Experience. Outcomes.

The Adaptive Network

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About us

We’re a networking systems, services and software company

We enable you to deliver rewarding experiences for your end-users and drive better outcomes for your organization through the creation and deployment of the Adaptive Network

1,300+
customers across
North America, CALA,
EMEA and APAC

80%
of the world’s largest
service providers
being served

5,700+
employees
in 80+ countries

Industry leadership

IHS Markit™

NAMED CIENA #1

Ciena ranked #1 in key service provider purchase criteria:

- Product Reliability
- Solution Breadth
- Technology Innovation
- R&D investment

Ciena ranked #1 in optical market and key sub-segments:

- Data Center Interconnect
- Optical Transport & Switching
- Transport SDN

IHS Technology Optical Equipment Vendor Leadership / Global Service Provider Survey, December 2017

CIENA WAS THE **1st**

- 100G transport SDN testbed adopting OpenFlow and an open source controller
- Coherent optics with 40G and 100G solutions
- OTN control plane on an optical switch
- Carrier Ethernet aggregation switch supporting a virtualized switching architecture

- Intelligent optical core switch
- Packet-optical convergence platform
- Multi-vendor SDN/NFV ecosystem
- Carrier SDN platform
- Multi-domain orchestrator that integrates data center, NFV, and the WAN

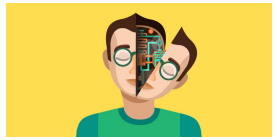
CIENA HOLDS 2,000+ PATENTS WORLDWIDE

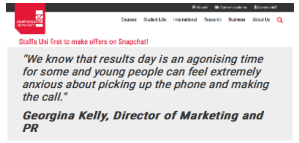
R&E Evolving Scenario

R&E Evolving Scenario

Students

3 different devices to access information
Half of them are connected for more than 8 hrs. a day
96 % owns a Smartphone
70 % are watching more than 2hrs. of YouTube per day





Faculty Staff – Finding new ways to support.

Machine Learning

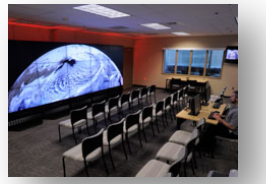
Campus Security Cameras
Threat identification

New ways to connect with Students
Social Media Interaction

Genome Project

A single Human Genome FASTQ File
200 Gigabytes

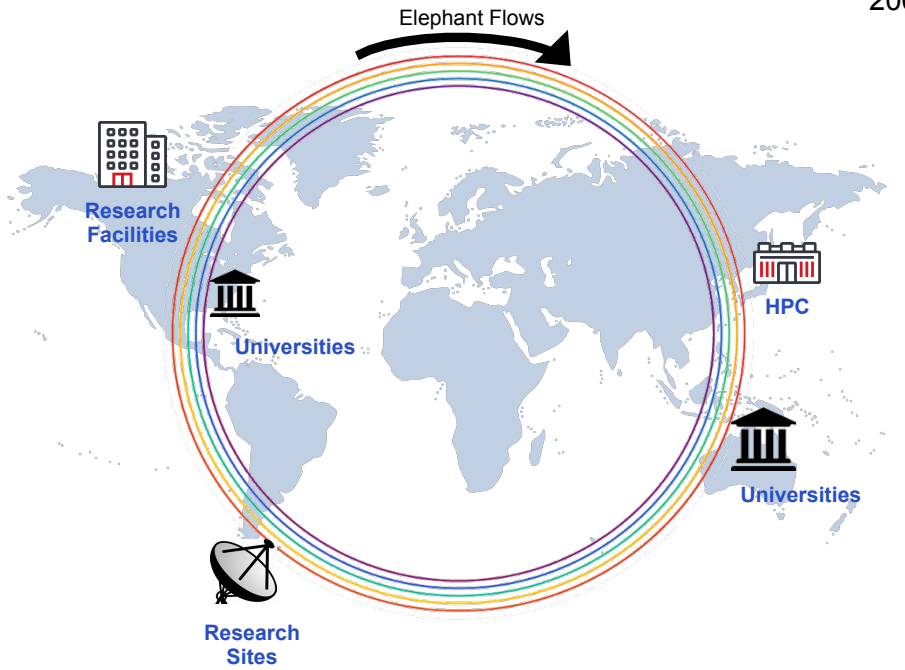
Weather Predictions



NASA Center for Climate Simulation
More than 300 PB

Advanced Physics

CERN
1 PB data / day
and stores
200 PB



Researchers – Collaboration is the key

Evolution of learning is requiring a different network

Remote Interaction

Personalized Learning

Ubiquitous Content

Distance Learning

Virtual Reality

One network, many different applications

Massive Scale

100G to
400G to
800G and
above

Operational Efficiency

Abstract Complexity
Reduce Footprint
Improve Energy Efficiency

Openness

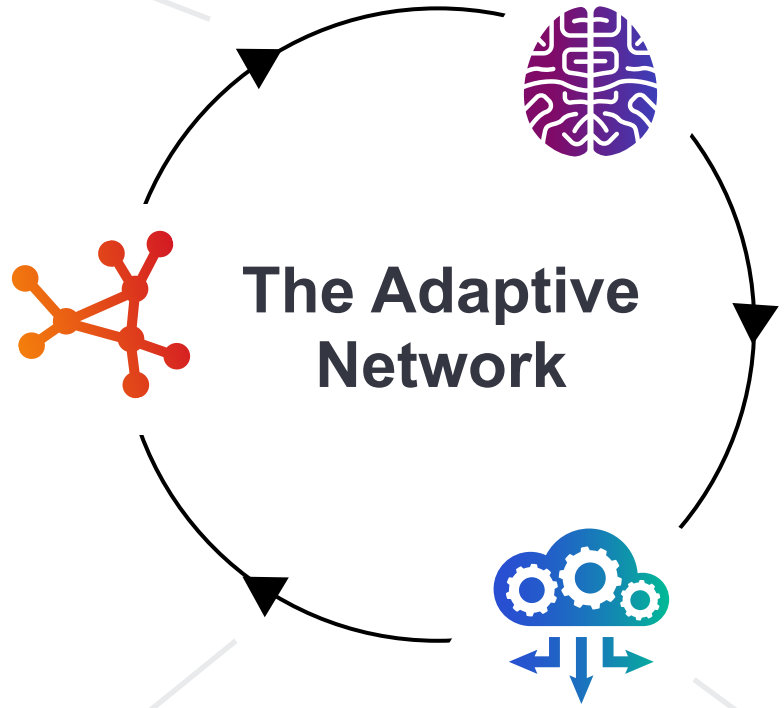
Multi-domain Orchestration
Avoid vendor lock-in
Future proof

The Adaptive Network

How it works

Analytics & Intelligence
Predictive and adaptive analytics based on both big data and small data

Telemetry



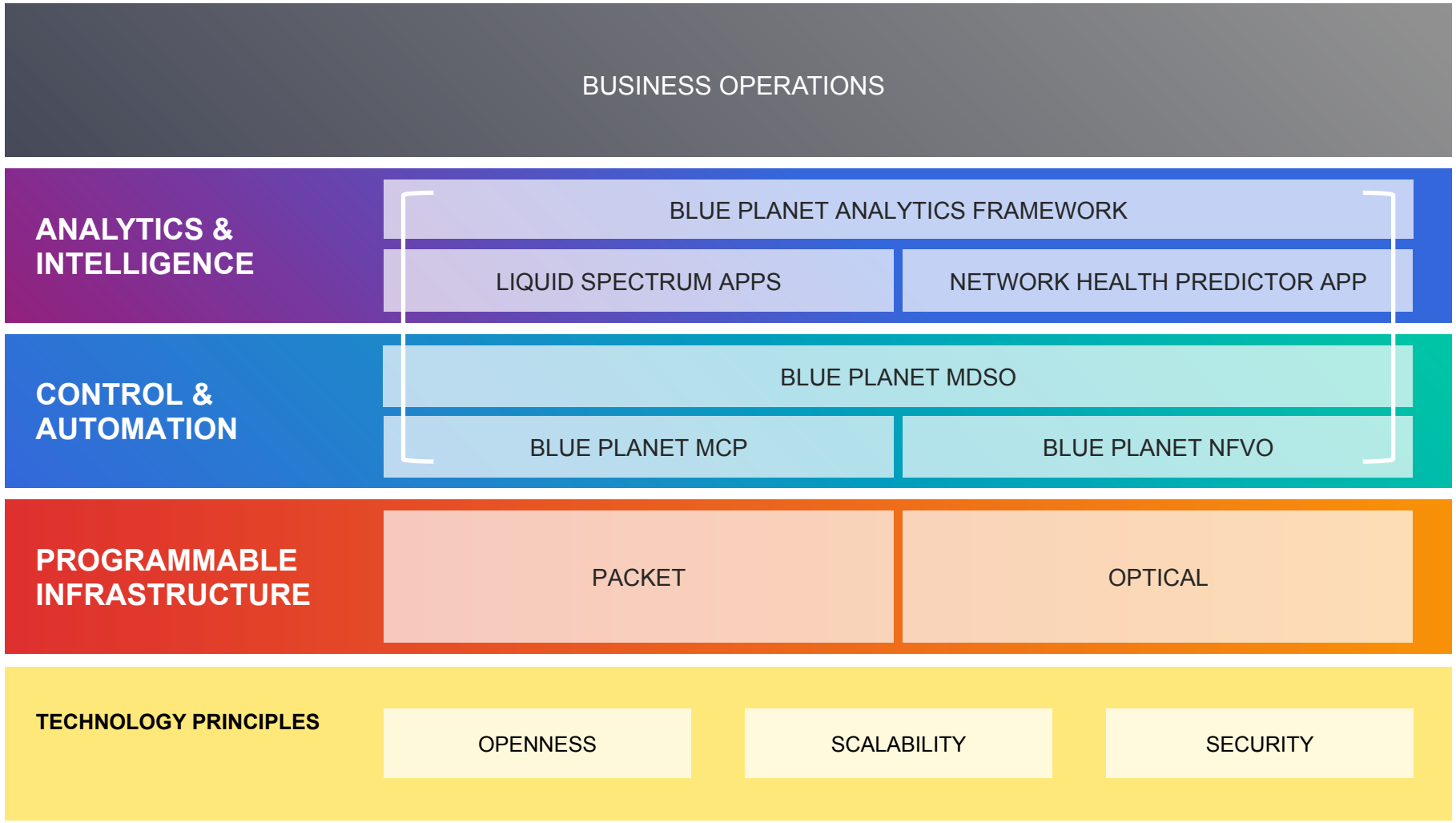
Programmable Infrastructure
Dynamic pool of virtual and physical network resources, instrumented, open, scalable, secure

Intent-based policies

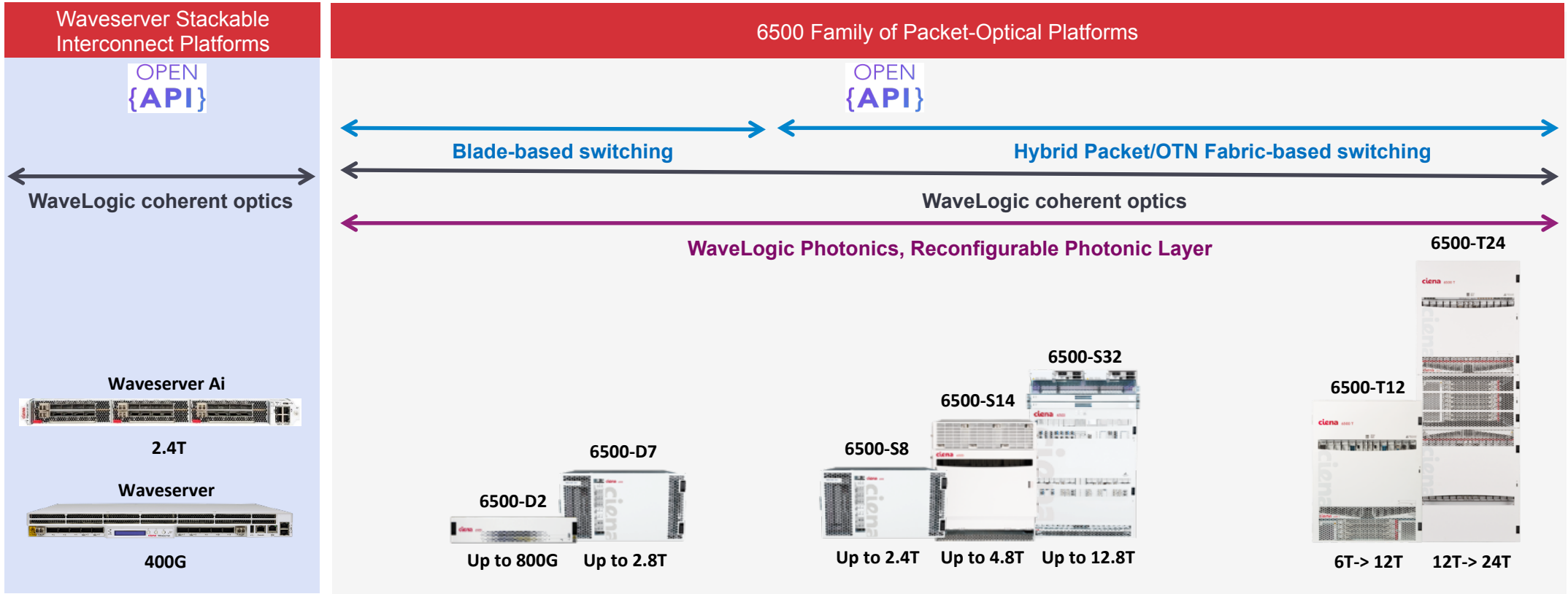
Automation

Software Control & Automation
Open orchestration

Where does Ciena fit into this framework?



Ciena's Coherent Packet-Optical Portfolio



Enabling the Adaptive Network

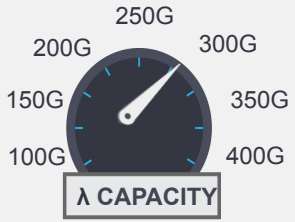
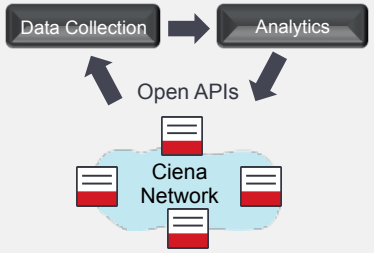
- **Capacity** – Twice the wavelength capacity across applications, industry-leading 30.4Tb/s on a fiber
- **Scale** – From 10Gb/s to 400Gb/s wavelengths, Terabit hybrid packet/OTN switching per slot, and 2.4T line capacity in 1RU
- **Programmability** – Flex grid reconfigurable photonic layer, 100G-400G tunable capacity in 50G steps, full range of Open APIs
- **Choice** – Fully integrated converged packet-optical to transponder-based systems, stackable modular platforms, open line systems and stand-alone modems

WaveLogic Ai Coherent Optics

What is it?

Industry-leading programmable coherent modem designed to transport more capacity across the fiber using minimal hardware.

- Provides unprecedented levels of scale, automation and intelligence - essential to on-demand and adaptive networks
- Allows providers to acquire new insights into their network, react to changing requirements in real-time, and offer new innovative services

New benchmark in performance & economics	Programmability	New levels of intelligence
• More capacity per wavelength, higher density, lower power 	• Tunable in granular 50G steps 	• Unprecedented, embedded real-time link monitoring 

Enabling the Adaptive Network

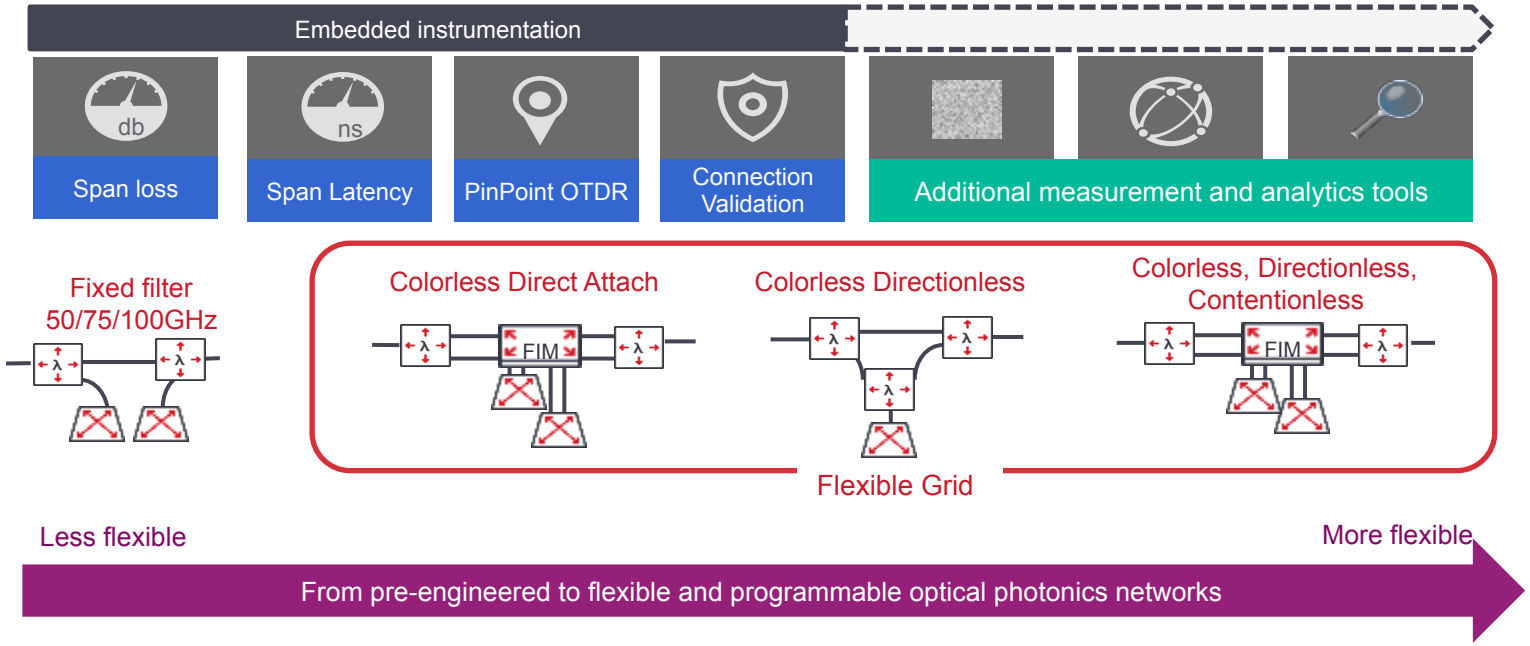
- Helps providers better scale their optical networks by providing twice the capacity per wavelength across all applications and three times the distance at equivalent capacity, all at less than half the power and footprint of solutions today
- Provides tunable capacity, from 100Gb/s to 400Gb/s in 50G steps, allowing operators to better match capacity to system margin using a single technology, and move bandwidth across the network as needed to address on-demand and ever changing customer requirements
- Extracts never-before-available network performance data which can be accessed through open interfaces and mined to build on-demand, optimally efficient, programmable networks

WaveLogic Photonics reconfigurable photonic layer

What is it?

Fully instrumented, intelligent photonic system composed of WaveLogic coherent optics and flexible line elements.

- Embedded and discrete software tools offer better automation, control, and visibility into the network
- Instrumentation includes:
  - Span loss, OSNR, Span latency
  - PinPoint integrated OTDR
  - Photonic connection validation
  - Network alarm correlation



Enabling the Adaptive Network

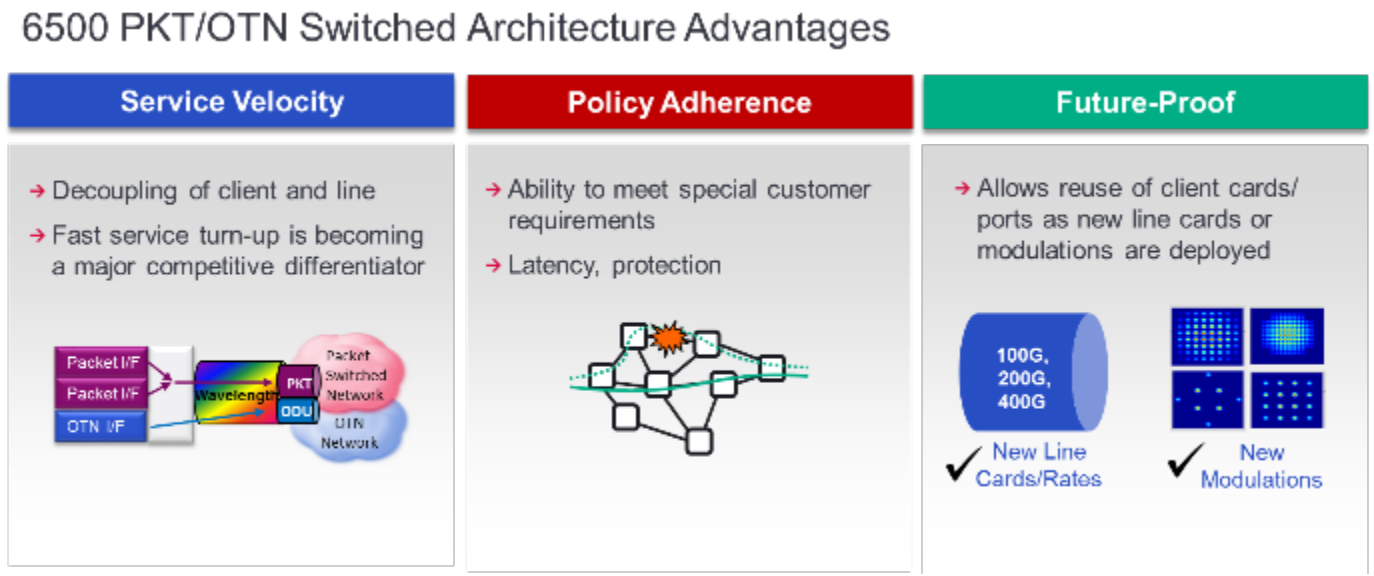
- Flexible grid reconfigurable photonic layer with integrated, rich instrumentation combines with Layer 0 control plane to enable a programmable network foundation that can dynamically re-route wavelengths and adapt to new traffic patterns as needed

6500 PKT/OTN Switching

What is it?

6500 hybrid packet/OTN switching

- Integrates three comprehensive networking layers into a single platform to support customizable high capacity connectivity from the metro edge, between data centers, along the backbone core, and across ocean floors
- Allows providers to scale their networks across a wide range of applications using fewer separate boxes



Enabling the Adaptive Network

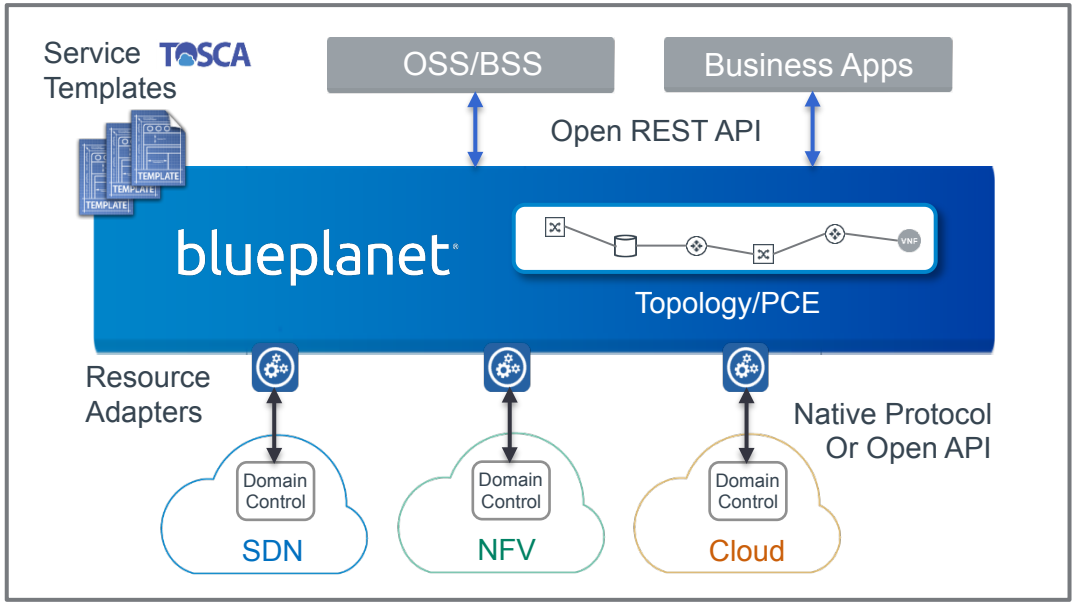
- Decoupling of client and line allows for fast service turn-up, a key building block for enabling a more dynamic, adaptive network
- Ability to better scale the network, increasing network bandwidth efficiencies with right-sized and in-service adjustable ODUflex containers
- OTN switching and control plane enhances programmability, where services can be established, protected, and restored according to specific SLAs and policies
- OTN future-proofs networks with built-in support for new FlexE client and line rates of the future (beyond 100G (B100G) rates)

Blue Planet Multi-Domain Service Orchestration (MDSO)

What is it?

Software for simplifying the end-to-end management and automation of network services

- Traditional WAN (optical, Ethernet, IP/MPLS), NFV, cloud and hybrid
- Model-driven abstraction to simplify service lifecycle management
- Vendor-agnostic architecture built on open-source components
- Microservices-based platform supports rapid upgrades and scaling
- DevOps-style resource on-boarding and service development



Blue Planet MDSO architecture and elements

Enabling the Adaptive Network

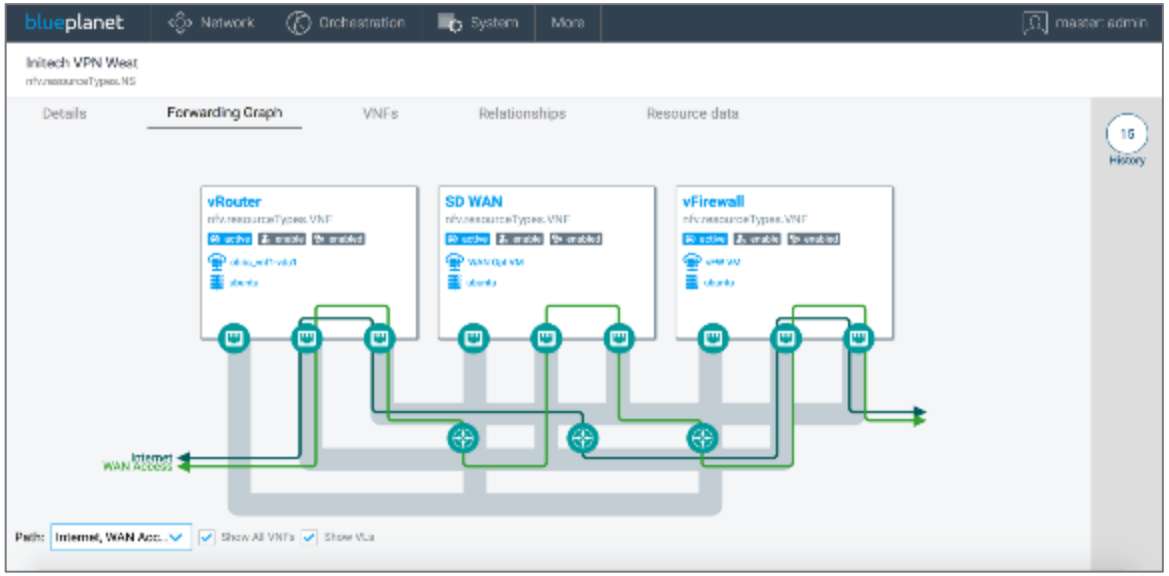
- Provides software-control for automating service delivery across multi-vendor and multi-technology networks
- Facilitates the adoption of SDN, NFV, and open APIs to enable network programmability
- Integrates with Blue Planet Analytics and MCP to support self-healing and self-optimizing (closed-loop) capabilities powered by big data insights

Blue Planet NFV Orchestration (NFVO)

What is it?

Software for automating the delivery and lifecycle management of NFV-based network services

- Instantiates, manages and chains VNFs across multiple data centers
- Complies with ETSI NFV Release 2 specifications
- Vendor-agnostic design supports any VNF and cloud management platform (VIM)
- Agile, DevOps-style resource on-boarding and service development
- Deployed in multiple production networks



Screenshot: NFV service visualization in Blue Planet Orchestration

Enabling the Adaptive Network

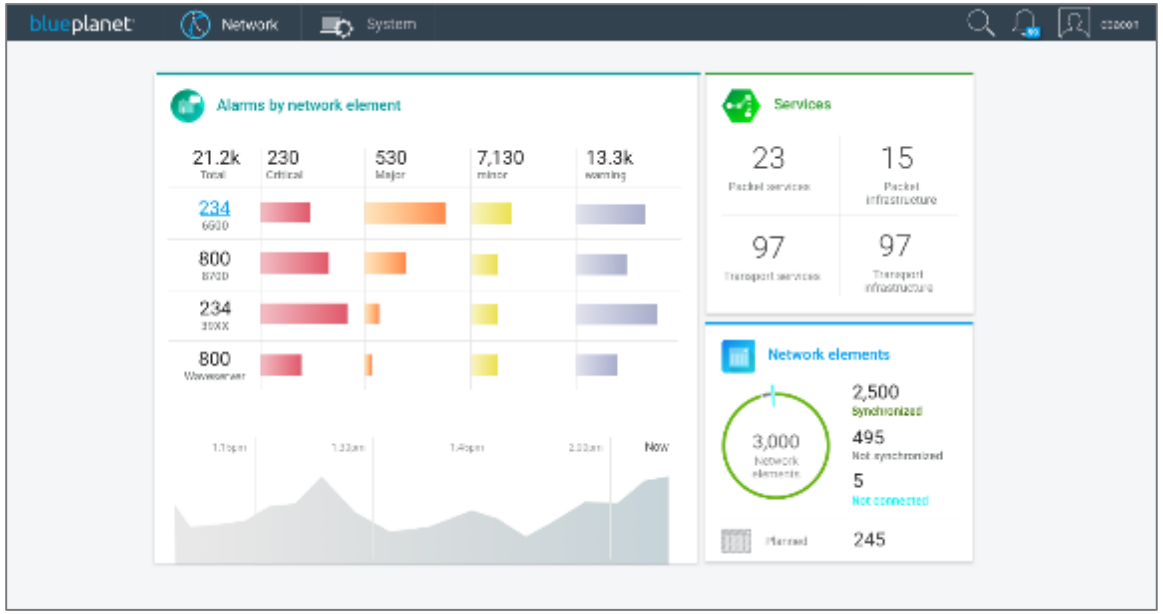
- Provides software-control for automating the delivery of virtualized network services
- Facilitates the adoption of SDN, NFV, and open APIs to enable network programmability
- Integrates with Blue Planet Analytics and MCP to support self-healing and self-optimizing (closed-loop) capabilities powered by big data insights

Blue Planet Manage, Control and Plan (MCP)

What is it?

Domain Controller for automating Ciena packet-optical networks

- Converges multi-layer SDN-based management (full FCAPS), control, and planning
- Provides complete service fulfillment and assurance
- Supports Ciena Liquid Spectrum apps
- Open and extensible architecture - simplified programmability and integration via REST APIs



Screenshot: Alarm visualization and correlation in Blue Planet MCP

Enabling the Adaptive Network

- Provides software-control for automating service delivery across Ciena packet-optical networks
- Delivers the foundation for Ciena customers to begin their journey to an adaptive network
- Integrates with Blue Planet Analytics to support self-healing and self-optimizing (closed-loop) capabilities powered by big data insights
- Integrates with MDSO for extending automation across multi-vendor and multi-technology networks

Analytic & Intelligence

"In the past, decisions were often made using best-guess or anecdotal information and handled through over-provisioning. We now have a need to use real-time network telemetry and analytics to intelligently engineer the underlying infrastructure for optimal capacity."

Inder Monga, Executive Director, ESnet

DELIVERS INSIGHT

- Improves decision-making
- Provides at-a-glance interactive dashboard
- Identifies trending and potential network degradation

REDUCES EFFORT

- Automates data aggregation and analysis
- Streamlines planning and operations
- Accelerates troubleshooting efforts

OPTIMIZES THE NETWORK

- Maximizes network utilization and performance
- Recovers unused network assets
- Enables bandwidth recovery

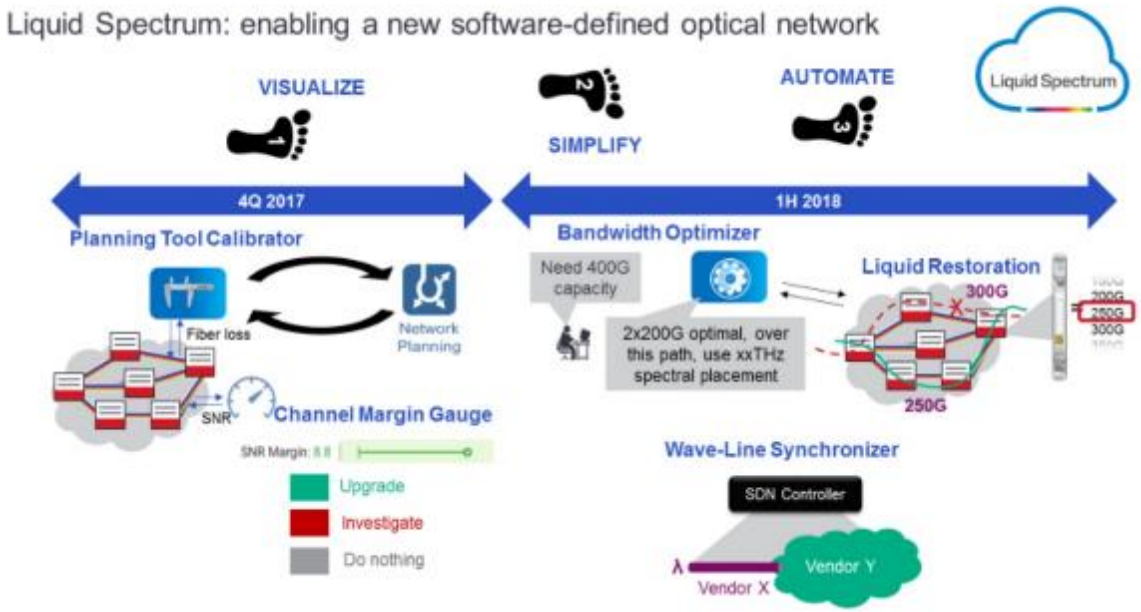
Improved Customer Satisfaction and Financial Performance

Liquid Spectrum APPs

What are they?

Advanced software apps designed to change the way optical networks are engineered, operated, and monetized

- Available apps: Performance Meter, Bandwidth Optimizer, Wave-Line Synchronizer
- Combine variable bit-rate coherent optics, flexible grid reconfigurable photonic layer, and SDN control in an open architecture
- Provides visibility to, and mines, available system margin
- Allows network providers to gain optical capacity on demand, improve reach for a specific channel, or increase service availability

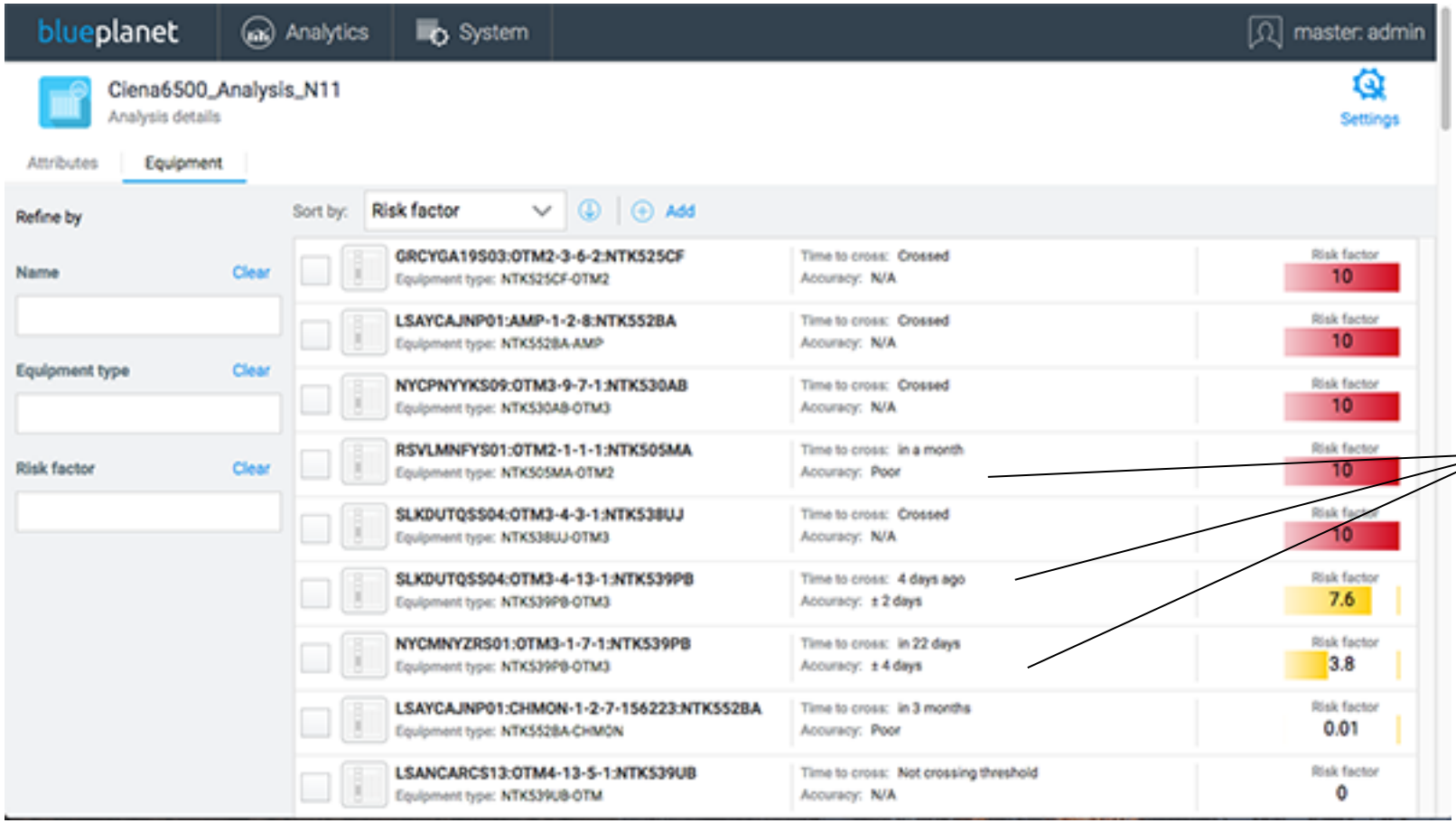


Enabling the Adaptive Network

- Performance Meter - provides visibility into the real-time performance of the network and the ability to proactively ensure optimal capacity and resource efficiencies
- Bandwidth Optimizer - simplifies and accelerates wavelength turn-up through real-time monitoring and automation, providing users with optimal capacity, spectral assignment, and equipment needs based on service requirements
- Wave-Line Synchronizer - automates wavelength provisioning in multi-vendor networks

Blue Planet Analytics Overview
Applications – NHP - Analysis Page

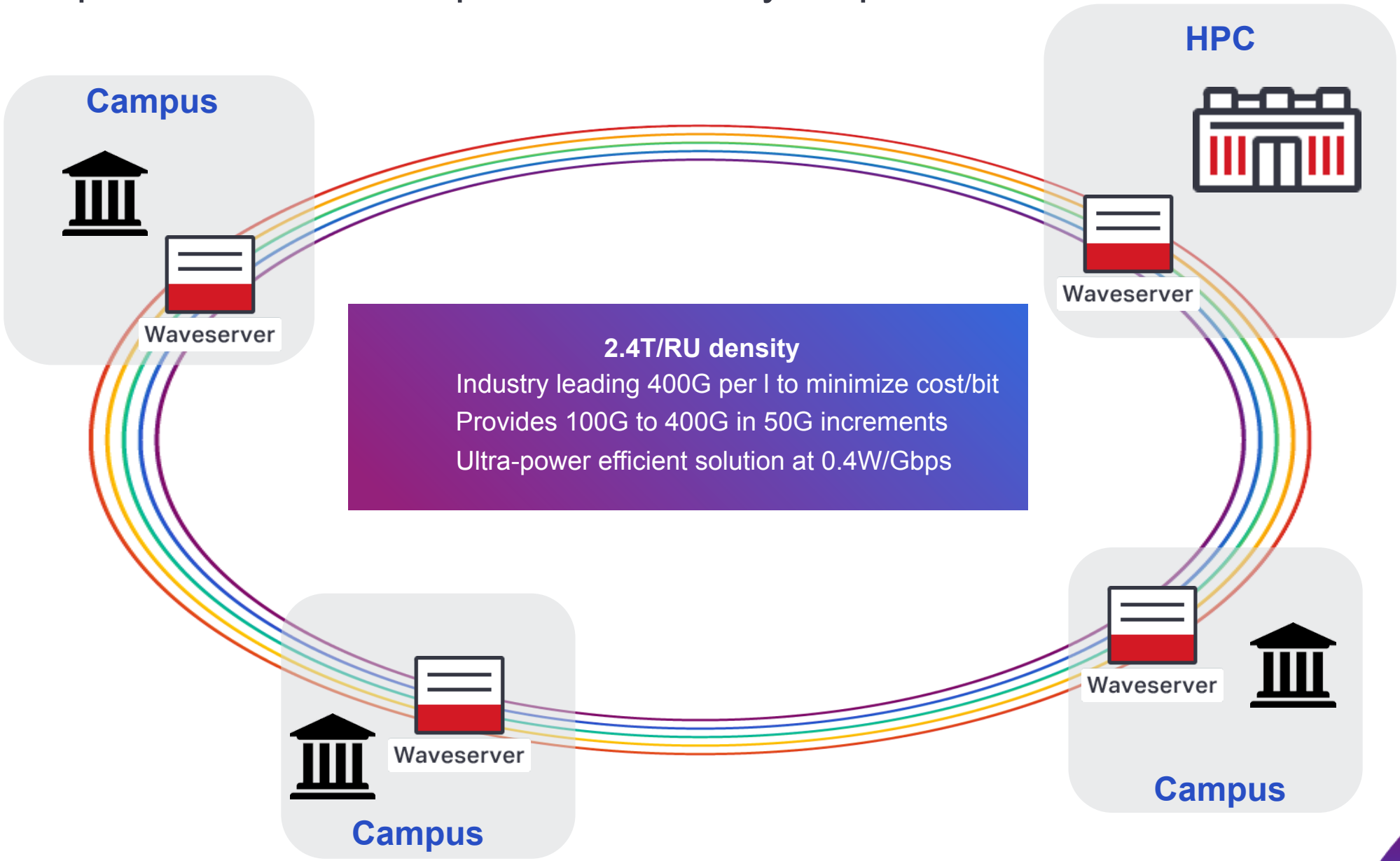
- User can access the details of each analysis
- View provide the analysis of each port and can be sorted/filtered
- The vast majority of the ports will have risk factor of 0.



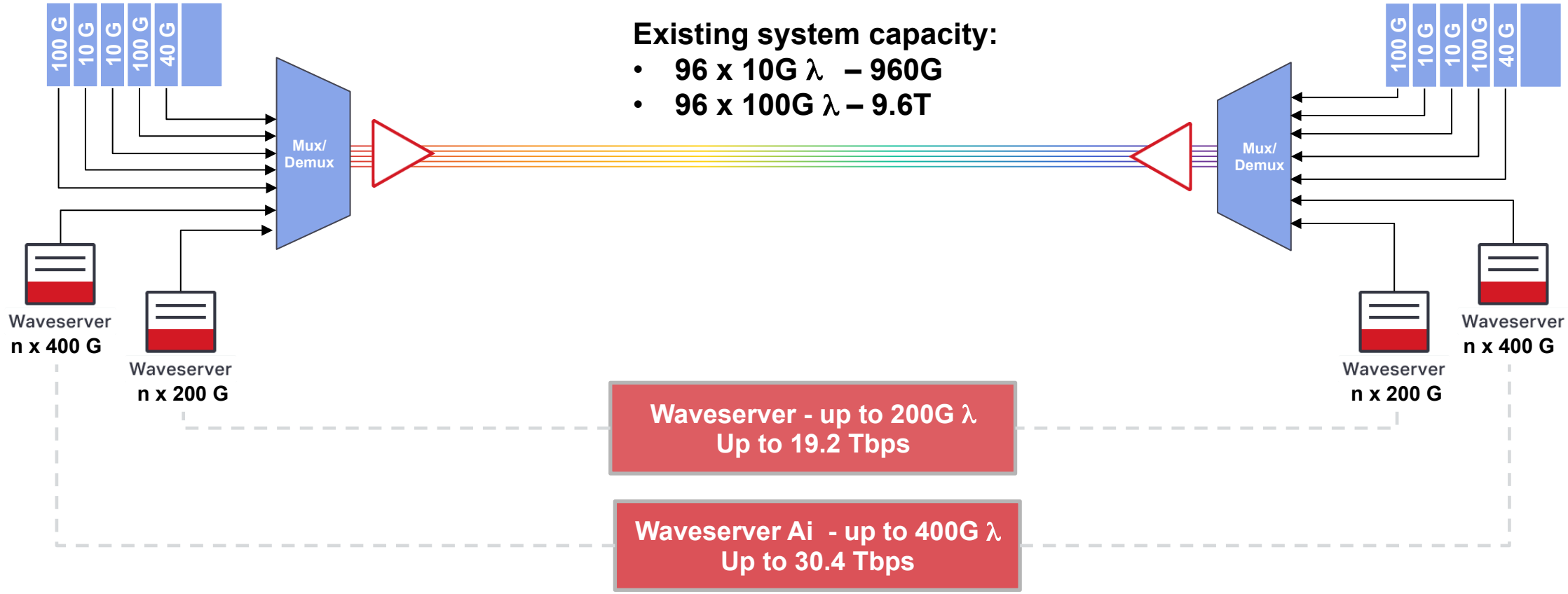
Measure of Accuracy in +/- days

R&E Use Cases

The Adaptive Network Campus Connectivity - Optical

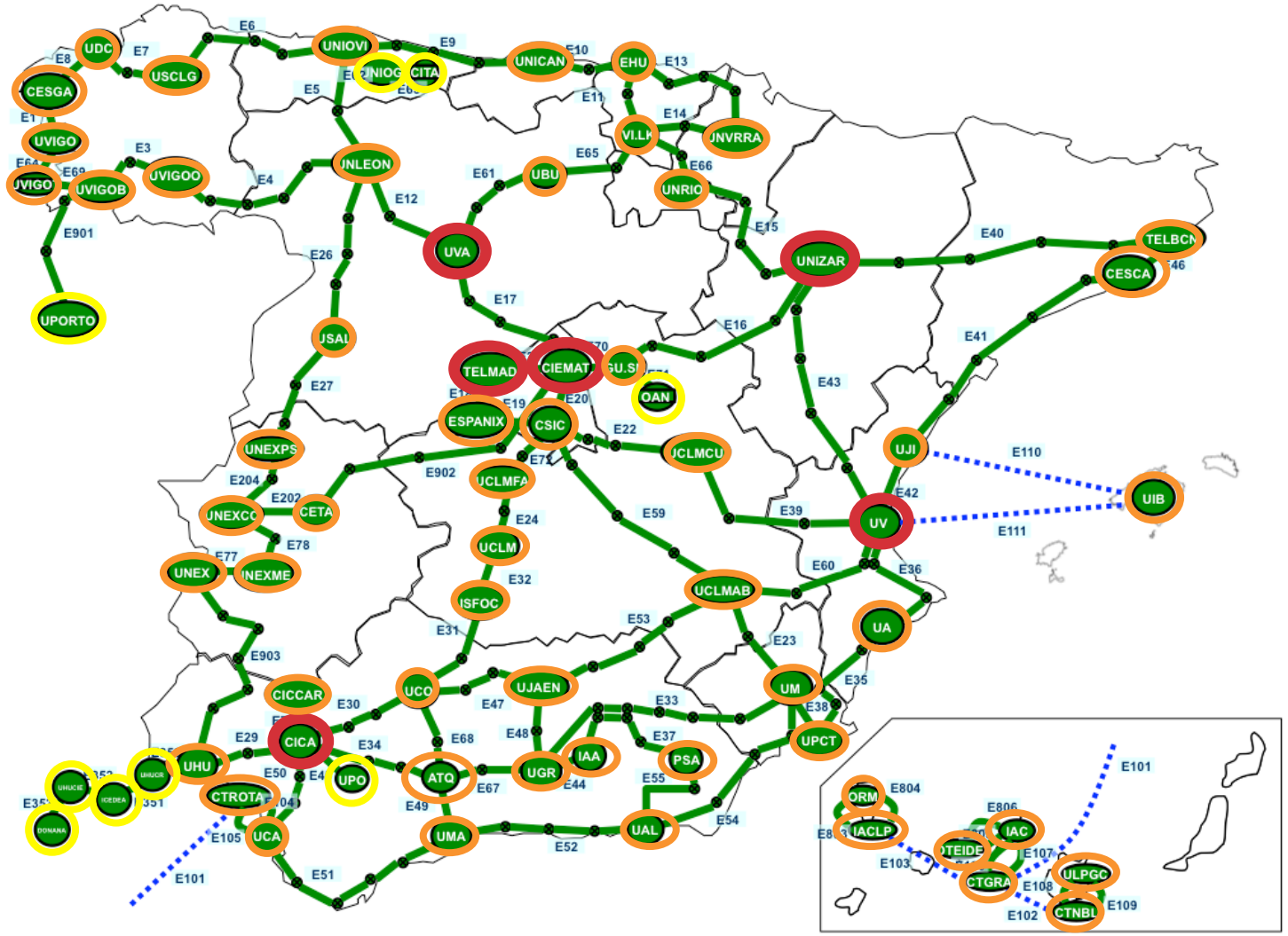


The adaptive network providing scalability to legacy network



Cost-effectively increase capacity and improve density over non-Ciena legacy line systems

The adaptive network for NRENS - Backbones



- Colorless Directionless Contentionless
- Flex Grid
- Control Plane Restauration & Protection
- Agile Photonic
- Open APIs

Ciena R&E Community References

Public

Ciena strong collaboration with the R&E Community

Joint Research

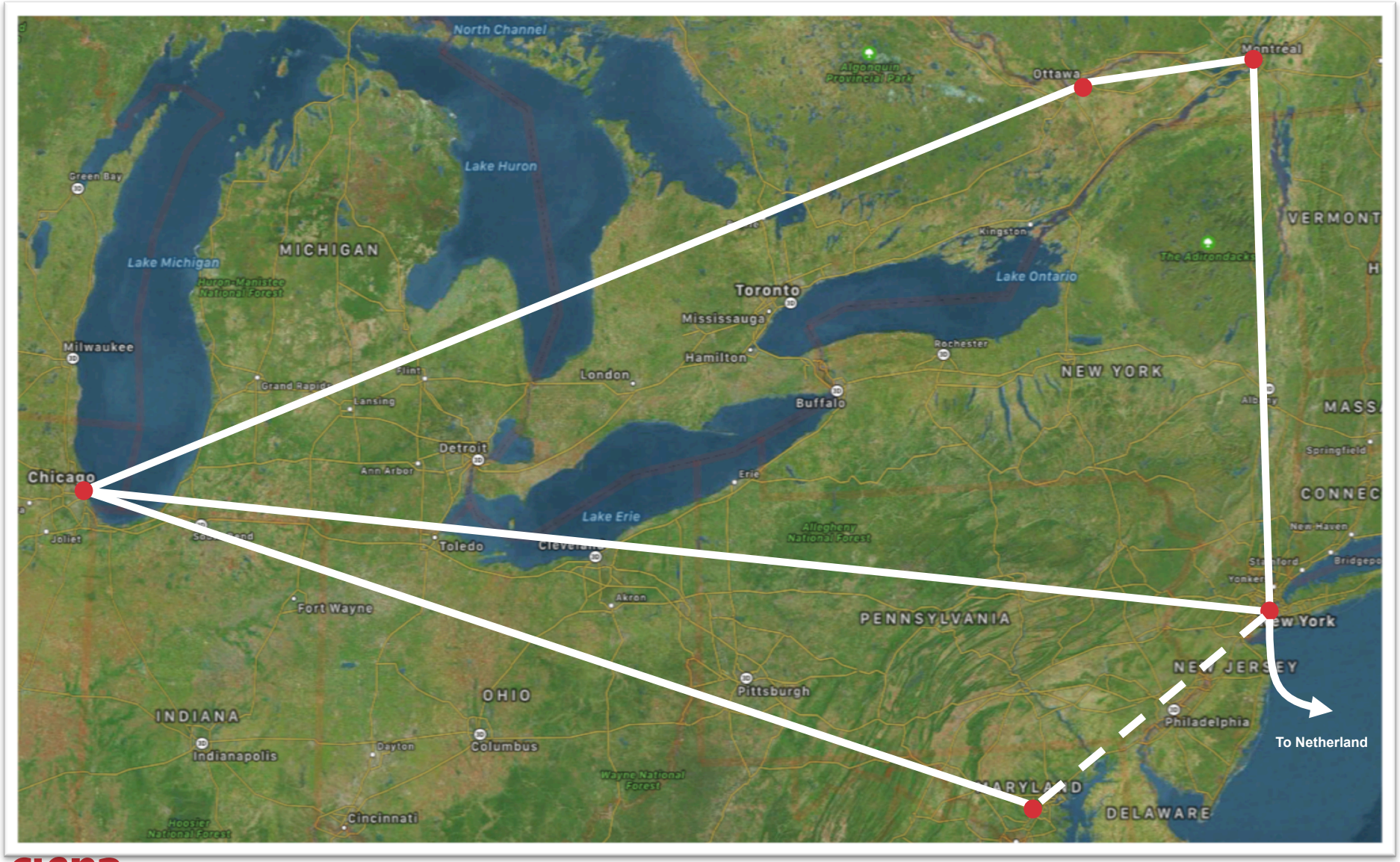
Aston University

UNIVERSITY OF AMSTERDAM

- Digital Signal Processing
- Material Science
- Component testing @ measurements
- System Simulation & Verification
- Cloud
- Advanced Next Gen Architectures
- Novel network software control
- Cyber Security

Ciena strong collaboration with the R&E Community

Ciena Environment for Network Innovation (CENI)



Evolution of Networked Services through a Corridor in Quebec and Ontario for Research and Innovation

http://www.encqor.ca

Ciena Public References in the R&E Community (with Hyperlink)

UK's Jisc Delivers World's First 400G National Research and Education Network with Ciena

WaveLogic Ai technology to power network serving more than 18 million Jisc users

LONDON and HANOVER, Md. — January 31, 2018

CANARIE, StarLight and Ciena Complete 300G Trial

Shows the ability to provide 50 percent more capacity at longer distance to meet growing demand from scientific research, OTT, disaster recovery and DCI applications

HANOVER, Md. — June 15, 2016

CESNET and GÉANT Deploy 300 Gbps Wavelength in R&E community

Prague, CZ, 23 January, 2018. CESNET, marking a R&E community first deployment of Ciena´s Waveserver Ai platform, has interconnected GÉANT´s high-capacity routers using a 300 Gbps alien wavelength over 530km of CESNET network with Czech Light Open Line System. This accomplishment shows how the research and education (R&E) community can establish reliable all-optical transmission that transit multiple networks for the high-performance computer (HPC) networks, data storage and transfer capabilities and collaborative working environments that are crucial to Europe's modern academic and scientific organizations.

Partnership supports surging bandwidth needs essential to scientific research and collaboration.

KISTI and Ciena Drive High-Bandwidth Research and Collaboration with New 100GE Transoceanic R&E Network

Korean research institute deploys 8700 Packetwave Platform to improve network scalability and help power the acceleration of data movement in the petascale computing era

HANOVER, Md. — May 9, 2016

MAX and Ciena Join Forces to Expand Opportunities for Collaborative Research in the Science and Higher Education Communities

New MAX-Ciena 200 Gbps Connection Will Facilitate Multi-Domain SDN Technology Development and Testing

ESnet Taps Ciena for 400G Research and Education Network

Network to support growing demand for data-intensive transfer and research on high energy physics, climate science and genomics

HANOVER, Md. — November 10, 2015

Ciena Public References in the R&E Community

http://www.ciena.com/about/newsroom/press-releases/Ciena-Joins-National-Science-Foundations-GENI-Project_prx.html

http://www.ciena.com/about/newsroom/press-releases/Ciena-Teams-with-RE-Networking-Leaders-to-Build-International-Software-Defined-WAN-to-Accelerate-SDN-Ecosystem_prx.html?src=PR

http://www.ciena.com/about/newsroom/press-releases/UWaterloo-and-Ciena-research-drives-advancements-in-Internet-connectivity.html

http://www.ciena.com/about/newsroom/press-releases/NORDUnet-Transforms-Network-with-Ciena_prx.html

https://www.computecanada.ca/featured/compute-canada-demonstrates-one-of-the-fastest-long-distance-academic-big-data-transfers-in-canada/

http://www.ciena.com/about/newsroom/press-releases/NORDUnet-Transforms-Network-with-Ciena_prx.html

http://www.ciena.com/about/newsroom/press-releases/Ciena-Teams-with-RE-Networking-Leaders-to-Build-International-Software-Defined-WAN-to-Accelerate-SDN-Ecosystem_prx.html

Conclusiones

Conclusiones

- La comunidad educativa y de investigación está en **constante cambio**.
- Nuevas aplicaciones ávidas de **ancho de banda**
- Sistemas **abiertos y que fomenten entornos de colaboración.**
- Diseñar las redes **de tal manera que sean capaces de evolucionar y escalar sin problemas a futuro.**
- La arquitectura presentada es una **visión** de hacia dónde deben evolucionar las redes. No hay una solución única para todos los casos.
- Teniendo en cuenta el estado actual de la red y nuestra idea de futuro, la intención es acercarnos a ella en la medida de lo posible.
- Estamos **abiertos** y **dispuestos** para colaborar con ustedes y hacer **evolucionar** sus redes.

Gracias