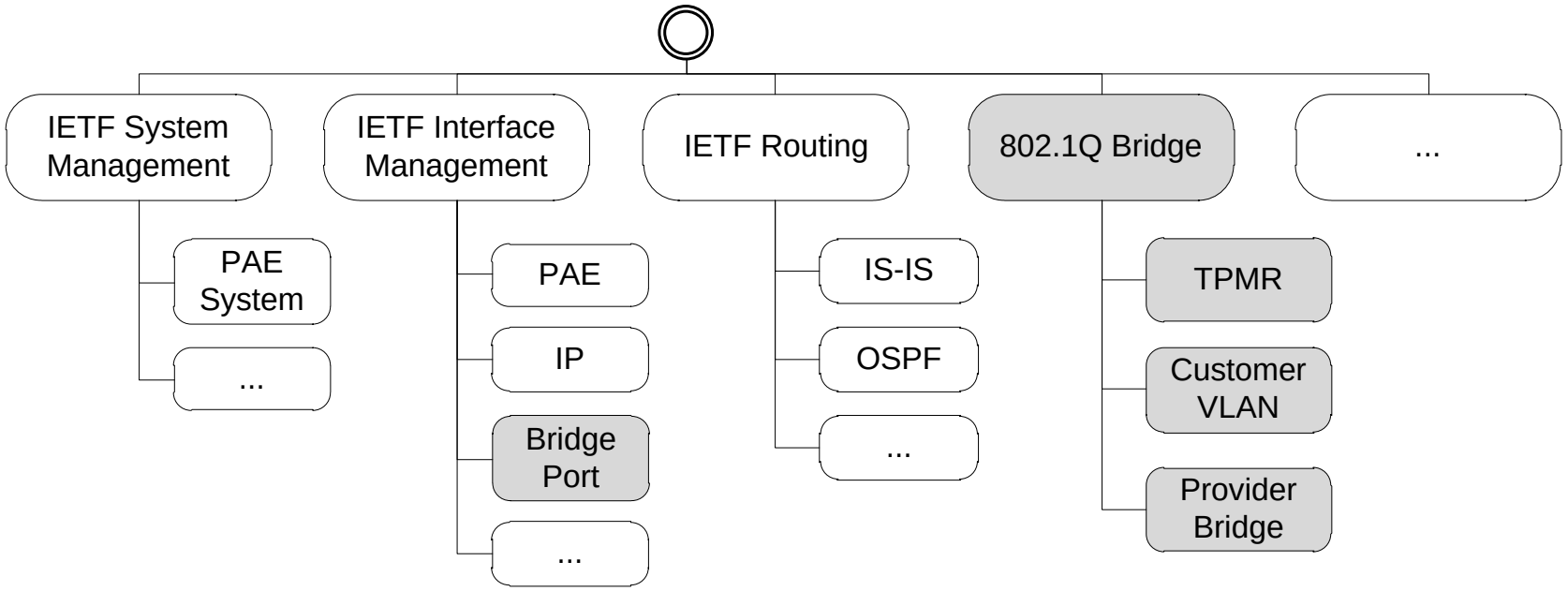


# IETF Interface Management Model

- IETF Interface Management Model can be represented as shown below
  - UML-ized depiction of YANG model specified in RFC 7223

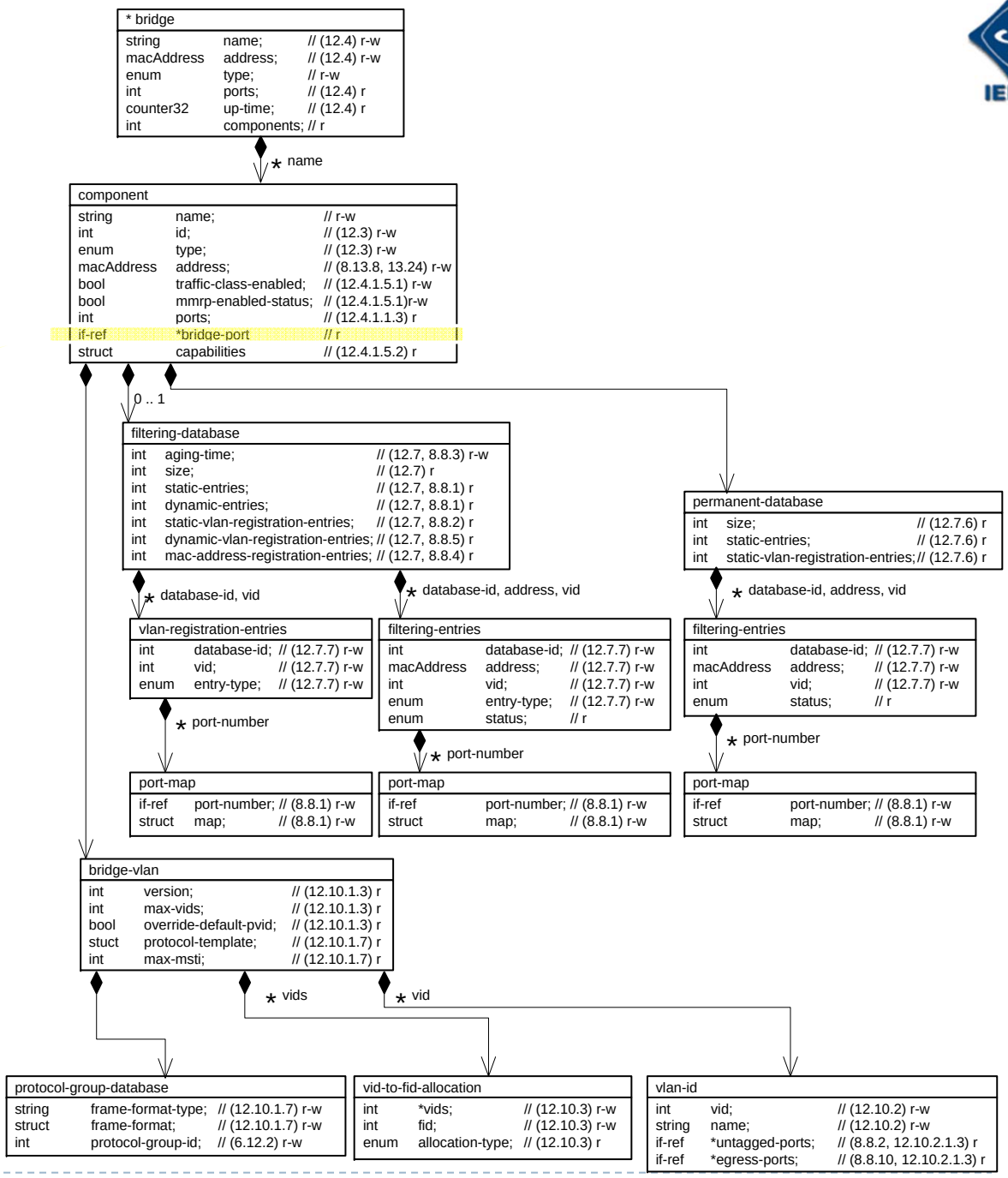


# IEEE 802.1 Objects Within YANG Object Hierarchy

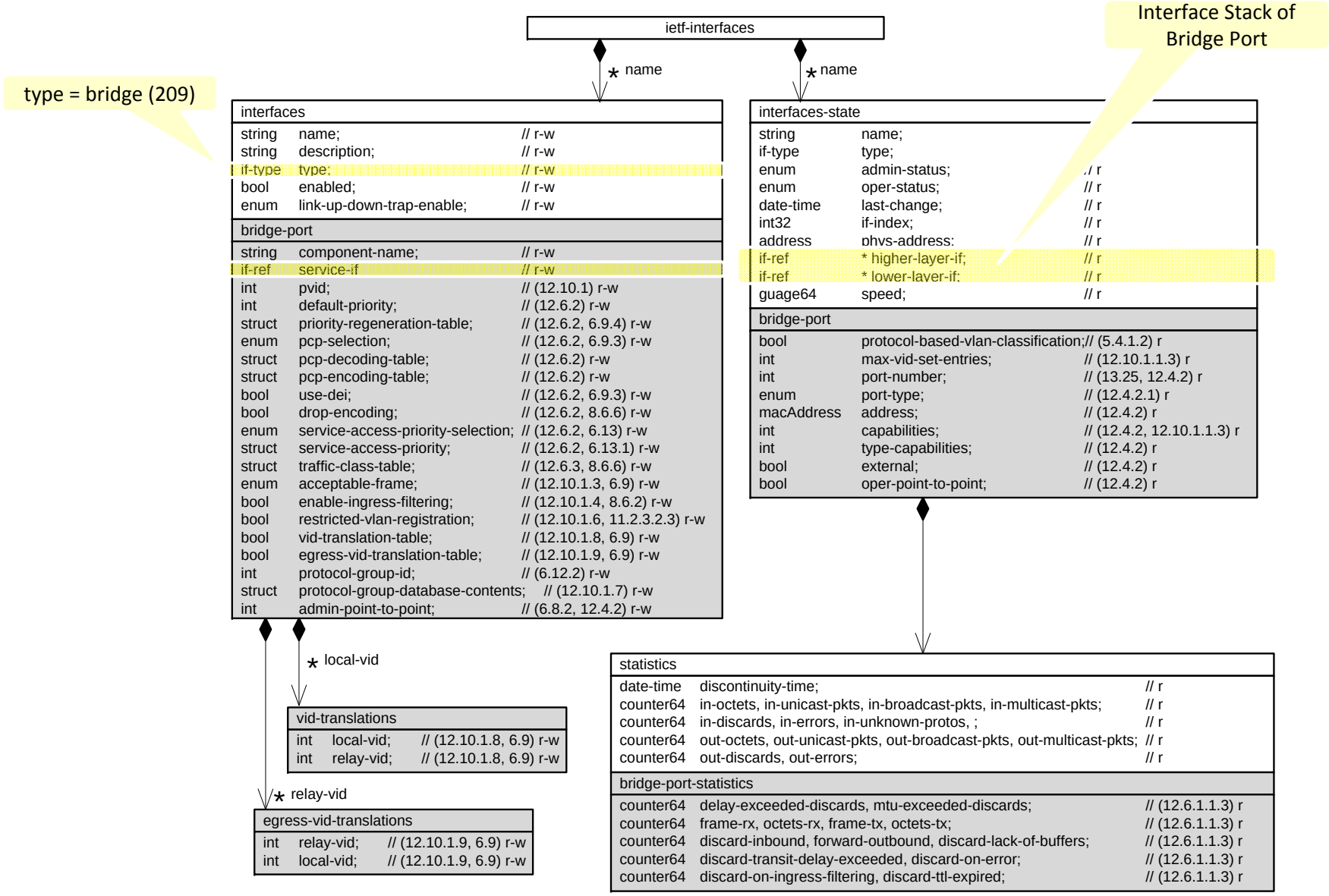


# Introducing the [Generic] Bridge YANG Model

The list of Bridge Ports



# Introducing the Bridge Port Interface Model

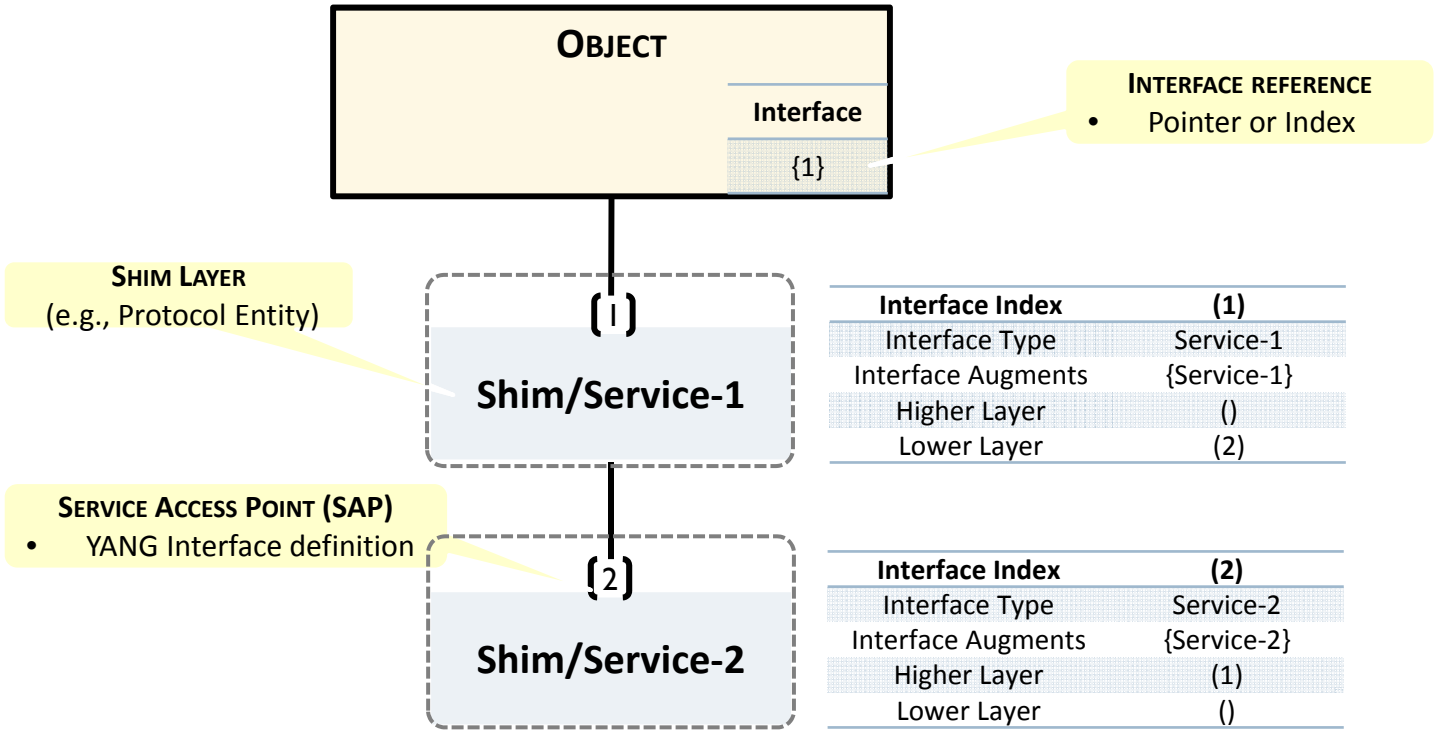


# YANG Bridge Port Model Except

```
augment "/if:interfaces/if:interface" {
    when "/if:type = 'ianaif:bridge'{
      description
        "Applies when a Bridge interface";
    }
    description
      "Augment the interface model with the Bridge Port";
    container bridge-port {
      leaf component-name {
        type dot1qtypes:component-ref;
        description
          “Used to reference configured Component nodes.”;
      }
      :
      leaf service-if {
        type interface-ref;
        description
          “Reference to interfaces pointed to by the Bridge Port”;
      }
      :
    }
}
```

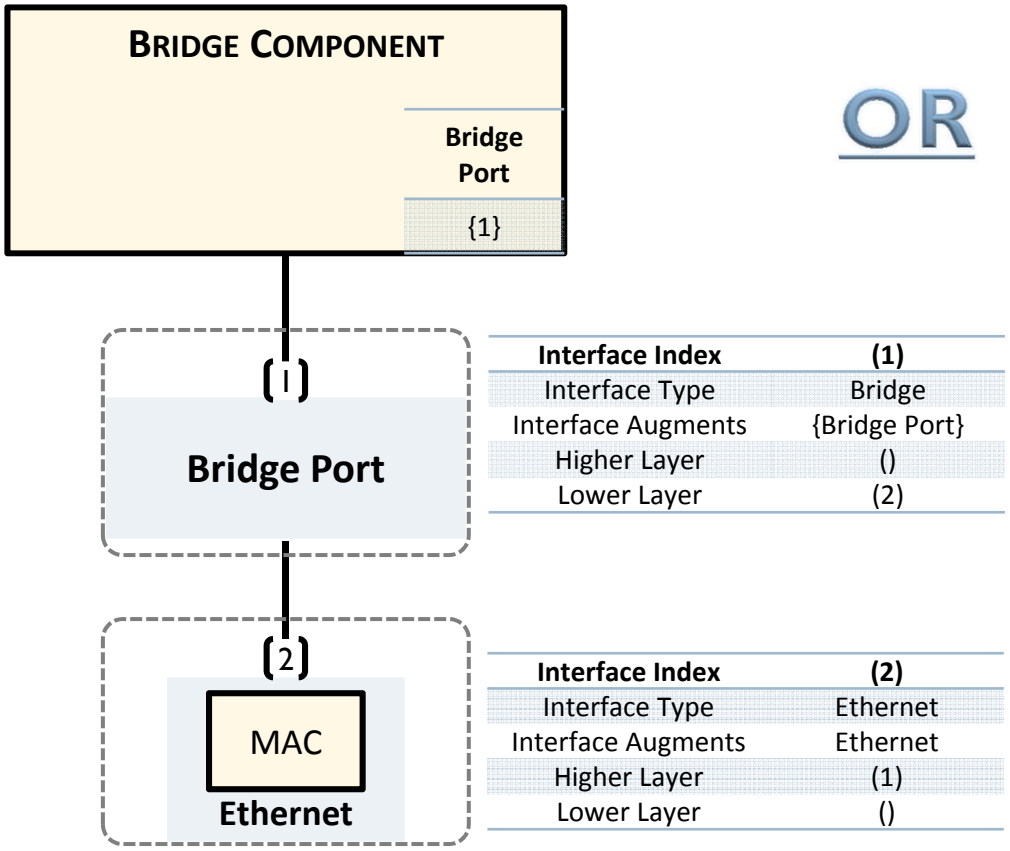
# Interface Stack Diagram Representation

- A SAP is an abstraction and does not necessarily correspond to any concrete realization within a system
- The entities that support a particular SAP compose an interface stack
- Each YANG Interface definition contains an interface stack table



# Interface Stack — Bridge Port

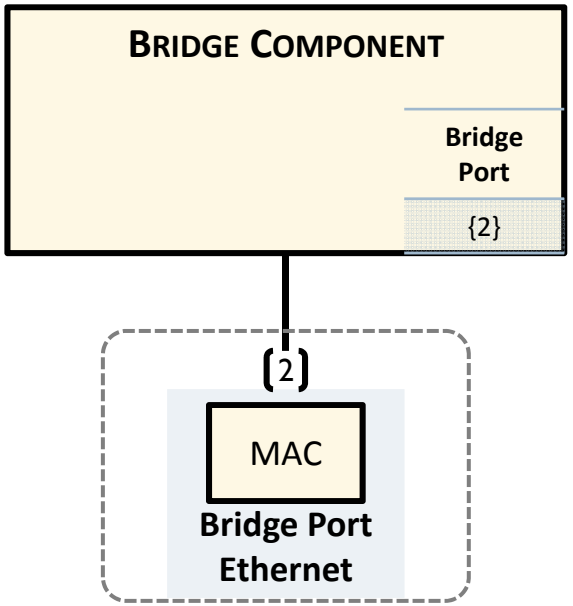
- The Bridge Port interface provides a pointer to a service interface
- The placement of CFM maintenance points (relative to other services) would suggest that a separate SAP between the Bridge Ports and actual interface is required




| Interface Index | (1) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | (2) |

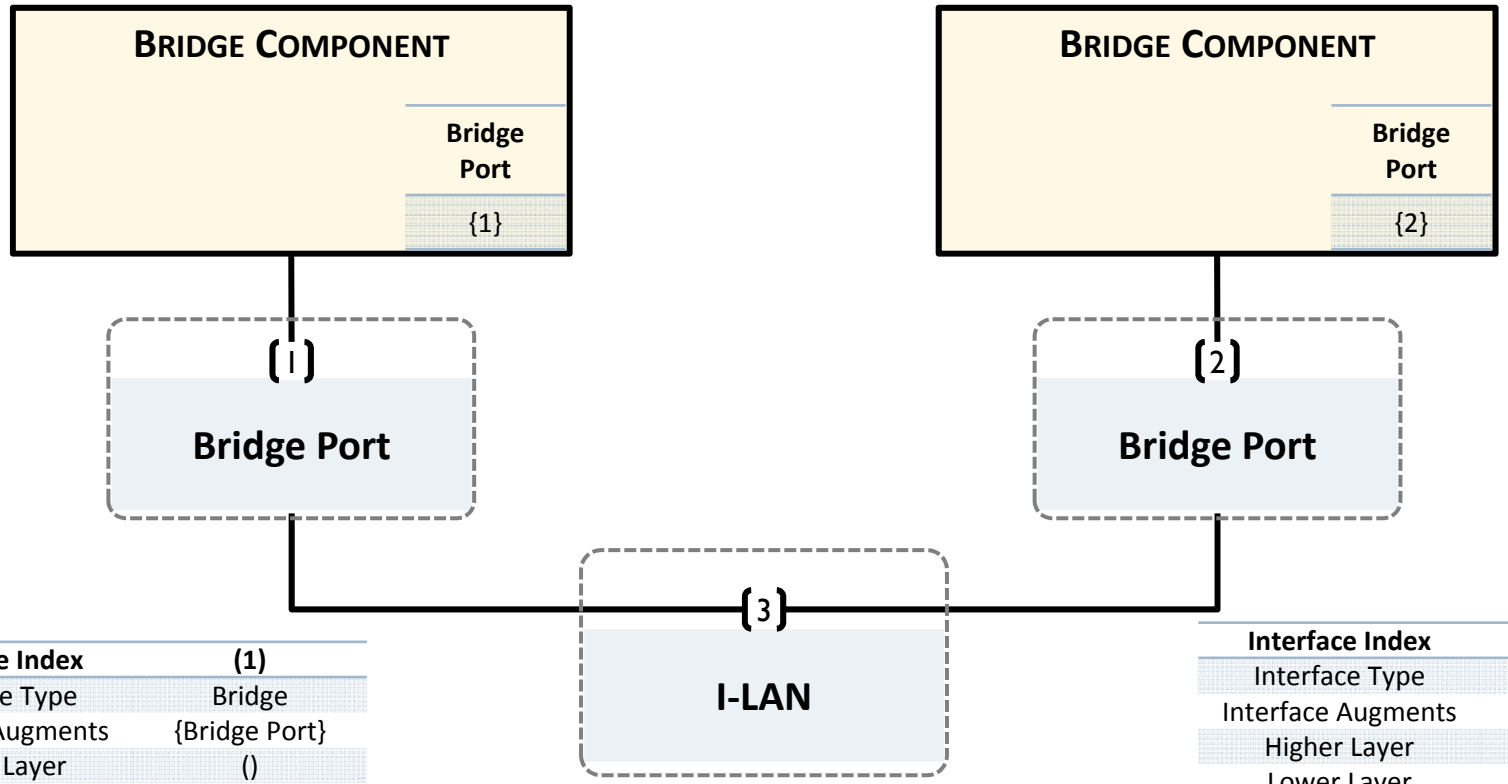
| Interface Index | (2) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | Ethernet |
| Higher Layer | (1) |
| Lower Layer | () |

OR




| Interface Index | (2) |
|---|---|
| Interface Type | ?? |
| Interface Augments | {Bridge Port, Ethernet} |
| Higher Layer | () |
| Lower Layer | () |

# Interface Stack — Bridge Ports and Internal LAN



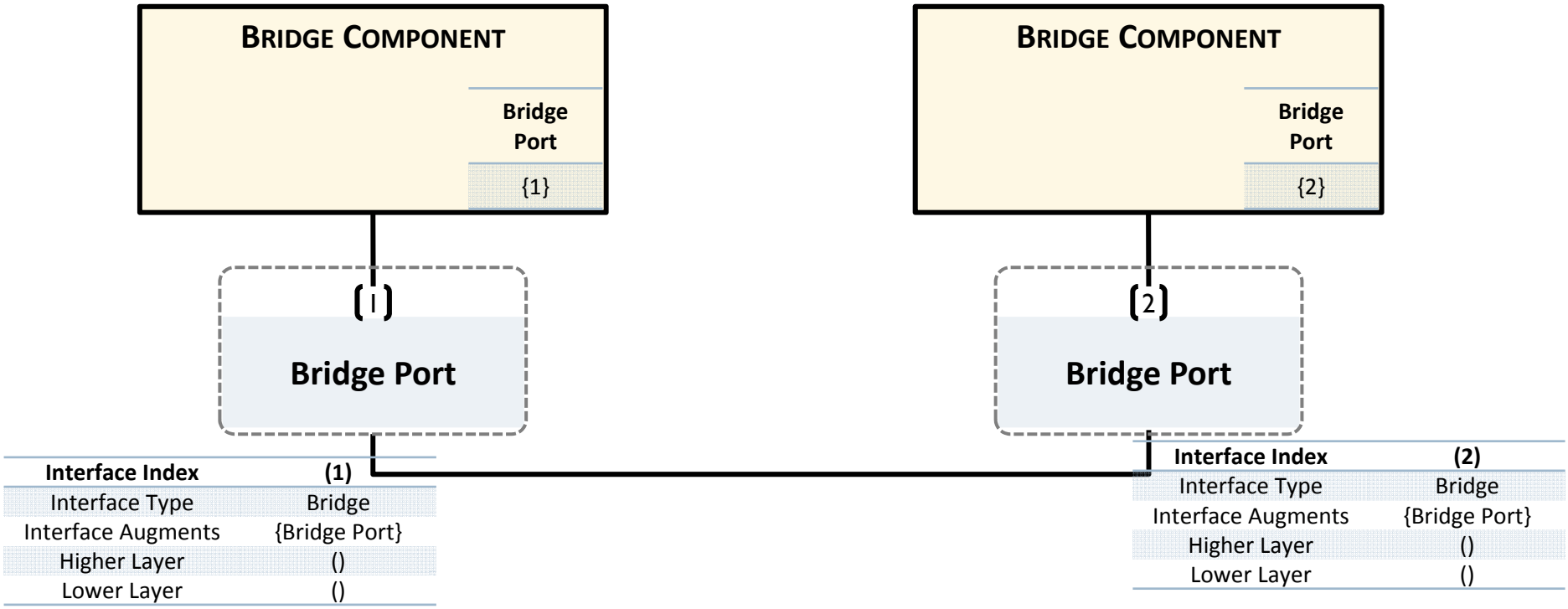

| Interface Index | (1) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | (3) |

| Interface Index | (3) |
|---|---|
| Interface Type | ILAN |
| Interface Augments | {ILAN} |
| Higher Layer | (1), (2) |
| Lower Layer | () |

| Interface Index | (2) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | (3) |

# Interface Stack — Bridge Ports and Internal LAN

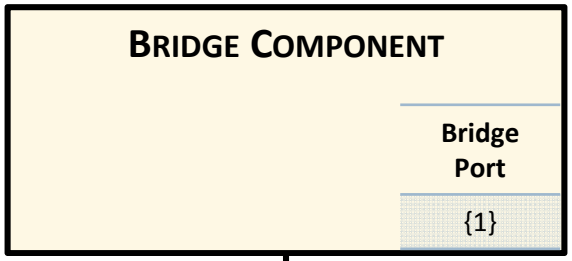
## Alternative

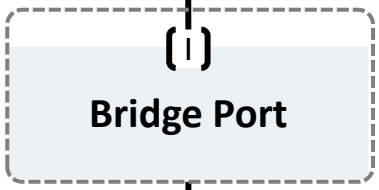



| Interface Index | (1) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | () |

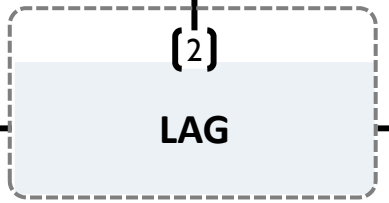
| Interface Index | (2) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | () |

# Interface Stack — Bridge Port (LAG)

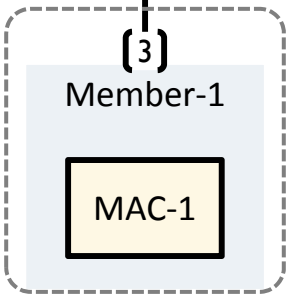


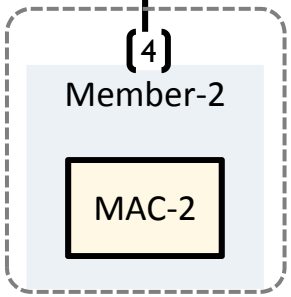

| Interface Index | (1) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | (2) |




| Interface Index | (2) |
|---|---|
| Interface Type | LAG |
| Interface Augments | {LAG} |
| Higher Layer | (1) |
| Lower Layer | (3), (4) |



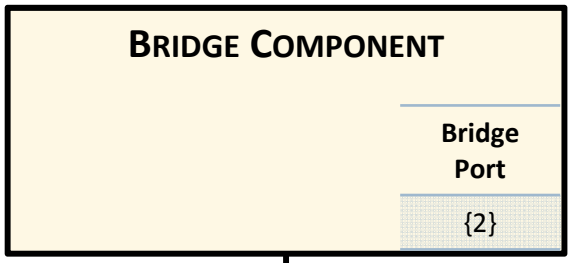

| Interface Index | (3) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet, LAG Member} |
| Higher Layer | (2) |
| Lower Layer | () |




| Interface Index | (4) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet, LAG Member} |
| Higher Layer | (2) |
| Lower Layer | () |

# Interface Stack — Bridge Port (LAG)

## Alternative




(2)
**LAG Bridge Port**

| Interface Index | (2) |
|---|---|
| Interface Type | ?? |
| Interface Augments | {LAG, Bridge Port} |
| Higher Layer | () |
| Lower Layer | (3), (4) |

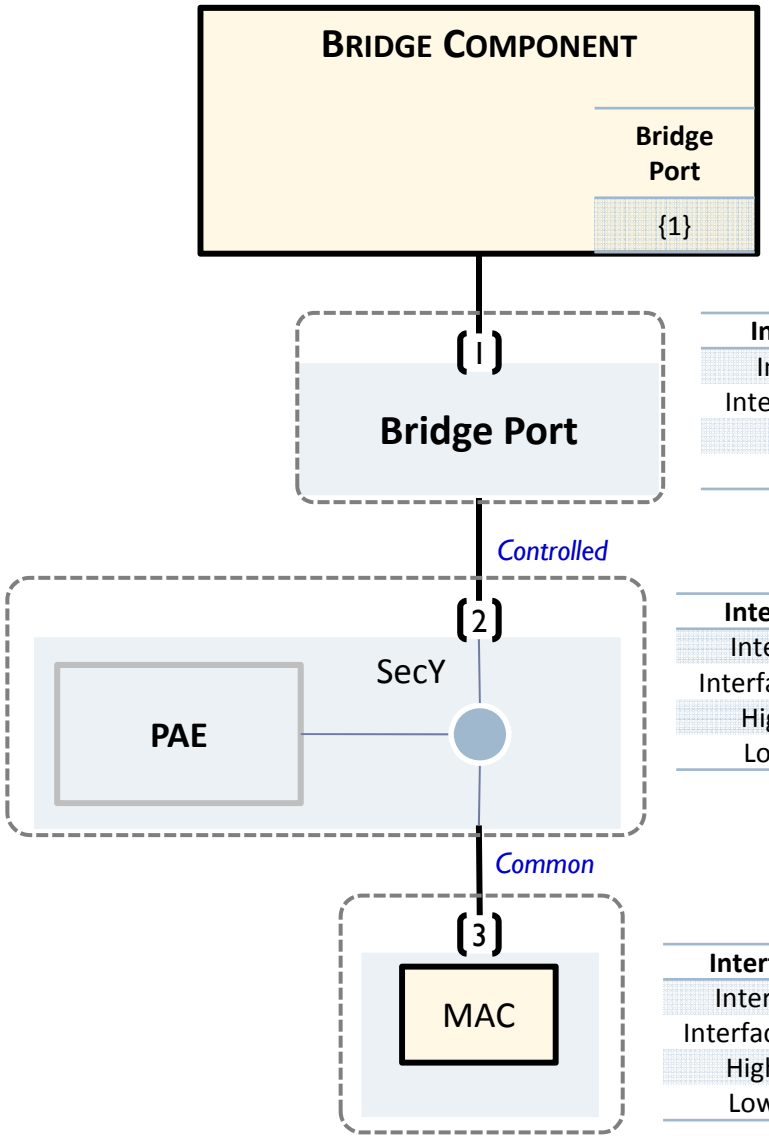
(3) Member-1 — MAC-1

| Interface Index | (3) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet, LAG Member} |
| Higher Layer | (2) |
| Lower Layer | () |

(4) Member-2 — MAC-2

| Interface Index | (4) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet, LAG Member} |
| Higher Layer | (2) |
| Lower Layer | () |

# Interface Stack — Bridge Port with MACSec



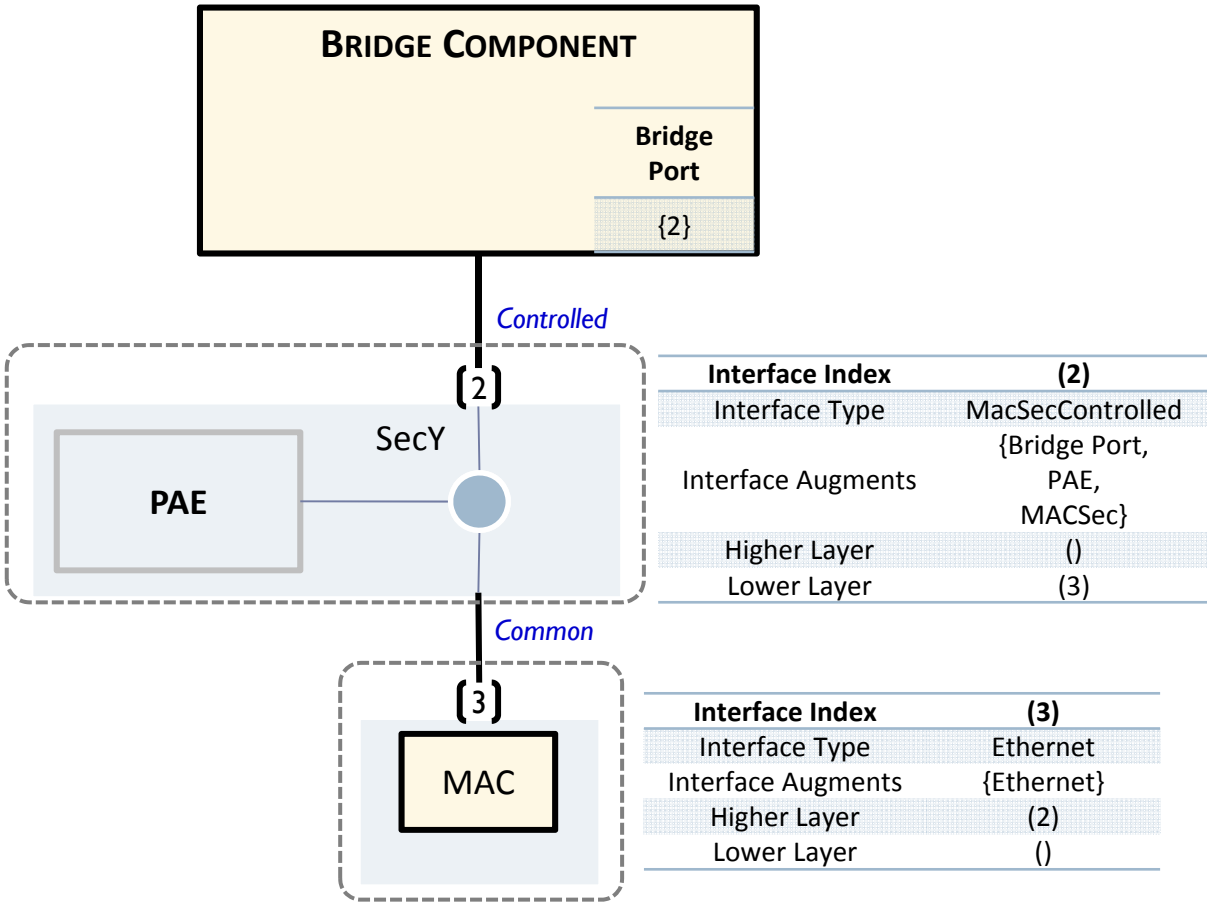

| Interface Index | (1) |
|---|---|
| Interface Type | Bridge |
| Interface Augments | {Bridge Port} |
| Higher Layer | () |
| Lower Layer | (2) |

| Interface Index | (2) |
|---|---|
| Interface Type | MacSecControlled |
| Interface Augments | {PAE} |
| Higher Layer | (1) |
| Lower Layer | (3) |

| Interface Index | (3) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet} |
| Higher Layer | (2) |
| Lower Layer | () |

# Interface Stack — Bridge Port with MACSec

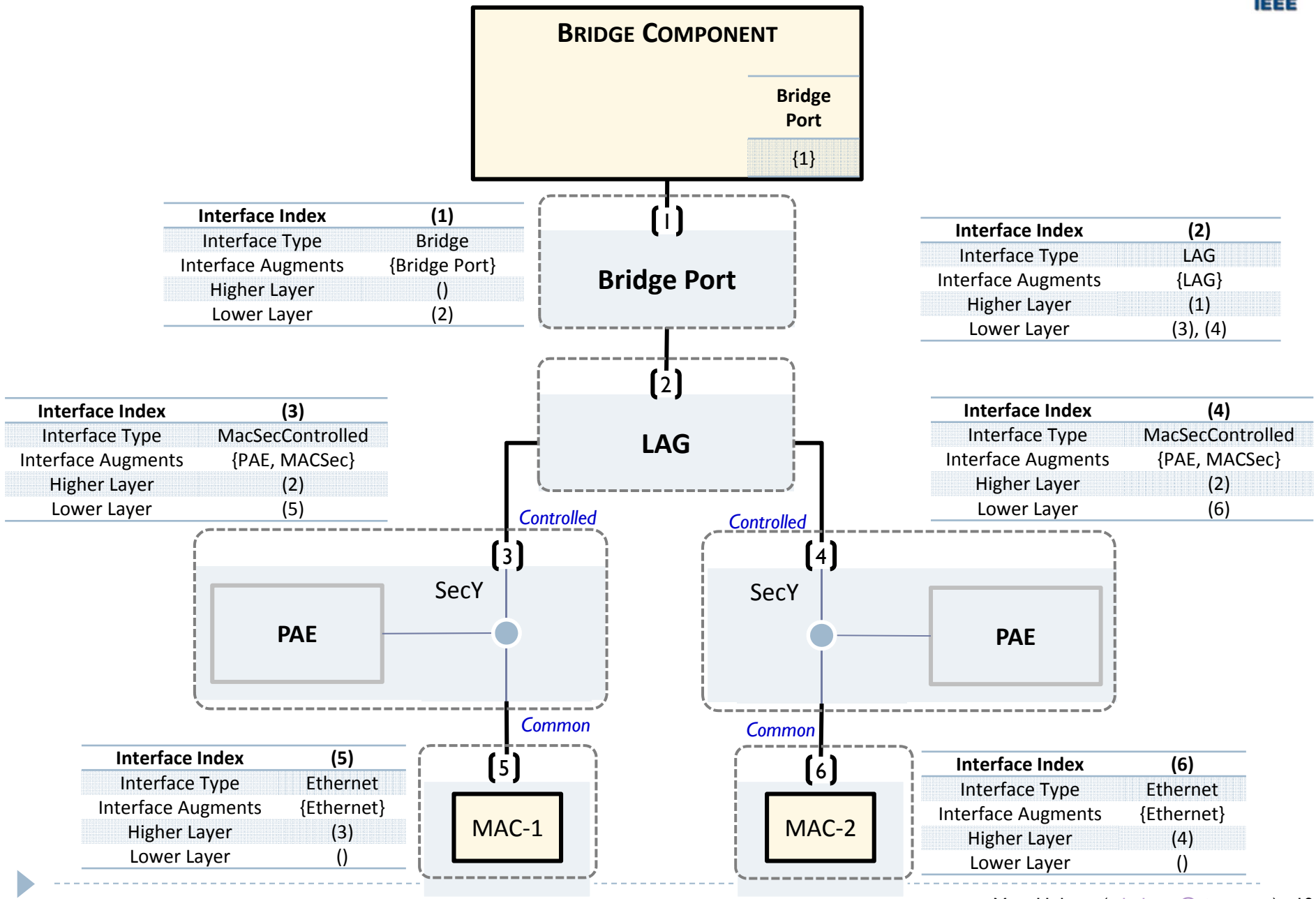
## Alternative




| Interface Index | (2) |
|---|---|
| Interface Type | MacSecControlled |
| Interface Augments | {Bridge Port, PAE, MACSec} |
| Higher Layer | () |
| Lower Layer | (3) |

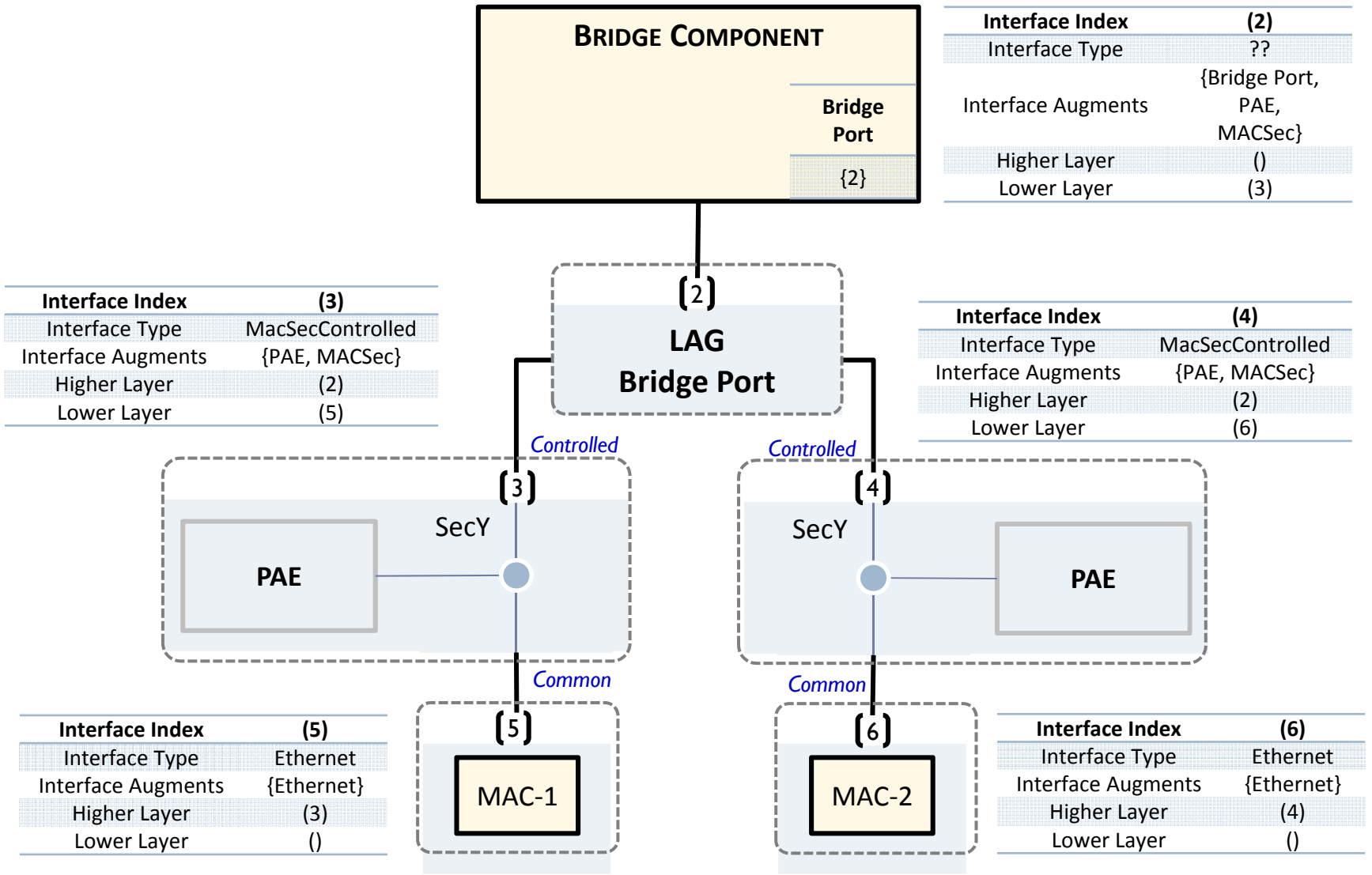
| Interface Index | (3) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet} |
| Higher Layer | (2) |
| Lower Layer | () |

# Interface Stack – Bridge Port (LAG) with MACSec



# Interface Stack – Bridge Port (LAG) with MACSec

## Alternative




| Interface Index | (2) |
|---|---|
| Interface Type | ?? |
| Interface Augments | {Bridge Port, PAE, MACSec} |
| Higher Layer | () |
| Lower Layer | (3) |

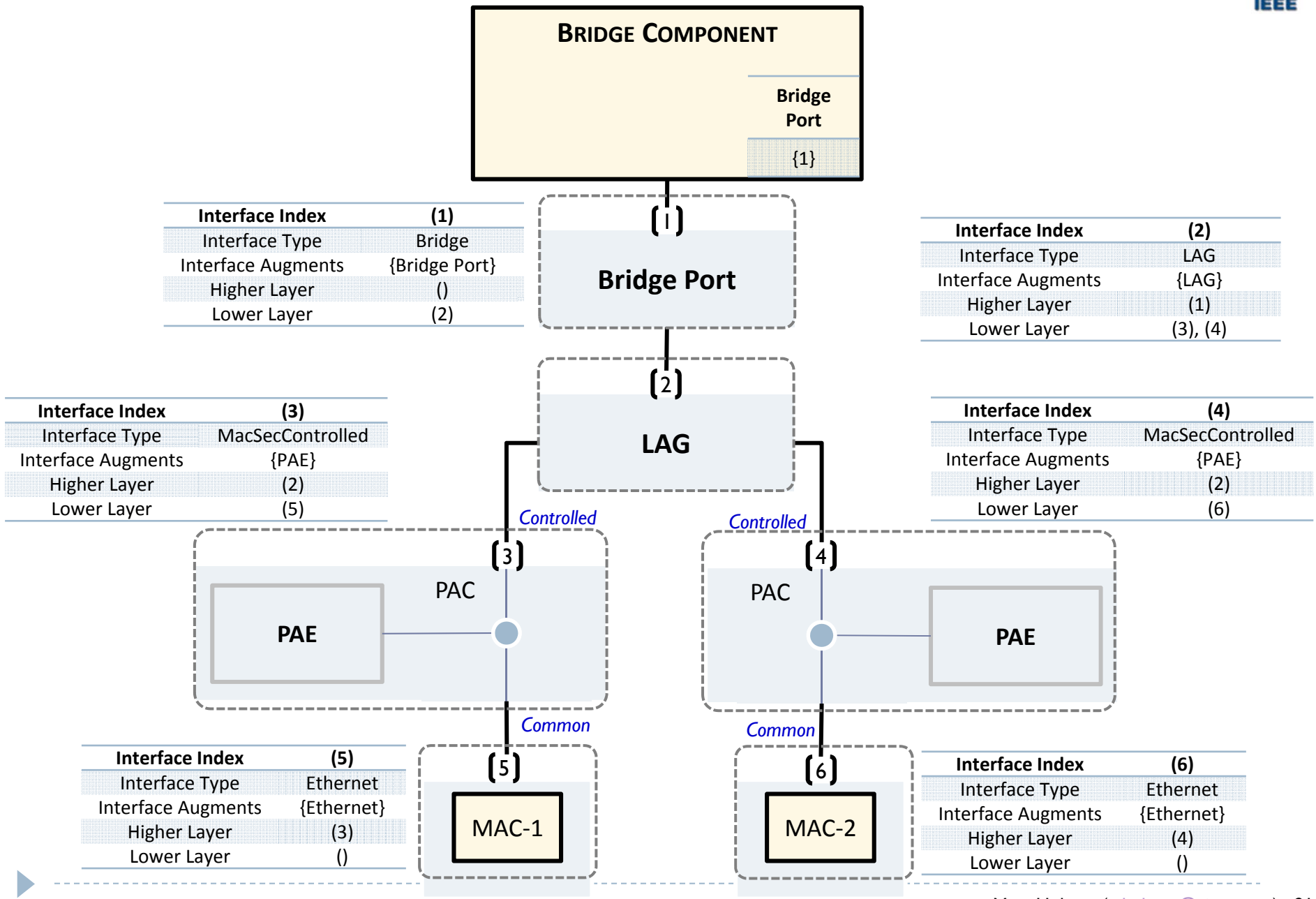
| Interface Index | (3) |
|---|---|
| Interface Type | MacSecControlled |
| Interface Augments | {PAE, MACSec} |
| Higher Layer | (2) |
| Lower Layer | (5) |

| Interface Index | (4) |
|---|---|
| Interface Type | MacSecControlled |
| Interface Augments | {PAE, MACSec} |
| Higher Layer | (2) |
| Lower Layer | (6) |

| Interface Index | (5) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet} |
| Higher Layer | (3) |
| Lower Layer | () |

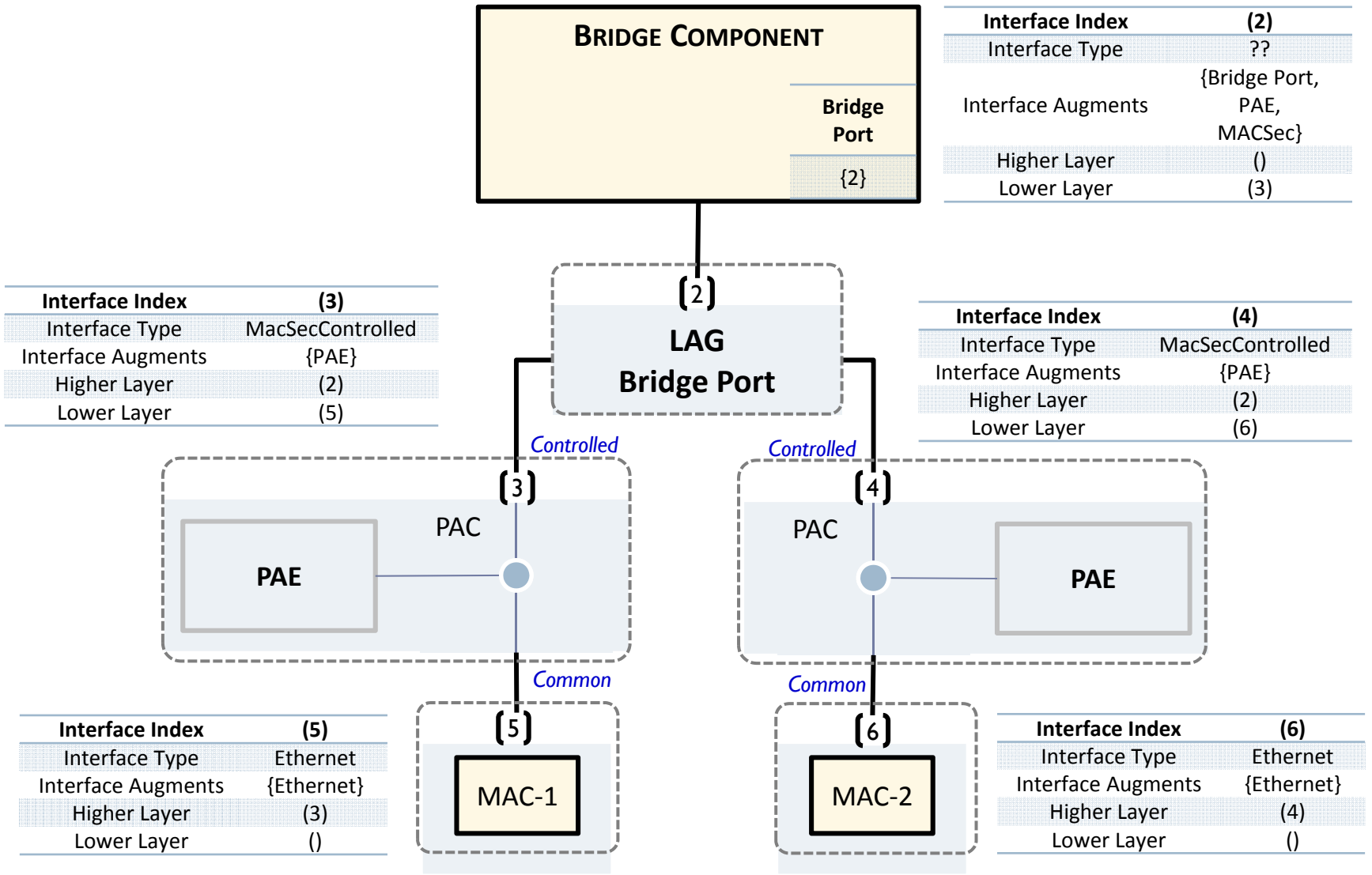
| Interface Index | (6) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet} |
| Higher Layer | (4) |
| Lower Layer | () |

# Interface Stack – Bridge Port (LAG) without MACSec



# Interface Stack – Bridge Port (LAG) without MACSec

## Alternative




| Interface Index | (2) |
|---|---|
| Interface Type | ?? |
| Interface Augments | {Bridge Port, PAE, MACSec} |
| Higher Layer | () |
| Lower Layer | (3) |

| Interface Index | (3) |
|---|---|
| Interface Type | MacSecControlled |
| Interface Augments | {PAE} |
| Higher Layer | (2) |
| Lower Layer | (5) |

| Interface Index | (4) |
|---|---|
| Interface Type | MacSecControlled |
| Interface Augments | {PAE} |
| Higher Layer | (2) |
| Lower Layer | (6) |

| Interface Index | (5) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet} |
| Higher Layer | (3) |
| Lower Layer | () |

| Interface Index | (6) |
|---|---|
| Interface Type | Ethernet |
| Interface Augments | {Ethernet} |
| Higher Layer | (4) |
| Lower Layer | () |

# NETCONF and YANG Example Configuration

Bridge Port

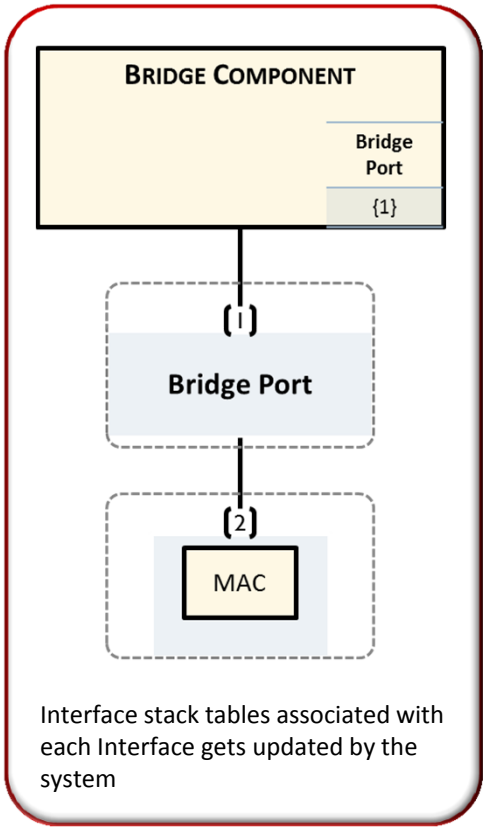
# Bridge Port

```
<rpc message-id=”101” xmlns=”urn:ietf:params:xml:ns:yang:ietf-interfaces”>
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <interface xc:operation=“create”>
          <name>if-1</name>
          <type>bridge</type>
            :
        </interface>
        <interface xc:operation=“create”>
          <name>if-2</name>
          <type>ethernetCsmacd</type>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

- Interface specific configuration items

# Bridge Port

```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1q-bridge">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <bridges xc:operation="create">
          <bridge>
            <name>the-bridge</name>
              :
            <component>
              <name>the-component</name>
                :
            </component>
          </bridge>
          :
        </bridges>
        <interface>
          <name>if-1</name>
            :
          <bridge-port>
            <component-name>the-component</component-name>
            <service-if>if-2</service-if>
            :
          </bridge-port>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```




Interface stack tables associated with each Interface gets updated by the system

# NETCONF and YANG Example Configuration

Bridge Port (with 2 member LAG)

# Bridge Port (with LAG)

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <interface xc:operation="create">
          <name>if-1</name>
          <type>bridge</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-2</name>
          <type>ieee8023adLag</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-3</name>
          <type>ethernetCsmacd</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-4</name>
          <type>ethernetCsmacd</type>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

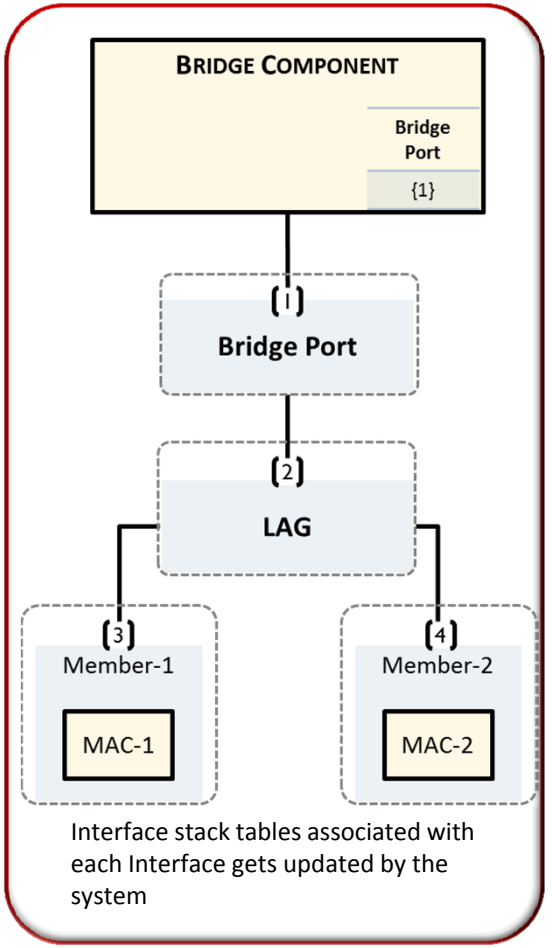
# Bridge Port (with LAG)

```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1ax">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <interface>
          <name>if-3</name>
          :
        </interface>
        <interface>
          <name>if-4</name>
          :
        </interface>
        <interface>
          <name>if-2</name>
          <members>
            <member>if-3</member>
            <member>if-4</member>
          </members>
          :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

- LAG member specific configuration items
- Link Aggregation Group specific configuration items

# Bridge Port (with LAG)

```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1q-bridge">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <bridges xc:operation="create">
          <bridge>
            <name>my-bridge</name>
              :
            <component>
              <name>the-component</name>
                :
            </component>
          </bridge>
          :
        </bridges>
        <interface>
          <name>if-1</name>
            :
          <bridge-port>
            <component-name>the-component</component-name>
            <service-if>if-2</service-if>
            :
          </bridge-port>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```



# NETCONF and YANG Example Configuration

Bridge Port (with MACSec)

# Bridge Port (with MACSec)

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <interface xc:operation="create">
          <name>if-1</name>
          <type>bridge</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-2</name>
          <type>macSecControlledIF</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-3</name>
          <type>ethernetCsmacd</type>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

# Bridge Port (with MACSec)

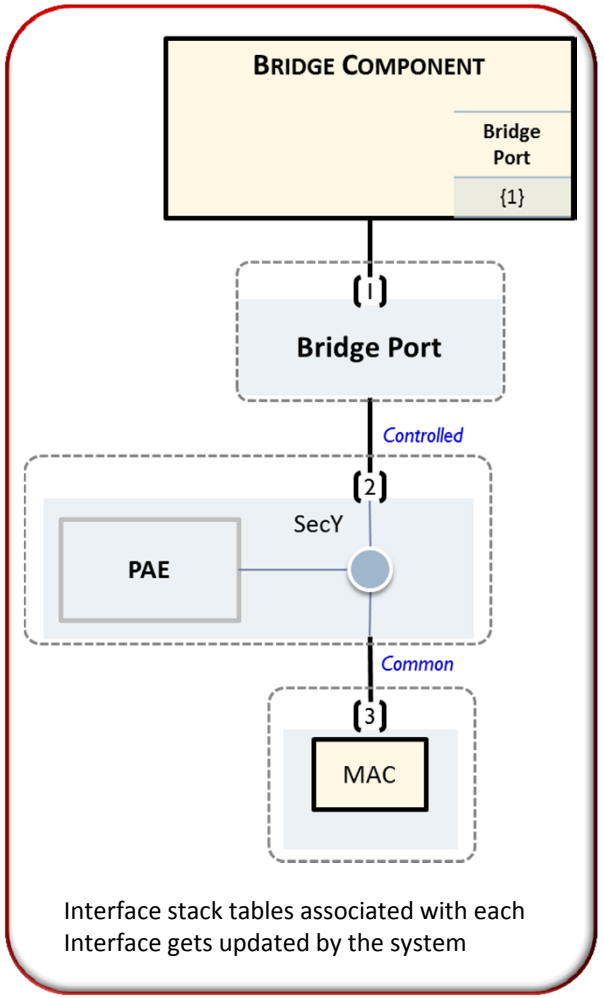
```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1x">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <system>
          <pae-system>
            <name>my-pae-system</name>
            :
          </pae-system>
          :
        </system>
        <interface>
          <name>if-2</name>
          <pae-system>my-pae-system</pae-system>
          :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

- PAE System specific configuration items

- PAE specific configuration items

# Bridge Port (with MACSec)

```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1q-bridge">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <bridges xc:operation="create">
          <bridge>
            <name>the-bridge</name>
              :
            <component>
              <name>the-component</name>
                :
            </component>
          </bridge>
          :
        </bridges>
        <interface>
          <name>if-1</name>
            :
          <bridge-port>
            <component-name>the-component</component-name>
            <service-if>if-2</service-if>
            :
          </bridge-port>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```




Interface stack tables associated with each Interface gets updated by the system

# NETCONF and YANG Example Configuration

Bridge Port (with 2 member LAG and MACSec)

# Bridge Port (with LAG plus MACSec)

```
<rpc message-id="101" xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <interface xc:operation="create">
          <name>if-1</name>
          <type>bridge</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-2</name>
          <type>ieee8023adLag</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-3</name>
          <type>macSecControlledIF</type>
            :
        </interface>
        <interface xc:operation="create">
          <name>if-4</name>
          <type>macSecControlledIF</type>
            :
        </interface>
```

# Bridge Port (with LAG plus MACSec)

```
          <interface xc:operation="create">
            <name>if-5</name>
            <type>ethernetCsmacd</type>
              :
          </interface>
          <interface xc:operation="create">
            <name>if-6</name>
            <type>ieee8023adLag</type>
              :
          </interface>
        </top>
      </config>
    </edit-config>
  </rpc>
```

# Bridge Port (with LAG plus MACSec)

```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1ax">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <interface>
          <name>if-3</name>
          :
        </interface>
        <interface>
          <name>if-4</name>
          :
        </interface>
        <interface>
          <name>if-2</name>
          <members>
            <member>if-3</member>
            <member>if-4</member>
          </members>
          :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

- LAG member specific configuration items

- Link Aggregation Group specific configuration items

# Bridge Port (with LAG plus MACSec)

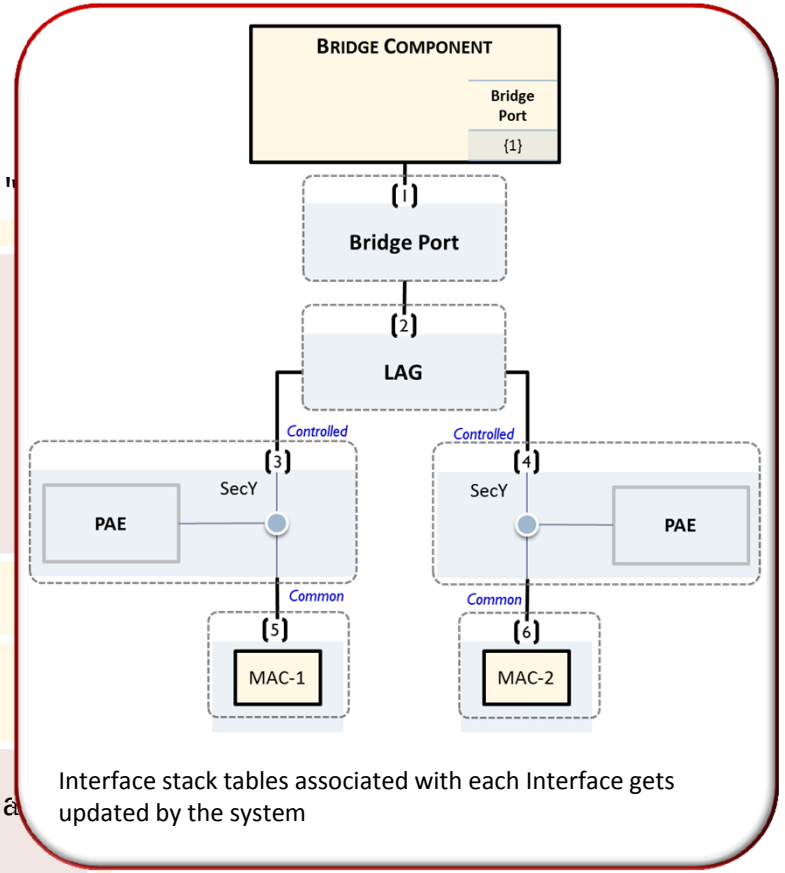
```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1x">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config">
        <system>
          <pae-system>
            <name>my-pae-system</name>
            :
          </pae-system>
          :
        </system>
        <interface>
          <name>if-3</name>
          <pae-system>my-pae-system</pae-system>
          :
        </interface>
        <interface>
          <name>if-4</name>
          <pae-system>my-pae-system</pae-system>
          :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```

- PAE System specific configuration items

- PAE specific configuration items

# Bridge Port (with LAG plus MACSec)

```
<rpc message-id="101" xmlns="urn:ieee:params:xml:ns:yang:ieee-dot1q-bridge">
  <edit-config>
    <target>
      <running/>
    </target>
    <config>
      <top xmlns="http://example.com/schema/1.2/config"
        <bridges xc:operation="create">
          <bridge>
            <name>my-bridge</name>
              :
            <component>
              <name>the-component</name>
                :
            </component>
          </bridge>
          :
        </bridges>
        <interface>
          <name>if-1</name>
            :
          <bridge-port>
            <component-name>the-component</component-na
            <service-if>if-2</service-if>
            :
          </bridge-port>
            :
        </interface>
      </top>
    </config>
  </edit-config>
</rpc>
```




Interface stack tables associated with each Interface gets updated by the system