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Microservice Controller platform for Open Disaggregated Transport Networks

Designing the next generation Open Optical Network

TNC'2018 Workshop organized by GN4-2 JRA1-T1

- June 10th 2018 at Trondheim – Norway
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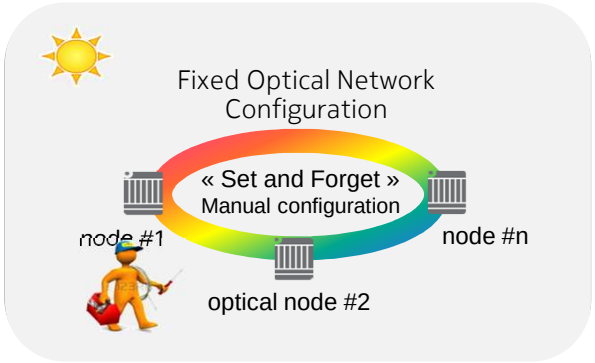
Content

- Towards Software Defined Media Channels …
- Within Open Disaggregated Transport Network
- Why to control Optical Channel configuration dynamically
- Spectrum Grid Defragmentation as SDN application
- Defragmentation network function performance
- Microservice Network Controller software architecture and implementation
- NOKIA Bell Labs Publication References

Towards Software Defined Optical Channels on-demand

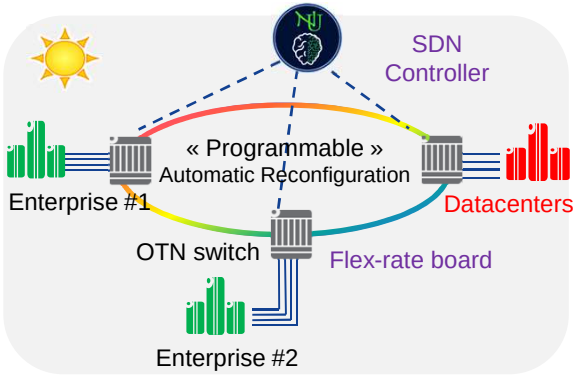
Media Channel + OTSi will be configured per Datacenter applications when used

TODAY



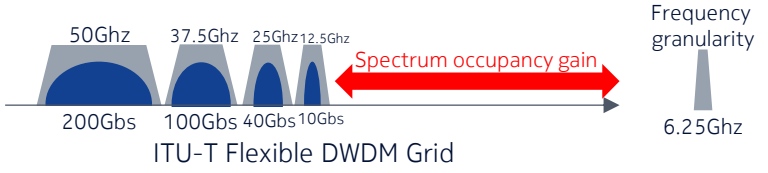
VS.

COMING SOLUTIONS



Optical channel configuration never changed
Guaranteed setting with large margins
Deployment of services in months
Single Vendor Optical Systems

Define/try and continuously adjust configuration
Setting with just-required performance
Fast delivery of optical channels on application demand
Multi Vendor Optical Systems



ODTN: Open & Disaggregated Transport Network

(an ONF Project)

https://www.opennetworking.org/solutions/odtn/

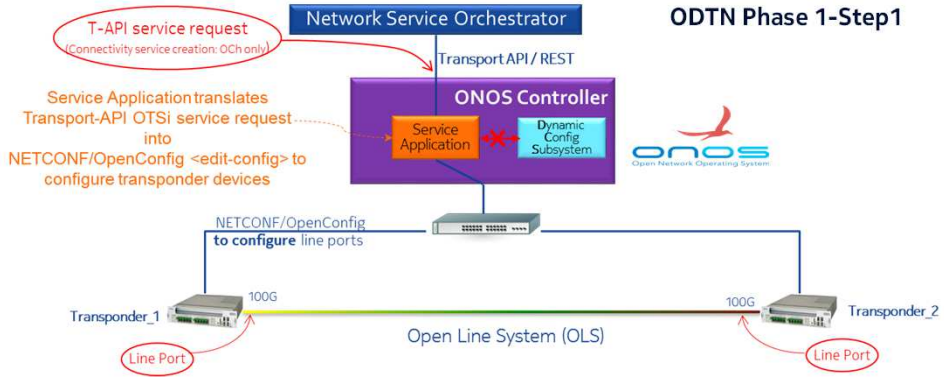
ODTN Project Wiki Home:
https://wiki.onosproject.org/display/ODTN/ODTN

Future Transport Network reference implementation using:

- Open source Resource Controller**: ONOS**
- Open source data model: **Transport API, OpenConfig**
- Open/Disaggregated switching devices from vendors
- Deliverables:
  (i) Pt-to-pt Open Line System (**Q3-2018**),
  (ii) Meshed ROADM Network. (**Q1-2019**),
  (iii) Disaggregated ROADM Network. (**Q2-2019**)

Participants involved in Phase1-Step1:

Telefónica, NTT Communications, CTTC, COMCAST, China Unicom, TIM, NOKIA, NEC, infinera, OPLINK, ZTE



ODTN Challenges & Milestones: Demonstration of end-to-end Open Configuration and Operation control

Phase1: Point-to-Point — Transponder scenario (*Step 1*) → Open Line System scenario (*Step 2*)

Phase2: Mesh ROADM network — single vendor Optical System devices (*Step 1*)

Phase3: Disaggregated ROADM network — multi-vendor Optical devices (*Step 2*)

Jan 2018 — Apr 2018 — Aug 2018 — Dec 2018 — Mar 2019 — Jun 2019

Field trials at Operator Labs

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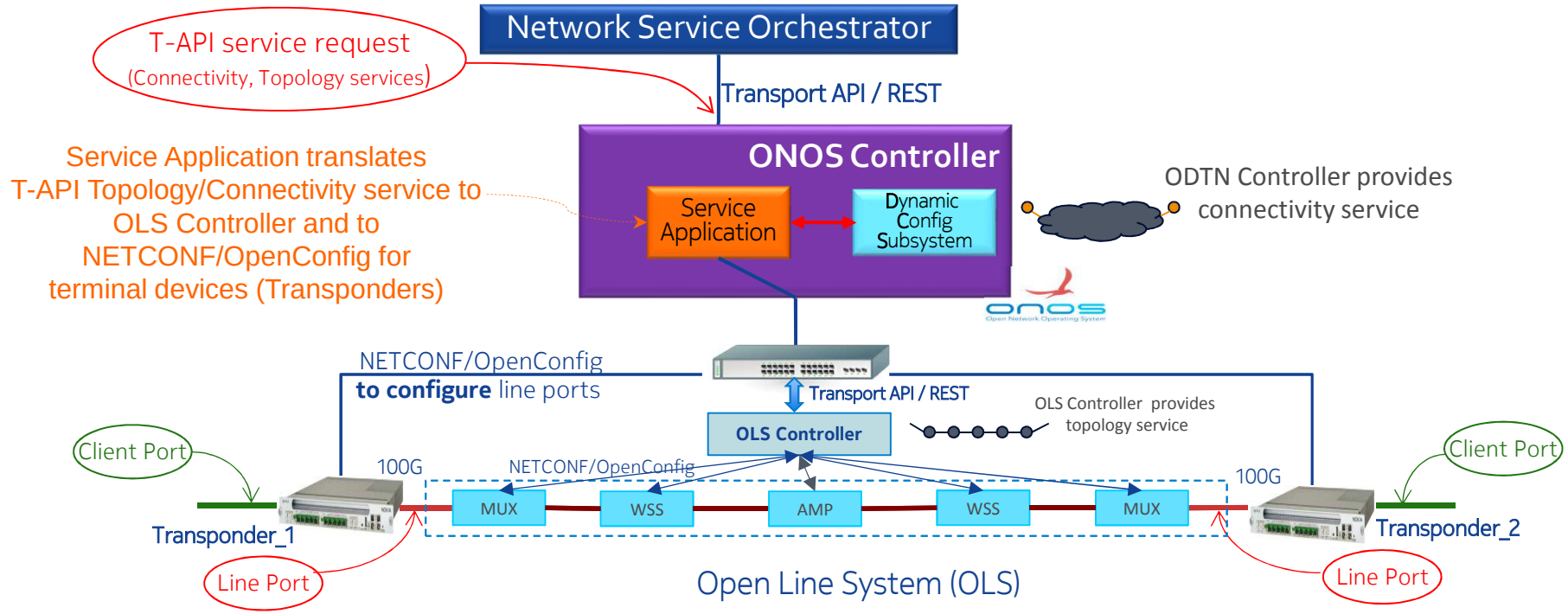
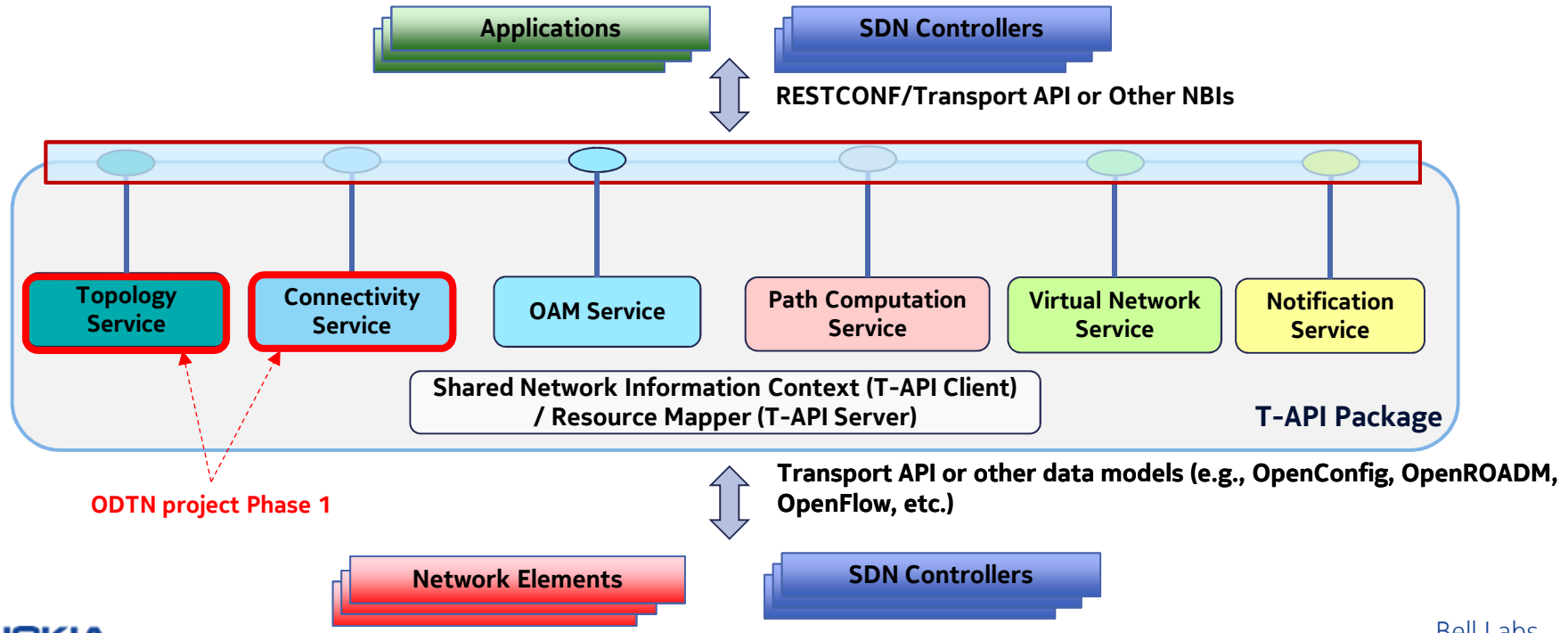
ONOS Service Application development – Phase 1 / Step 2
Integration and 2nd lab demonstration targeted on August 2018



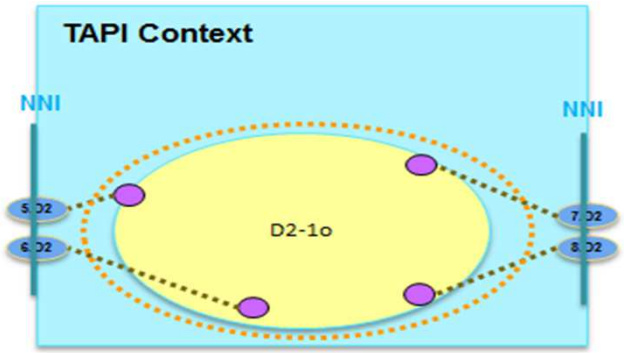
Open Networking Foundation - Transport API Functional architecture

T-API 2.1 data model embracing optical channel services

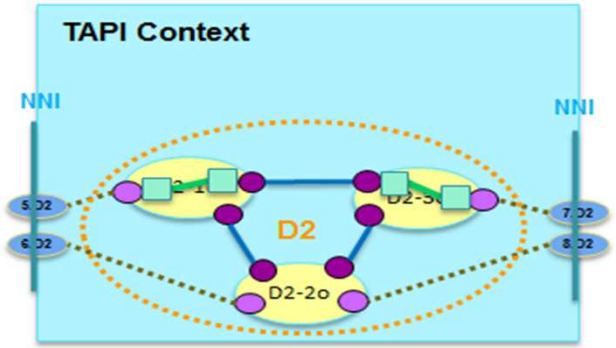


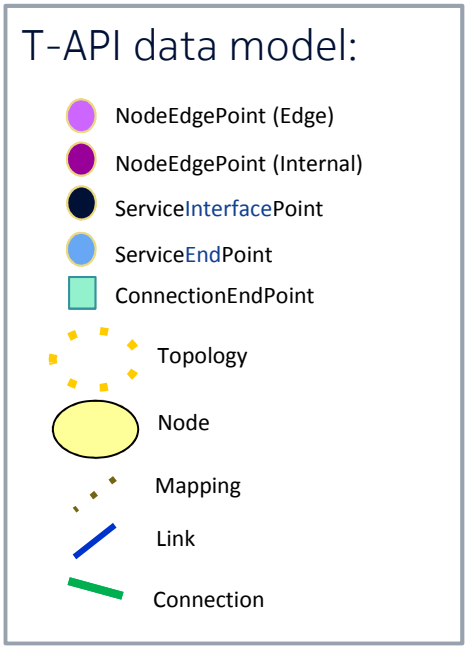
ODTN use cases involving Open Line System Topology Service

- OTSi network service topology exposed by Open Line System Controller
  - Option B1: Node topology abstraction:



  - Option B2: Media Layer topology abstraction:

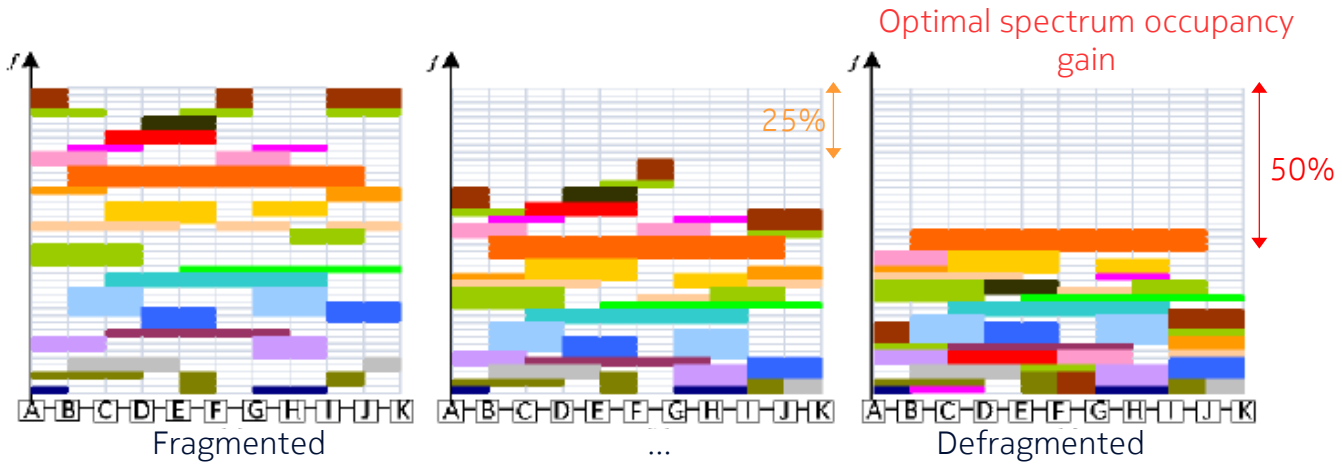




Needs to control Media Channels and Optical Tributary Signals

OTSi Assembly to be set per TAPI service requests

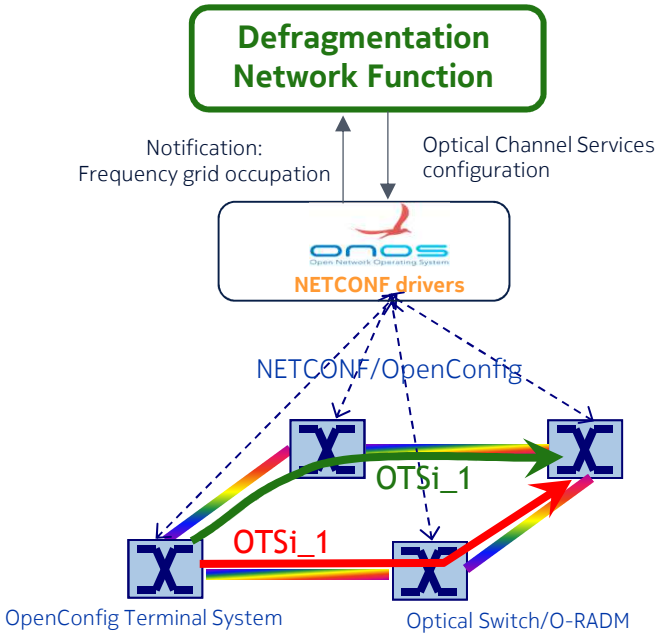
- Advanced Optical Systems configuration without connectivity service disruption
- Optical channels are set when Connectivity Services creation are requested
- Service constraints make DWDM Spectrum grid becomes fragmented
- Spectrum grid fragmentation leads to connectivity service rejections



Optical channel rerouting and migration as SDN applications
Defragmentation network functio

- **Defragmentation Network Function** selects a set of optical channels to be monitored then:
  - A new optical channel setting is computed
  - The decision to perform reconfiguration depends on spectrum occupancy gain → implemented as a rule

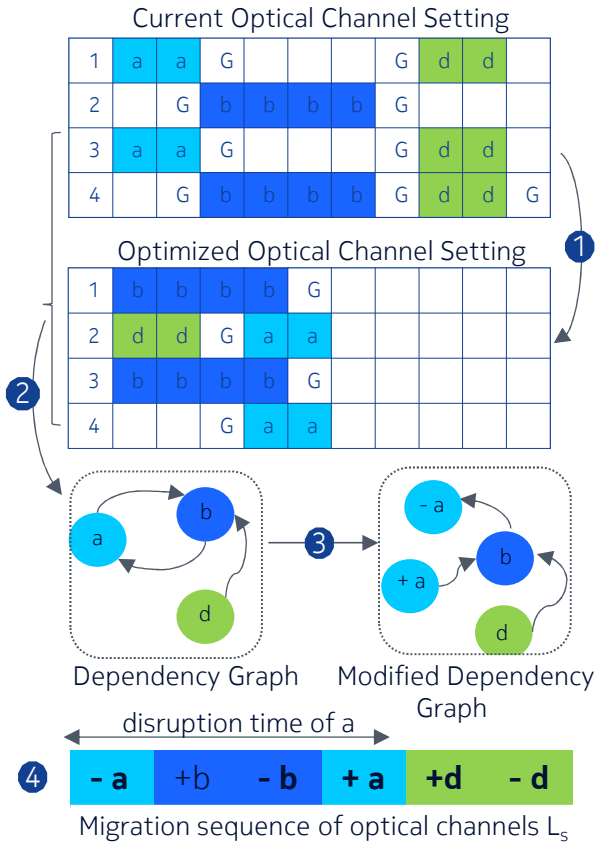
- **Defragmentation Network Function** computes a sequence of lightpath migration that minimizing the total connectivity service disruption time



Defragmentation network function optimally reconfigures Optical Channels (Media Channels, OTSi)

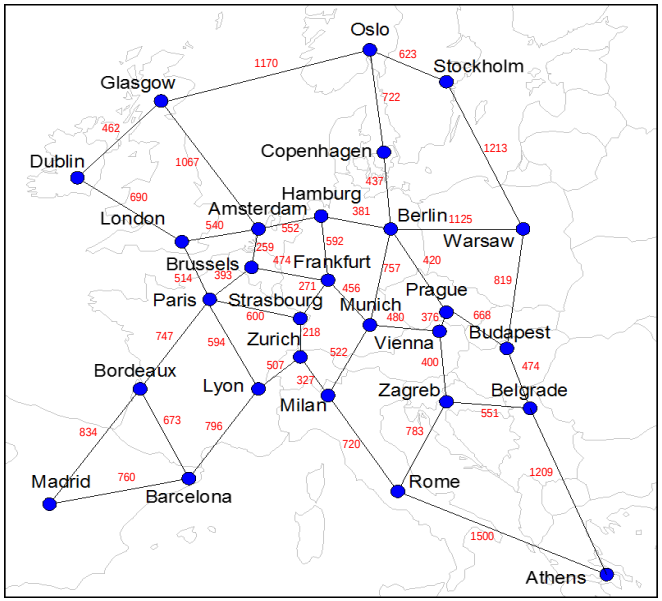
Workflow of Defragmentation Network Function

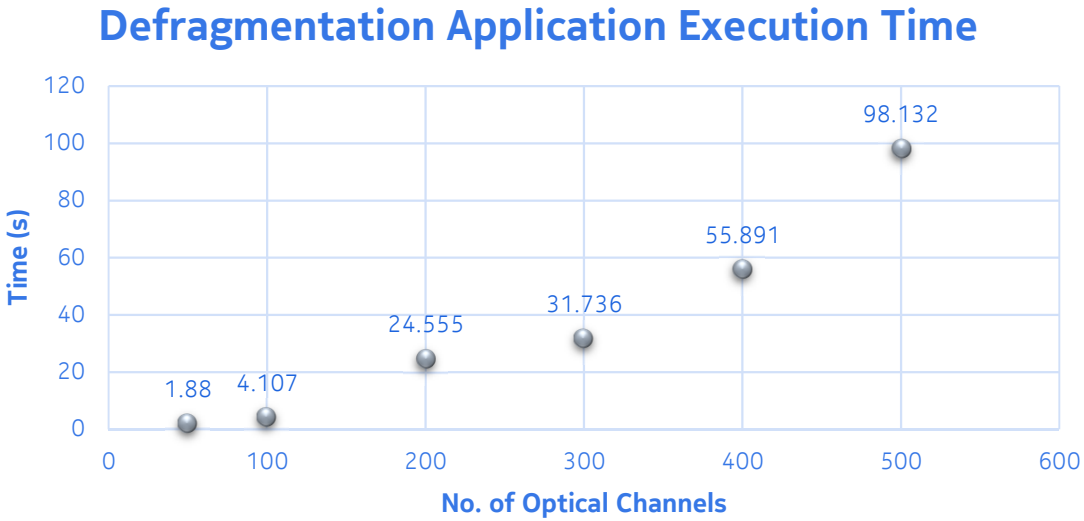
- **Defragmentation application** involves in two sets of algorithms:
  - **Spectrum occupancy gain**:
    1. compute the optimal spectral occupancy from the current optical channel setting
       - ➢ To minimize the spectrum occupancy on each optical link
       - ➢ To assess the spectrum occupancy gain on the network
  - **Optical channel migration**: is divided into 3 steps:
    2. Build Frequency Slot Dependency Graph of Optical Channels
    3. Apply **Minimum Feedback Vertex Set (MFVS) algorithm** to build a Modified Dependency Graph
    4. Apply **Machine Learning algorithm**: find the optical channel migration sequences with the shortest network disruption time



Defragmentation Network Function – Execution time

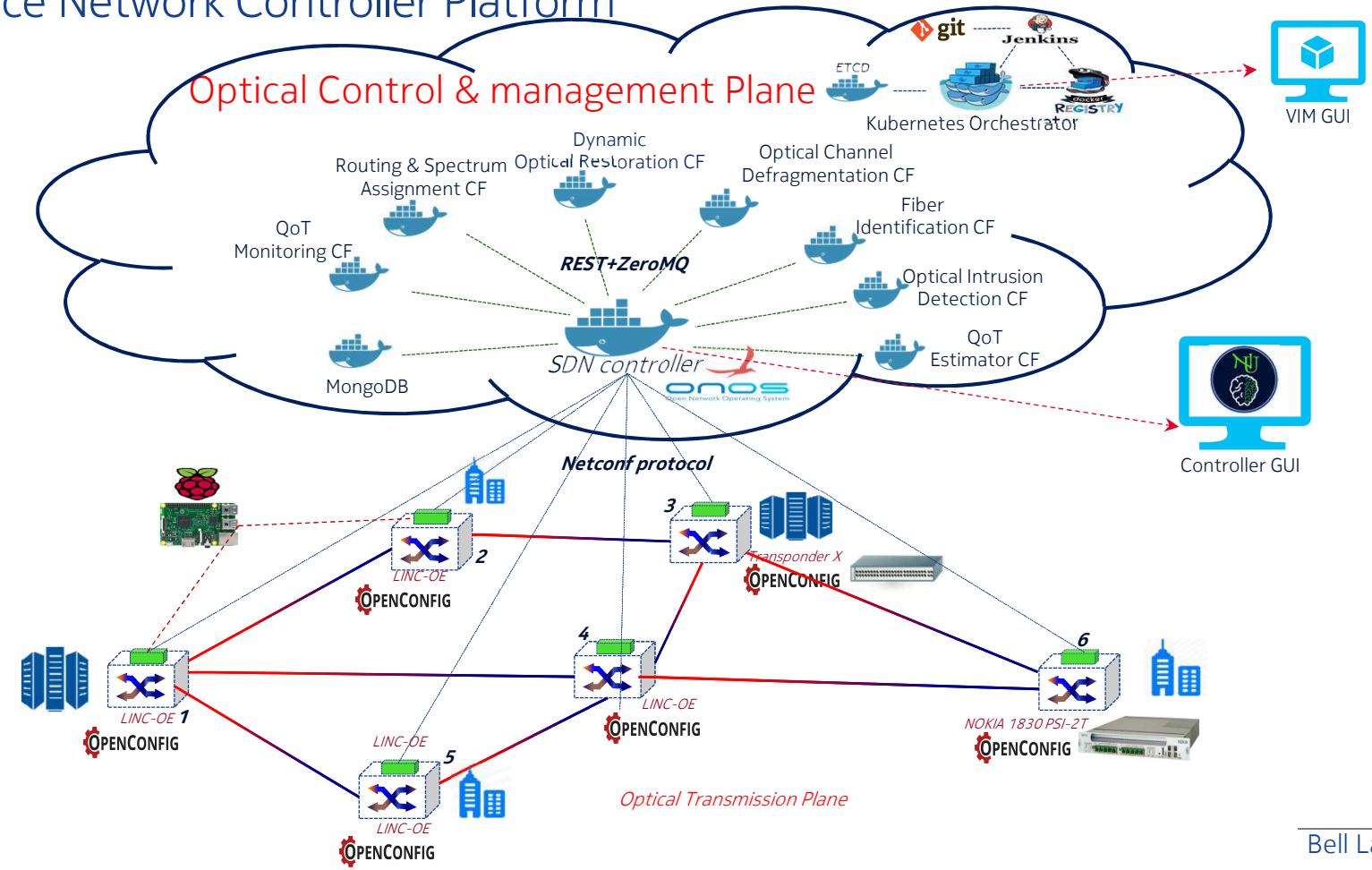
European Network topology: 28 nodes, 43 links



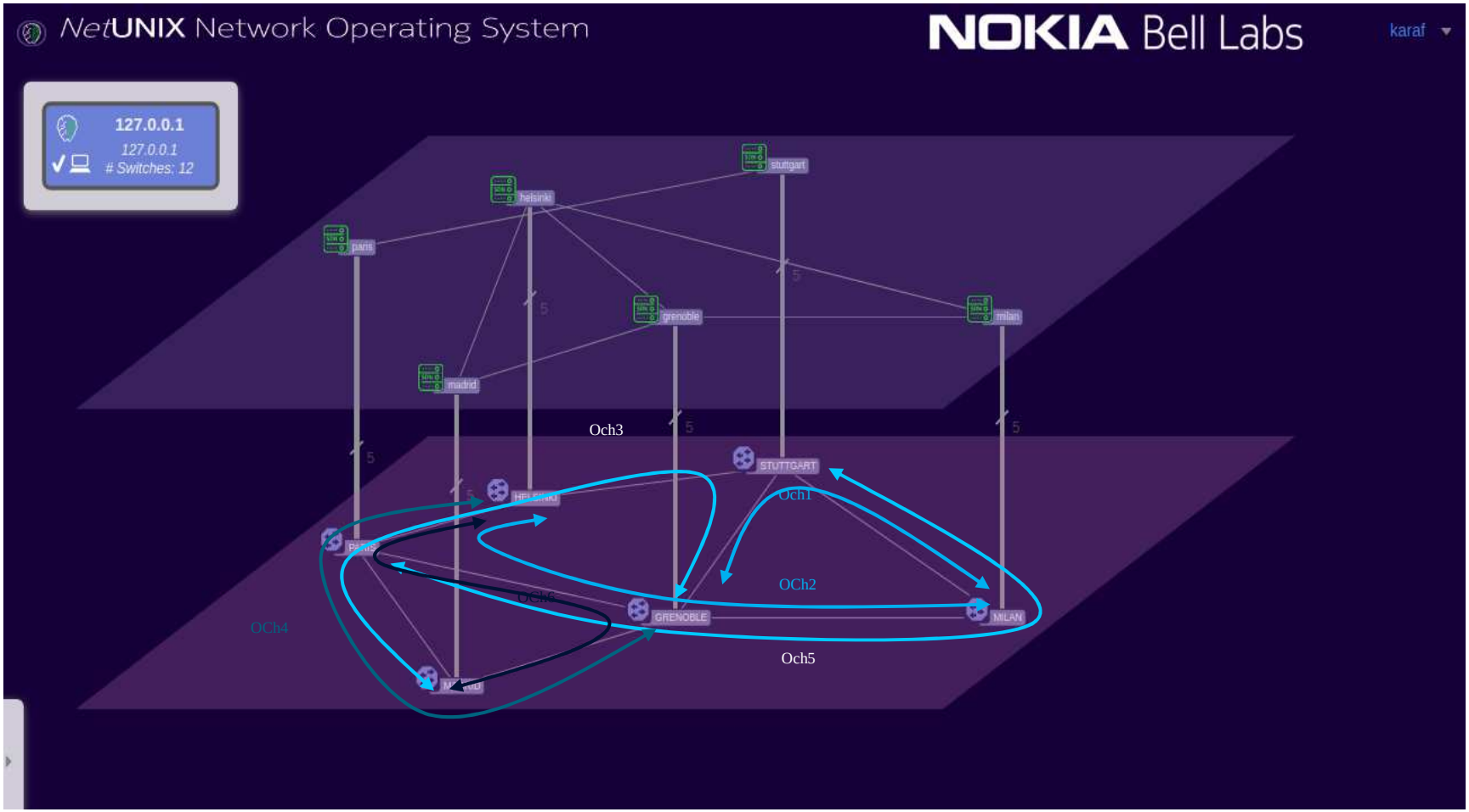


These measurements include the computation time of the optimal optical channel migration sequence.

Microservice Network Controller Platform



Controller GUI: Optical Channel Provisioning



Controller GUI: DWDM Frequency Grid allocation

Frequency Index (n) ITU-T Rec. G.694.1	PARIS - MADRID	GRENOBLE - STUTTGART	MADRID - GRENOBLE	GRENOBLE - MILAN	PARIS - GRENOBLE	HELSINKI - STUTTGART	PARIS - HELSINKI	STUTTGART - MILAN
0		1		2	2		2	1
1		1		2	2		2	1
2		1		2	2		2	1
3		1		2	2		2	1
4		1		2	2		2	1
5		1		2	2		2	1
6		1		2	2		2	1
7		1		2	2		2	1
8								
9	3	3		5	5	3	3	5
10	3	3		5	5	3	3	5
11	3	3		5	5	3	3	5
12	3	3		5	5	3	3	5
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14	3	3		5	5	3	3	5
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16	3	3		5	5	3	3	5
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18	4		4				4	
19	4		4				4	
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21	4		4				4	
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23	4		4				4	
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25	4		4				4	
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Bell Labs References

1. **M. Weldon et al.**, “The Future X Network: A Bell Labs Perspective,” ISBN 978-1498759267, CRC Press (2015).
2. **Q. Pham Van et al.**, “Virtualized routing and spectrum allocation function in Elastic Optical Networks,” ECOC, 2016
3. **M. Thottan et al.**, «Programmable Network Operating System: Creating the Network Brain», Keynotes Innovations in Clouds, Internet and Networks Conference, March 2017
4. **A. Dupas et al.**, “Bandwidth Variable Transmitter for Software Defined Networks” W1I.6 OFC’2017
5. **Q. Pham Van et al.**, «Container-based Microservices SDN Control Plane Framework for Future Optical Networks» iPoP 2018
6. **M. Dallaglio, Q. Pham Van et al.**, «Demonstration of a SDN-based Spectrum Monitoring of Elastic Optical Networks» OFC’2017 Tu3L.5
7. **Q. Pham Van et al.**, «Genetic Algorithm for Dynamic Optical Channel Defragmentation Application in Software-Defined Elastic Optical Networks» ICTON’2018 (*to appear*)
8. **…**

Many Thanks to:

- **NOKIA Bell Labs colleagues,**
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- **SENDATE CELTIC-Plus Project**
- **ONF ONOS ODTN Project members …**

- **GEANT & TERENA NC'2018 for this opportunity!**


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