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HKNOG
Hong Kong Network Operators' Group

A Glimpse into Software-Defined Optical Networks of the Future

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September, 2017

Today’s Presentation

1	Capacity Evolution
2	The Challenge with current Optical Networks
3	The Autonomous Optical Network
4	Application Examples

About Ciena

Ciena: Provider of Fibre based connectivity & On-Demand Business solutions – So that Customers can thrive in a Web-Scale World.

HARDWARE	SOFTWARE	SERVICES
Converged packet-optical and Ethernet platforms	Automation & orchestration, across physical and & virtual	Professional services and technical services

- **Founded in 1992, IPO 1997**
- **5,500+ employees, 60+ countries**
- **1,300+ customers; 80% of World's largest Service Providers**

North America	CALA	EMEA	APAC
750+ customers	100+ customers	350+ customers	130+ customers

History of pioneering innovation

1996

1997

1998 World's **first commercial DWDM** system

1999 World's first **metro 40-channel DWDM** system

2001 World's first Optical **Control-plane** deployment (AT&T)

2002 World's first **Resilient Packet Ring** solution

2003 World's first Connection oriented Ethernet

2005 World's first commercial deployment of **electronic Dispersion Compensating Optics**

2007 World's first Commercial **OTN platform**

2008 World's first **Coherent Optics** (40G)

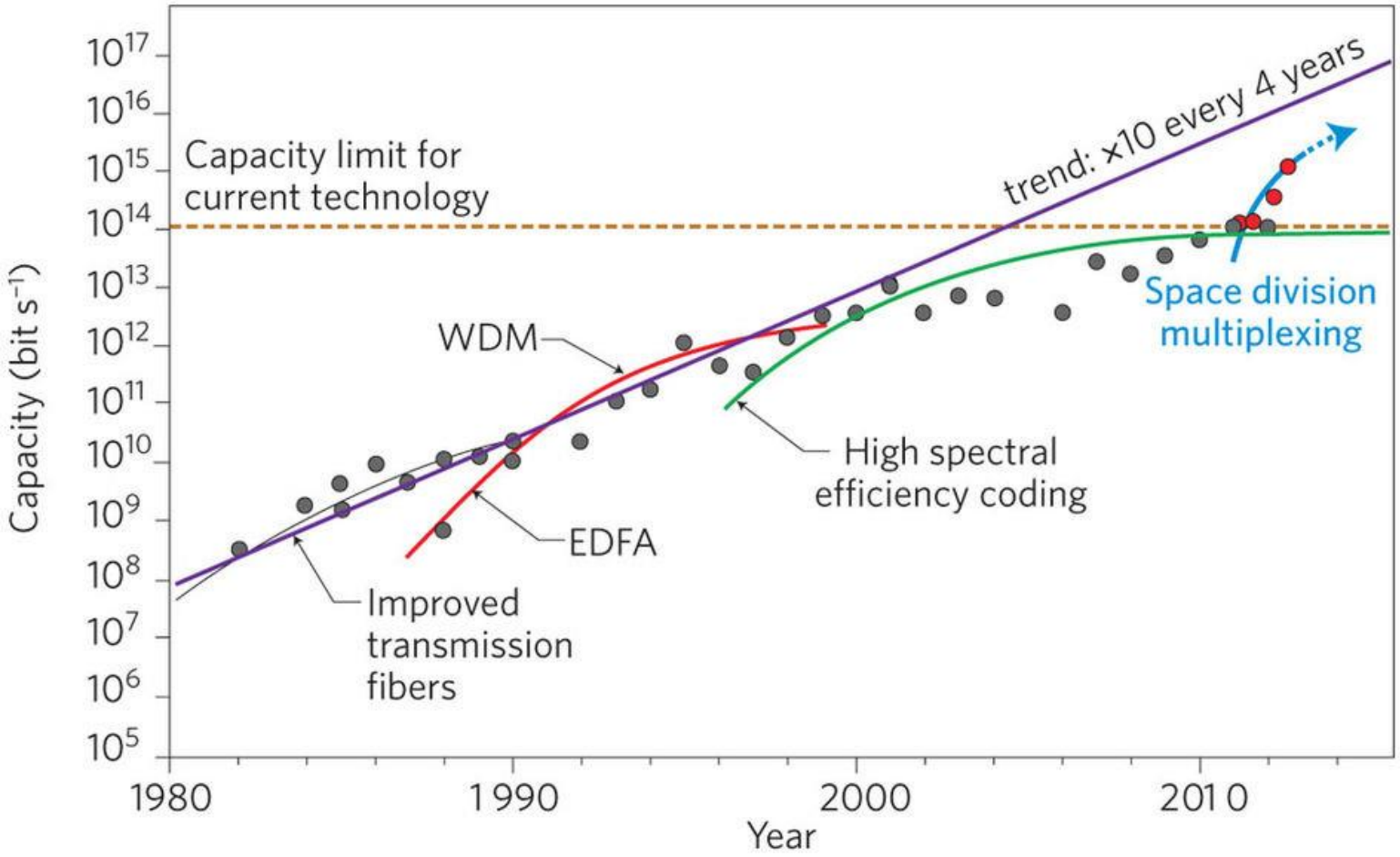
2012 World's first Programmable Optical line card

2014 World's first commercial **100G Coherent**

2016 World's first commercial FIPS-Certified **in-flight 200G Optical Encryption**

Guinness World Record: **longest un-regenerated fibre optic link** 10,358.16km

Evolution of Optical Transmission Capacity



Continuing to scale faster than Moore's Law

Source: Nature Research, 2016

On-demand Content consumption & Cloud are changing network/operations requirements

Video

Mobility

Internet of Things

Cloud

Massive SCALE and ON-DEMAND unpredictability are REDEFINING how optical networks are built

Optical Networks are Engineered and Operated in a Predominantly Static Fashion

New demands =
New Hardware

FIXED CAPACITY

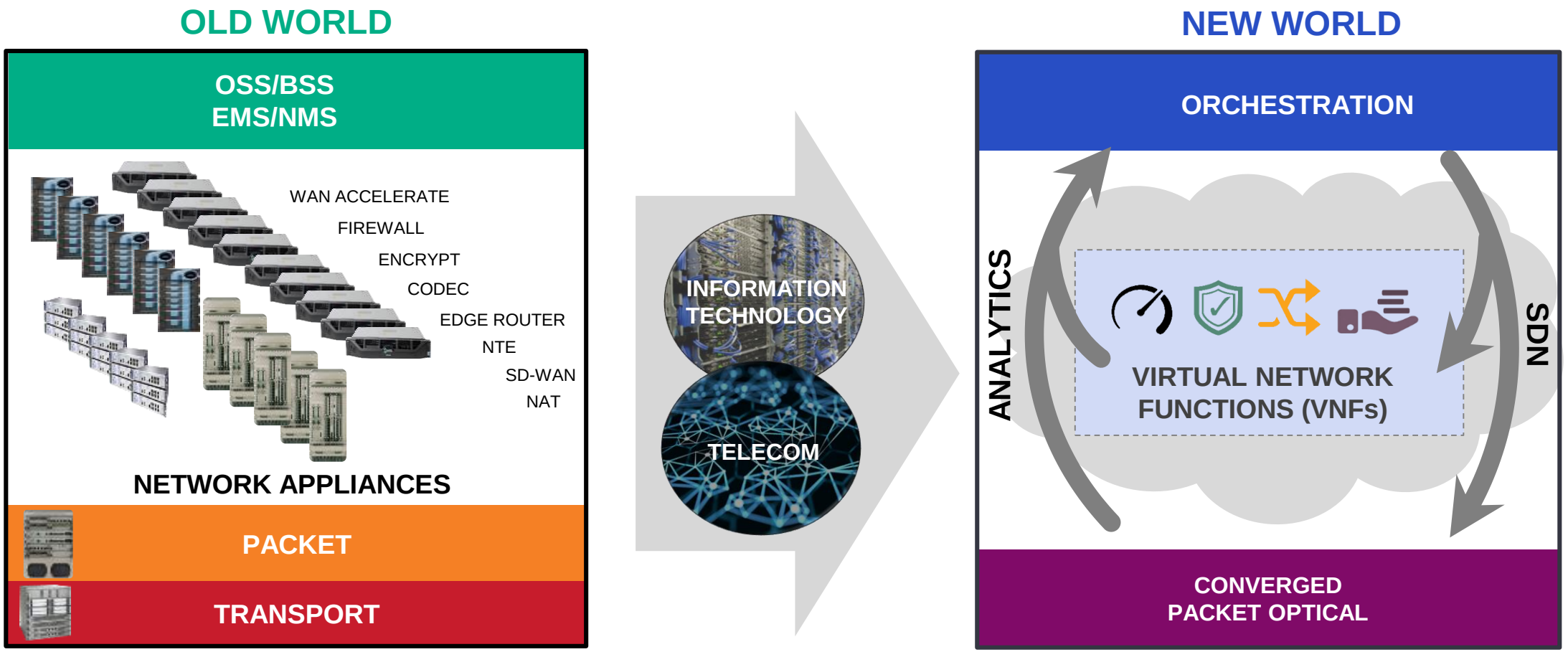
- Designed for best guess predictions of worst case conditions
- Application-specific HW for lowest cost
- Nailed-up capacity; “set and forget” operating model

LACK OF ANALYTICS AND TOOLS

- Lack of real-time fiber / network data
- Inability to access real-time data from network
- Lack of appropriate tools; manual processes

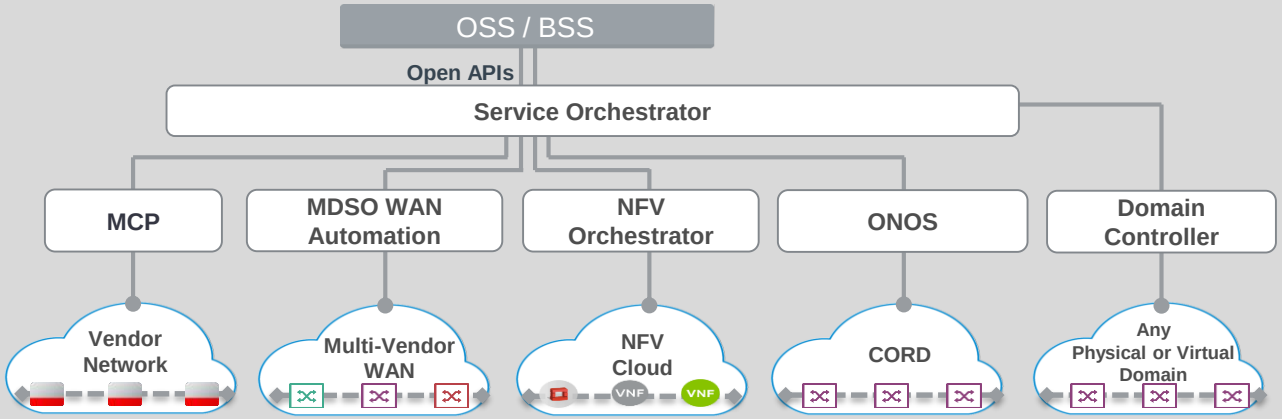
Unsustainable operating model in today’s environment

Plus, Software is Eating the World

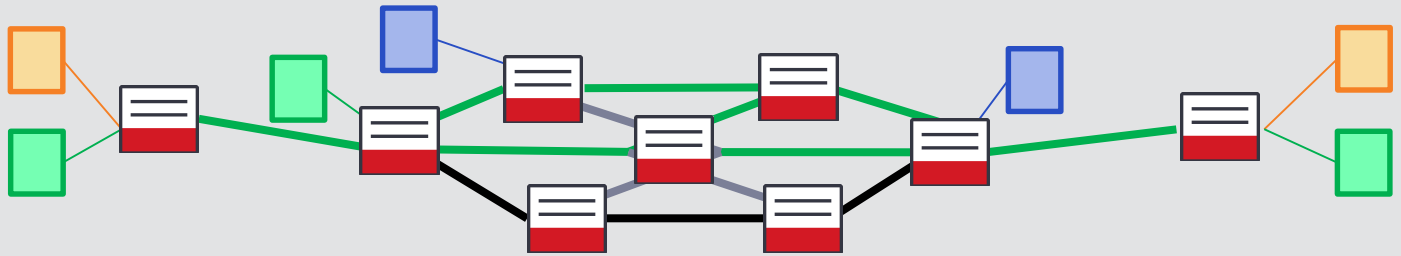


Getting there requires Transformation

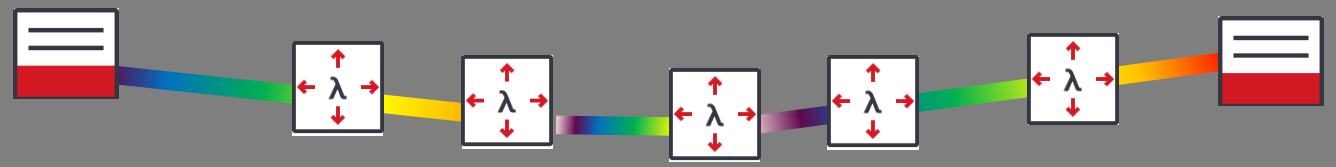
Software-based Transformation



Services and Function Virtualization



Transport Layer Evolution



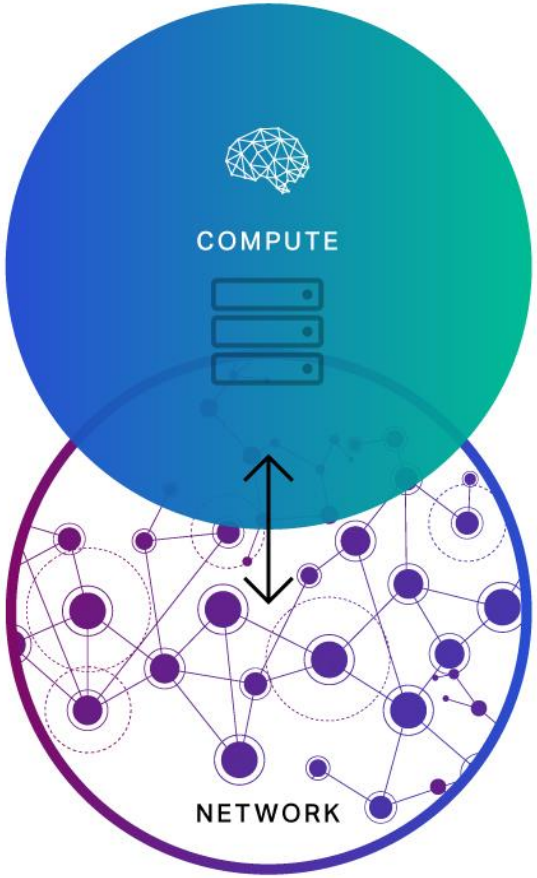
End goal - Vision of the Autonomous Optical Network

What if…

- the network could self-monitor and predict failures before they occur?
- …adapt to BW demands in real time and allocate capacity as needed?

Then you would get…

- increased automation
- network optimization
- increased profitability



Software-Defined Optical

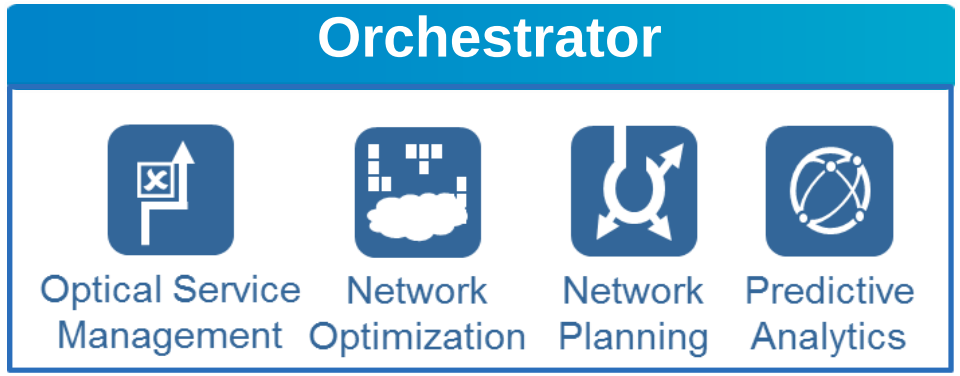
Software-defined Optical Networking… we call it Liquid Spectrum

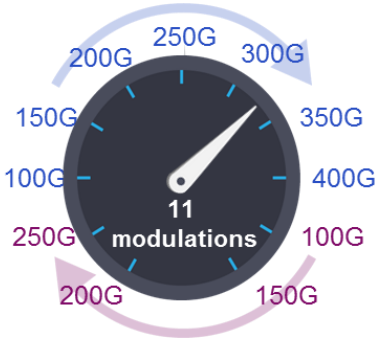
Liquid Spectrum

Simplicity - Advanced software applications that abstract complexity

Choice with open and disaggregated software

Agility and Scale with programmable hardware





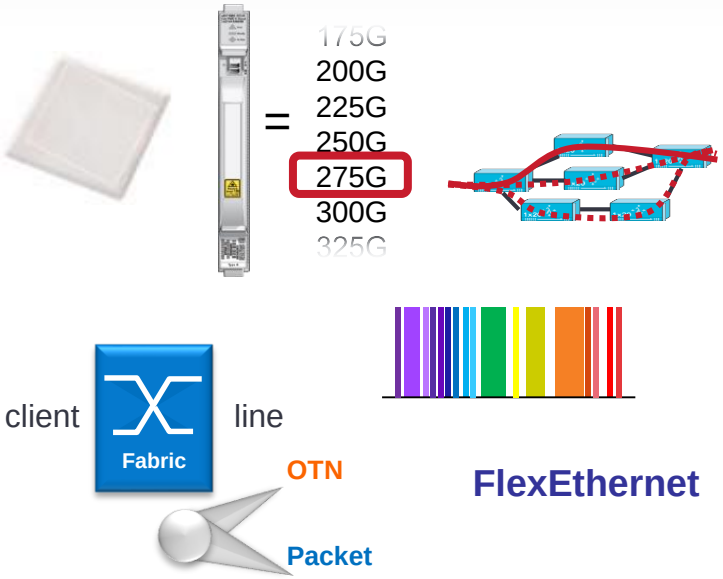
Monitoring:

- OSNR and SNR
- CD/PMD
- BER and Latency
- etc…

Building Blocks of the Software-Defined Optical Network

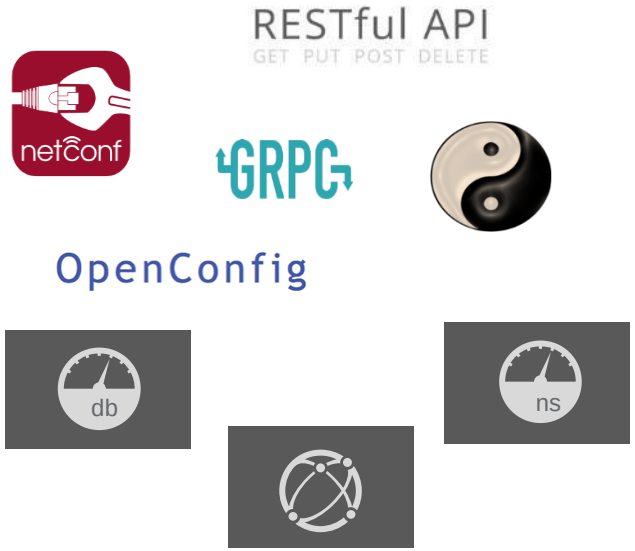
AGILE PACKET-OPTICAL ENGINE
Flexible & Instrumented Technology

- Adjusts to new application layer requirements
- Key factor in driving lowest cost / bit



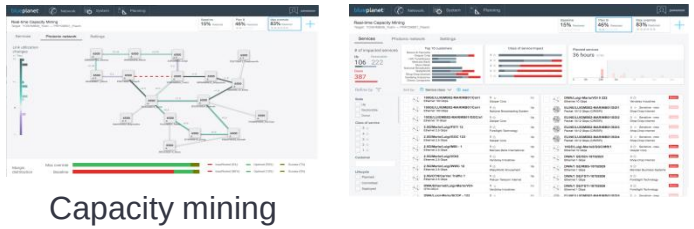
ADVANCED TELEMETRY
Open Interfaces

- Access to all data from network
- Multiple data models, multiple protocols



SOFTWARE APPLICATIONS
Analytics & Control

- Leverage instrumentation to connect business policy to transport bandwidth
- Automate by rule and manage by exception



Capacity mining

DWDM Visualizer

Programmable Coherent Optics

Automation and Intelligence required for building the dynamic, on-demand network

New efficiencies

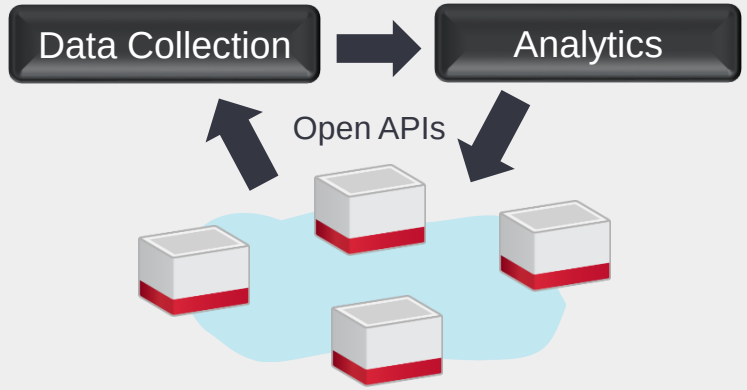
- Further serial integration, up to 400G/λ
- Twice the capacity, three times the distance to drive down cost/power

Unmatched Programmability for Optimal Capacity

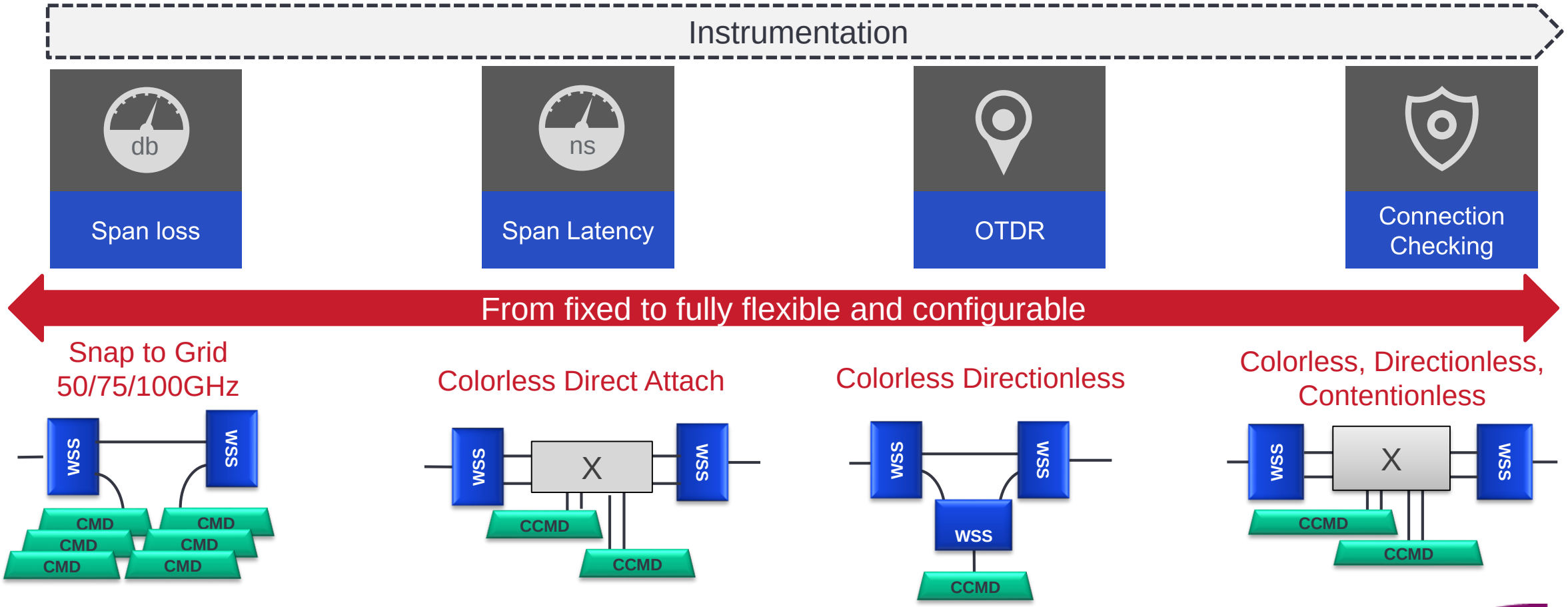
- Better match optimal capacity to existing network margin across applications

New levels of intelligence

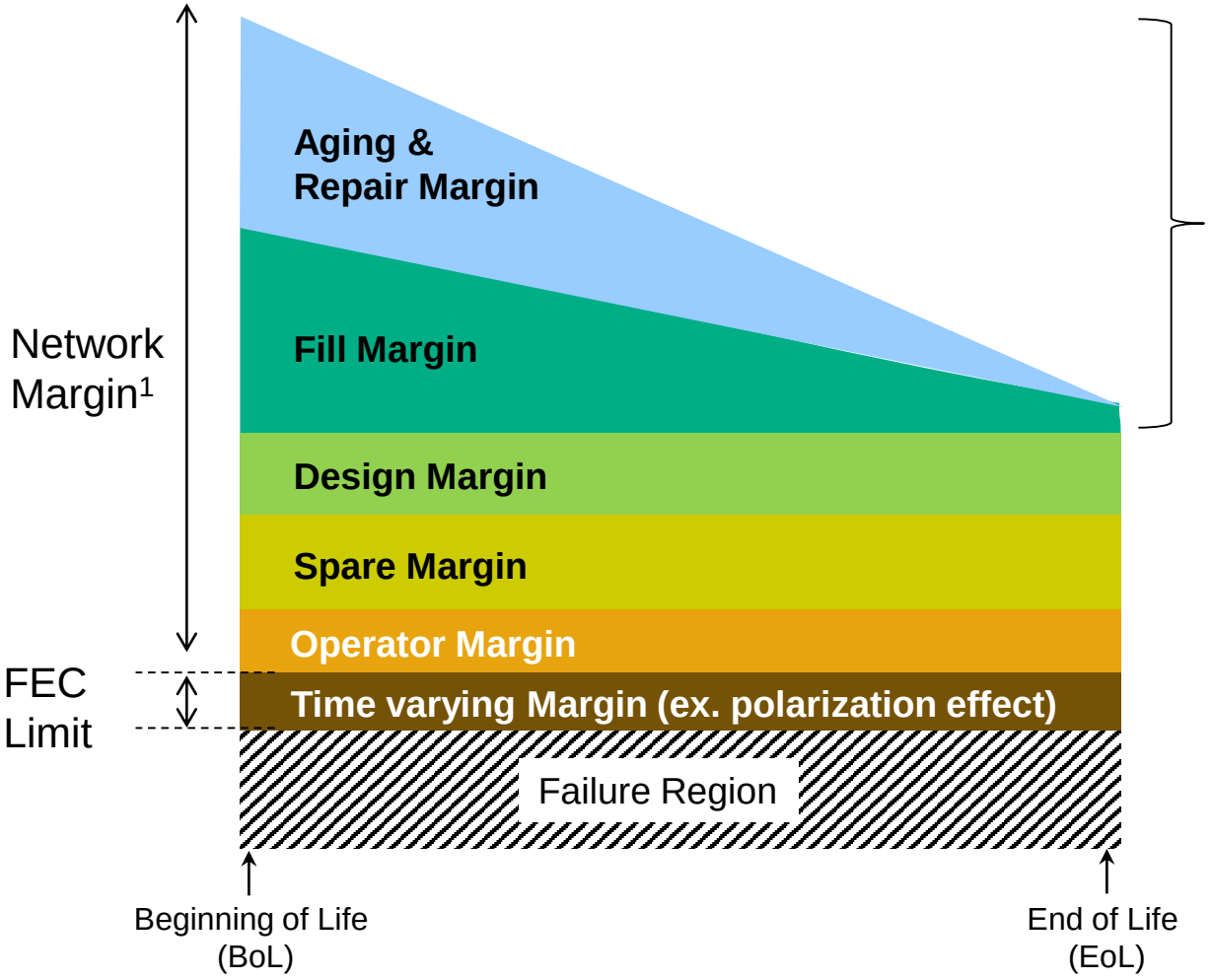
- Comprehensive signal monitoring for real-time network performance visibility enabling data driven decisions



Fully Flexible Photonic Layer



System Margin – “Liquid” variable in optical networks



Additional margin available fully or in part for short to mid-term applications (days, months, or years)

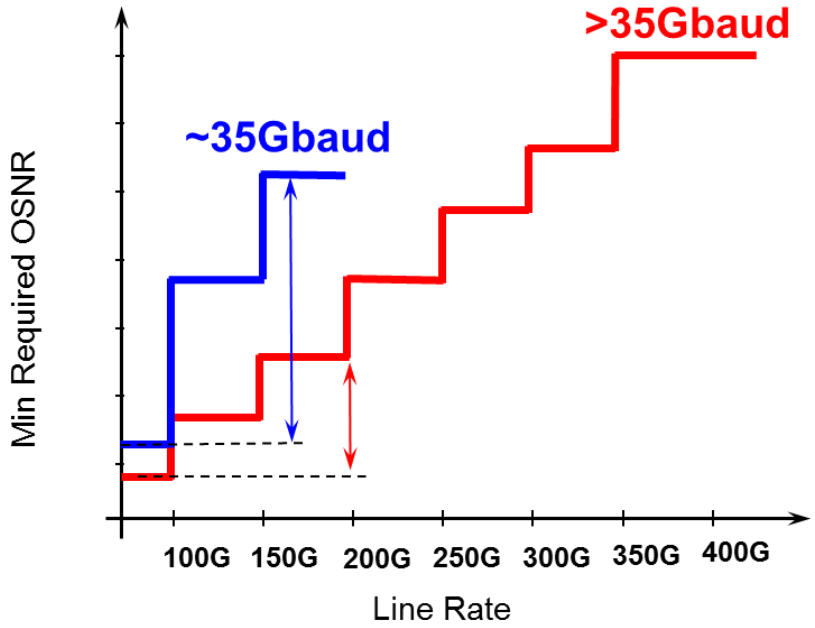
Unrecognized margin resulting from errors in offline design parameter estimation (**△planned vs. real values)**

Available margin not fully utilized by modems
(optimized with FlexRate Txpndrs)

1. Inspired from “*Design of low-margin optical networks”,* Y. Pointurier, JOCN, 2016.

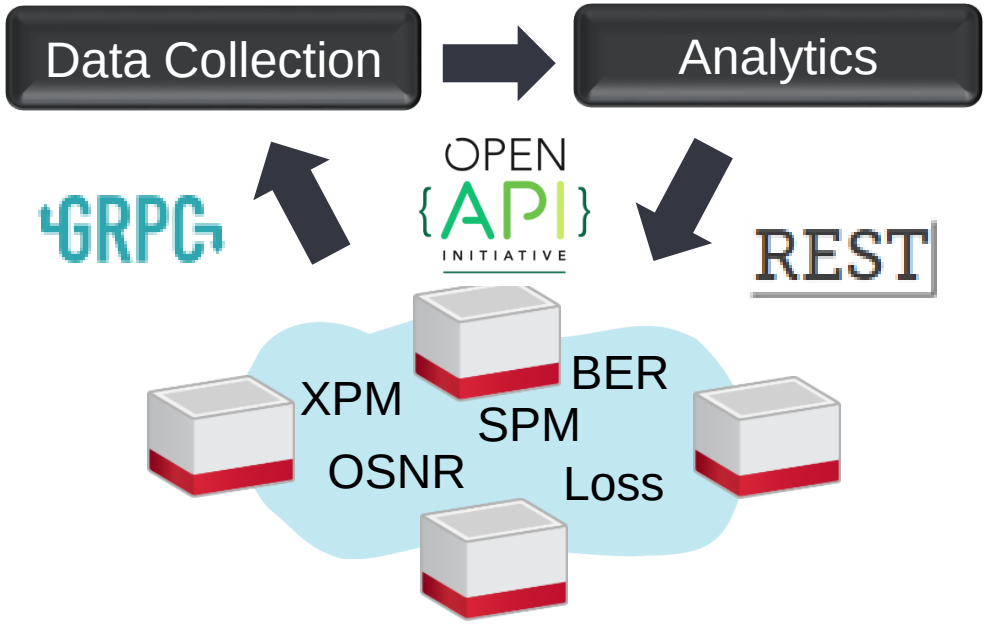
Enablers in optimizing capacity for available SNR margin

Programmable coherent modems



Finer granularity of line rate speeds leads to better utilization of the available margin in the network

Real-time access to network data

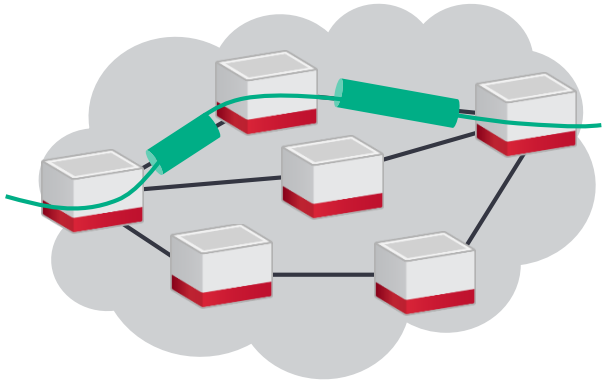


Network programmability and automation requires instrumented hardware and Open APIs

Examples of SDN Applications: Changing how Optical Networks are managed

Channel Margin Gauge

Today's PMO



SNR?

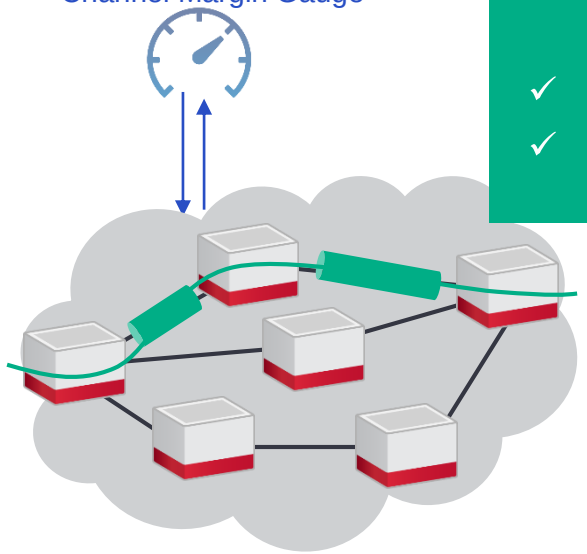
Consequences:

- Conservative margin, hardware at suboptimal capacity

Channel Margin Gauge

OPEN {API}

Channel Margin Gauge



Performance Meter provides:

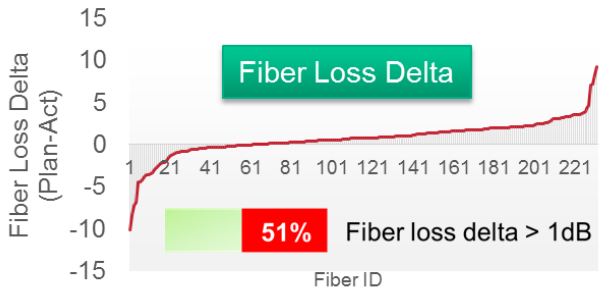
- ✓ performance SNR for a single channel
- ✓ for all channels on a path
- ✓ or for all channels in the network

Proactively ensure optimal network performance

Planning Tool Calibrator

Today's PMO

- Link engineering based on best-guess fiber data

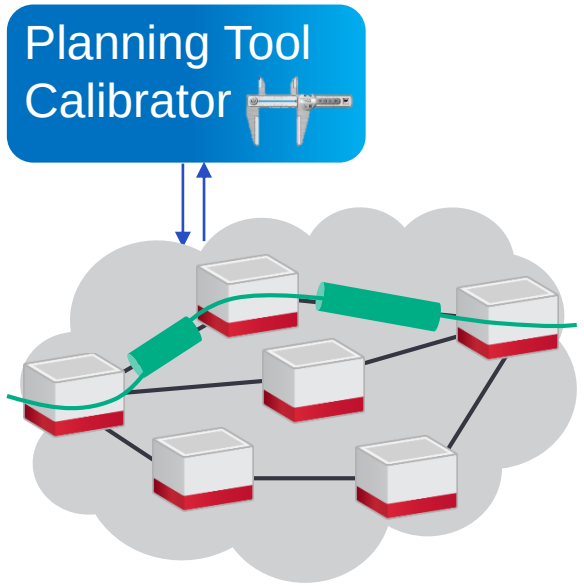


Consequences:

- Incorrect calculations, hardware at suboptimal capacity

Planning Tool Calibrator

OPEN {API}



Planning Tool Calibrator:

✓ Captures actual network loss data.

Ensure optimal network performance

Bandwidth Optimizer

Today's PMO

- Need 400G capacity from points A-Z

Planning tool

"Will 100G wave work?" "Pass"
"Will 200G wave work?" "Fail"

Where to place on spectrum? 150G?

Consequences:
- Lengthy, complex manual engineering process

Bandwidth Optimizer

OPEN {API}

- Need 400G capacity from points A-Z

Bandwidth Optimizer

"Need 400G from A-Z"

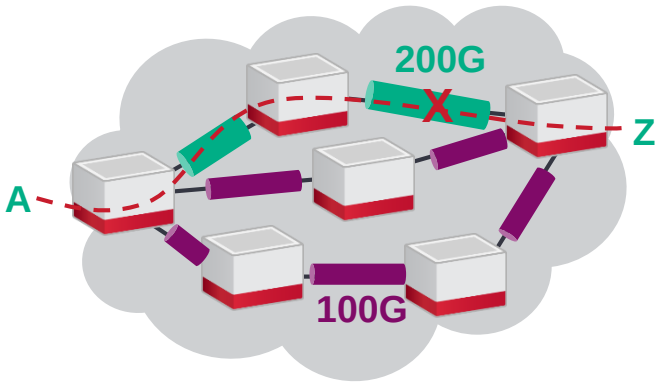
"Based on service policy, 2 x 200G optimal"
"Recommended placement is xx THz"
"This is what you need to order"

Simpler/accelerated turn-up, quickly respond to new service demands using existing network resources

Liquid Restoration

Today's PMO

Exact match restoration



Consequences:

- Traffic loss if full capacity cannot be restored

Liquid Restoration

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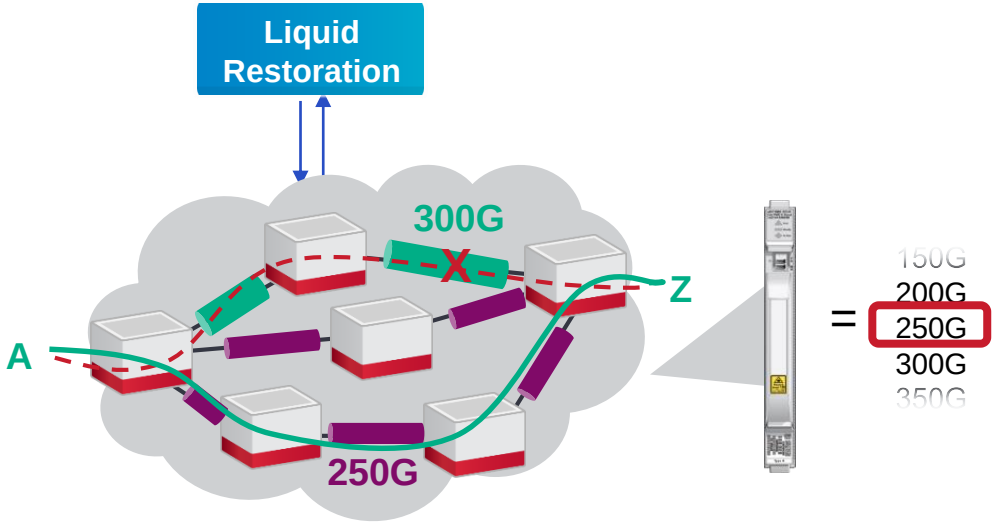

Uses available network resources to increase service availability

Experience. Outcomes.