STRAUSS

Scalable and efficient orches**tra**tion of Ethernet services **us**ing **s**oftware-defined and flexible optical networks

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Graduate School for the Creation of New Photonics Industries (GPI)

R&D Advisor, NICT

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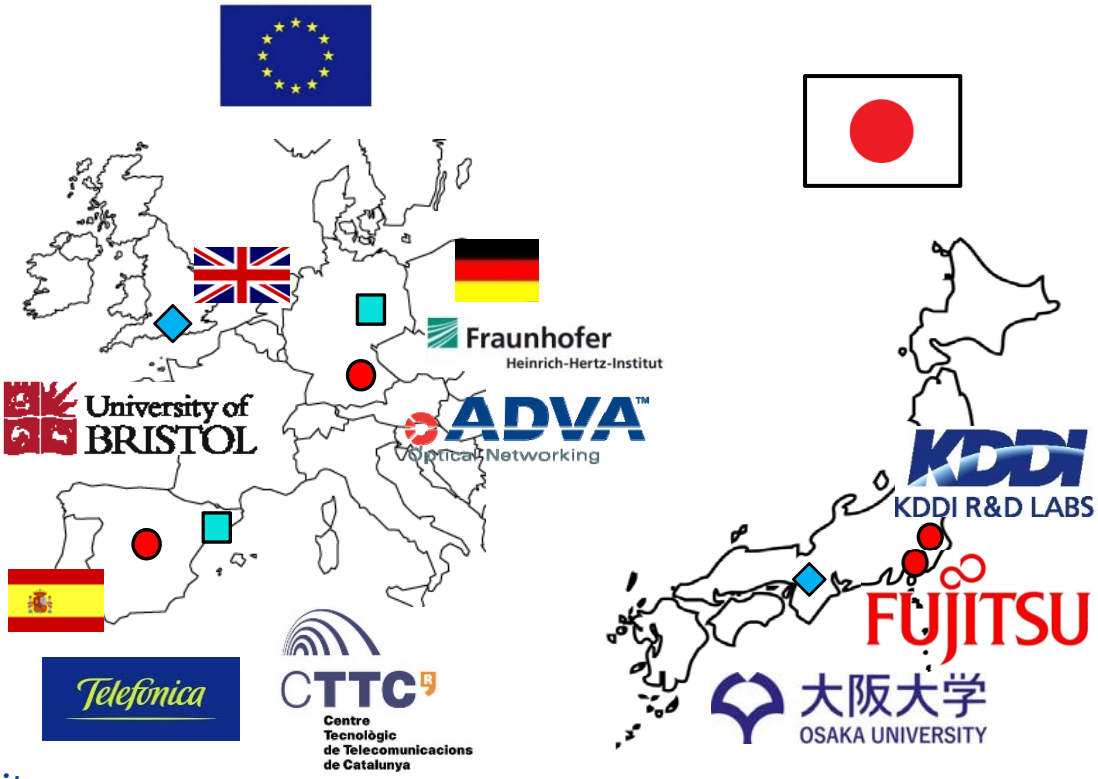
Project facts and consortium

* Project Facts
  * Period: 1/6/2013~31/5/2016 (3-yr)
  * Duration: 36M
  * EU Funding: 1.49 M€
  * JP Funding: 2.82 M€
* JP CONSORTIUM
  * Osaka University
  * Fujitsu Ltd.
  * KDDI R&D Laboratories Inc.
* EU CONSORTIUM
  * CTTC (ES)
  * ADVA Optical Networking (DE),
  * Telefónica I+D (ES)
  * University of Bristol (UK)
  * Fraunhofer – HHI (DE)
* Contact:
  * Ken-ichi Kitayama, Osaka University
  * Raul Muñoz, CTTC



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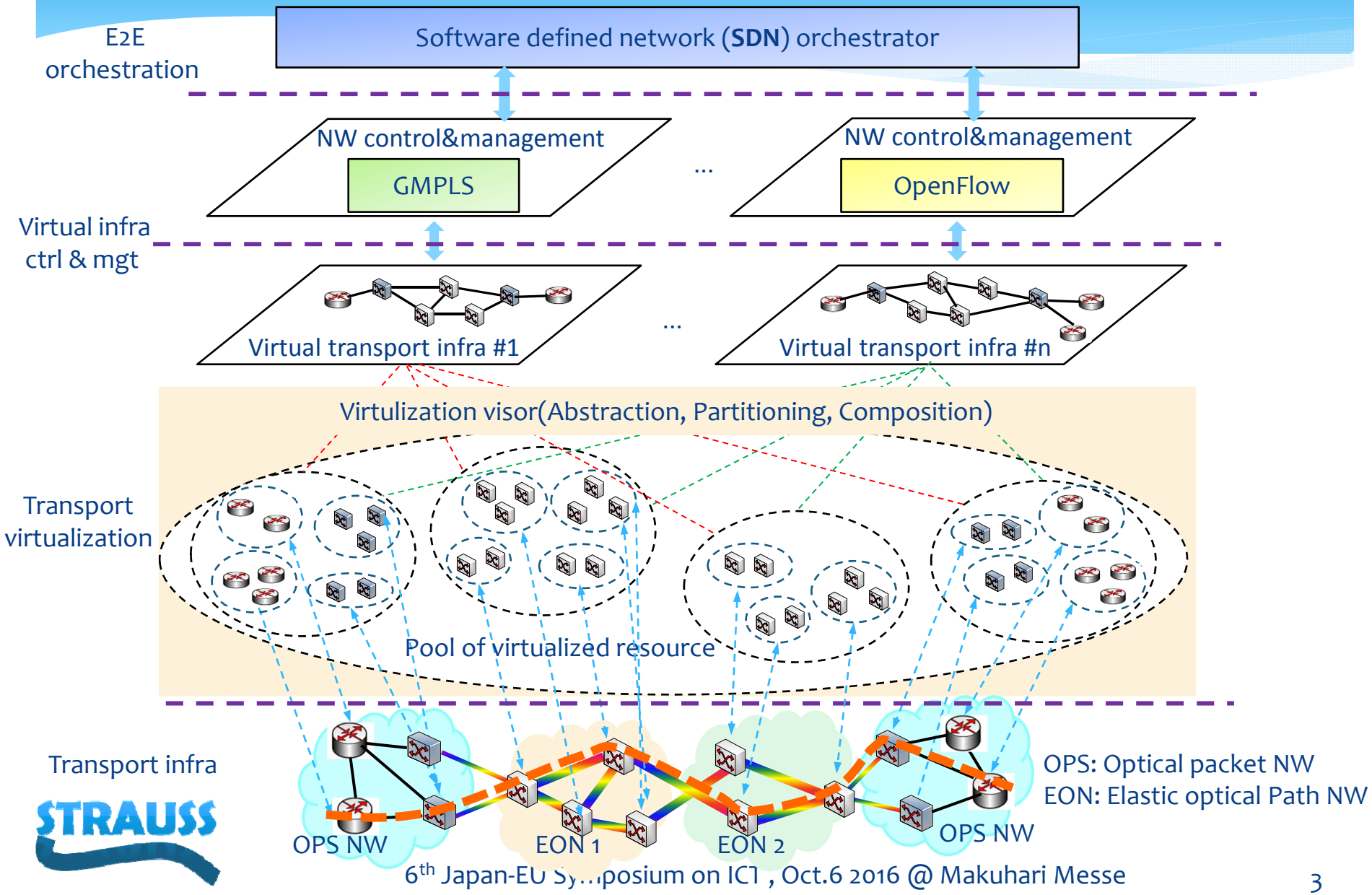
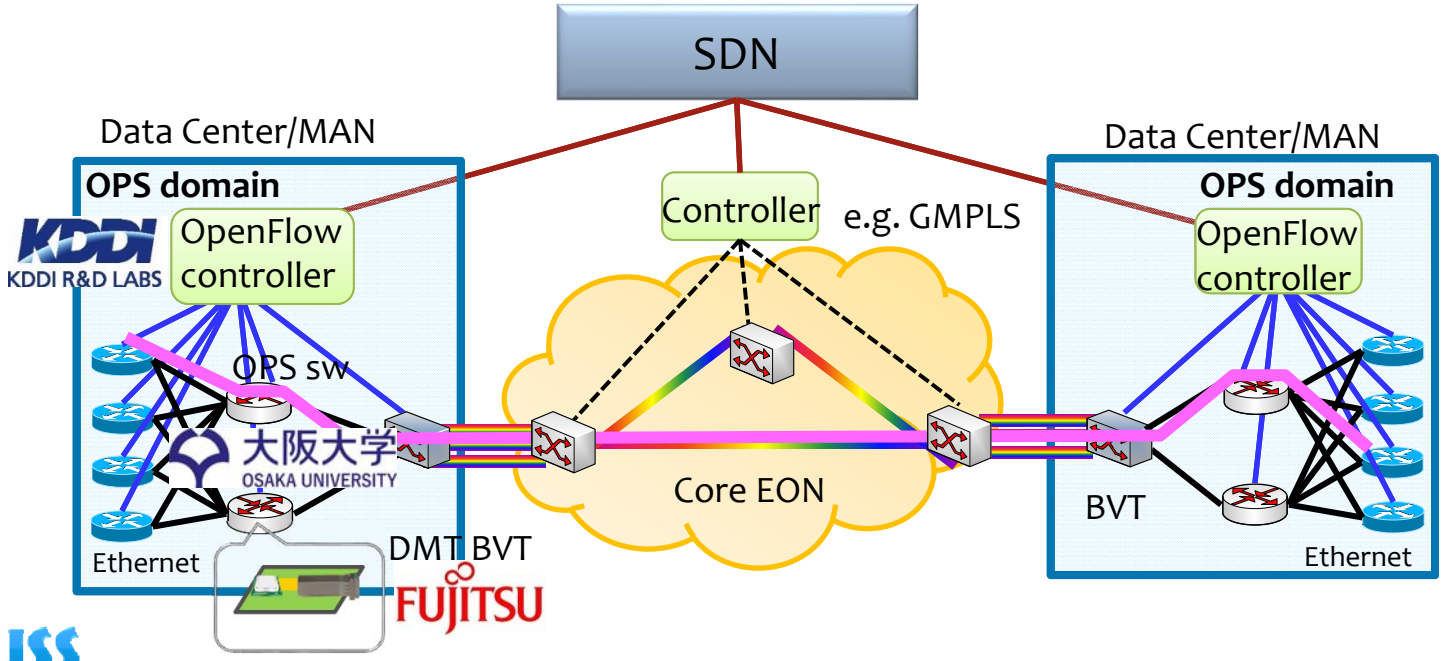
Overall architecture



The need for >100Gb/s optical Ethernet transport over EON and OPS

* An efficient transport infrastructures for > 100Gb/s Ethernet services between OPS data centers / MAN over elastic optical core network.
  * >100Gb/s discrete multitone (DMT) bandwidth-variable transceiver (BVT)
  * Fixed-length, variable-capacity (FL-VC) optical packet switching (OPS)
  * Sliceable OPS/OCS network control by OpenFlow



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WP2 Task 2.3: OPS technology and integrated interface

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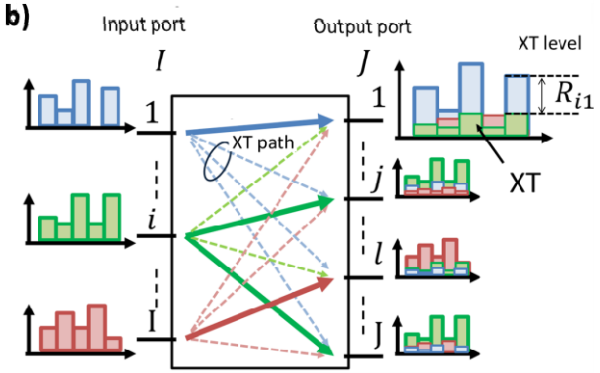
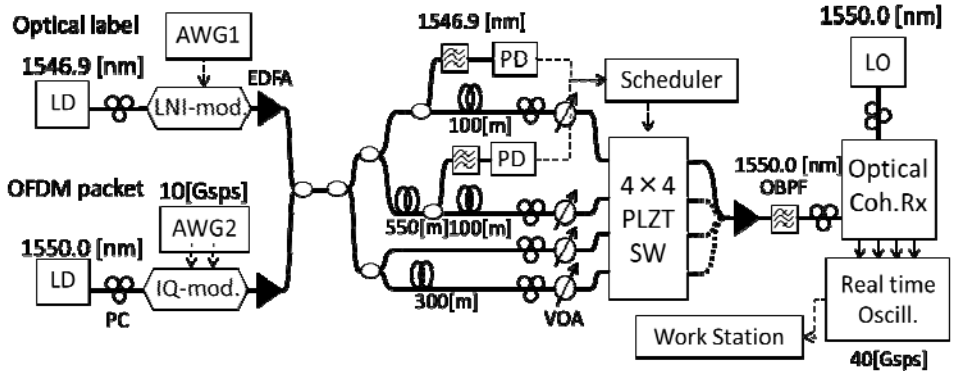
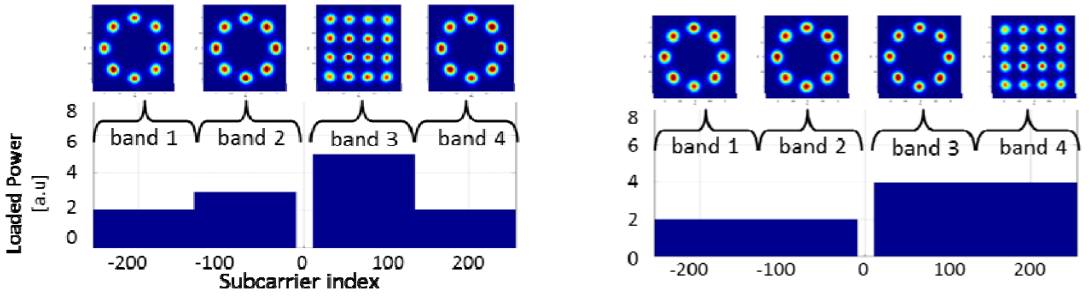
- Cross-talk (XT) tolerant FL-VC packet concept has been extended to asynchronous multi-port packet switching
- Experimental demonstration of a 4x4 switching of 10Gbaud CO-OFDM packet
  - 8.3% throughput improvement (31.2Gbps) has been achieved



XT-tolerant FL-VC optical packets

Experimental setup





WP2 : 400Gb/s DMT transceiver demonstrator

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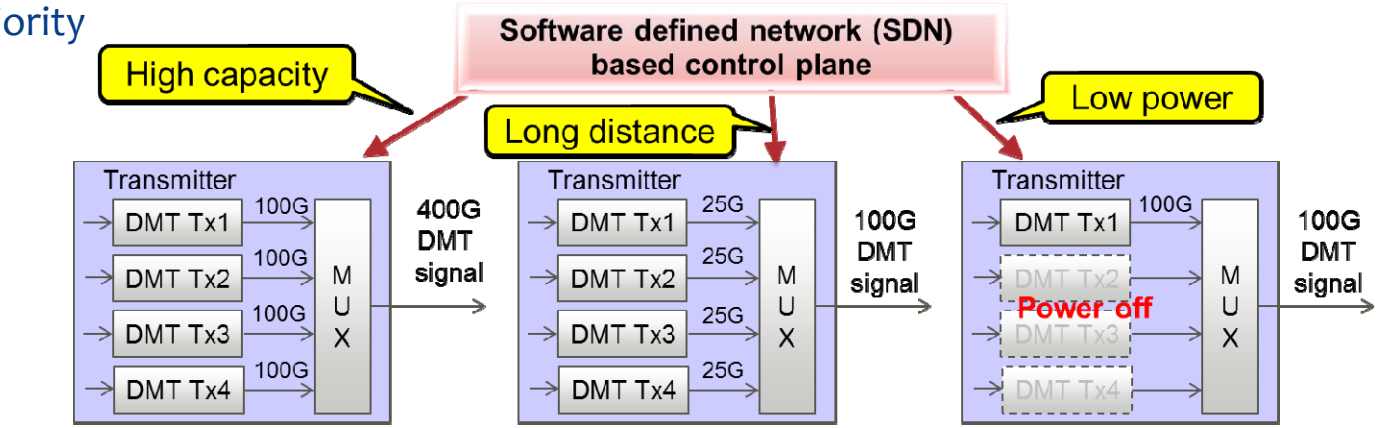
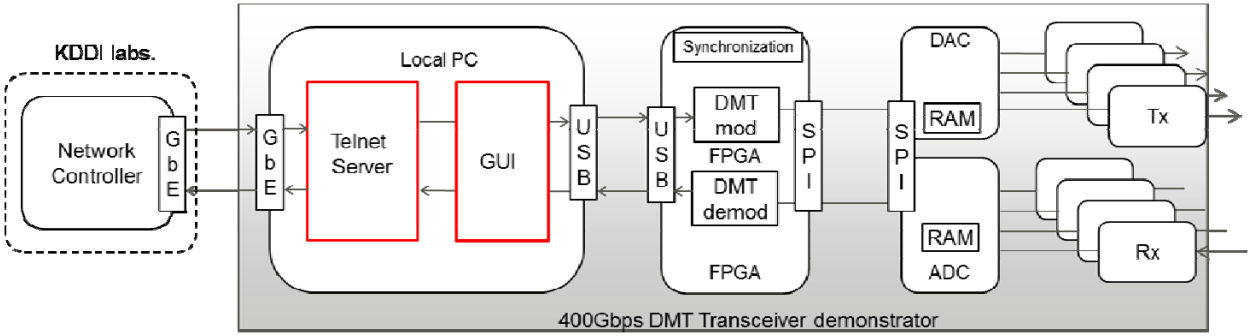
* 400Gb/s DMT transceiver demonstrator with policy based control according to the network priority



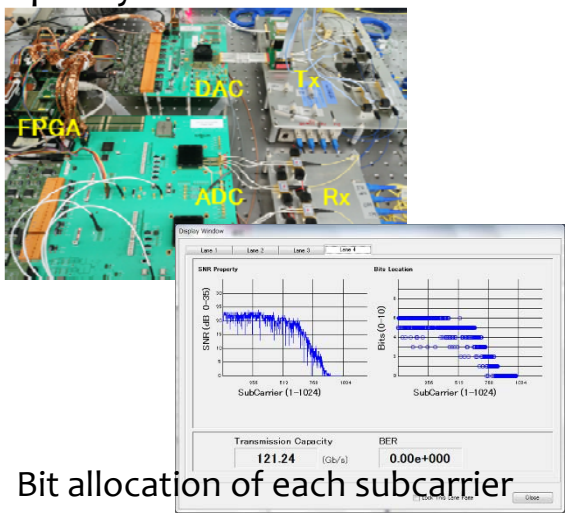
Capacity prioritized policy

Distance prioritized policy

Energy-efficiency prioritized policy



400 Gbps DMT transceiver demonstrator



Bit allocation of each subcarrier

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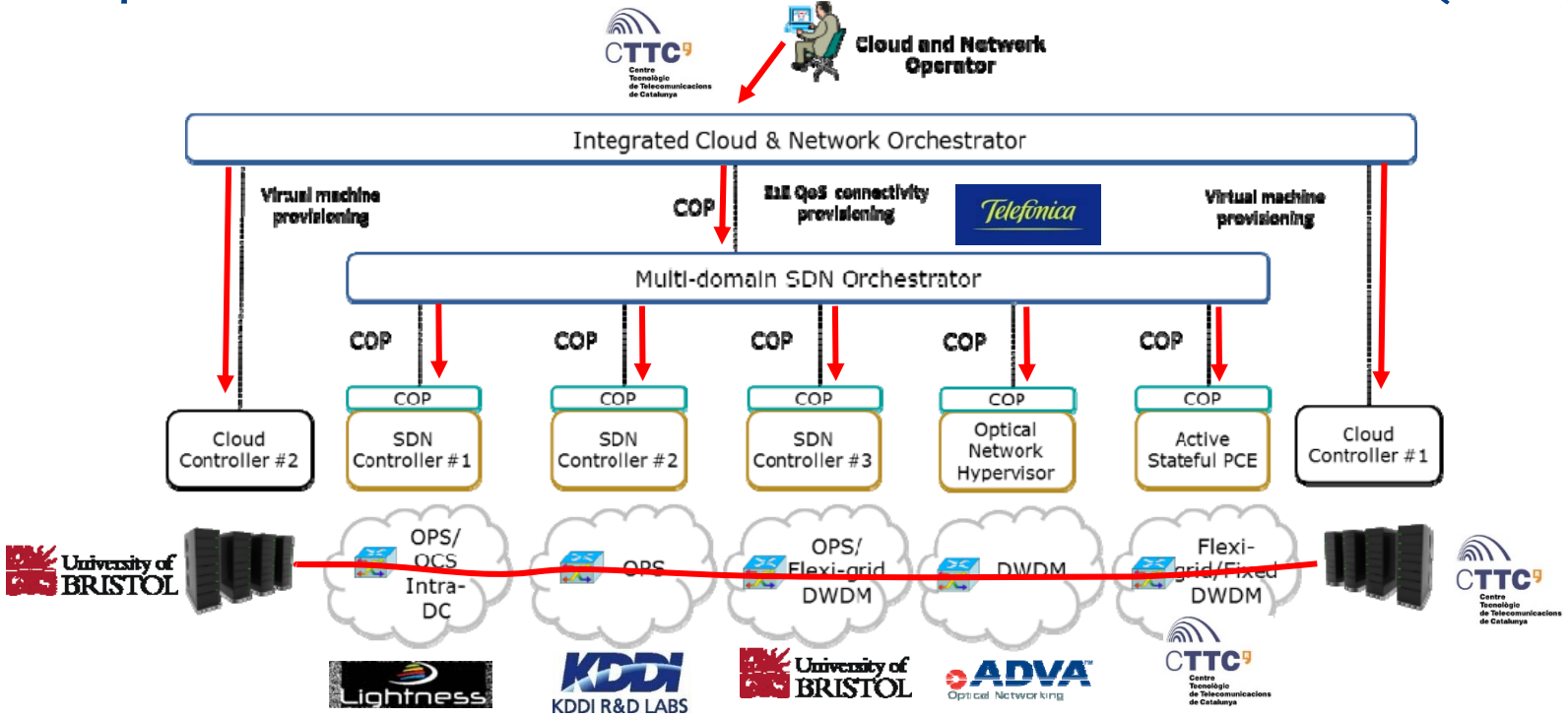
WP3 : Interoperability between EU orchestrator and JP network controller

KDDI R&D LABS

* Orchestration of multi-domain and multi-technology optical transport networks
* Implementation of "Control Orchestration Protocol (COP)"



COP: Control Orchestration Protocol, DC: Datacenter, DWDM: Dense Wavelength Division Multiplexing, E2E: End-to-end, OPS: Optical Packet Switch, OCS: Optical Circuit Switch.

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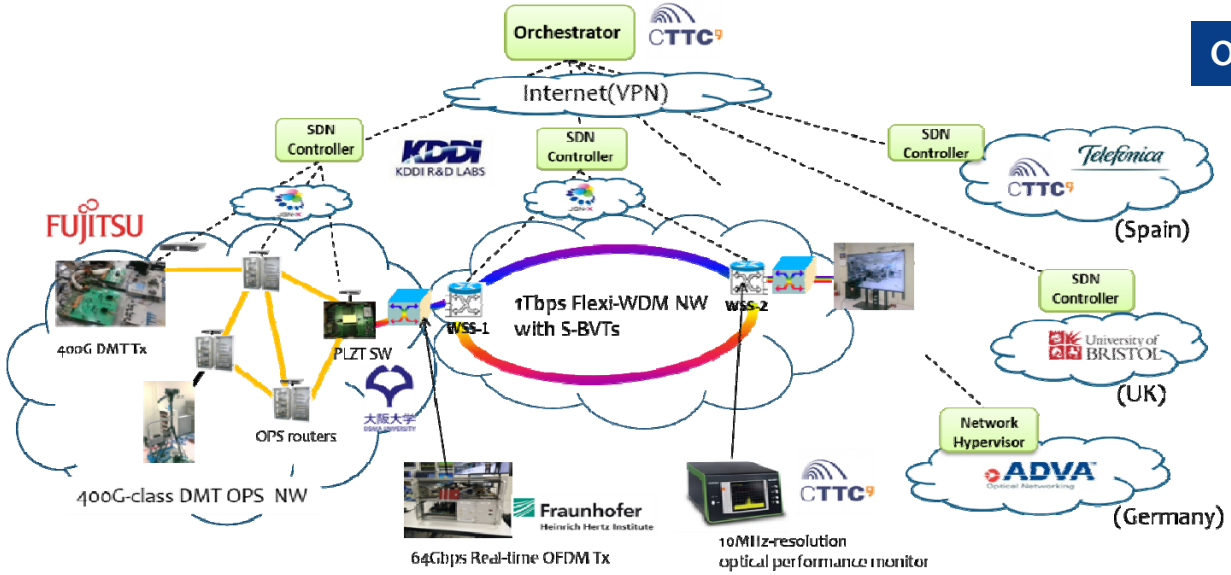
Testbed demo : Real-time congestion-aware services provisioning

To be cont'd

* Collaboration work with NICT.
* Cognitive SDN orchestration over **400 Gbps OPS** and **Tbps-class flexi-WDM** networks is demonstrated.
* **SDN-controllable** OFDM transponders and the extended transport API enable the **congestion-aware provisioning** of end-to-end real-time services



OFC2016, post-deadline paper, TH5B.2

Testbed demo : Real-time congestion-aware services provisioning

*Node A to ROADM2
*Real-time HD-TV stream
*10GE -> 100G OPS -> 10G-OTN

*Node C to ROADM2
• 400G DMT packet -> 80G DD-OFDM (Offline)
*100G w/ 17% packet rate (Effective bitrate: 15Gbps)

HD camera

IP media gateway

Cognitive SDN Orchestrator

Internet (VPN)

SDN Controller

SDN Controller

JGN-X

JGN-X

Node A

Node B

Node C

400G DMT Tx

10GE to 10G-OTN

DMT Rx

DSP

ROADM 1

ROADM 2

50-km SMF + DCF

Hi-rez Channel Monitor

80G DD-OFDM /200G CO-OFDM

8λx100G DP-QPSK

(Not in use)

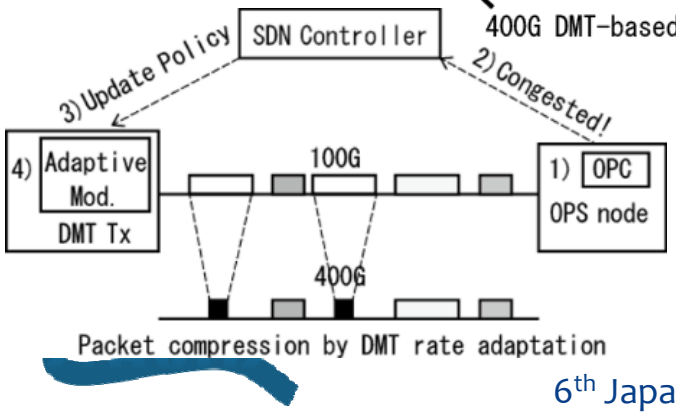
IP media gateway

HD-TV monitor

DD-OFDM Rx (offline)

400G DMT-based OPS Domain

>1Tbps Flexi-WDM OCS Domain



Congestion-aware control algorithm
① Detection of congestion
② Alarming
③ Change of transmission policy
④ 100G to 400G upgrade

OFC2016, post-deadline paper, TH5B.2

WP5 : Standardization activities

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* IEEE802.3 ETHERNET WORKING GROUP

  Standardization Task force meeting： 3 times

  - May 2015 Pittsburgh
  - July 2015 Waikoloa
  - Sept 2015 Bonita springs

  Contribution document： 1 times

  - May 2015 Pittsburgh

  Task force, Ad hoc group

  - P802.3bs 200 Gb/s and 400 Gb/s Ethernet task Force
  - Next Generation Enterprise / Campus / Data Center Ethernet(NG-ECDC)

  The discussion is being continued at NG-ECDC after the STRAUSS project ends

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Concluding remarks

* A well-integrated team between the JP and EU partners enabled a close collaboration.
* Teaming up academia, telecom carrier, and vendor brought about synergistic effect.
* High-impact outcome than expected were yielded in the standardization activities as well as high-profile scientific conferences and journals.

Thank you !!!

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