Optical peRformanCe monitoring enabling dynamic networks using a Holistic cross-layEr, Self-configurable Truly flexible appRoAch

Project Presentation

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Smart optical and wireless network technologies

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Consortium

- COMPUTER TECHNOLOGY INSTITUTE & PRESS DIOPHANTUS (CTI)
- TELECOM ITALIA (TILAB)
- INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS (ICCS/NTUA)
- ALCATEL - LUCENT BELL LABS France (ALBLF)
- SCUOLA SUPERIORE DI STUDI UNIVERSITARIE DI PERFEZIONAMENTO SANT'ANNA (SSSA)
- NEXTWORKS (NXW)

Motivation

"ICT 6 – 2014: Smart optical and wireless network technologies"

1. "Address the lack of dynamic control and management of optical network resources within and across operator's domains for lower cost and more flexible use of resources"
   - ý The physical layer is accounted with worst case assumptions and gross margins
   - ý Physical layer monitoring information is not exploited in optimization processes
   - ý Failures are treated as black or white
   - þ We need to close the loop between physical layer and the control plane: interacting with the physical layer enables a dynamically controlled network that is used in a more flexible and efficient way
2. "Address the limitations of current optical transmission technologies"
   - ý Increasing the nominal transmission rate can go wasted if operation margins are too gross
   - þ Reducing the margins benefits current and future transmission technologies

ORCHESTRA vision: "An optical network has to be observable before it can become controllable and be subject to optimization"

Vision

An optical network has to be observable before it can become controllable and be subject to optimization

- ORCHESTRA proposes to close the control loop by enabling physical layer observability
- Observability relies on the coherent receivers that are extended, almost for free, to operate as software defined impairment optical performance monitors (soft-OPM)
- Physical layer information of single or multiple soft-OPMs is used to take better optimization decisions
- Re-acting dynamically on the network to increase its efficiency

Objectives

1. Develop an advanced DSP-based physical-layer multi-impairment monitoring algorithm suite

2. Develop a holistic approach to Quality of Transmission (QoT) determination in all network lightpaths using information from distributed software-defined optical performance monitors (soft-OPMs) and advanced correlation algorithms

3. Develop a hierarchical control and monitoring infrastructure providing active and passive monitoring capabilities with rapid and effective reactions to degradations and failures

4. Develop dynamic optimization procedures for fault management and network re-optimization

5. Lower the barriers of resource sharing among operators' domains through the efficient monitoring of alien lightpaths and accurate physical layer SLAs

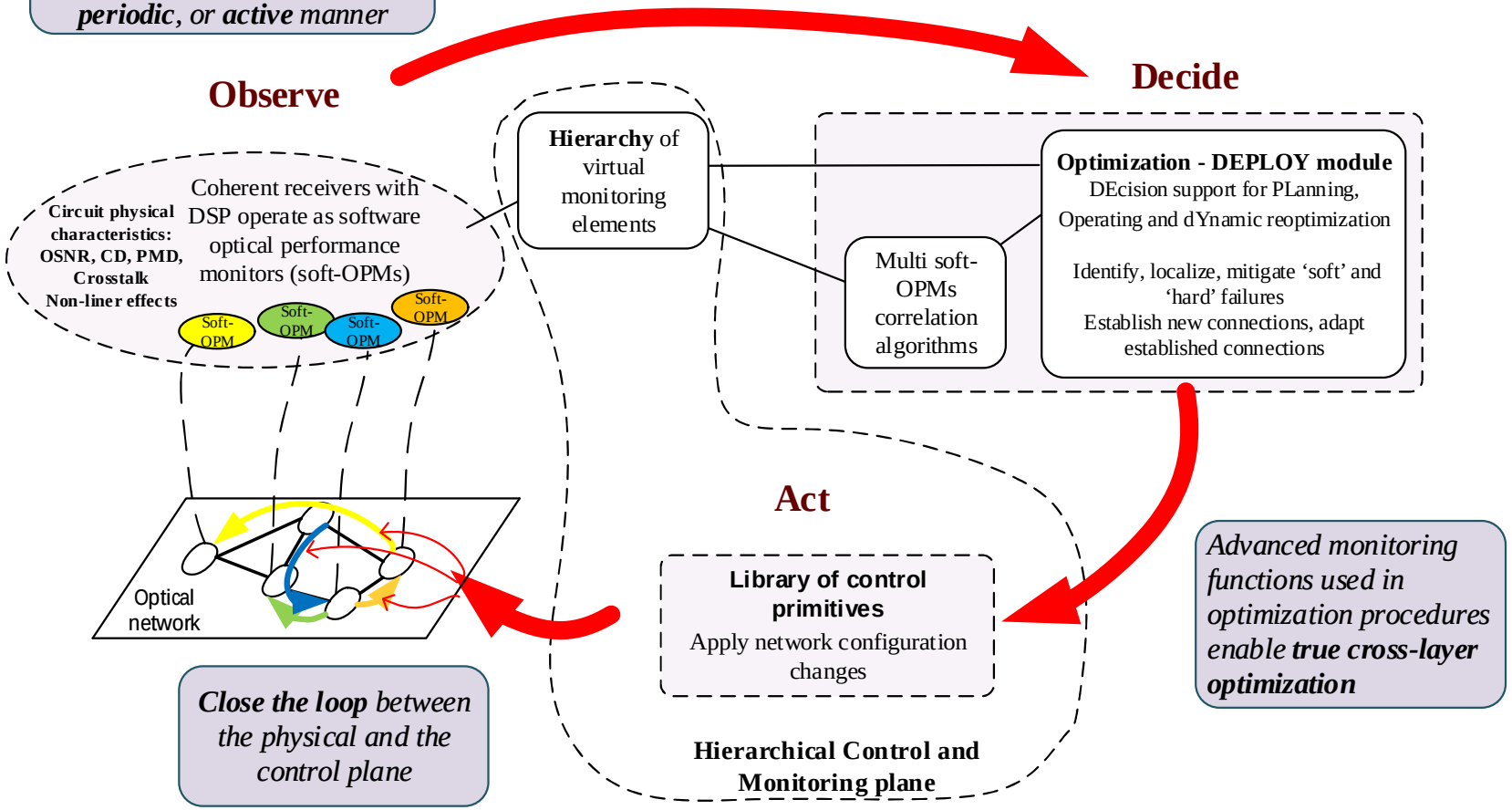
6. Demonstrate dynamic and highly efficient flexible network operation enabled by software-defined optical performance monitoring

The Big Picture

Advanced DSP algorithms add real-time multi-impairment monitoring capability to coherent receivers
*Monitors operate in a **threshold**, **periodic**, or **active** manner*

*A novel **hierarchical monitoring plane** handles monitoring information in an efficient and scalable manner*

***Impairment information from multiple soft-OPMs** deployed in the network is **correlated** to provide even more knowledge of the state of the physical layer*



***Close the loop** between the physical and the control plane*

*Advanced monitoring functions used in optimization procedures enable **true cross-layer optimization***

ORCHESTRA vision: "An optical network has to be observable before it can become controllable and be subject to optimization"

Overall Approach

ORCHESTRA

Requirements & Specifications

Dynamic network specifications and use cases driven by accurate real-time physical layer monitoring information

Identify DSP-based algorithms to be developed

Requirements for the management and control plane

DSP-based development for advanced monitoring

Flexible Optical Transceiver

DSP algorithms for coherent modulation and demodulation

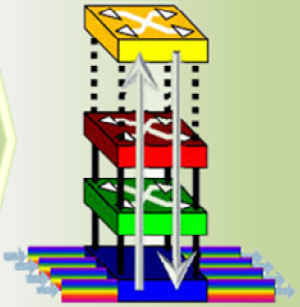
DSP-based impairment monitoring algorithms suite

Interface between programmable transceiver and control plane

Dynamic network cross-layer optimization

Cross-layer monitoring functions

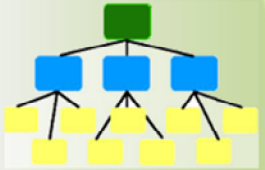
Dynamic network optimization procedures



Control and monitoring workflows for handling dynamic network use cases

Monitoring and control Infrastructure

Hierarchical monitoring infrastructure



Communication functionalities

Control primitives for dynamic network operation and optimization

API that enables interaction between modules

Performance evaluation in lab and field demo

Evaluation scenarios

Test-bed development

Lab experiments

Field demo

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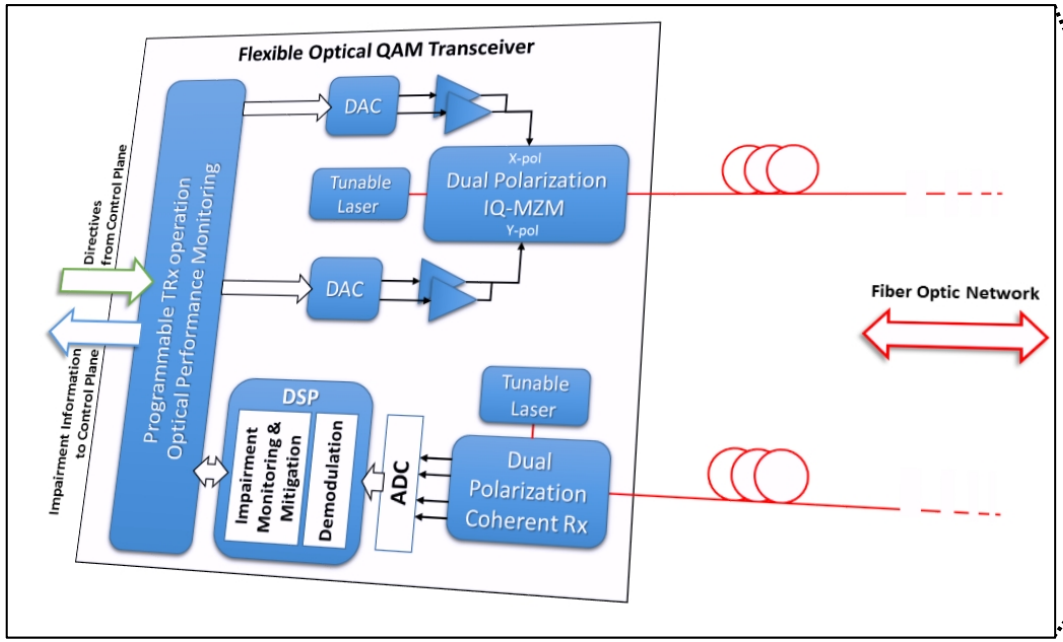
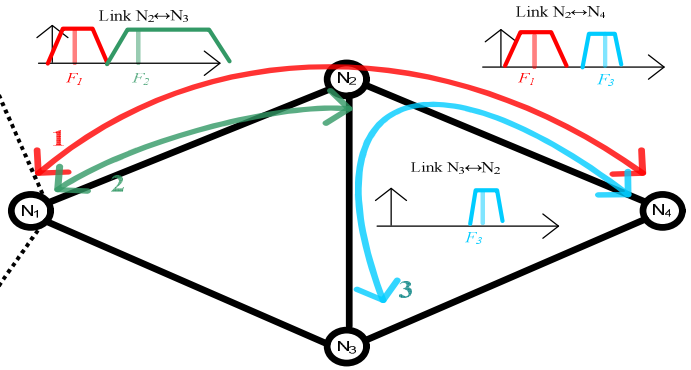
Building Block: Flexible TRx and DSP

DSP-enabled coherent transceivers are the norm in core optical network, but their potential in terms of monitoring functionality remains untapped

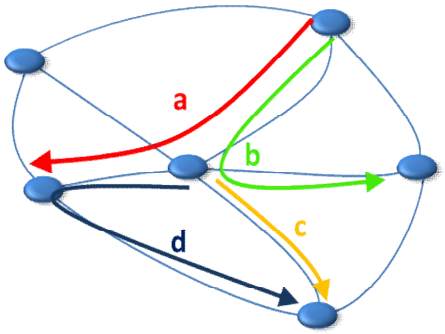
Programmable, multi-format, FEC- and rate-adaptive transceivers empowering flexible optical networks are the next big thing





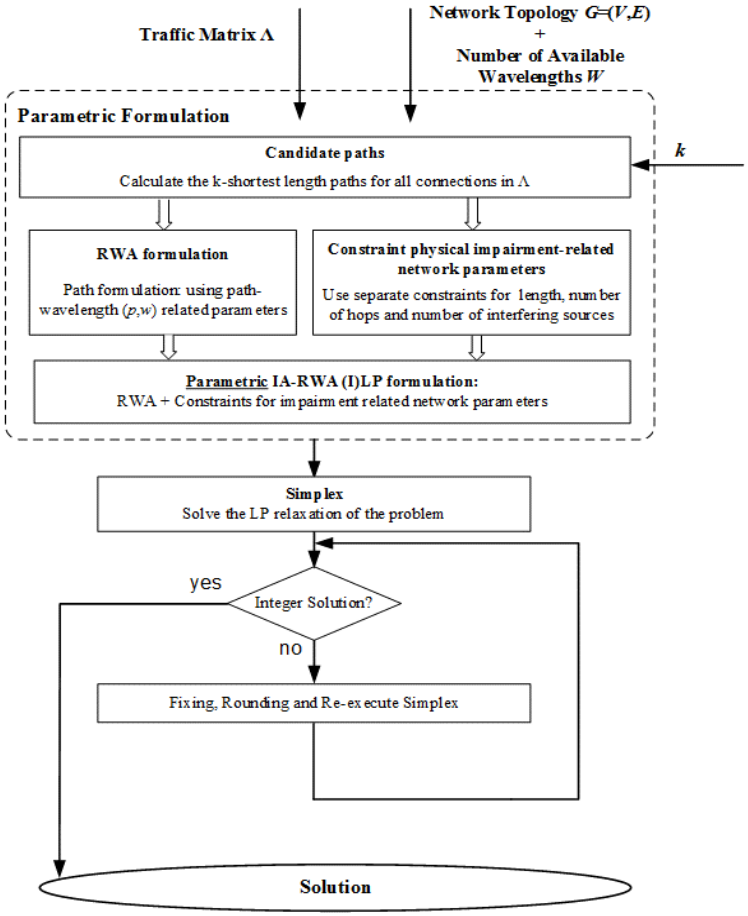
ORCHESTRA will develop an advanced, DSP-based, multi-impairment monitoring algorithm suite that will provide the control plane with unprecedented detail on the state of the physical-layer. ORCHESTRA will build a prototype flexible transceiver to showcase dynamic network operation combined with physical layer awareness.

Building Block : Network Optimization



Impairment information from multiple monitors will be correlated to provide even more knowledge of the physical layer and enable true cross-layer optimization

The Decision support for PLanning, Operating and dYnamic reoptimization (DEPLOY) module will contain algorithms for the optimized allocation of resources



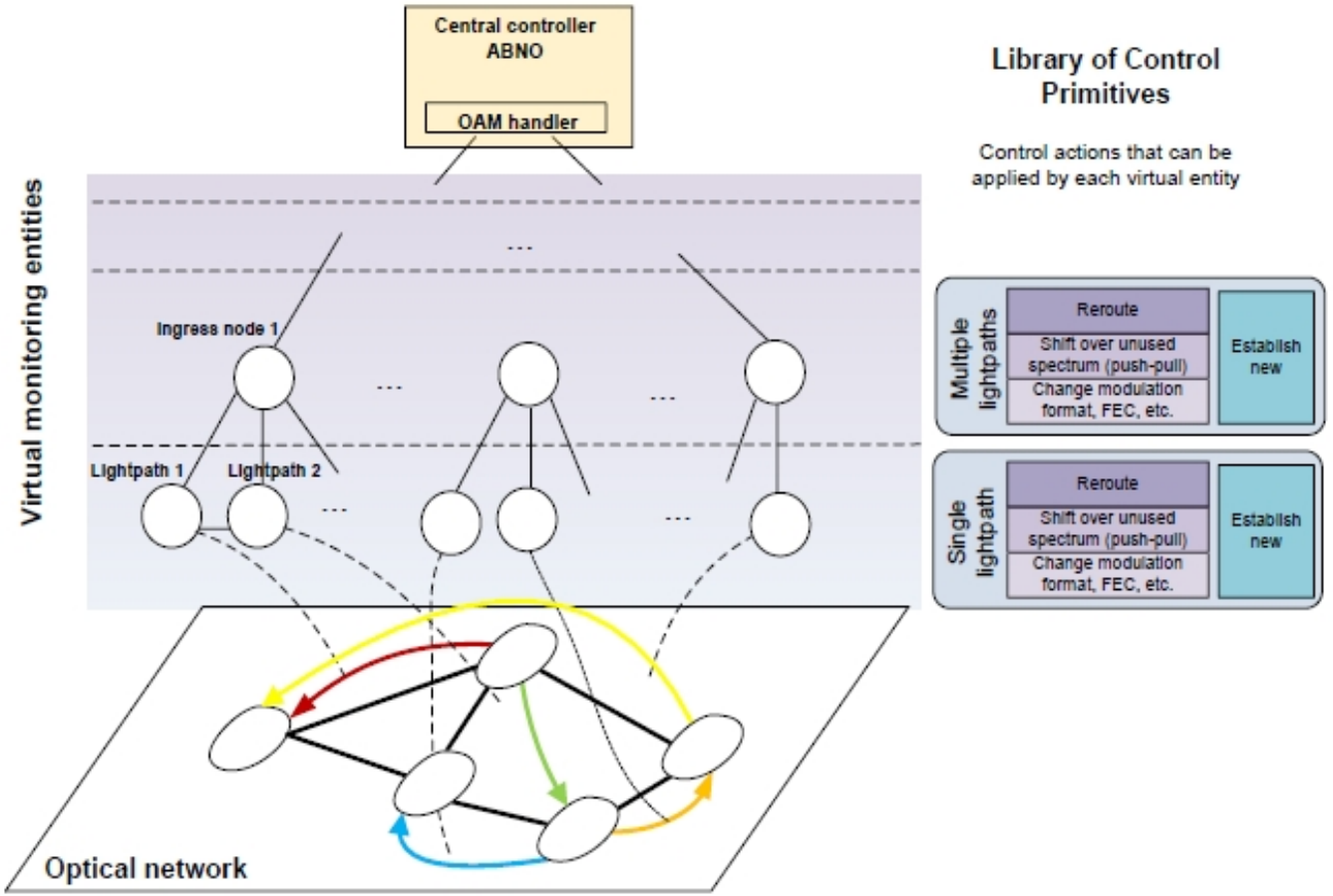
DEPLOY's objective is to use network resources efficiently

DEPLOY will satisfy the QoS/QoT requirements of the connections

DEPLOY will achieve CAPEX and OPEX savings

DEPLOY's efficient hard and soft failures handling will increase network availability

Building Block : Control & Monitoring



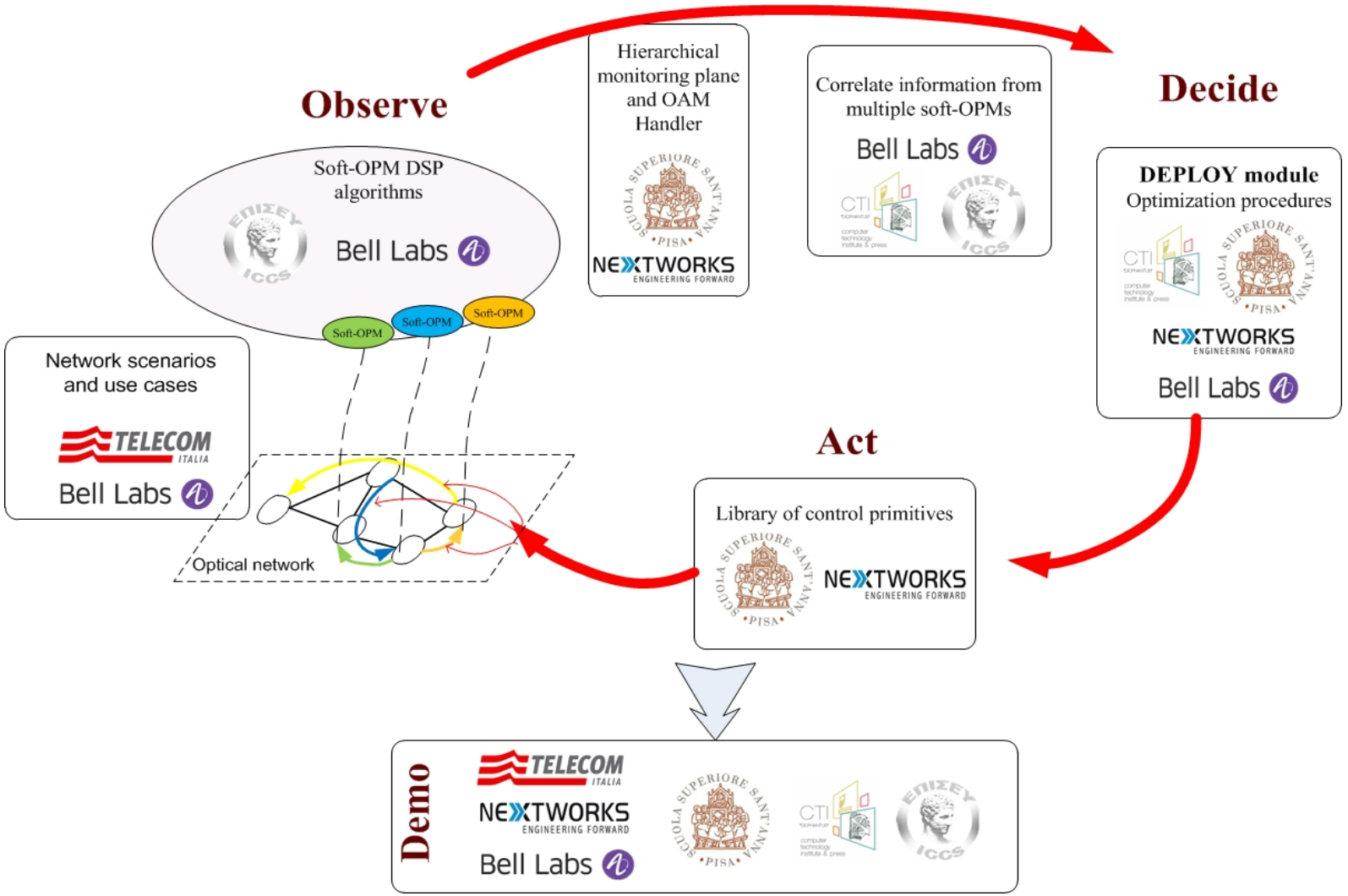
The hierarchical monitoring plane will provide scalable, active and passive monitoring capabilities with rapid and effective reactions to degradations and failures

Demos

- Lab experiments at the network-level, evaluating hierarchical control and monitoring plane and optimization procedures
- Lab experiments to evaluate the developed DSP monitoring algorithms in a commercial optical transport platform

- Field trial demonstration of ORCHESTRA concepts in a real-world application scenario, using TILAB's regional network

Partner Roles



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