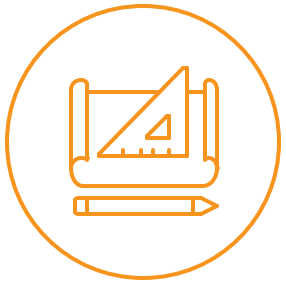
AARNet

Australia's Academic and Research Network

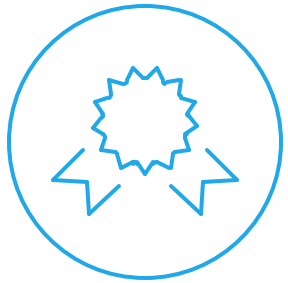
Peter Stamp, AARNet Network Architecture
AusNOG 2025

Who we are and what we do



Pioneered the internet in Australia in 1989

Not-for profit company



Licensed telecommunications carrier

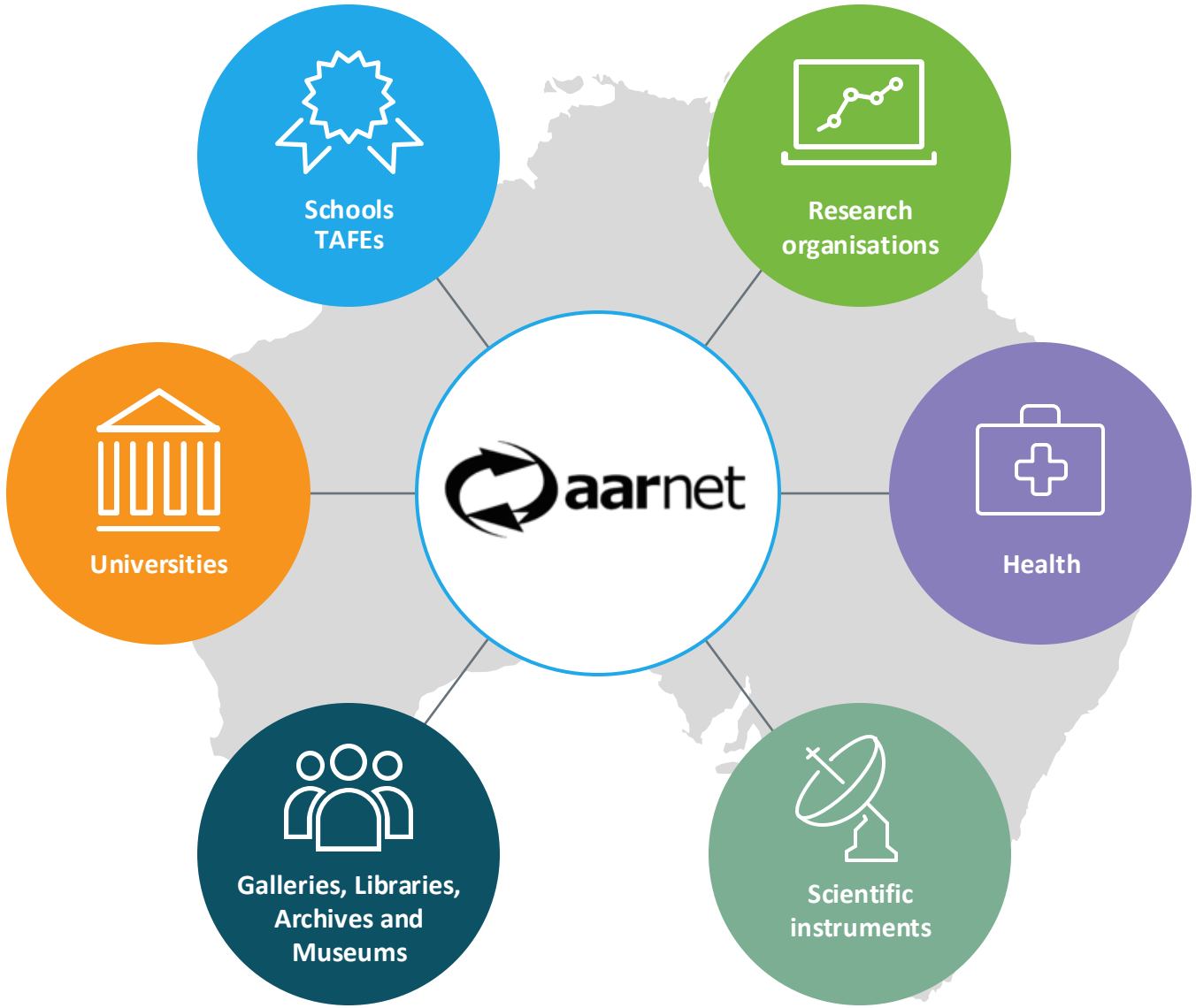
Owned by 38 universities and CSIRO

Serves more than 2 million people

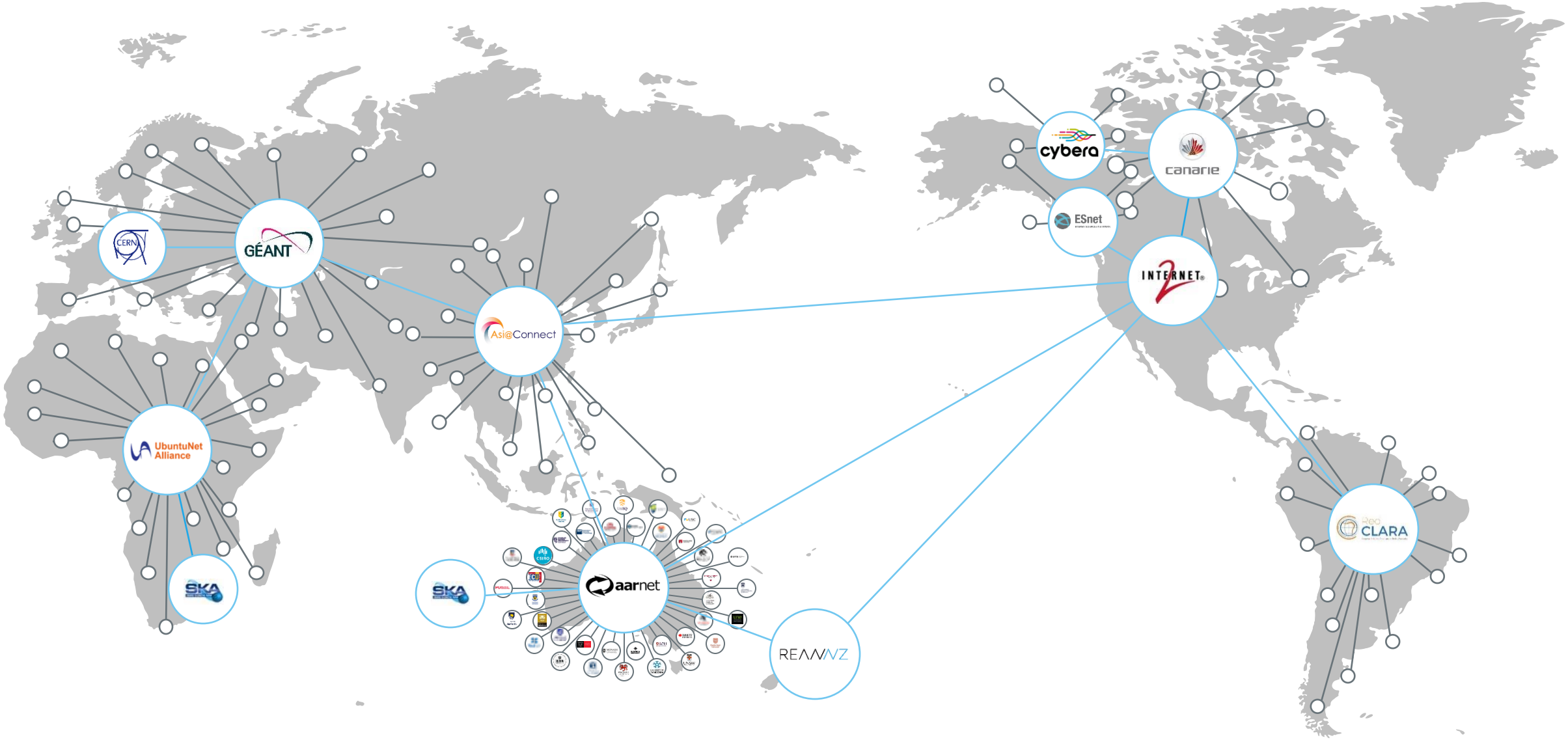
Proudly Australian owned and operated

Learn more at aarnet.edu.au

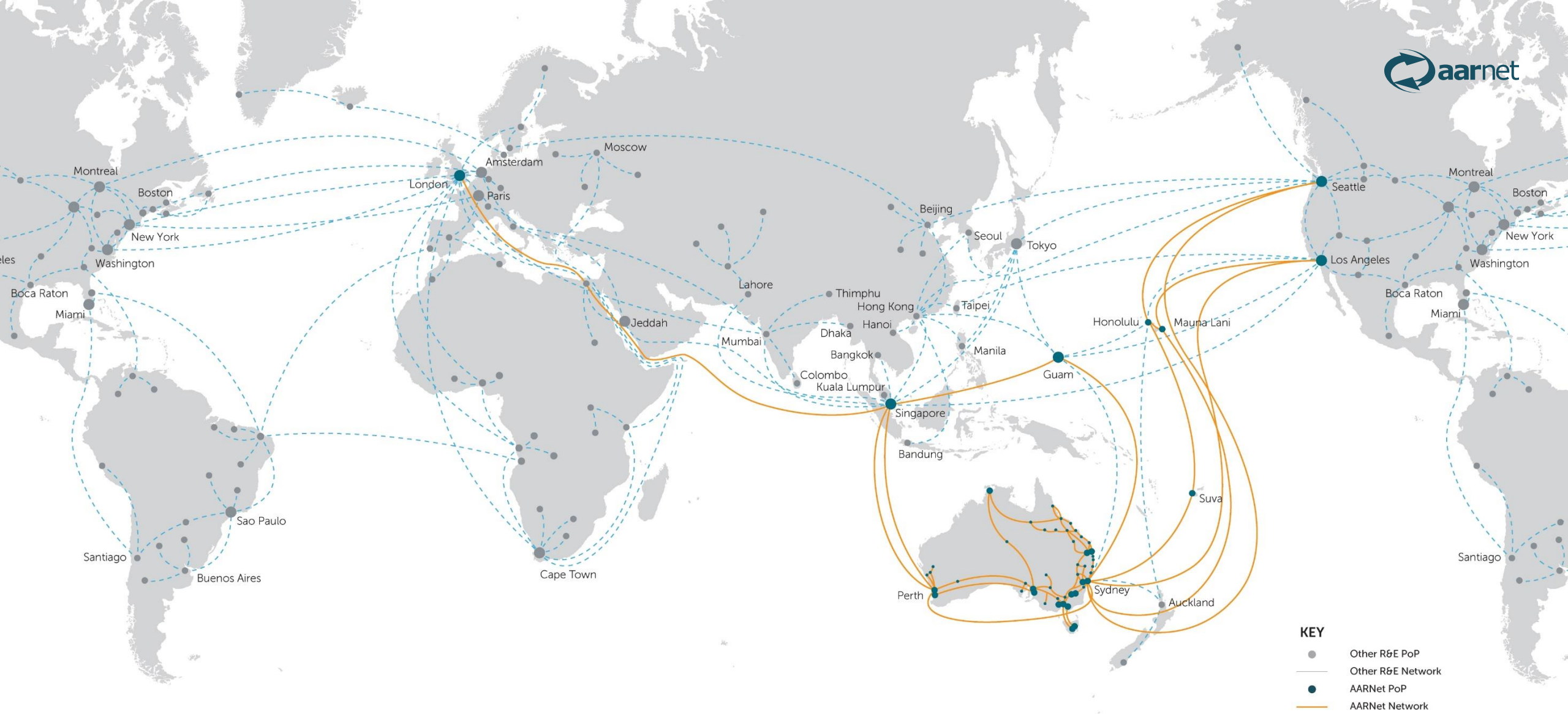
Research & Education Community



NREN Community

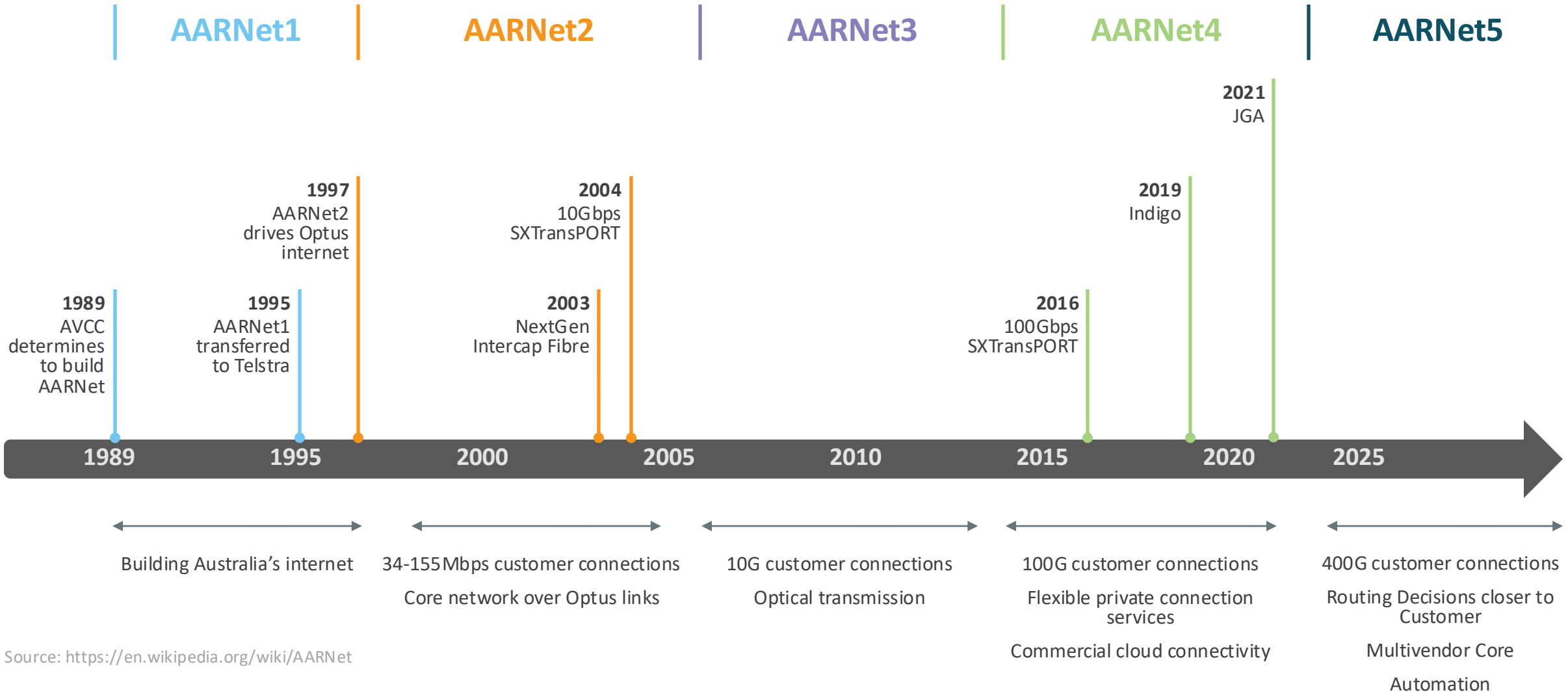


National Network



International Network

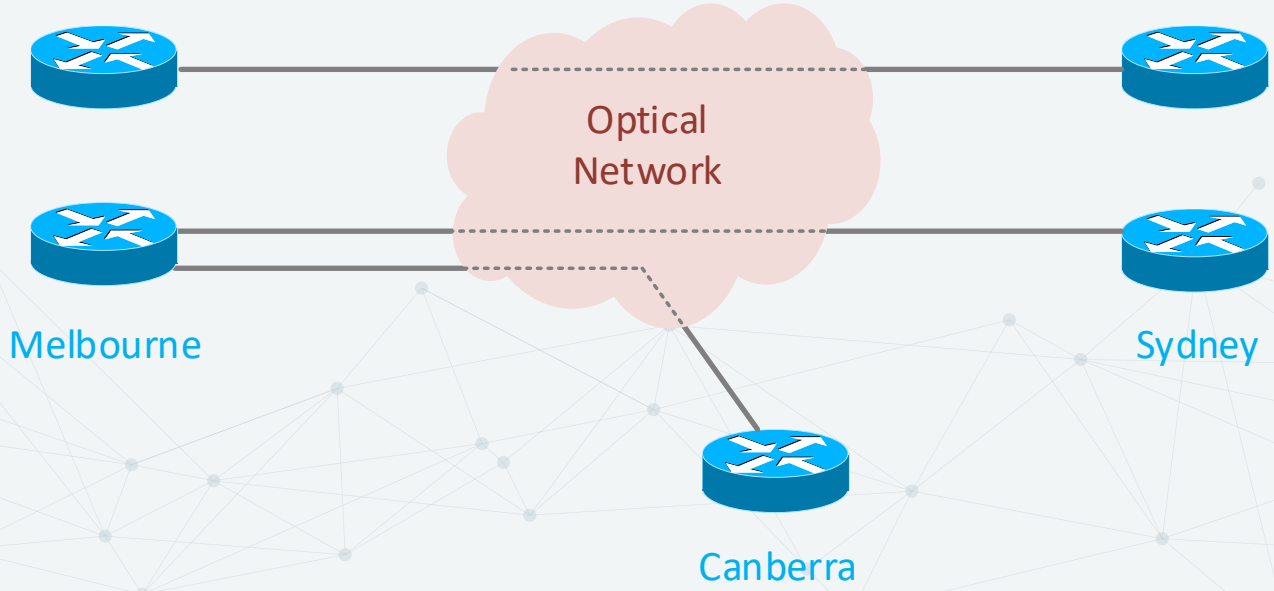
AARNet: a brief history



Source: https://en.wikipedia.org/wiki/AARNet

Packet-Optical Convergence

Separation of Packet and Optical Networks



The packet (IP/MPLS) routers:

- Sees the optical network as a provider of nailed-up point-to-point circuits
- Uses inexpensive, short-range optics.

The optical network:

- Carries the signal 100's or 1000's of KMs!
- Hides the complexities of the optical transmission, such as distance, signal strength and modulation.

Optical Network Components

Everything You Always Wanted to Know About Optical Networking – But Were Afraid To Ask

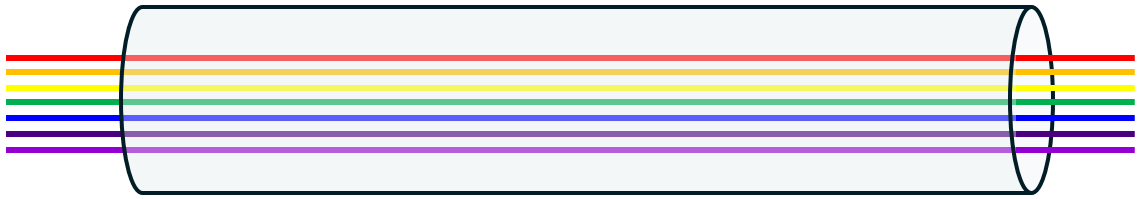
Richard A Steenbergen

YouTube – NANOG

24 Oct 2023

DWDM (Dense Wavelength Division Multiplexing):

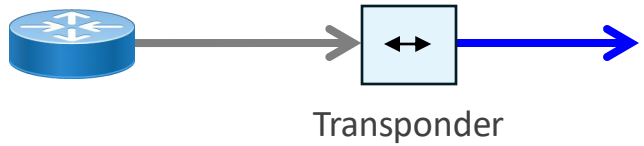
- Carries multiple signals over a single fiber pair.
- Each sent as a different wavelength (or colour) of light.
- Commonly 32 to 96 channels.
- Over long distances at very high bandwidth.

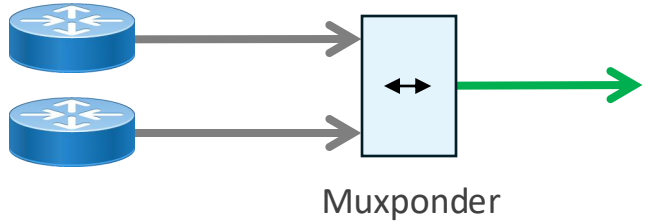


Optical Network Components

Transponders:

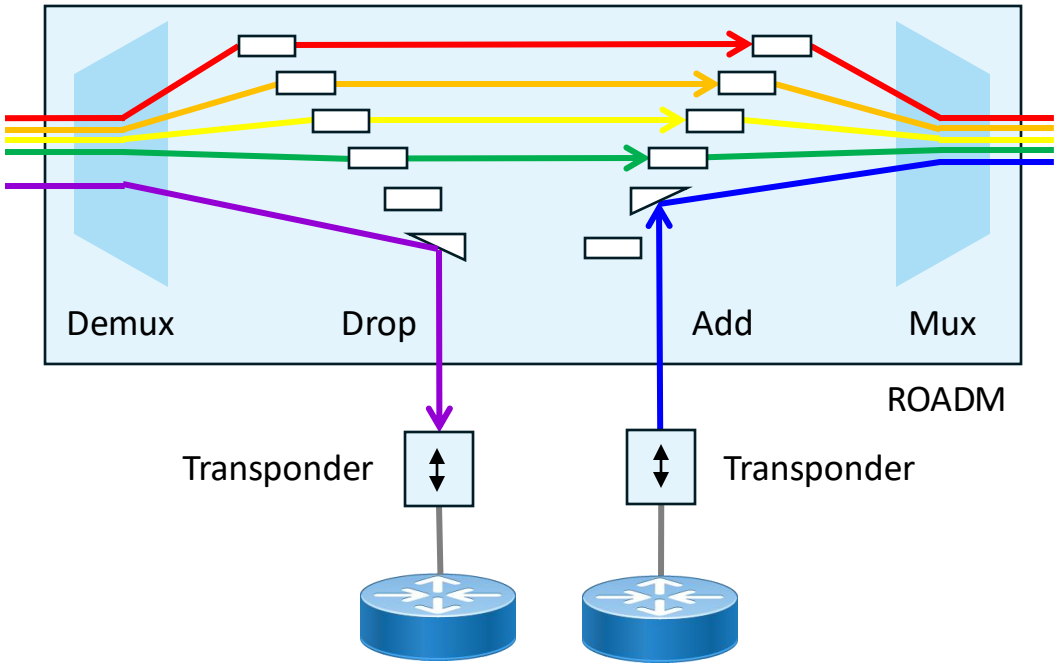
- Receive “grey” signals from the client.
- Converts them into one DWDM wavelength “colour”.
- Ready for transmission over the long-haul DWDM system.
- From here the signal is optical, not electrical, to the far end.





ROADM (Reconfigurable Optical Add-Drop Multiplexer):

- A wavelength switch.
- **Optical:** Switches light without conversion to an electrical signal.
- **Multiplexer:** Addition, removal, or pass-through of wavelengths.
- **Reconfigurable:** Allows the operator to configure which wavelengths are added, dropped and passed through.



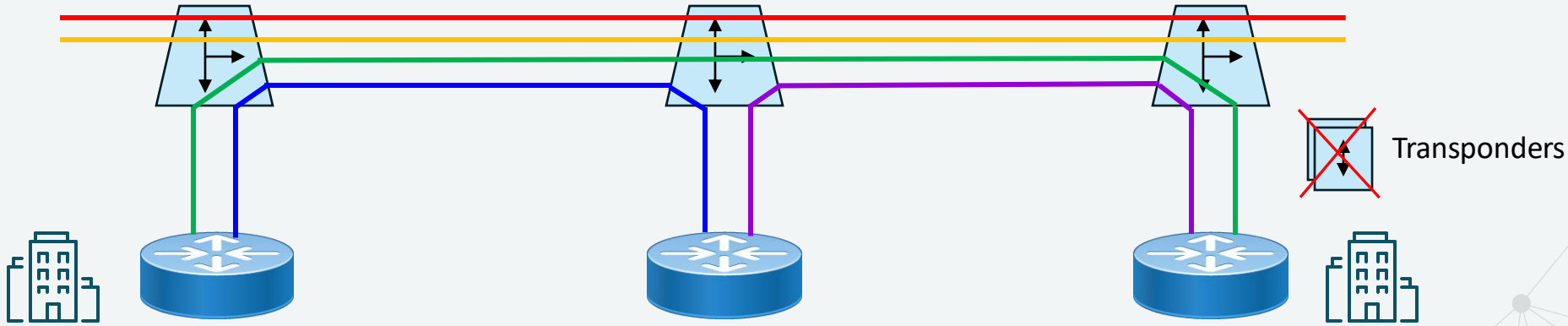
Packet Optical Convergence

A router is co-located at each ROADM site:

- 1RU, low-power, 2 to 4 400G/100G interfaces.
- Combined role as the Inter-capital core router, and a regional PE router.
- DWDM (coherent) 400G QSFP-DD ZR+ pluggable optics.
- Eliminates the need for expensive transponders as the router connects directly to the ROADM.

How it works:

- Made possible by the advancements of ZR+ optics.
- The router configures the optic to a specific wavelength … with a high launch power.
- The optical signal is directly multiplexed onto the DWDM carrier by the ROADM.
- Close coordination between the optical and router teams: wavelength, power levels, dispersion.



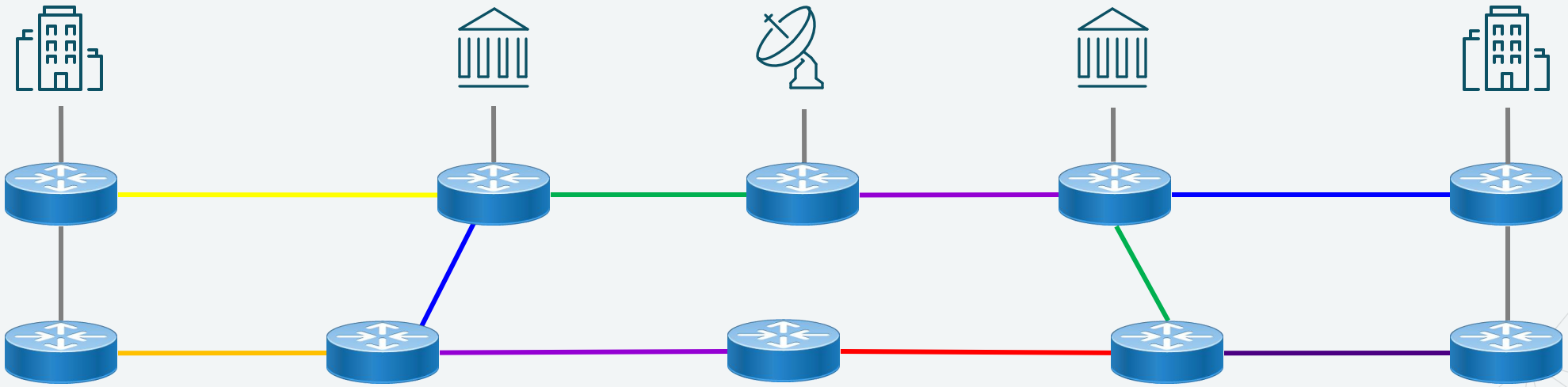
Benefits

Cost and equipment lifecycle:

- No longer need to buy and maintain (most) transponders.
- Retire end-of-life SDH equipment.
- Space and power:
  - Transponders occupied 1RU and used 150W
  - ZR+ optics use 25W and plug directly into routers

Increased network coverage:

- Every ROADM site now has an access router for customer connections:
- 1/10/25/100G Ethernet access ports.
- Basic services: L2 e-line, L2 e-LAN, L3VPN.



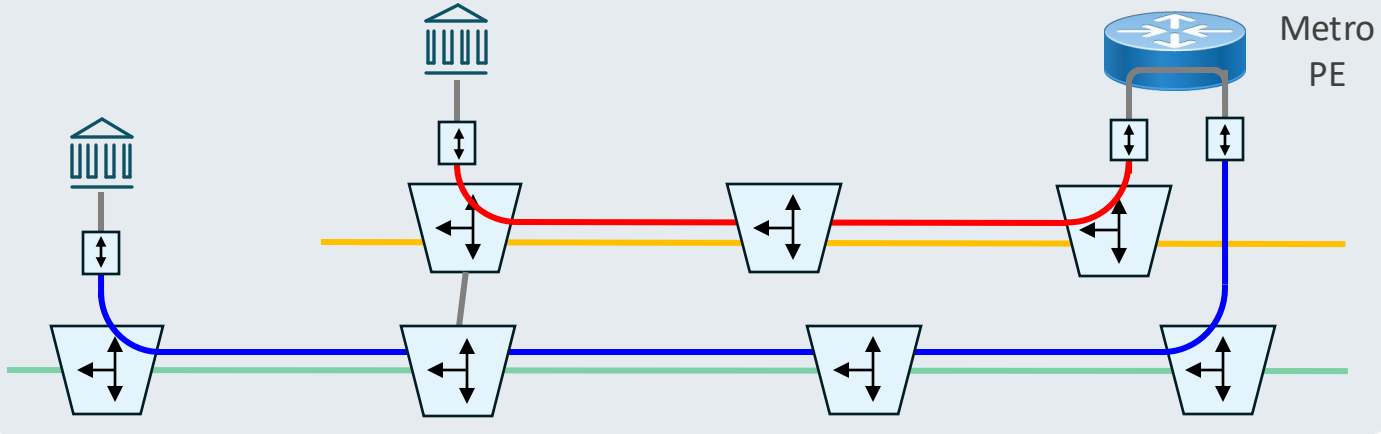
Benefits: closer to the customer

Scenario:

- A point-to-point 1G Ethernet circuit.
- 2 regional campuses 30km apart, 300km from the closest capital city.

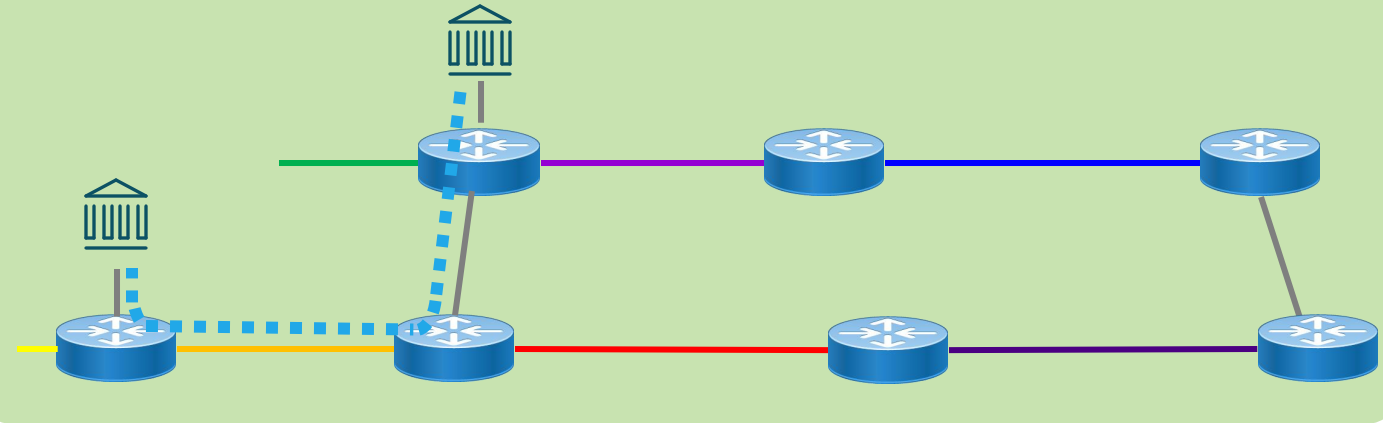
On an optical network:

- The service hairpins via the city.
- Increased latency.
- Outages in the city affect the service.
- Uses transponders in each site.



On a packet-optical network:

- A L2 PE router located at each ROADM site.
- Customer connects to a 1/10/25/100G port.
- P2P L2VPN service over MPLS core.
- Optimal switching, latency.
- Removes dependency on the city PE.



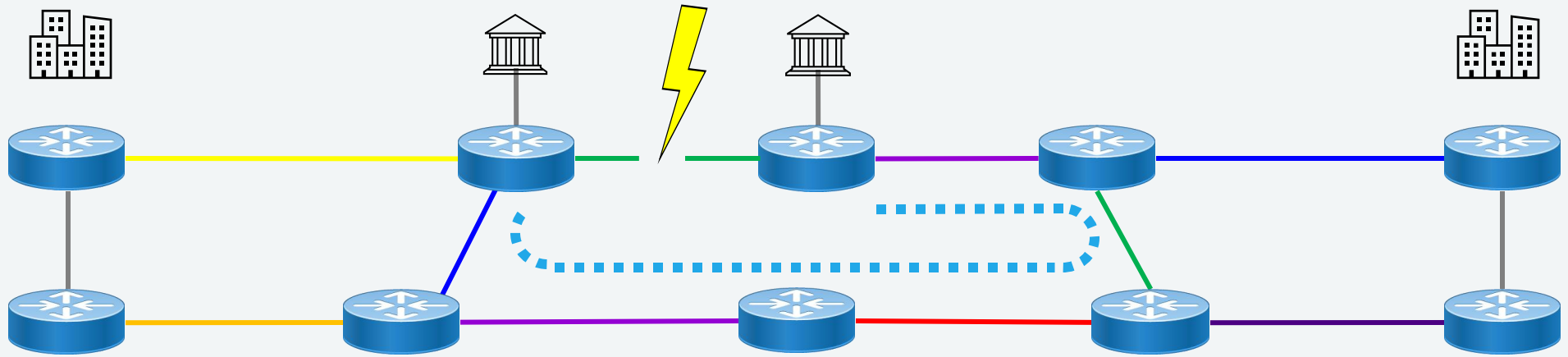
Benefits: service protection

In an Optical Network:

- Protection requires manual provisioning - a fixed active path and a fixed backup path.

With Packet Optical integration:

- Inherent Protection: The shortest available path in the IP routing table is used, with Fast Re-Route.



- In an optical network it takes complexity and customisation to **provide** protection
- In a packet network it takes complexity and customisation to **avoid** protection

AARNet5 Automation

Model-driven services

Services

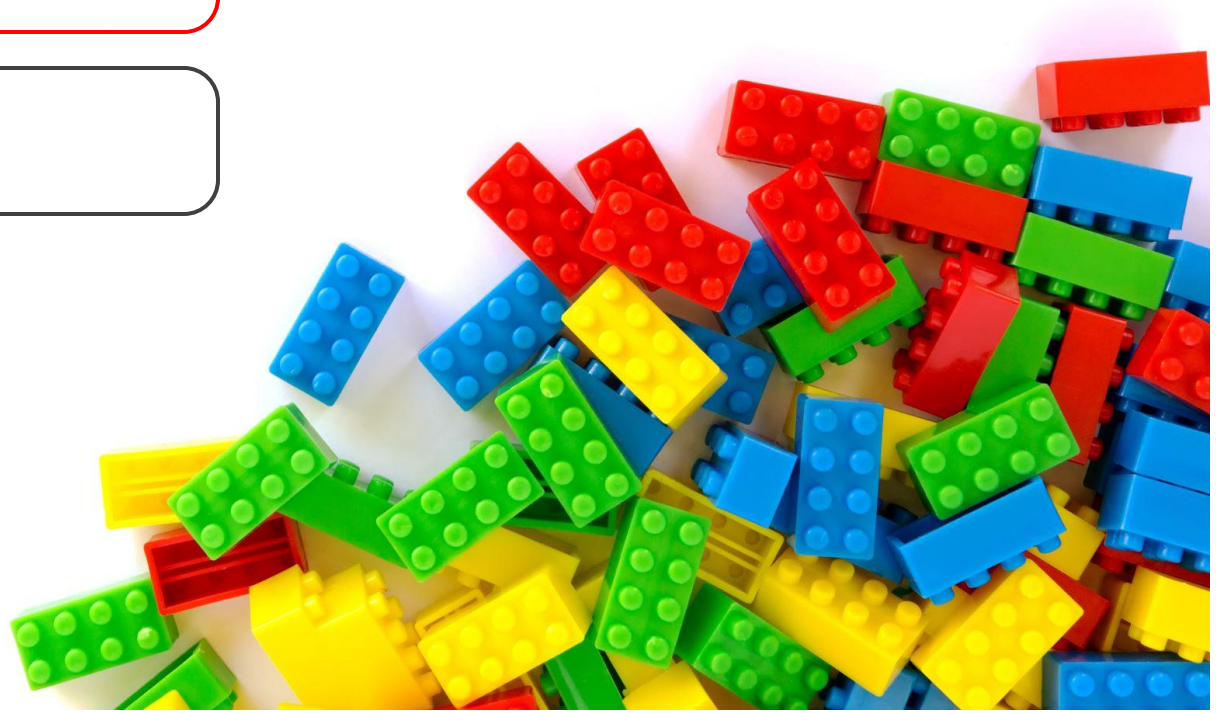
The building blocks of our automation

Components

Standardised

Repeatable

for delivering network functions



Why Standardise?

Services

Biscuit Order Form

Filling:

- ❑ Apricot
- ✓ Raspberry
- ❑ Lemon

Shape:

- ❑ Circle
- ❑ Square
- ✓ Heart

✓ Icing sugar

Gingerbread Order Form

Face:

- ❑ Crazy
- ✓ Happy
- ❑ Blank
- ❑ Sad

Features:

- ❑ Smarties
- ✓ Chocolate feet
- ✓ Sprinkles

AARNet5 Services

Customer products and services:

- A customer access link.
- A point-to-point Ethernet service.
- An Internet service.

Infrastructure Services:

- Device management template.
- Backbone links.
- Routing protocols.

Benefits:

- Standard services.
- Configuration compliance.
- Deployment consistent with network design.

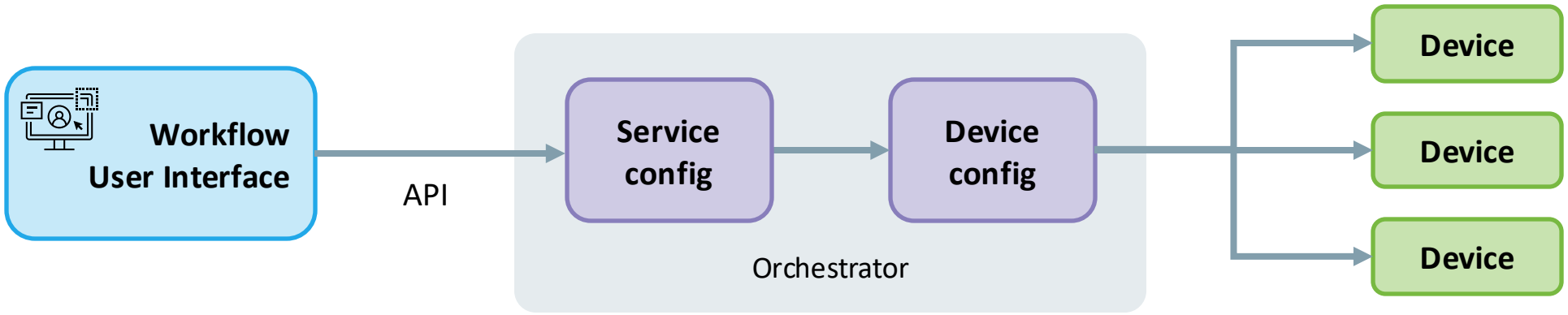
Service Orchestrator

What it does

- Automates the orchestration and lifecycle of network services
- Model-Driven Approach:
  - Define a service
  - Create instances of the service
  - Service config is translated into device config and deployed
- Service Lifecycle Management:
  - Create
  - Modify
  - Audit
  - Decommission ←

Cisco NSO – Network Services Orchestrator

- Service Lifecycle Management
- Multi-vendor
- Northbound RESTCONF API to OSS
- Flexible:
  - Orchestrator is master
  - Device config is master
  - A mix of both



Define the service – Yang Model

- Create the “order form” for a network service.
- **Yang modelling language:**
  - Developed by the IETF, used by vendor CLI’s and API’s.
  - Captures the services capabilities:
    - options, parameters and constraints.
  - Independent of device vendors, models, etc.
  - Abstracts away the complexity of configuring the device

Biscuit Order Form

Filling:		Shape:	
❑	Apricot	❑	Circle
✓	Raspberry	❑	Square
❑	Lemon	✓	Heart
✓	Icing sugar		

Orchestrator

```
module router-mgmt {
  list router-mgmt {
    key device-name;
    leaf device-name {
      type string;
      mandatory true;
    }
    leaf role {
      type enumeration {
        enum "CORE";
        enum "PE";
        enum "NTU";
      }
    }
    list syslog-server {
      key server-address;
      leaf server-address {
         type inet:ipv4-address;
      }
      leaf vrf {
        type string;
      }
    }
  }
}
```

Define the service - Template

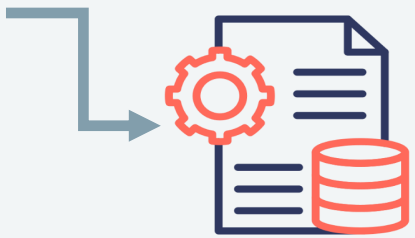
```
<config-template xmlns="http://tail-f.com/ns/config/1.0">
  <devices xmlns="http://tail-f.com/ns/ncs">
    <device>
      <name>{/device-name}</name>
      <config>

        <hostname xmlns=".../cisco-ios-xr">{/device-name}</hostname>

        <configuration xmlns=".../juniper">
          <system>
            <host-name>{/device-name}</host-name>
          </system>
        </configuration>

        <logging xmlns=".../cisco-ios-xr">
          <facility>local7</facility>
          <?foreach {/syslog-servers}?>
          <host>
            <address>{server-address}</address>
            <vrf>{vrf}</vrf>
            <severity>info</severity>
          </host>
          <?end?>
        </logging>

      </config>
    </device>
  </devices>
</config-template>
```



Orchestrator

- Expands the options in the model into device config
  - Target device config as XML
  - Access all the {values} in the service model
  - Static configuration
- Multi-vendor

```
hostname vic-mel-core2
```

```
system {
    host-name vic-mel-core2;
}
```

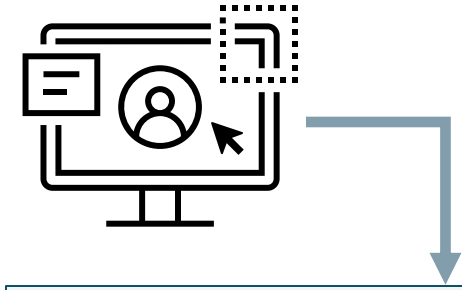
- Logic: foreach loops, if-else, variables, macros, etc

```
logging facility local7
logging 10.80.6.1 vrf admin severity info
logging 10.33.2.1 vrf admin severity info
```

- Python code to support complex logic, text processing, data structures, IP addresses, etc

Create an instance

1. Portal user executes “new router” workflow.
2. Workflow system allocates resources in inventory.
3. Sends a RESTCONF API call to the orchestrator.
4. Orchestrator expands template to generate device config.



```
RESTCONF
POST http://orchestrator/api/

  "router-mgmt": [
     {
          "device-name": "vic-mel-core2",
          "role": "CORE ",
          "syslog-server": [
               {
                    "server-address": "10.80.6.1",
                    "vrf": "admin"
               },
               {
                    "server-address": "10.33.2.1",
                    "vrf": "admin"
               }
          ]
     }
  ]
```

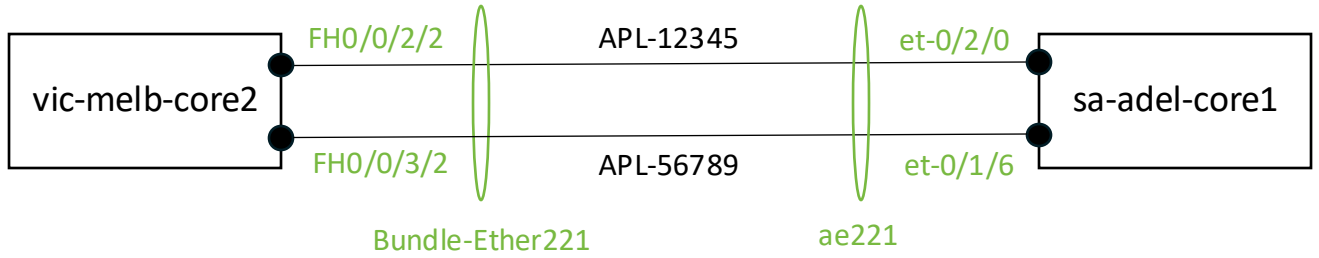
Orchestrator

```
system {
    host-name vic-mel-core2;
    syslog {
        host 10.80.6.1 {
            routing-instance admin;
            any info;
            facility-override local7;
        }
        host 10.33.2.1 {
            routing-instance admin;
            any info;
            facility-override local7;
        }
    }
}
```

```
hostname vic-mel-core2
logging facility local7
logging 10.80.6.1 vrf admin severity info
logging 10.33.2.1 vrf admin severity info
```

Example service: Backbone Link

```
backbone-link: {
        id: BB700050,
        endpoint-a: {
            device: vic-melb-core2,
            interface: Bundle-Ether221
        },
        endpoint-b: {
            device: sa-adel-core1,
            interface: ae221
        },
        lag-members: [
            {
                interface-a: FourHundredGigE0/0/2/2,
                interface-b: et-0/1/6,
                circuit-id: APL-12345
            },
            {
                interface-a: FourHundredGigE0/0/3/2,
                interface-b: et-0/2/0,
                circuit-id: APL-56789
            }
        ],
        address-ipv4: 10.24.8.50/31
        address-ipv6: 2000:a88:8::1/64
        bfd-mode: micro,
        lacp-mode: active,
        metric: 300,
        deploy-isis-sr: false,
        deploy-ospf-ldp: true,
        delay-measurement: true,
        srlgs: [ MELB_ADEL ],
        mtu: 9500
}
```



- ❑ LAG, LACP
- ❑ Member interfaces
- ❑ Interface descriptions
- ❑ IP addressing
- ❑ LLDP
- ❑ Micro-BFD
- ❑ ISIS, SR
- ❑ OSPF, LDP
- ❑ SR-TE attributes
- ❑ Delay measurement

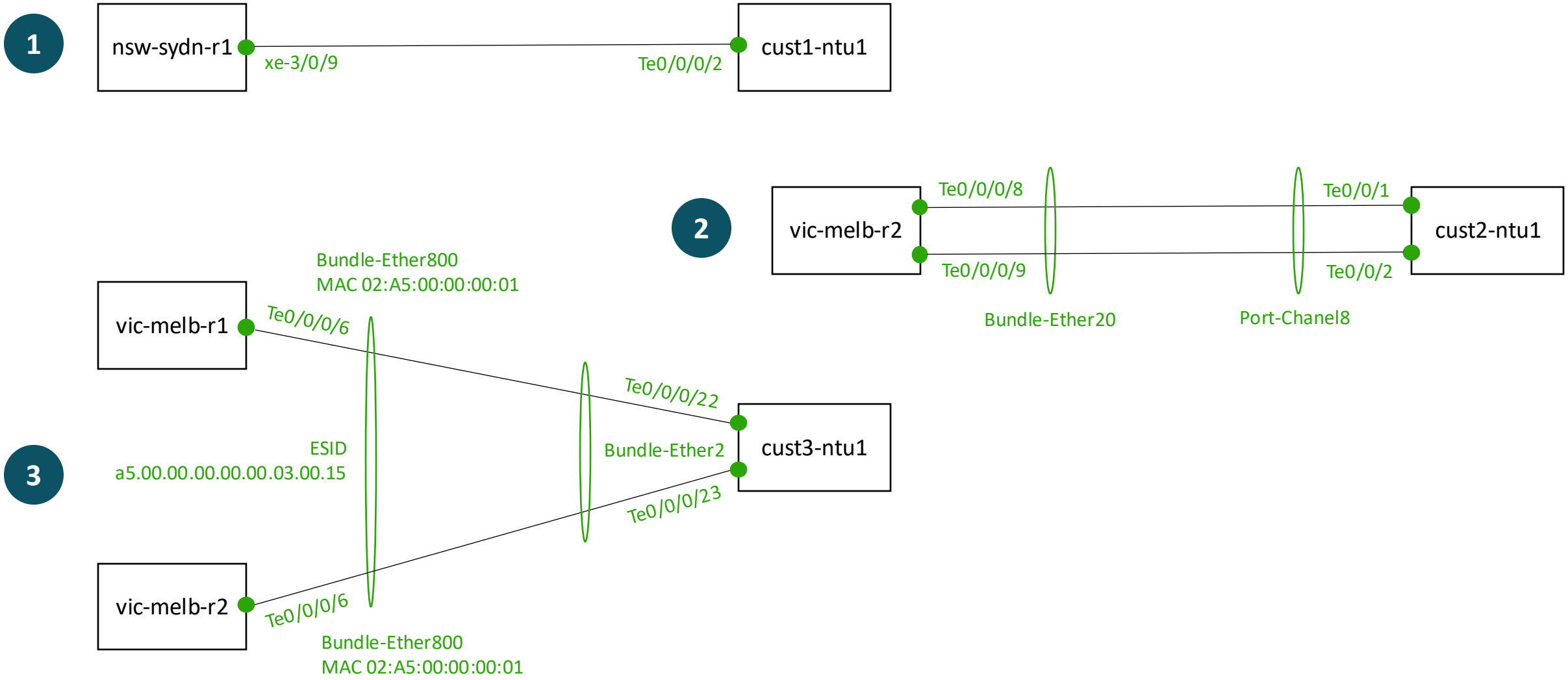
Benefits:

- 100’s of lines of device config.
- Multi-vendor.
- Compliant device config.
- No protocol or features forgotten.

Ongoing:

- Design changes and new features can be rolled out network wide by changing the template.

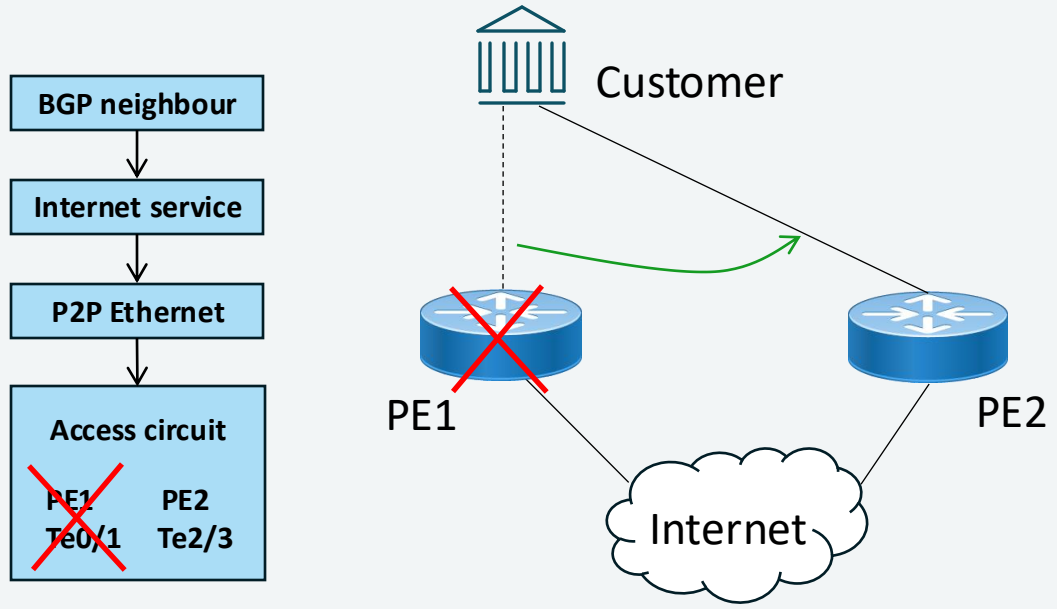
Example services – Access Circuit



Advanced Use-case

Migrate an Internet service:

- Hierarchical service model in inventory
- Internet service is built on a logical access circuit which specifies the device/interface
- Edit the access circuit to be a different device/interface
- The orchestrator will migrate the Internet service, BGP neighbour, filters, etc to the new device.



Thank You. Questions?