# METRO Solutions for Sustainable Business Growth

## Journey into the Cloud + 5G + AI Era

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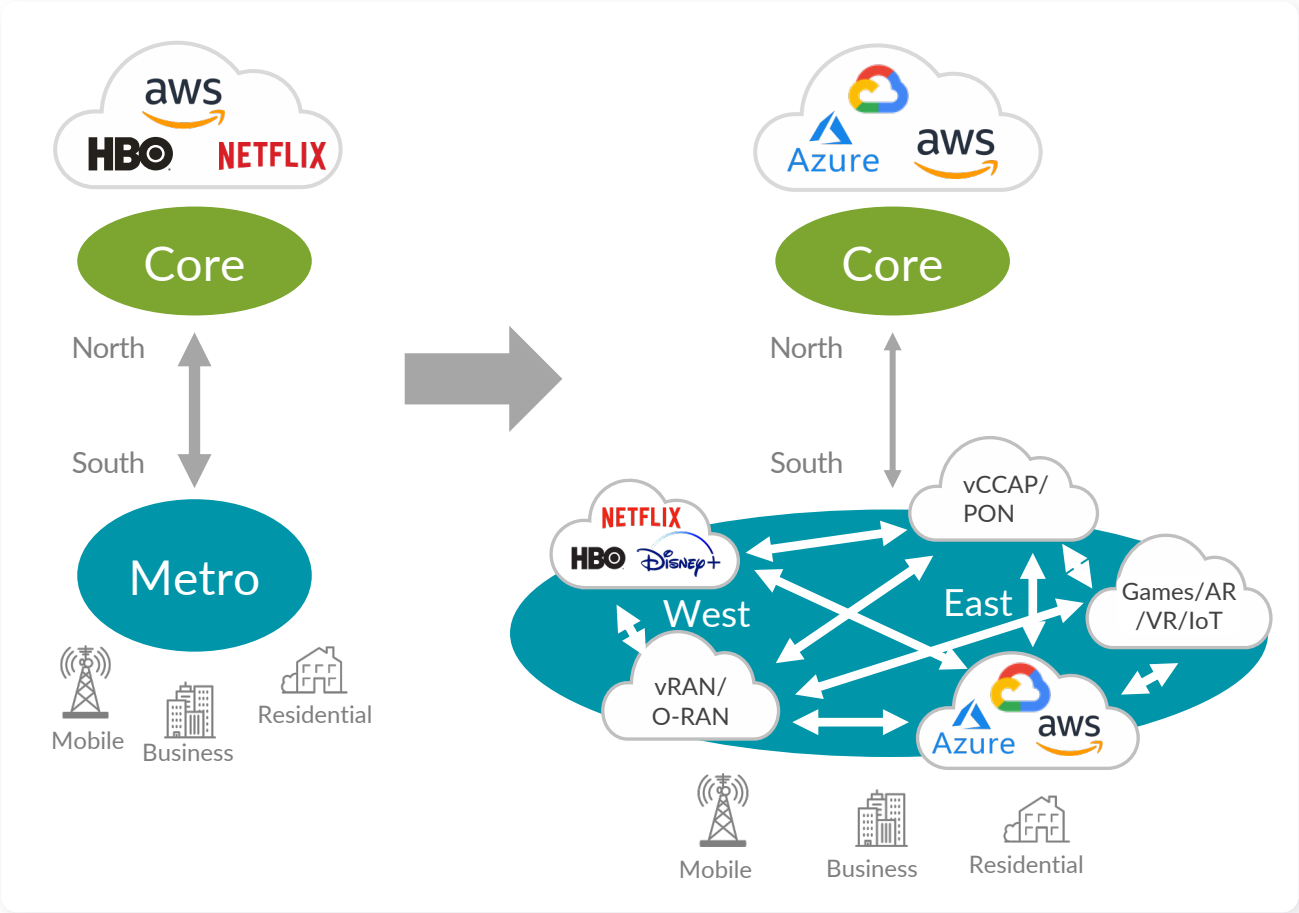
# Metro is the New Edge, Big Growth Opportunity

## Where Connectivity, Cloud & Experience Converge

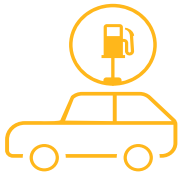



| | |
|---|---|
| **10%** | Price premium for excellent experience<br>by 1 in 4 subscribers |
| **50%** | Enterprise data will be distributed in edge clouds<br>by 2025 |
| **500%** | Metro transport traffic growth<br>from 2021 to 2027 |
| **$500B** | Edge computing TAM, growing at 49% CAGR<br>thru 2030 |

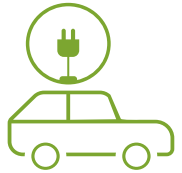
Sources: Forbes, Gartner, ACG Research, STL Partners

# A New Approach Demands a New Category

## Cloud Metro: New Category for Sustainable Business Growth



VS.




| | Retro Metro | Cloud Metro | | |
|---|---|---|---|---|
| Operations | Focus on Devices | Focus on Service Experiences | ✓ | ✓ |
| | Manual, “DIY” Operations | Cloud-Delivered Automation | ✓ | ✓ |
| | Individual Expertise | AI-Enabled Collective Intelligence | ✓ | ✓ |
| Systems | Traffic Aggregation Only | “Smart” Rich Features & Scale + Aggregation | ✓ | ✓ |
| | Monolithic Power Design | Energy-efficient Power Design | ✓ | ✓ |
| | Rip n Replace ~3 to 5 Years | PAYG, ~7 to 12 Years | ✓ | ✓ |
| Architecture | Scale Up | Scale Out + Scale Up | ✓ | ✓ |
| | Network Silos: Mobile vs. Biz vs. Consumer | Network Convergence with Network Slicing | ✓ | ✓ |
| | Passive Assurance | Embedded Active Assurance | ✓ | ✓ |
| | “Bolt-on” Security | Built-in Zero Trust Security | ✓ | ✓ |

# JUNIPER SUSTAINABILITY

- ✓ Systems
- ✓ Operations
- ✓ Architectures

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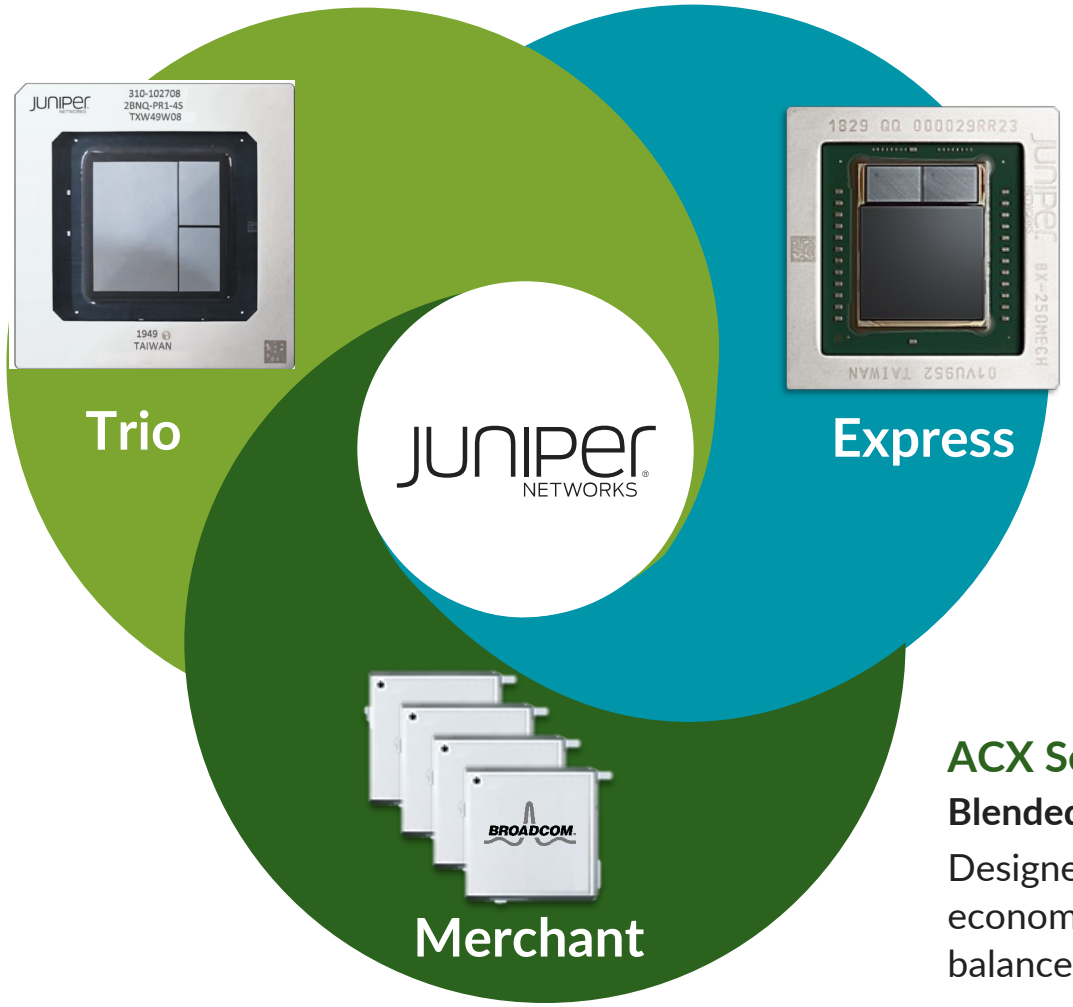
# Juniper Platform Synergy

## MX Series

**Flexible Logical Scale**

Large route forwarding tables, flexible tunnel encapsulation, rich quality of service (QoS), firewall security filters, traffic management counters, ML enabled.




## PTX Series

**Core Throughput**

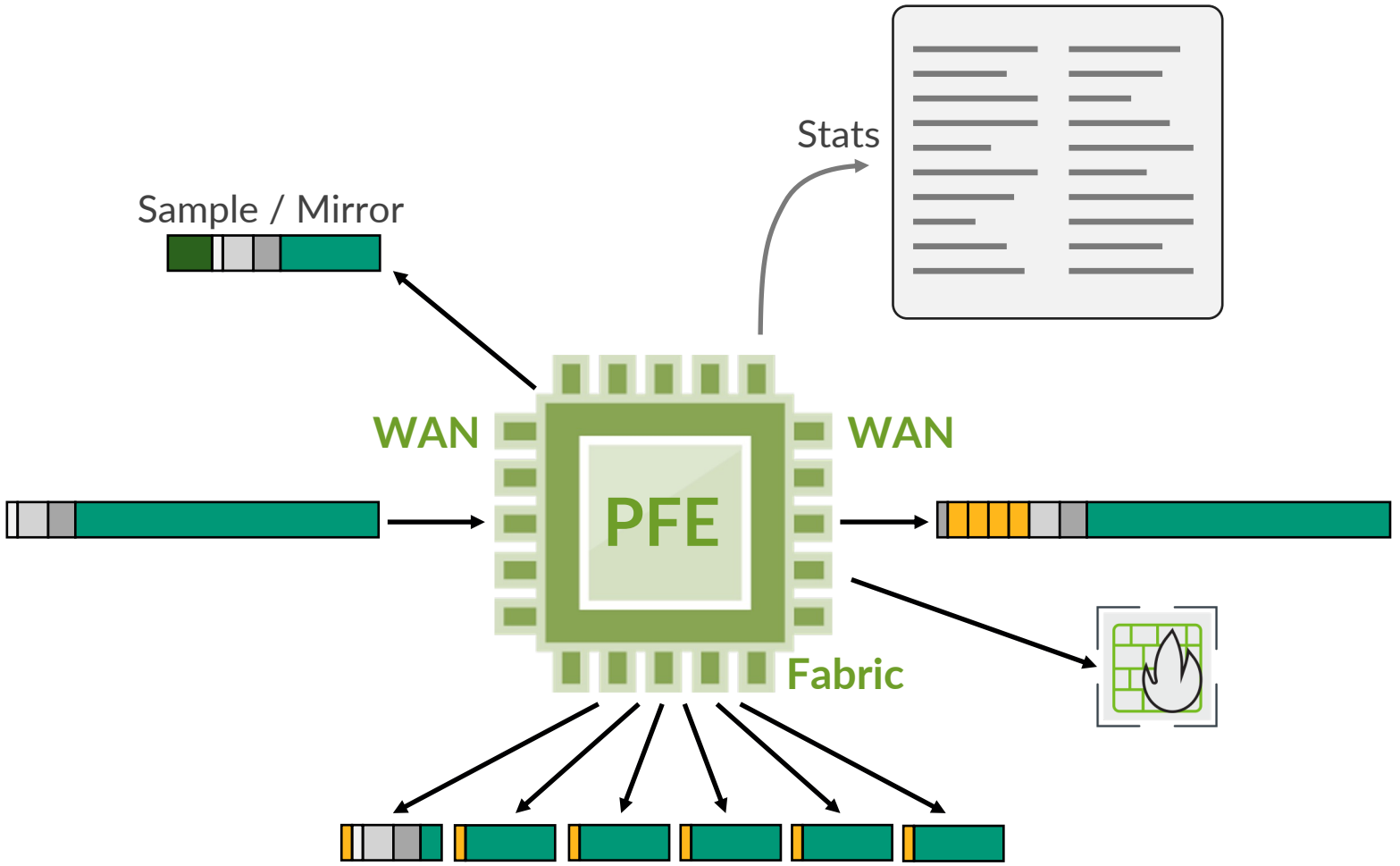
Forwarding performance with needed pipeline and memory characteristics for known operations such as scale, filtering, telemetry and sampling capabilities.

## ACX Series

**Blended Performance**

Designed for aggregation and economics. Scale and deployment balanced for the network edge.

# What's Inside Your Router?

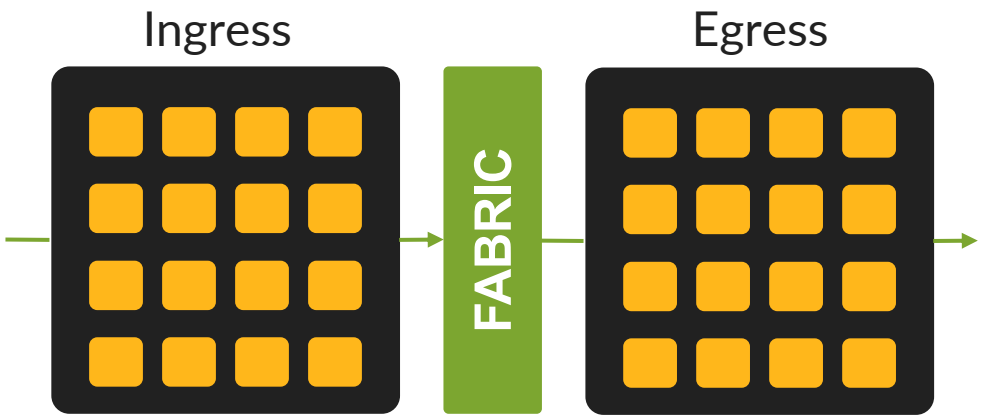



## Building Blocks

PHY
SERDES
CPU
DRAM
(R)GB
Internal Switch
Timing FPGA
TPM logic

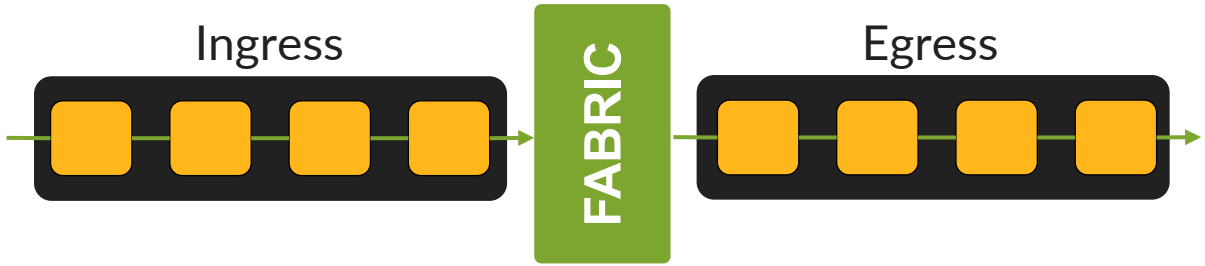
# Packets Forwarding Architectures

## Two Big Families




**Multiple Packet Processing Engines Run-to-Completion**

Flexibility / Logical Scale




**Pipeline**

Efficiency

Cloud Metro
Sustainable Operations
Sustainable Systems
Sustainable Architecture

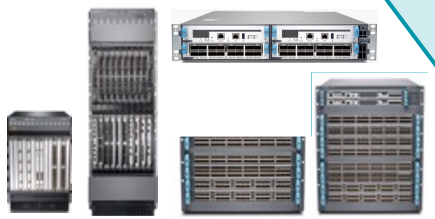
# Juniper WAN Portfolio

## Sustainable Operations

### Sustainable Systems

TRIO

MX



PTX

EXPRESS

ACX

BRCM

### Sustainable Architecture

**IP Services Fabric**
Converged + NW Slicing
(SRv6, EVPN)

\+

**Embedded Active Assurance**

\+

**Zero Trust Security**

New

**Juniper Optics**

TDM

10G XGS & EPON

400G ZR/ZR+

New

**Paragon Automation**


\+

**AI-Enabled**

\+

**Cloud Delivered aaS**





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# Cloud Metro Access & Aggregation: Juniper Differentiators

New

**ACX7024 / ACX7024X**

Optimized for 5G cell site xHaul

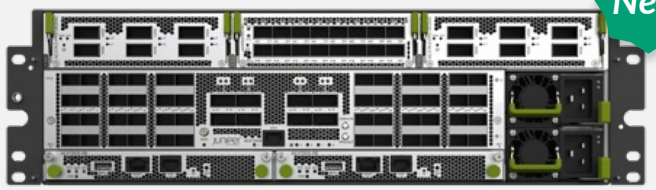
*360 Gbps, Temperature Hardened*
*24x 1/10/25GE (SFP28), 4x100GE (QDD)*
*Timing : SyncE, PTP and Class C/D*

**ACX7100-48L:** Leaf for 10G, 25G, 50G Access

*4.8 Tbps, 48x 10/25/50GE (SFP28), 6x 400GE (QDD)*
*Timing : SyncE, PTP and Class C*

**ACX7100-32C:** Spine for 100G Aggregation

*4.8 Tbps, 32x 100GE, 4x 400GE (QDD)*
*MACSEC, Timing: SyncE, PTP and Class C*



New

**ACX73348 / ACX7332**

SP Aggregation, E-WAN, Lean Edge, BNG CUPS

*2.4 Tbps, Temperature Hardened | 1/10/25/100/200/400G*
*Fixed ports: Up to 48x 1-25GE, 8x100GE*
*IO Slots: 2x 800G + 1x 400G*
*Redundant RE | MACSEC, Timing : SyncE, PTP and Class C, OP2*


**ACX7509:** Modular High Available Lean Edge, Aggregation

*4.8Tbps (6.2T over-subscribed) | Future 14.4T (J3), 25.6T (Q4) |*
*9x FPC Slots with 3 FPCs: 20x 1/10/25/50GE | 16x 100GE | 4x 400GE*
*Redundant FEB (optional) | MACSEC, Timing : SyncE, PTP and Class C*

# INTRODUCING CORA

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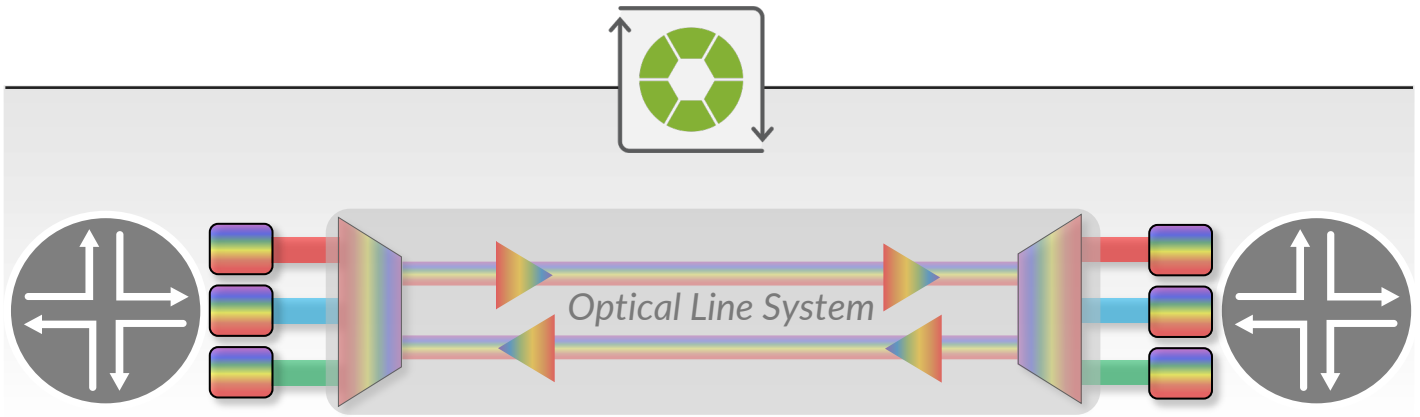
# Juniper's Converged Optical Routing Architecture (CORA)

## A Comprehensive IPoDWDM Solution

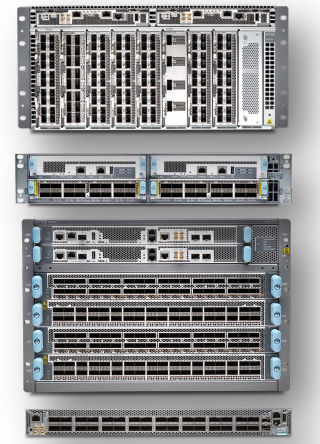
Juniper Coherent Optics (ZRx)

400GbE and Beyond

Paragon Automation




400GbE-Capable Routers and Switches



ACX

MX

PTX

QFX

### Extensible Architecture

- DCO standard compliance for interoperability
- Extensive 400GbE use case support and beyond.

### Sustainable Systems

- High-density systems for longevity
- Silicon + system + optics leadership with reduced power and space consumption

### Intelligent Automation

- Standards-compliant management APIs
- Full lifecycle automation use case support with multilayer visibility

# The Promise of IP over DWDM

## 400G coherent pluggable optics are the beginning of an industry evolution

### 400G and Beyond Adoption

**74%**

% of surveyed providers with 400G by end of 2024 [1]

### Network Modeling

**>90%**

% of surveyed providers who have modeled converged networks [2]

### IPoDWDM Deployments

**66%**

% surveyed providers who have or plan to deploy IPoDWDM [2]

**Expected TCO savings Up to 40% when deploying IPoDWDM [2, 3]**

[1] Heavy Reading Reports 2022, "Coherent Optics at 400G, 800G and Beyond A 2022 Heavy Reading Survey"
[2] Heavy Reading Reports 2021, "Coherent Optics at 400G, 800G and Beyond A 2021 Heavy Reading Survey"
[3] Cignal AI, "400ZR/ZR+ IPoDWDM Market Impact and Forecast", November 2021



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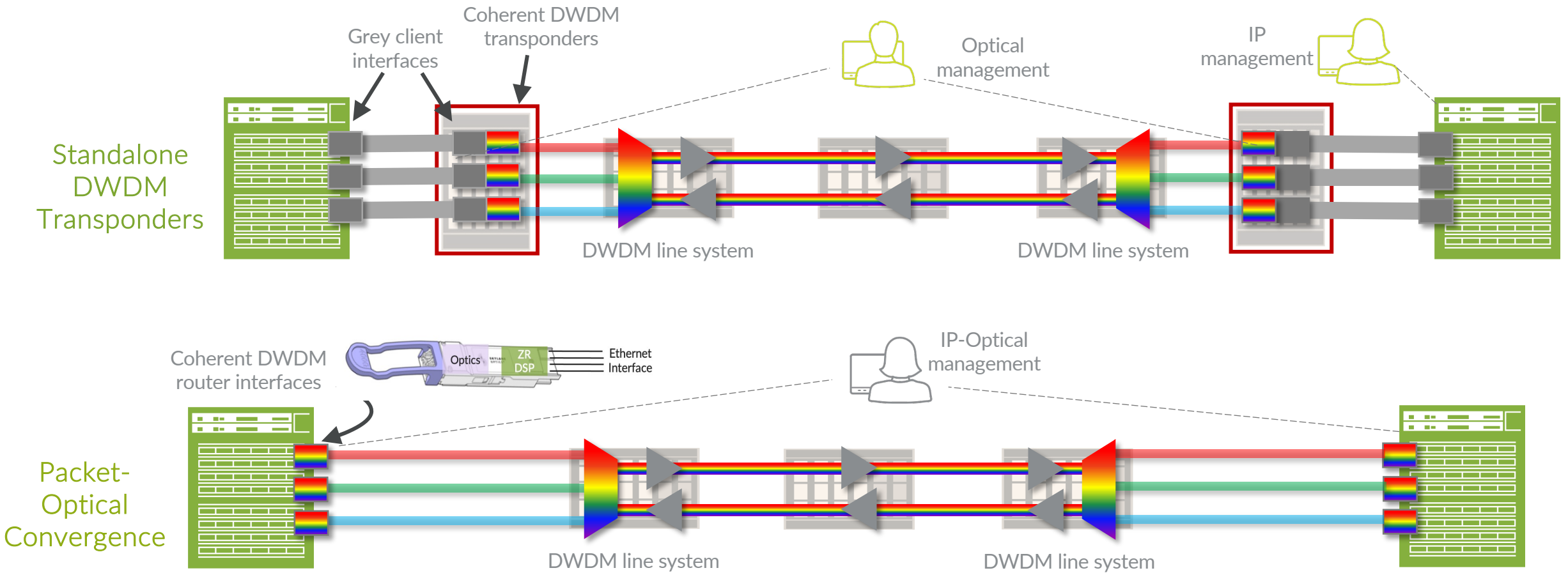
# IPoDWDM Architecture Benefits

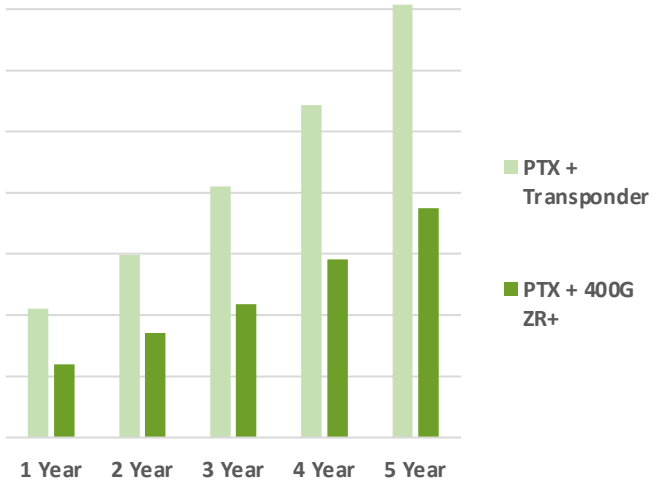
## Adopting a converging packet optical network




IP-optical integration eliminates hardware components,
increases reliability, lowers cost, reduces power consumption, and simplifies operations

# Benefits of adopting an IPoDWDM architecture

## Cumulative TCO

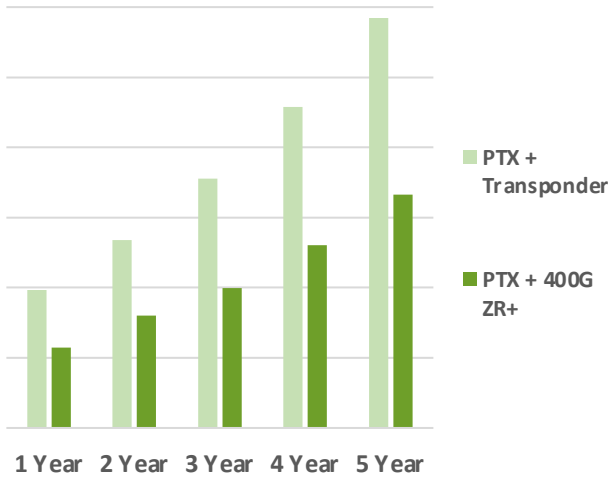



## Lower TCO

- **TCO Savings >45%** compared to traditional router + transponder pairs[1]
- **CAPEX Savings >40%**
- **Power, Space and Carbon Footprint Savings (54%, 77%, 55%)**

Based on conservative Juniper TCO analysis model

## Cumulative CAPEX




## New Use Cases

- Standardization & interoperability accelerate integration & deployments
- Expanding 400G ZR/ZR+ use case support, extensible to 800G & beyond

## Sustainability

- Reduced footprint by eliminating the need to transponders
- Significant power savings over traditional line system

## Operational Efficiency

- Multi-layer visibility through coherent pluggable optics
- Simplified operations with standard APIs & open data model

[1] Juniper's marketing TCO analysis based on PTX10001-36MR (9,600G initial capacity) and JCO400 ZR+ (v0.36.xlsx)



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# SUSTAINABLE ARCHITECTURE

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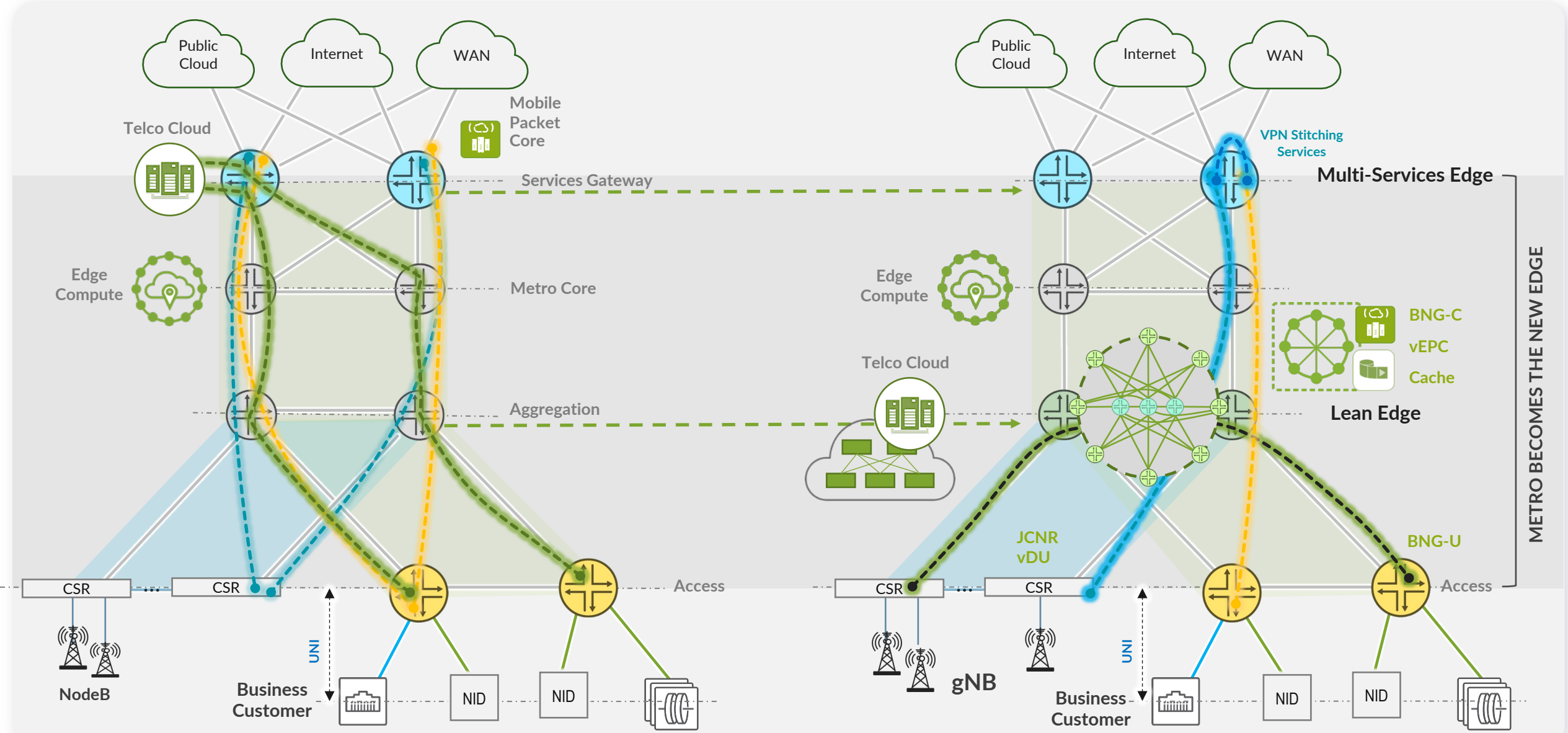
# Transformation of the METRO architecture

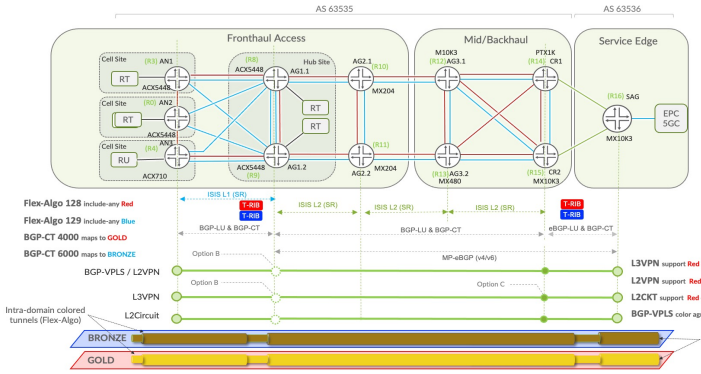


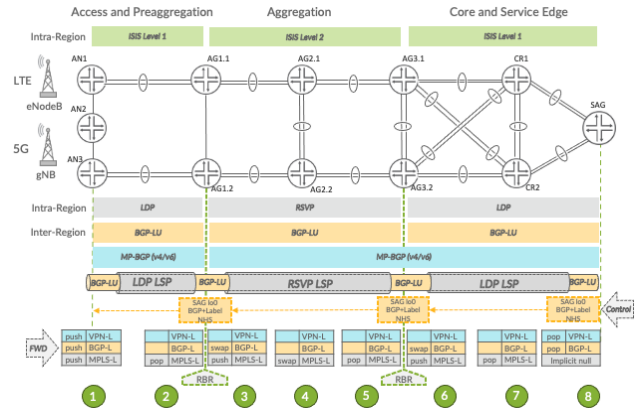
# Juniper Validated Design (JVD)

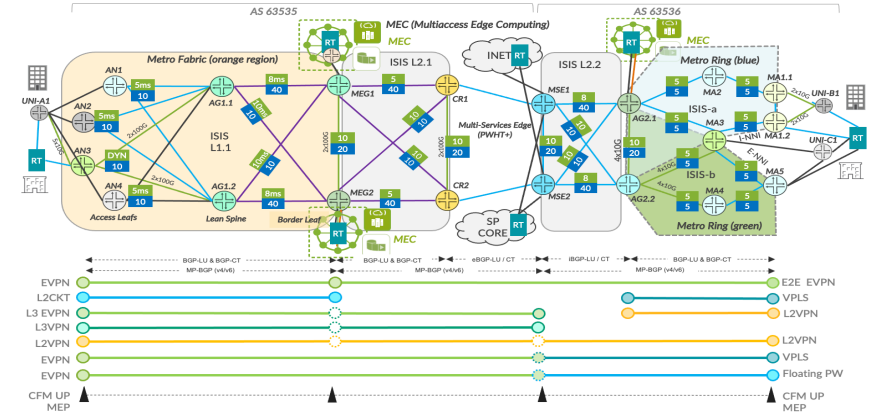
# Juniper Metro Validated Designs

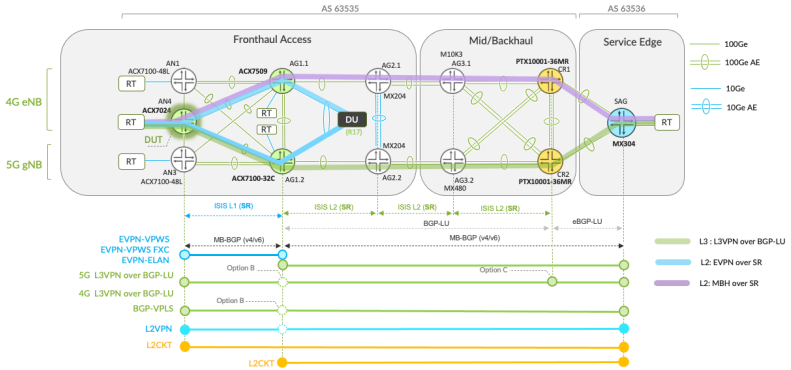
Cloud Metro

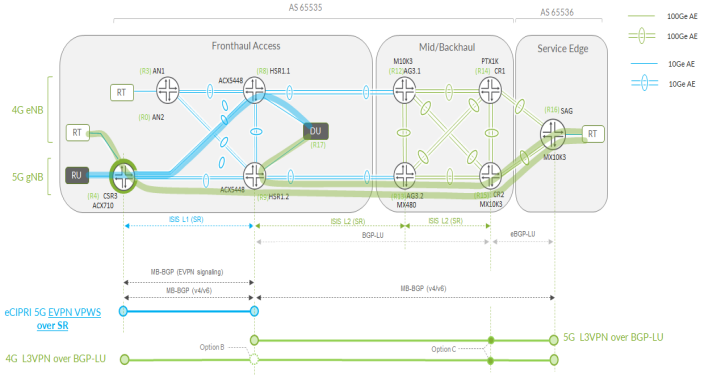
Sustainable Operations
Sustainable Systems
Sustainable Architecture

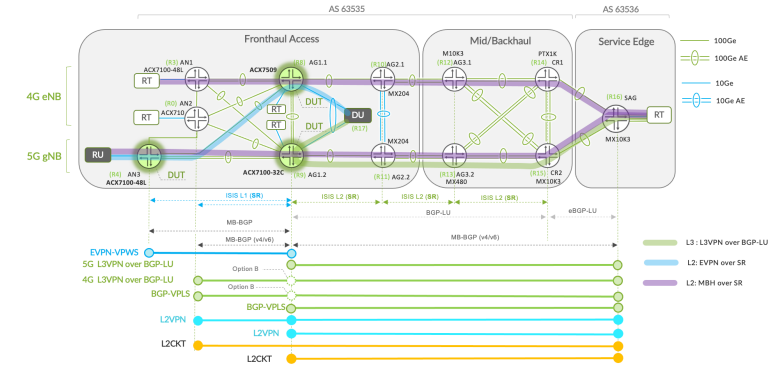


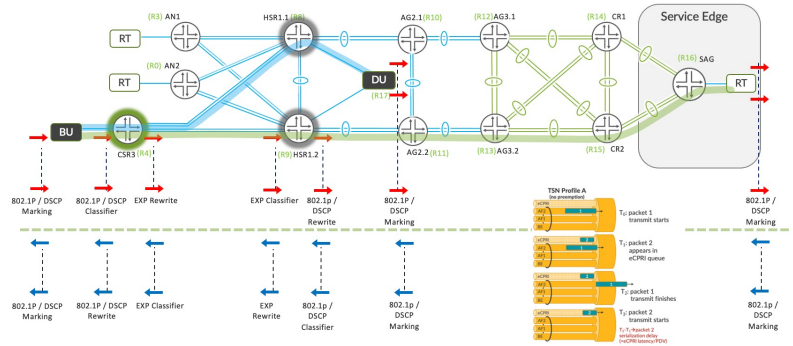



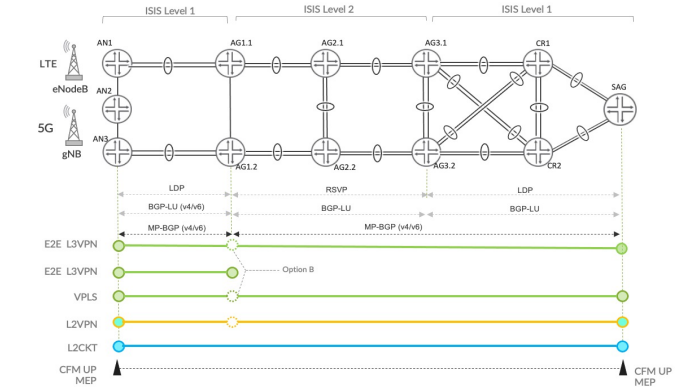



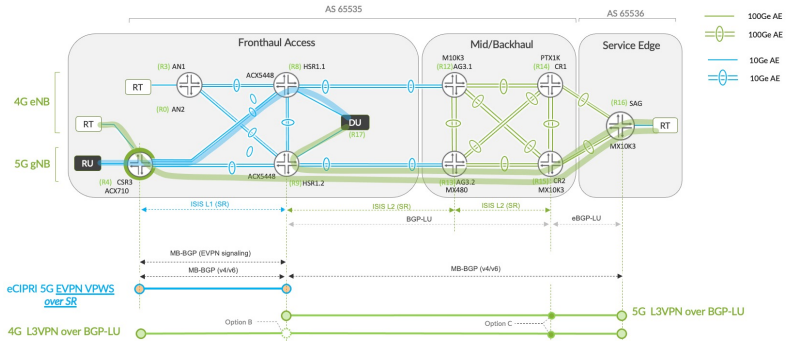





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# JVD Objectives

## Solution Consistency

- Build a coherent solution story for domain-specific Use Cases
- Reflection of customer reference architectures
- Identify gaps and ensure solution **design completeness**
- Develop cross platform and cross XBT solutions

## Feature Validation

- **Multidimentional** scale and feature validation
- Ensure software **Quality** for the domain specific use cases
- Multi-platform solution regression and **Automation** test cycles
- Drive technology roadmap

## Documentation

- Reference **Solution Architecture**
- Enables visibility into solution details
- Test Reports
- Configuration details
- Design Center & TechPost

# Juniper Design Center: Service Provider JVD

*https://www.juniper.net/documentation/solutions/us/en/service-provider-edge/*

Juniper Validated Designs (JVDs) | Configuration Examples and Guides

## Juniper Validated Designs (JVDs)

### 5G Fronthaul Network Using Seamless MPLS Segment Routing (JVD)

Seamless MPLS for 5G Fronthaul validated design using ACX7000 series in the context of the end-to-end converged 5G xHaul network.

- 5G Fronthaul Network Using Seamless MPLS Segment Routing (JVD) NEW
  - 5G Fronthaul Network Using Seamless MPLS Segment Routing (Solution Brief) NEW

### 5G CSR xHaul Seamless Segment Routing (JVD)

End-to-end network pre-slicing validated design for the 5G xHaul leveraging seamless segment routing using ACX710 and ACX5448 Universal Metro Routers.

- 5G CSR xHaul Seamless Segment Routing (JVD) NEW
  - 5G CSR xHaul Seamless Segment Routing (Solution Brief) NEW

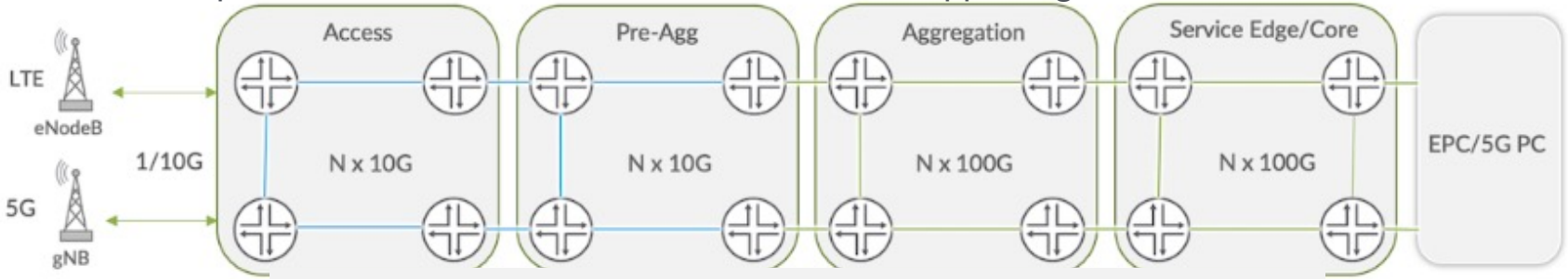
# TechPost: JVD Mobile Backhaul Solution

*https://community.juniper.net/blogs/kevin-brown/2022/06/28/jvd-mobile-backhaul-overview*


**Welcome to the Juniper Validated Design (JVD) series.**

For this validation blog, our team selected a profile out of the 5G xHaul reference architecture, which consists of Fronthaul, Midhaul, and Backhaul network segments. Today we'll focus on the backhaul portion to deliver 4G/5G Layer 2 and Layer 3 services over an inter-domain Seamless MPLS infrastructure. The mobile backhaul (MBH) encompasses the technologies required to provide connectivity from cell sites to the mobile packet core segment, spanning the fronthaul and midhaul domains. The MBH use case presents unique complexities due to requirements to support legacy and next-generation technologies simultaneously.

The featured solution builds upon Juniper Networks 4G MBH Design Guide by incorporating additional protection and optimization mechanisms which are critical for supporting modern mobile infrastructures.




## JVD Technical Blogs:

1. JVD Overview
2. Mobile Backhaul Overview
3. Seamless MPLS LDP with OSPF underlay
4. Building Border Agnostic Architectures with Seamless MPLS
5. Mobile Backhaul Services Overlay

https://community.juniper.net/home/techpost



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# SUSTAINABLE OPERATIONS

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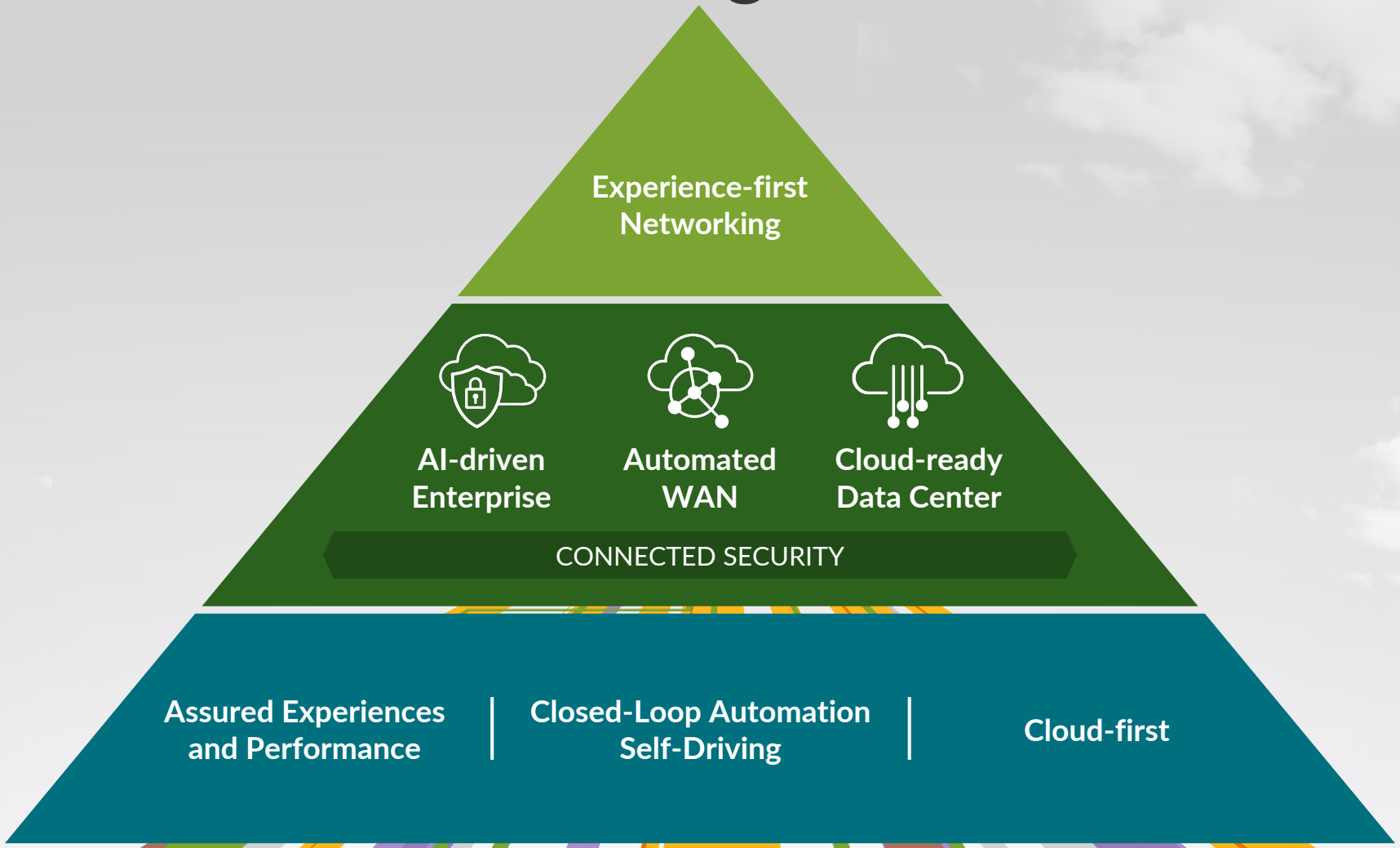
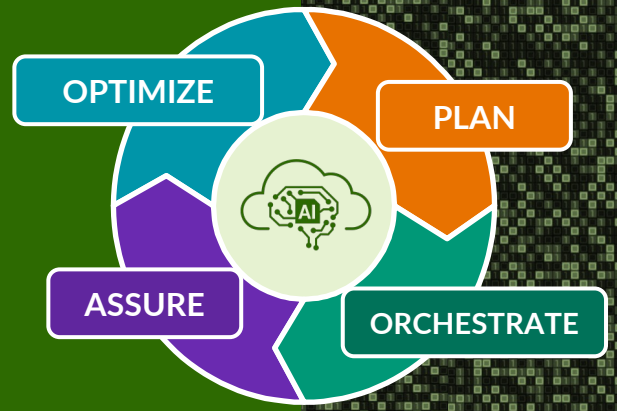
# Experience-First Networking



Juniper Paragon

# What is your need?

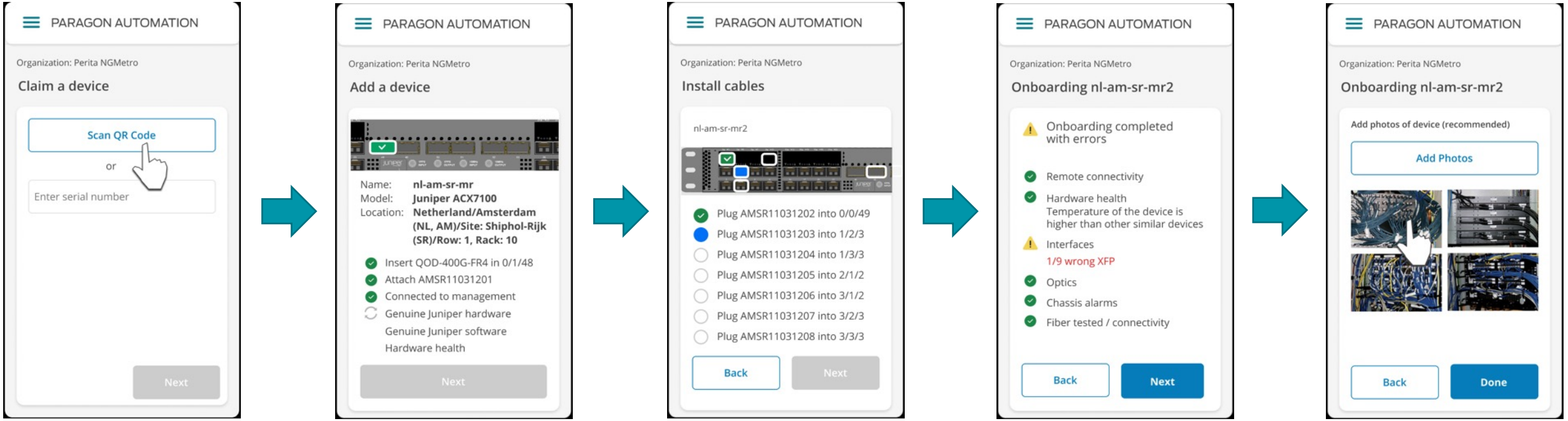



| PLAN | ORCHESTRATE | ASSURE | OPTIMIZE |
|---|---|---|---|
| Strategic network planning | Device onboarding | Trust and compliance | Latency based routing |
| Risk-failure analysis, scenario planning | Intent-based service orchestration | Network observability | Autonomous capacity optimization |
| | Device lifecycle management | Active assurance | Closed loop remediation |

AI-Enabled  Roadmap

# AI-Enabled Device Onboarding

## Secure, Error free, Every time: device onboarding with integrated service validation




**Scan QR Code on ACX7k or input device serial number**

**Check optics, connectivity, infra security, device health**

**Validate proper cabling**

**Report onboarding status and any errors**

**Upload photos to validate proper installation**

# Service Orchestration

## Stateful Service Provisioning and Service Monitoring with Closed-Loop Service Assurance

**Stateful, intent-based service provisioning:**
**"I need to deploy a service VPN for a customer across 3 different geographies, and I need it validated before go-live."**

↓

**Translate intent into service placement**

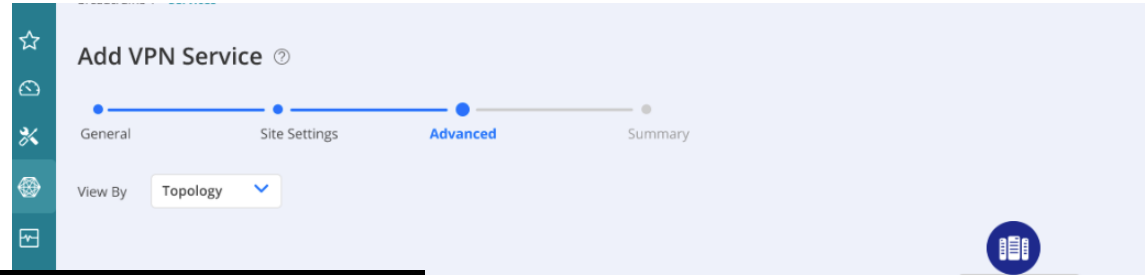
**Deploy the VPN**

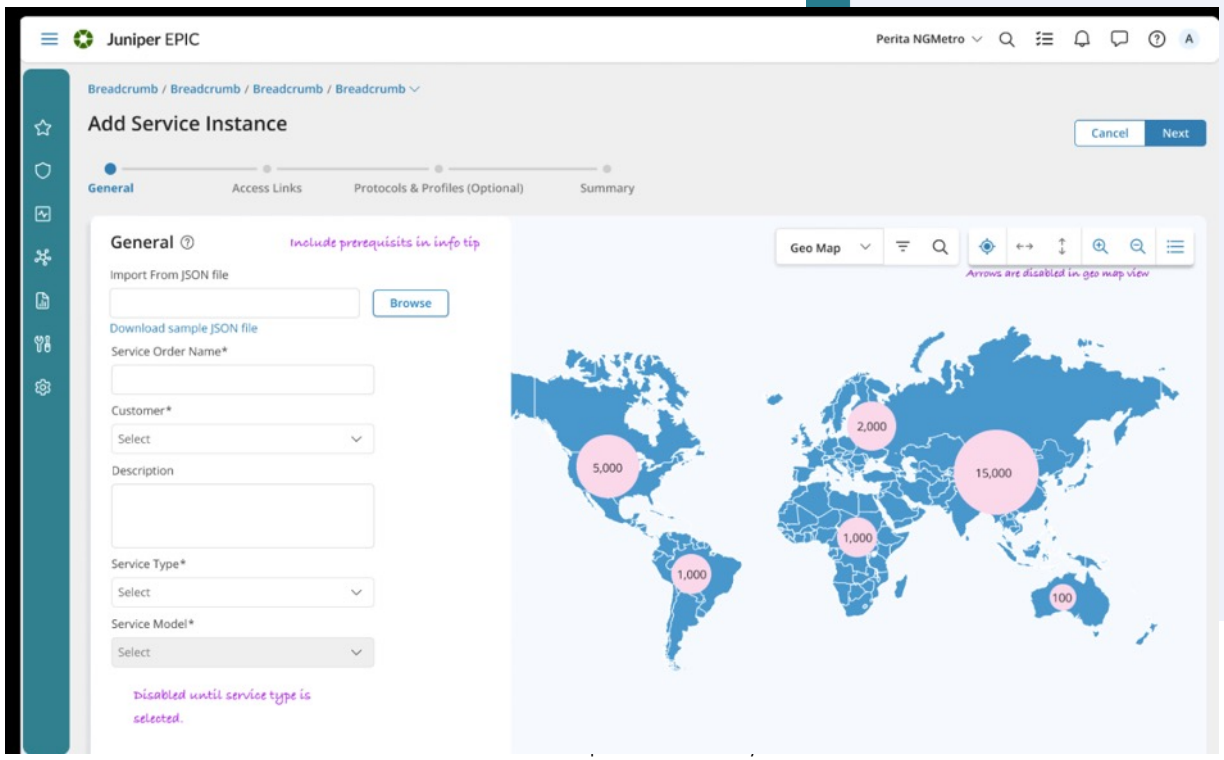
**Deploy VPN service monitoring**

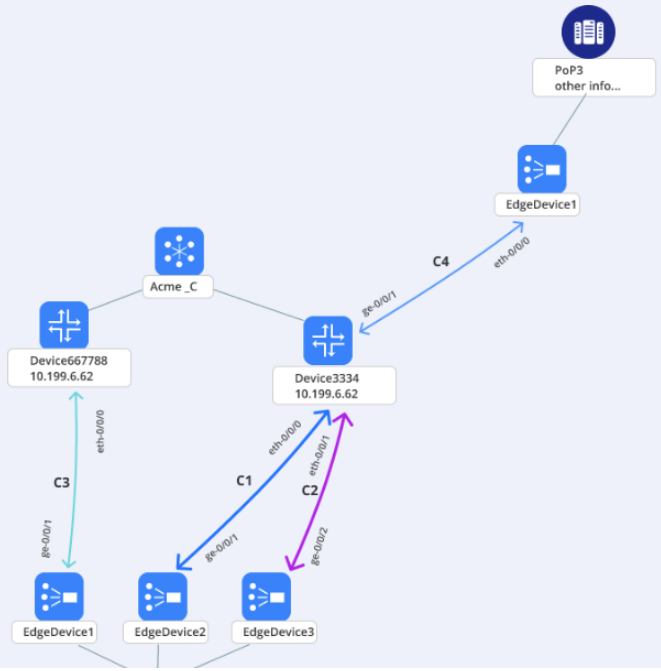
**Deploy VPN service assurance**

↓

**Outcome: automated, assured service delivery**



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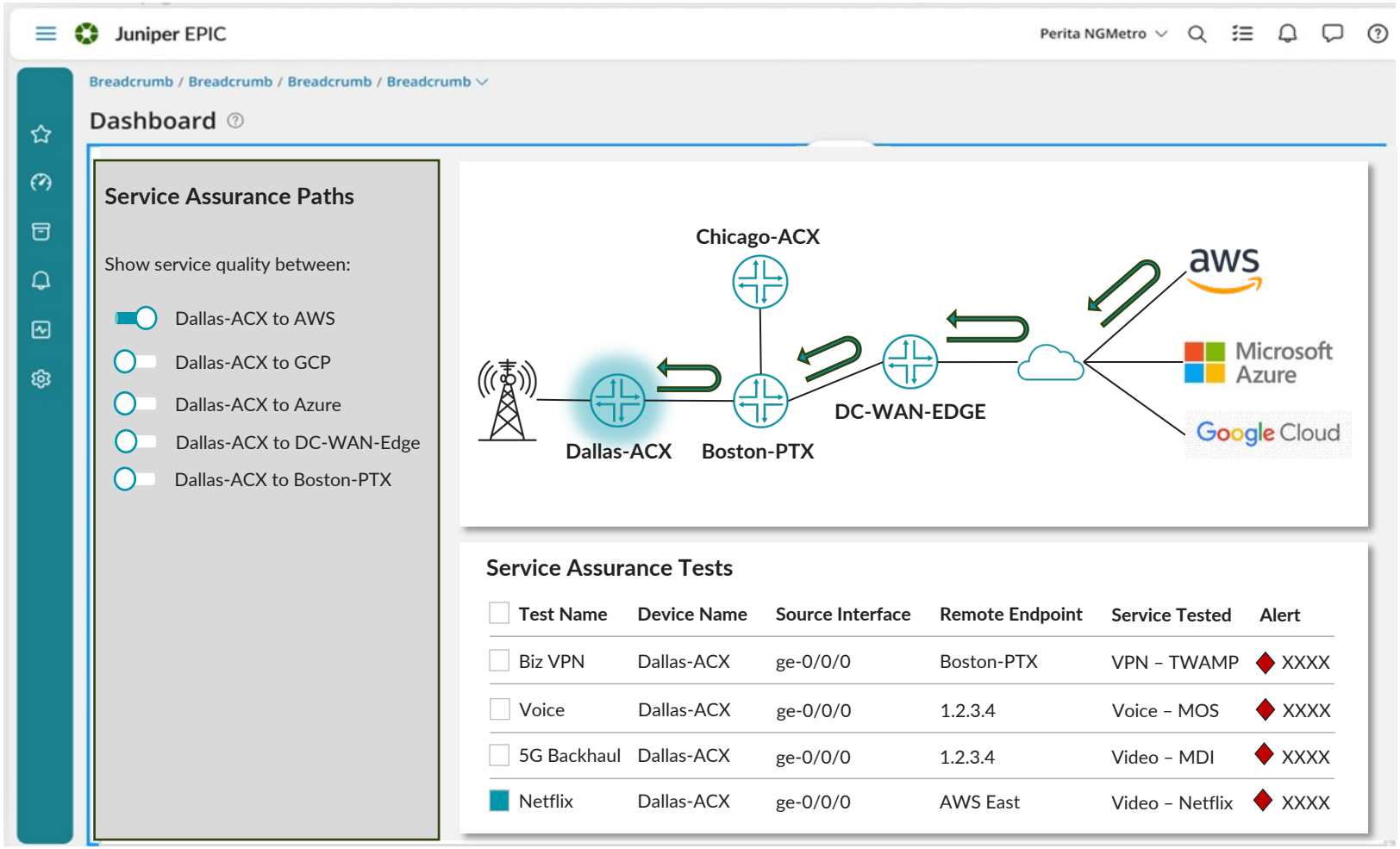
# Service Assurance

## Real-Time, Continuous Service Assurance




**Service Assurance addresses the key question:**

**"How do you know?"**

- How do you know if your service is up?
- If it's up, how do you know if the service quality is good (before customers call to complain)?
  - *Up is not the same as good!*

**Outcome:**

- **Proactive, nonstop service validation to ensure high-quality customer experience**

# Leading with Experience: Focus on Outcomes

## WAN AIOps for Deep Insights and Anomaly Detection

Marvis AIOps comes to Paragon:
**"I can't solve this problem using normal means, I need help resolving this outage."**

↓

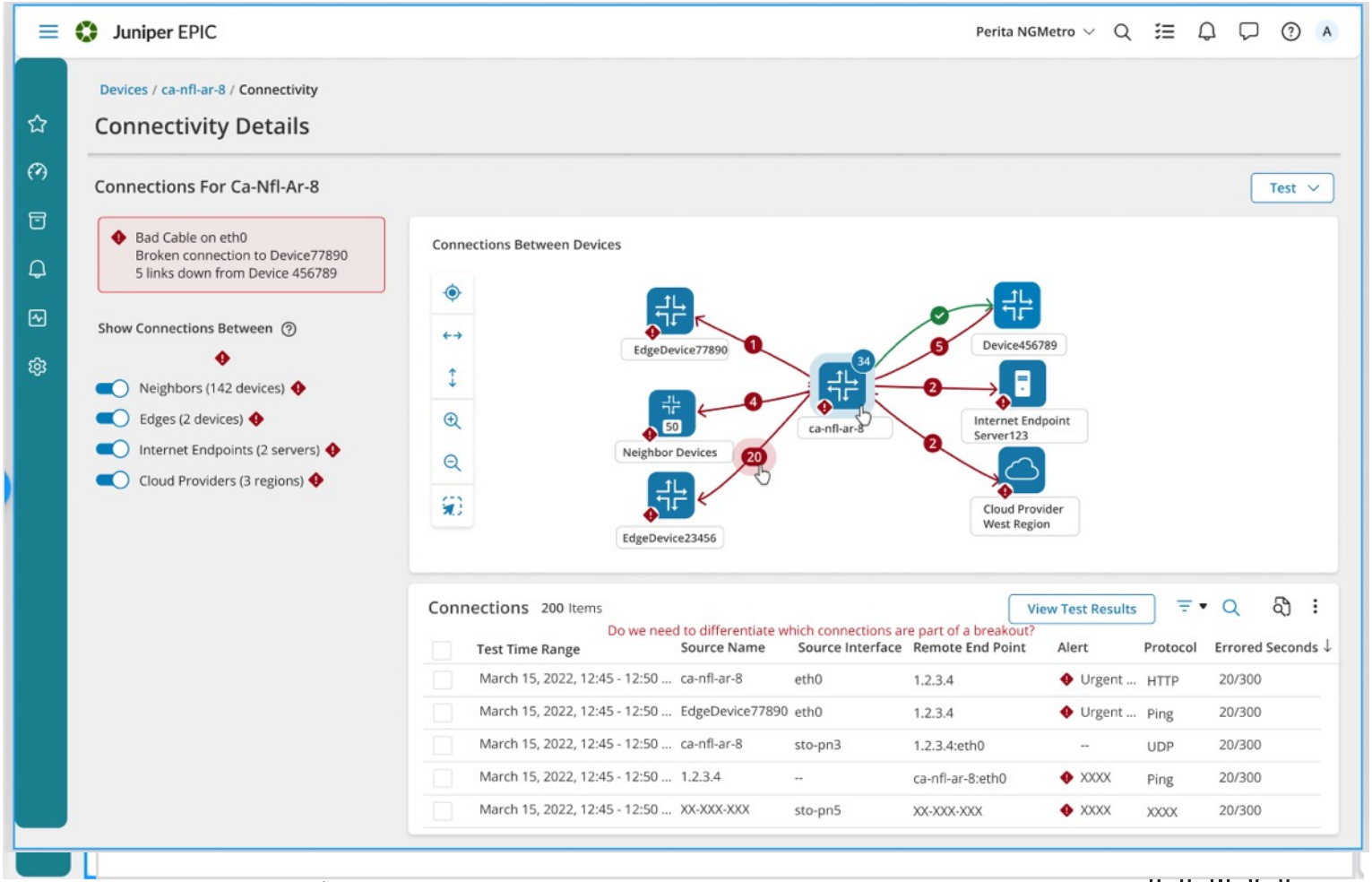
AI-assisted blackhole detection

+

AI-assisted bad optical cable detection with synthetic traffic testing

↓

Outcome: accelerated time to root cause identification, service restoration



# THANK YOU

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