ENABLING AUTOMATION IN SOFTWARE DEFINED NETWORKS

Domenico di Mola, Gert Grammel, Puneet Jain, Kieran Dalton

Juniper Networks

LEGAL STATEMENT

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AGENDA

- SDN TRANFORMATION FOR AUTONOMOUS NETWORK
- OPENESS, AUTOMATION AND SIMPLIFICATION OF SDN CONTROLLER
- EXAMPLE OF PRACTICAL IMPLEMENTATIONS IN MULTI-LAYER SDN CONTROLLER
- INTEGRATION OPPORTUNITIES IN NEXT GENERATION MULTI-LAYER SDN CONTROLLER
- KEY NOTES FOR ONOS COMMUNITY

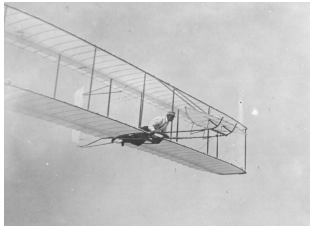
SDN TRANFORMATION FOR AUTONOMOUS NETWORK

AUTONOMOUS NETWORK

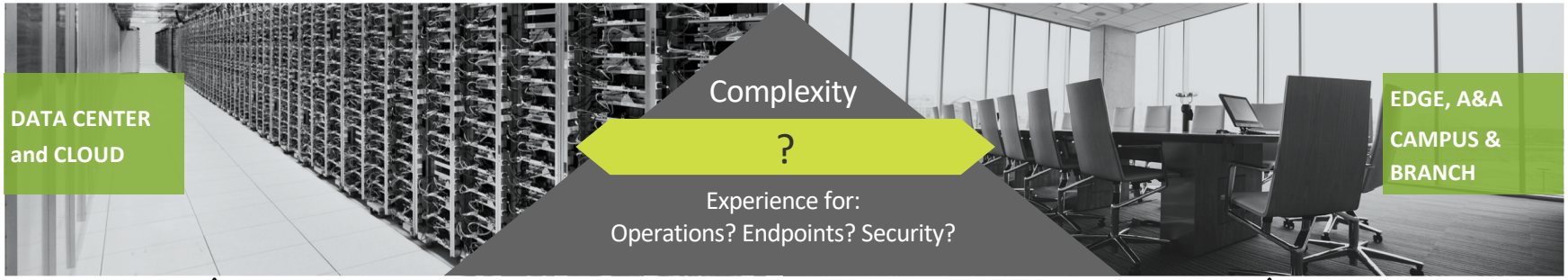
THE JOURNEY TO AUTOMATIC NETWORK?

TODAY

MANUAL OPERATION	OPERATION MONITORING	AUTOMATED NETWORK	SELF CONFIGURING DRIVING, HEALING	AUTOMATIC
SNMP COLLECTOR	HEALTH MONITORING	TELEMETRY STREAMS	SLA MONITORING	CLOSED LOOP AUTOMATION
CLI COMMAND	CAPACITY PLANNING	ANALYTIC ANOMALY DETECTION	PROACTIVE TASKING	INTENT BASED OPERATION



HOW DOES AUTOMATION MAKE DIFFERENCES?



Consistent workload

Controlled Environment

Known Connectivity

PREDICTABLE & UNIFORM

UNPREDICTABLE & VARIABLE

Heterogenous Device & Service

Uncontrolled Environment

Hybrid Connectivity

SEE

KNOW

DO

TRANSFORMATION IN AUTONOMOUS-SDN

THE AUTOMATIC NETWORK PARADIGM

SEE

- ❑ Collect data
- ❑ Structure, optimize and filter
- ❑ Analyze and visualize data

KNOW

- ❑ Processing and data science
- ❑ Machine learning and deep learning
- ❑ Identify and signal problems or patterns

DO

- ❑ Automate response/decisions
- ❑ Automatically regulate & remediate
- ❑ Raise actionable insights and predictions

ABSTRACTED VIEW

- ❑ SDN management of a fleet (not device)
- ❑ Standardized telemetry and analytics
- ❑ Cloud is for storage and AI compute

INSIGHTS and AI-DRIVEN EXPERIENCE

- ❑ Machine base operation framework
- ❑ Automate API for apps integration
- ❑ AI virtual assistants facilitate workflows

AUTOMATED WORKFLOWS

- ❑ Elevate ops and user experience
- ❑ Automatic troubleshooting and regulation
- ❑ Correlate, predict and identify patterns

OPENNESS, AUTOMATION, SIMPLIFICATION OF SDN CONTROLLER

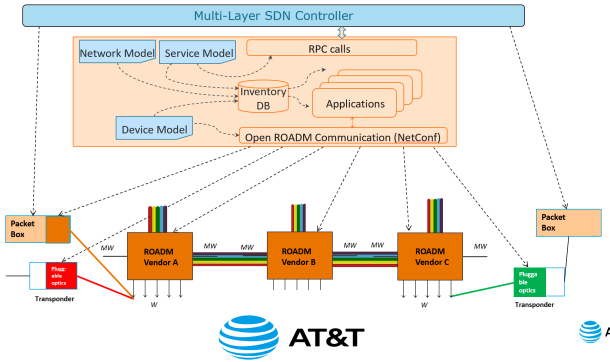
AUTOMATION FOR AUTONOMOUS-SDN

From building better networks…

…to making networking better.

OFC-2019 SERVICE PROVIDER PANEL ON MULTI-LAYER SDN

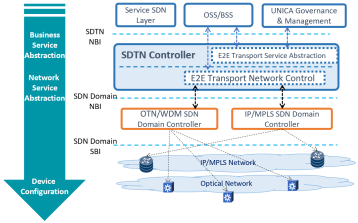
YANG Model Based Open ROADM Controller



Network Abstraction: A layered vision of transport network services and resources

Goals of the SDTN reference model

- To allow **independent network evolution** from the systems development life-cycles.
- To **simplify network and systems' integration** through standard interface models, thus reducing the costs.
- To **reduce network services provisioning complexity in OSSs** by providing abstracted service interface models.



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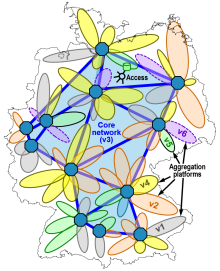
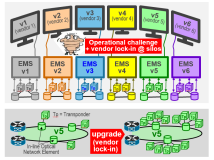
Current Vendor Silos in DT's Optical Transport Network





DT's Optical Transport Network (OTN) today:

- **Core (IP2), Aggregation (e.g. horseshoes), access.**
- **Parallel vendor silos.** Everything (HW, SW, EMS/GUI) is provided by the same vendor within a silo.

+ Common practice, clear responsibilities.
- **Operational challenge:** Many EMSs/GUIs, barrier for new vendors and technologies, cumbersome link control across domains.
- **Vendor lock-in** → high costs, delivery risks, innovation speed (e.g. for transponders) restricted by the vendor.

→ Need to get rid of these shortcomings!

Solution approach:

- **Disaggregation,**
- **Modular Building Blocks Enabling Flexible Architectures.**

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OPEN

- ❑ Common API
- ❑ Open source and ecosystem
- ❑ Multi-vendors (no lock-in)
- ❑ Interoperability (no silos)

AUTOMATED

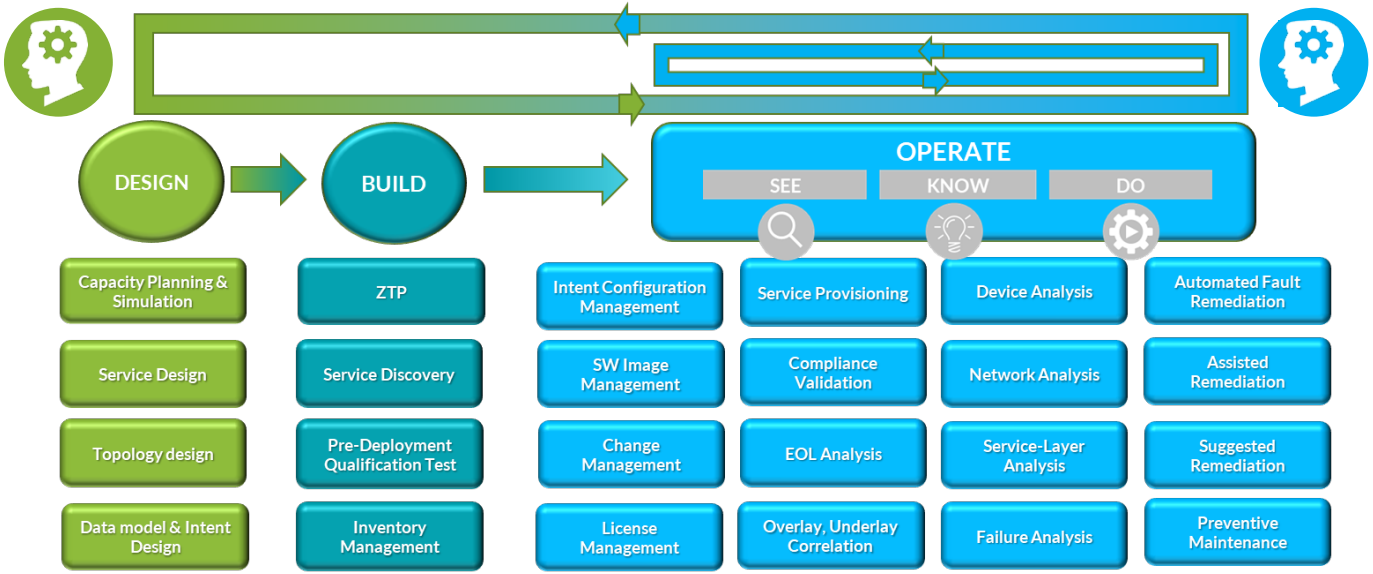
- ❑ Service abstraction modelling
- ❑ Integrated policy
- ❑ Integrated telemetry and monitoring

SIMPLE

- ❑ Intent base workflow
- ❑ Cloud enabled infrastructure (IaaS)
- ❑ Service is yet another software (SaaS)
- ❑ API based on boarding of 3rd party

NETWORK OPERATION FRAMEWORK

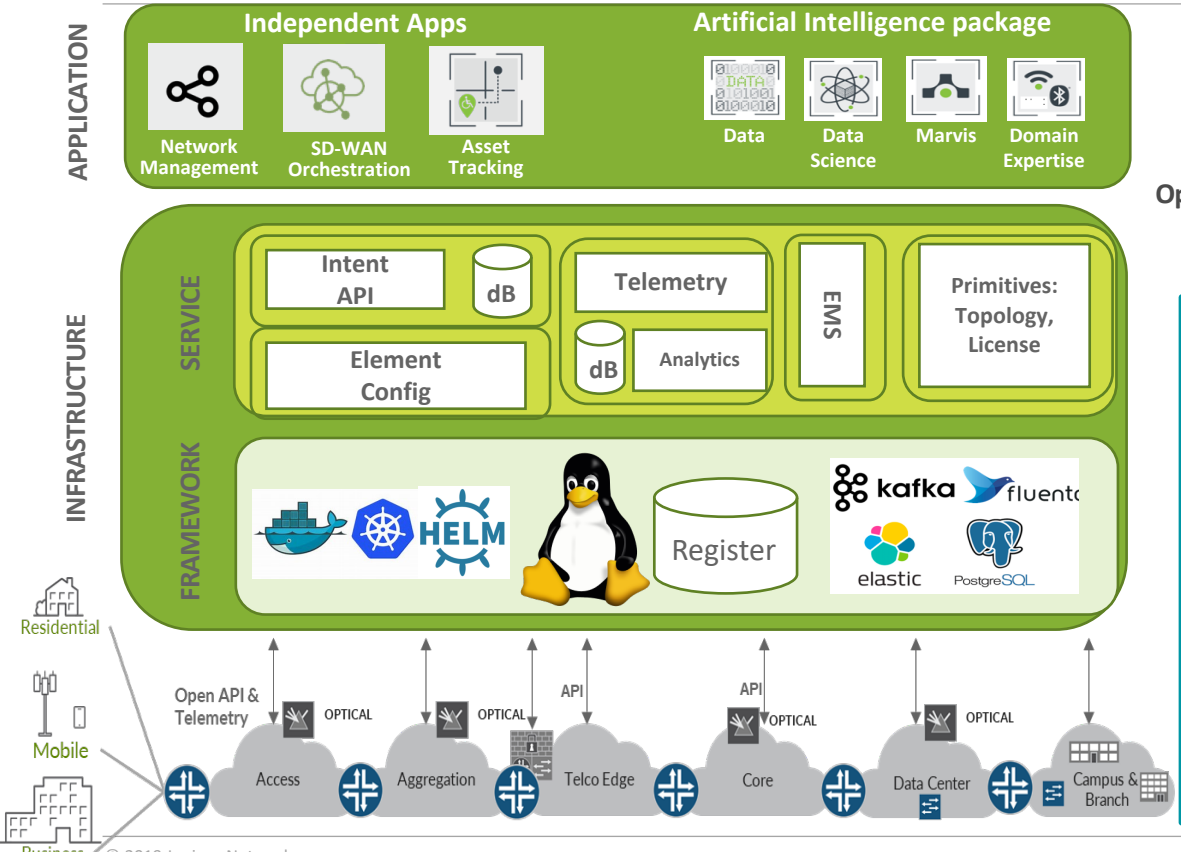
"AUTOMATED" & "AUTOMATIC"

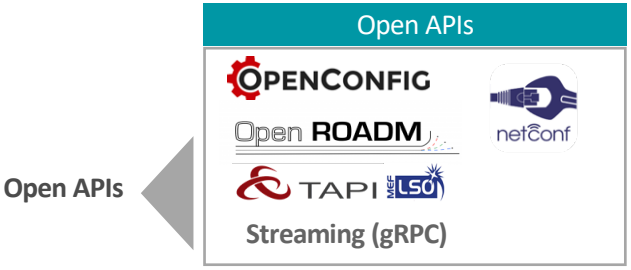


- ❑ Continuous Integration-Delivery
- ❑ Plan for availability (not 100%)
- ❑ Design and Build for automatic control
- ❑ Back-off of not working service/apps

- ❑ Integrated DevOps
- ❑ Measure and Control budget error (%)
- ❑ Execute in automatic workflow
- ❑ Focus on Mean Time to Repair

MODERN CLOUD BASED SDN ARCHITECTURE





Open Source common framework (Infra-aaS)

- ❑ Kubernetes Orchestration for cloud service
- ❑ Scale out for multi-tenant solution
- ❑ HA and resiliency
- ❑ Life cycle management of apps and services

Scalable and flexible services/apps toolbox

- ❑ Intent to configuration (HOW not WHAT)
- ❑ Telemetry into the network
- ❑ Analytics to identify deviation.
- ❑ Automation for closed loop reconciliation.

EXAMPLE OF PRACTICAL IMPLEMENTATIONS IN MULTI-LAYER SDN CONTROLLER

WHY SIMPLIFICATION?

"Automation applied to an inefficient operation will **magnify the inefficiency**

Automation applied to an efficient operation will **magnify the efficiency**

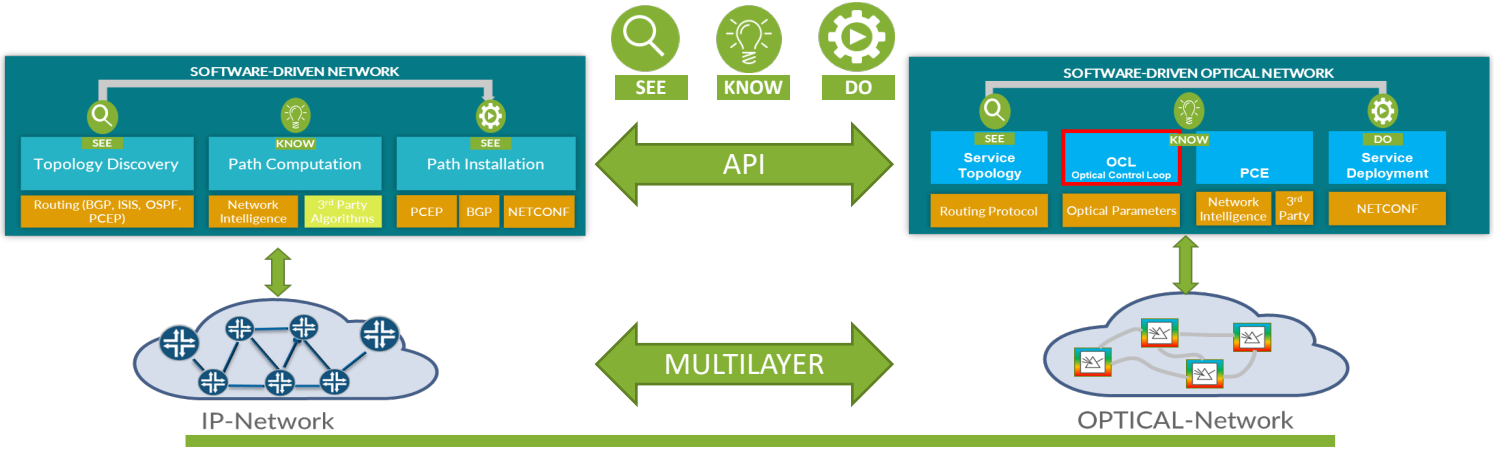
Bill Gates

Simplicity is the **ultimate sophistication**

Leonardo Da Vinci"

Simplify FIRST → THEN Automate

IP-OPTICAL SDN CONTROLLER
MULTI-LAYER SOLUTION FOR AUTOMATIC NETWORK

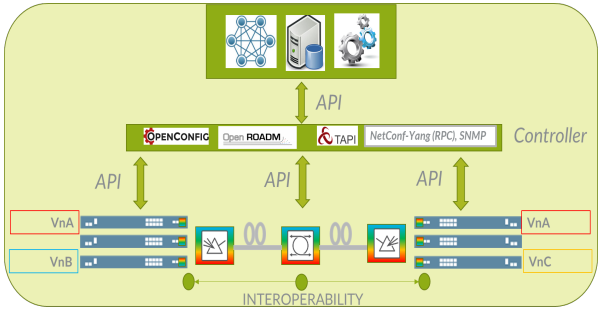


- Microservices and API architecture
- Real time multi-layer TE networking controller
- <What> <If> scenario analysis
  - IP/MPLS network simulation and optimization
  - Optical Abstract Link exchange for multi-layer use cases
  - Optical network simulation and optimization (see TIP-PSE)
- **Real Time Optical Control Loop (OCL)**
  - **Optical Analog Control Loop and parameters with real time telemetry stream**

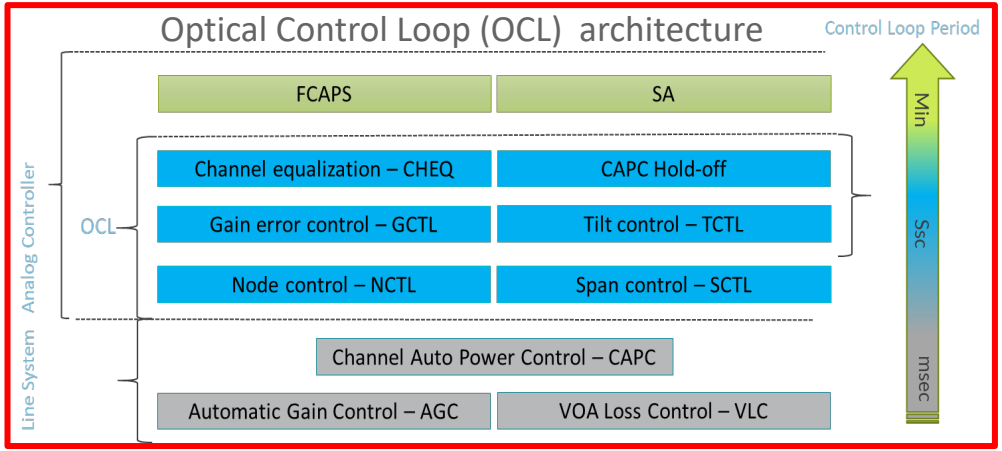
FOCUS ON OPTICAL AUTOMATION

OCL SERVICE FOR AUTOMATIC OPEN-OLS CONTROL PLANE

OPEN & DISAGGREGATED OPERATIONAL AGILITY



- ❑ BEST TRADE-OFF COST & PERFORMACE
- ❑ SELECT THE BEST SUPPLIERS
- ❑ AUTOMATION AND SIMPLIFICATION
- ❑ UNIFIED OPEN-NBI API



- ❑ Stateless representation of network topology (each nodes/elements)
- ❑ API/RPC messaging for real time communication/telemetry
- ❑ Virtualization of optical functionalities at device/element (vendor agnostic)

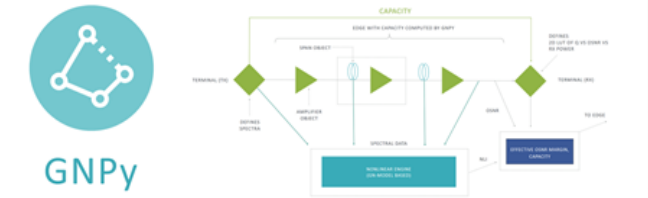
INTEGRATION OPPORTUNITIES IN NEXT GENERATION MULTI-LAYER SDN CONTROLLER

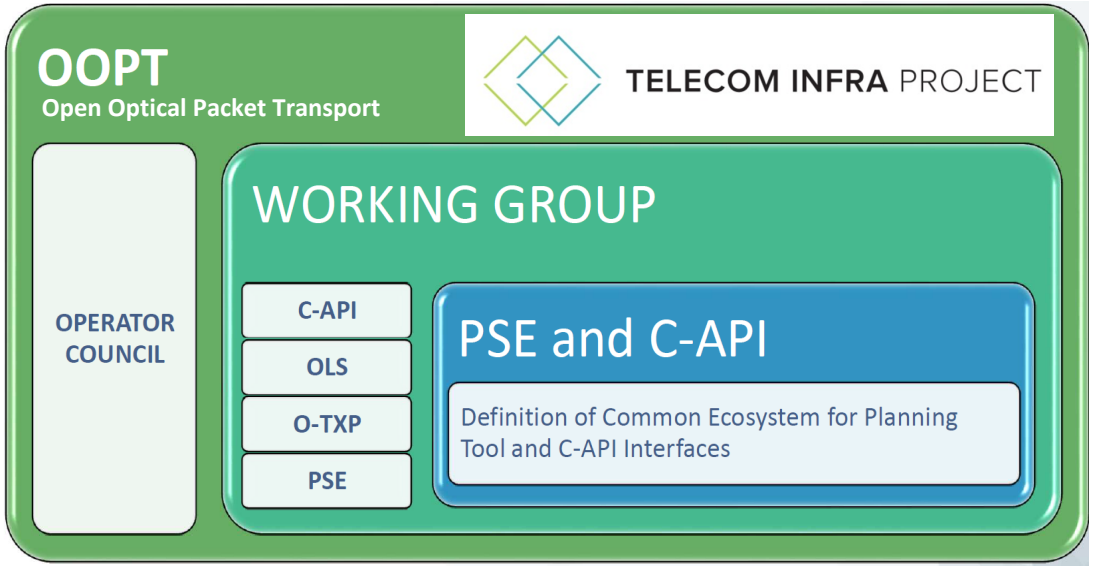
TELECOM INFRA PROJECT (TIP-OOPT-PSE)

THE ISSUE WITH PROPRIETARY OPTICAL PLANNING-SIMULATION TOOLS

Problem Statements of PSE (Physical Simulation Environment)

- Lack of standard definition of optical parameters (transfer functions)
  - Definition of data-model
- Lack of common validation algorithms
- Vendor agnostic HW

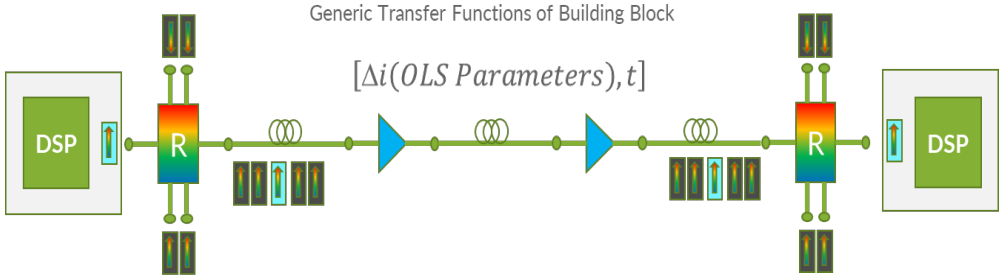




- **GNPy**, a "**G**aussian **N**oise Model in **Py**thon" as vendor-independent Optical Simulation Engine
- Define the network models of the optical device transfer function parameters.
- Enable a Multi-Vendors and Open Source solution

AUTOMATING DESIGN & OPTIMIZATION WORKFLOW

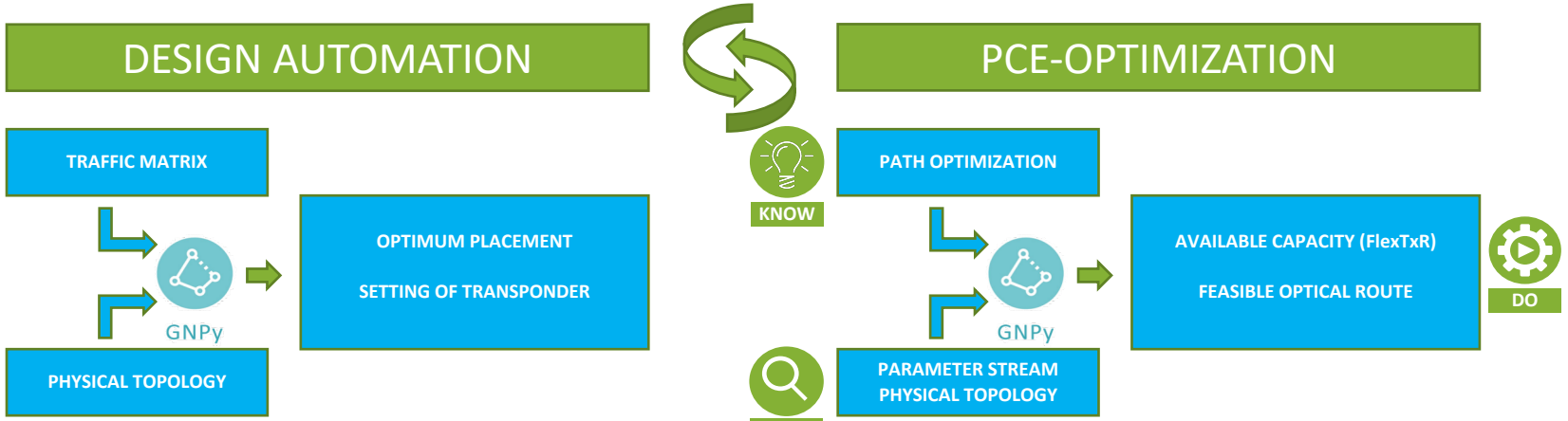
GNPY OPTICAL SIMULATOR USE CASES



$\overline{O}(BER(FEC), Pout, OSNR, DSP, \ldots) = [\Delta(OLS\ Parameters), t]\ \overline{I}(BER(FEC), Pin, OSNR, DSP \ldots)$

$[\Delta(OLS\ Parameters), t] = \Pi i[\Delta i(OLS\ Parameters), t]$

- Wavelength Service Performances
  - capacity, bandwidth, can programmed via DSP
- Wavelength Service SNR
  - It's function of Nodes and Link OLS parameters and time (aging, failures)
- A global Transfer function
  - It can provide an analytic representation between In and Out of Wavelength Service



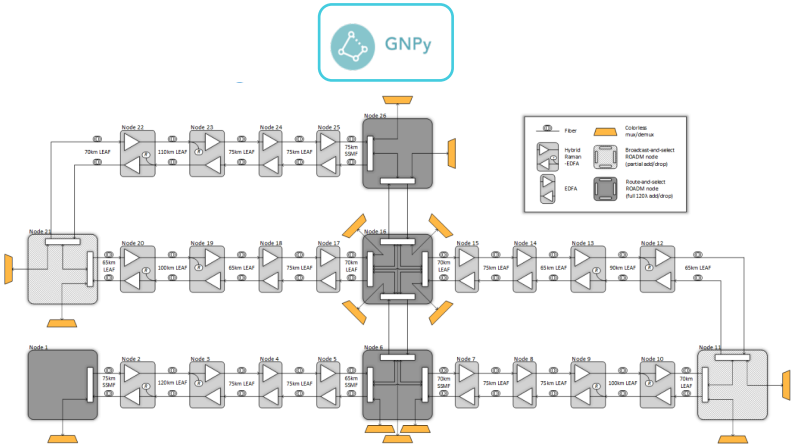
GNPY VALIDATION OF MODEL ACCURACY

4 locations: Orange, fb, Microsoft, UTD

Multi-Vendor lab trials : Arista, Cisco, Ciena, Infinera, Juniper, Nokia, Acacia, Coriant, 4 unique chipsets, focus on 8QAM

"Multi-Vendor Experimental Validation of an Open Source QoT Estimator for Optical Networks," J. Lightwave Technol. 36, 3073-3082 (2018).

M. Filer[(1)], M. Cantono[(2)], A. Ferrari[(2)], G. Grammel[(3)], G. Galimberti[(4)], and V. Curri[(2)], [(1)]Microsoft, [(2)]Politecnico di Milano, [(3)]Juniper, [(4)]Cisco

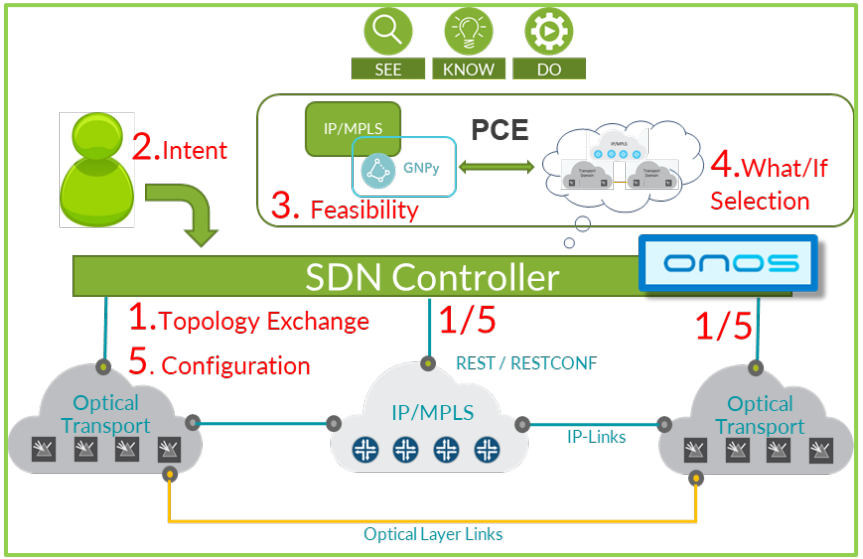


KEY NOTES FOR ONOS COMMUNITY

Key Notes

What's next for the ONOS Community?

- Service provider have identified gaps in current solutions:
  1. Optical SDN Controller automation
     - Optical controllers should act in a see-know-do model to provide dynamic control
     - This requires closed loop control – based on measured data
  2. Open Multi-Layer Planner-Optimization
     - GNPy is a candidate for this.
     - Open Source community developed simulator for design and planning



Thank You

Follow Up Links:

https://telecominfraproject.com/
https://github.com/Telecominfraproject/oopt-gnpy
https://www.slideshare.net/MarkFiler/ecoc-2018-market-focus-opensource-optical-transmission-performance-estimator-for-disaggregated-and-open-optical-networks
https://www.slideshare.net/domenico966/mwc-2017-ooptpseddmjuniper1709-80235583?qid=1ff1eac1-018c-409d-9e1a-60b76314130a&v=&b=&from_search=2
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