



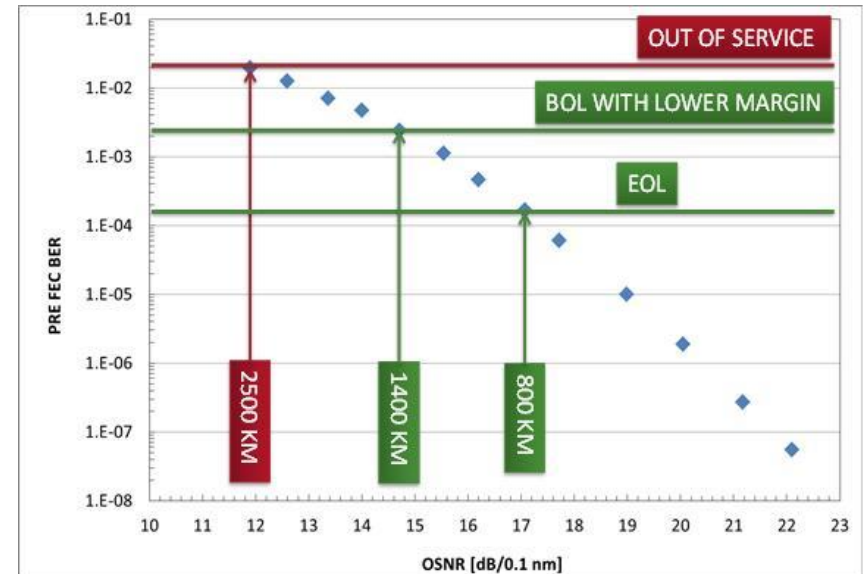
ORCHESTRA – Optical performance monitoring enabling flexible networking

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- ❌ Optical networks are designed under worst case assumptions & gross margins for the physical layer

“End-of-life (EOL) margins”

- Equipment (amp, fiber) aging
- Interference (Nonlinear impair.)
- Polarization effects



- ❌ Reducing the margins improves efficiency and reduces investments
 - But in a static network BER (soft-failure) problems will arise
- ❌ Physical layer monitoring information is not used in network lifecycle
 - Planning mistakes are not corrected
 - Soft- and hard-failures are treated as black or white: limited knowledge of the cause of failure and limited dynamicity in the control actions

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



The project

Call identifier: H2020-ICT-2014-1

Topic: ICT-06-2014

*Smart optical and wireless
network technologies*

Grant Agreement no: 645360

Project Start: February 1, 2015

Duration: 36 months

Budget: 2.6 million Euros

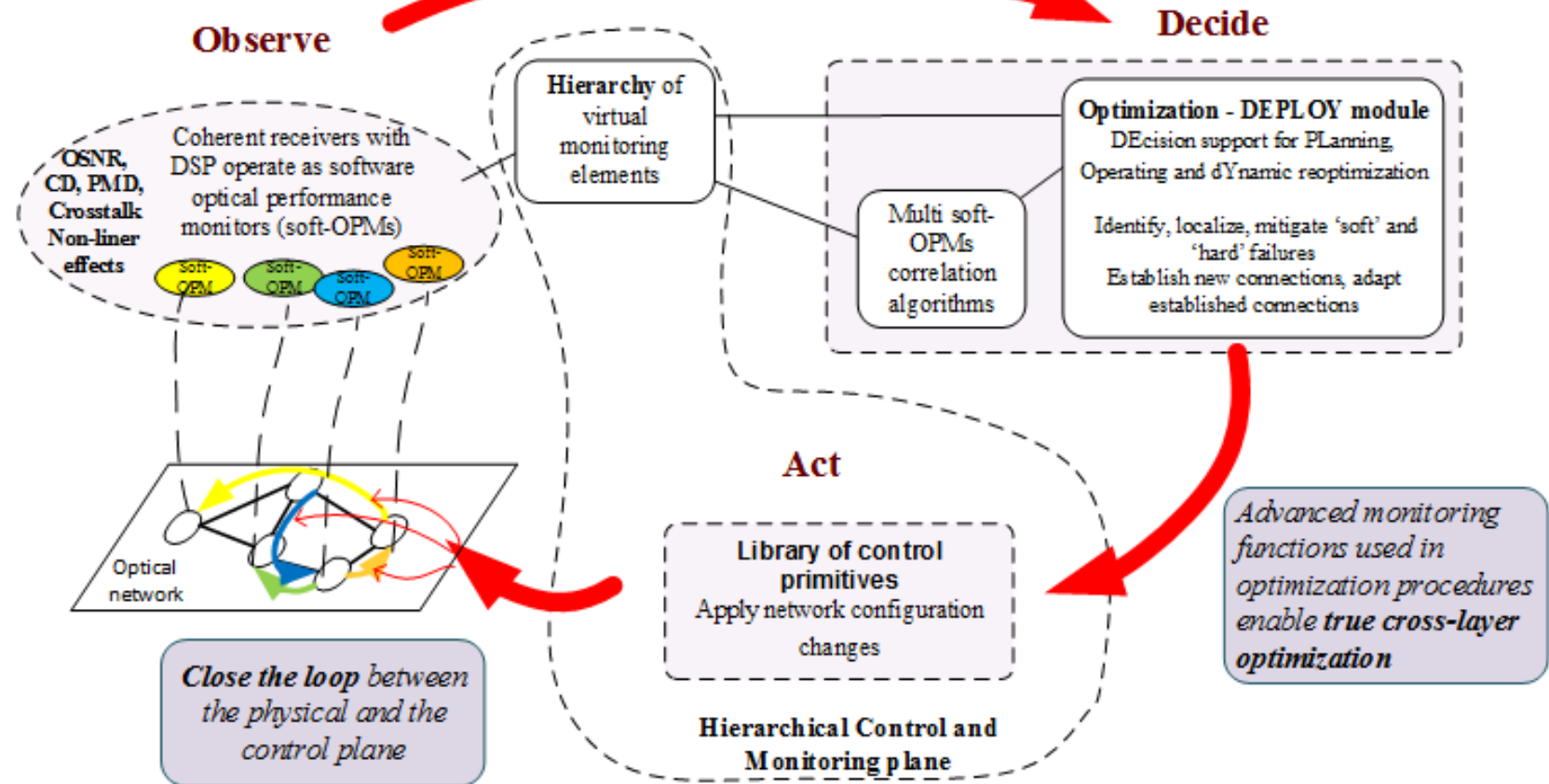
www.orchestraproject.eu

- 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**) 

The Big Picture

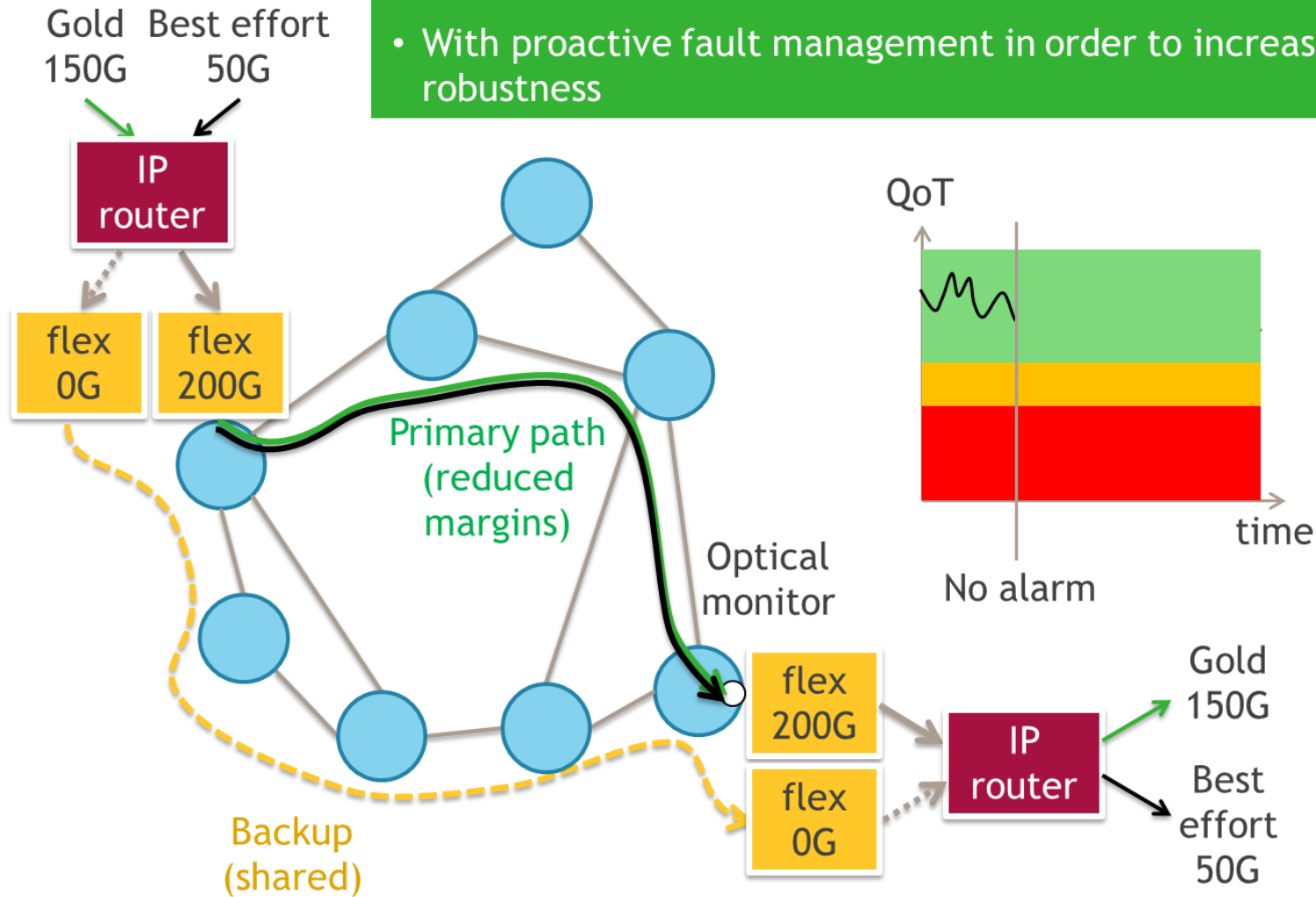
*Advanced DSP algorithms add real-time multi-impairment monitoring capability to coherent receivers
Monitors operate in a **threshold, periodic, or active** manner*

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

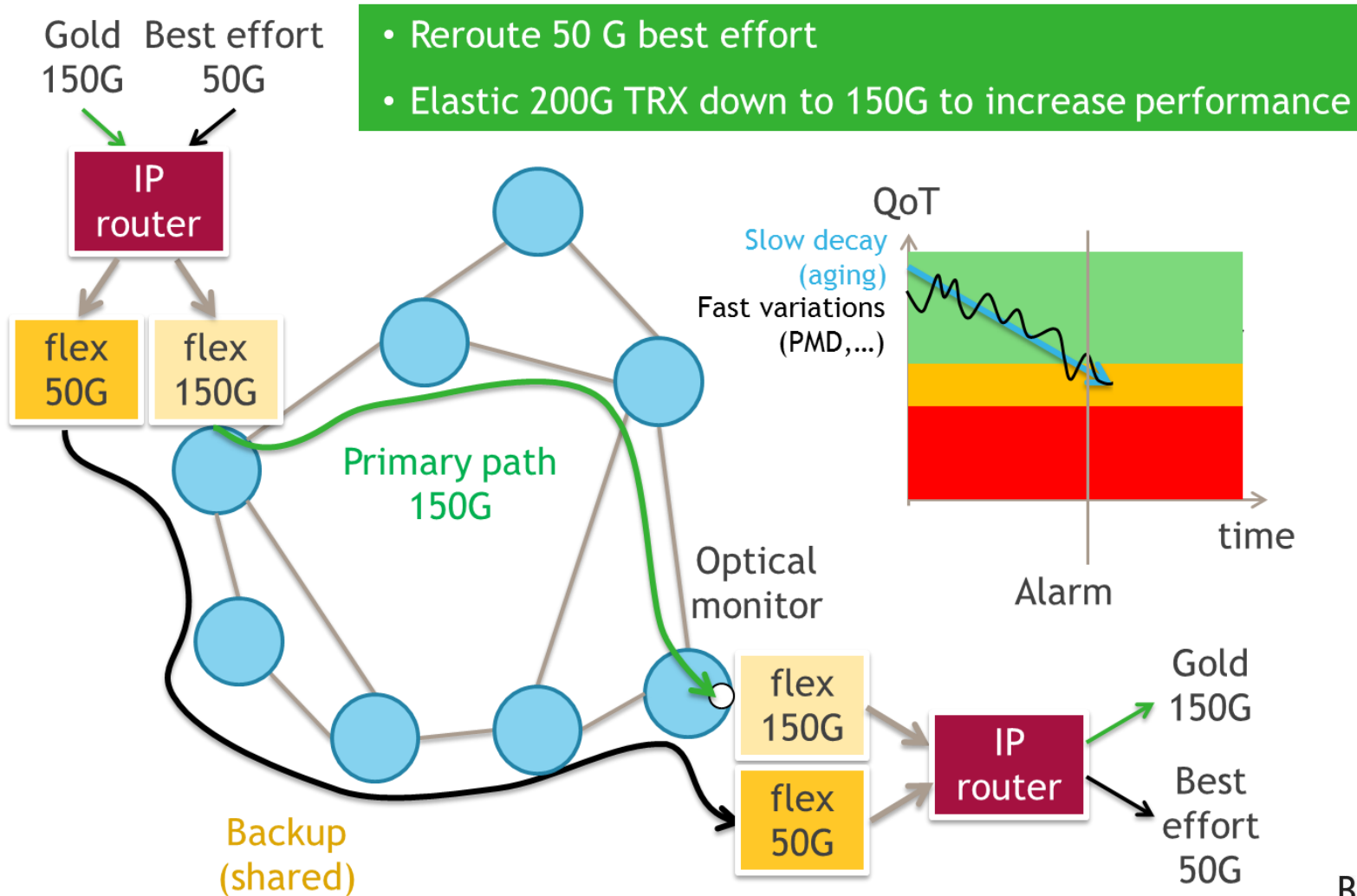


Postpone Investment

- Just-enough-margin design to limit overprovisioning
- With proactive fault management in order to increase robustness

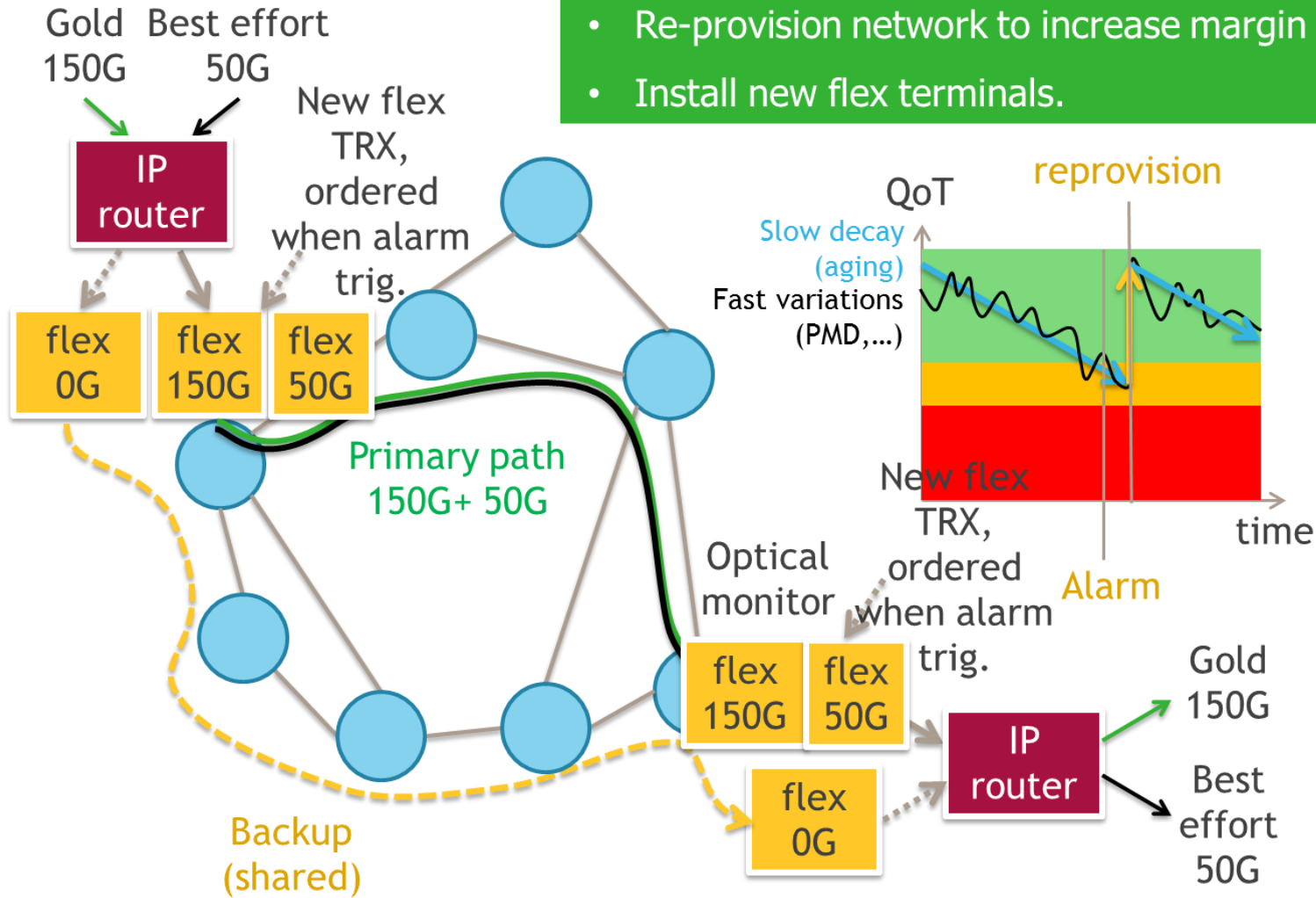


Routing and Use of Port Flexibility



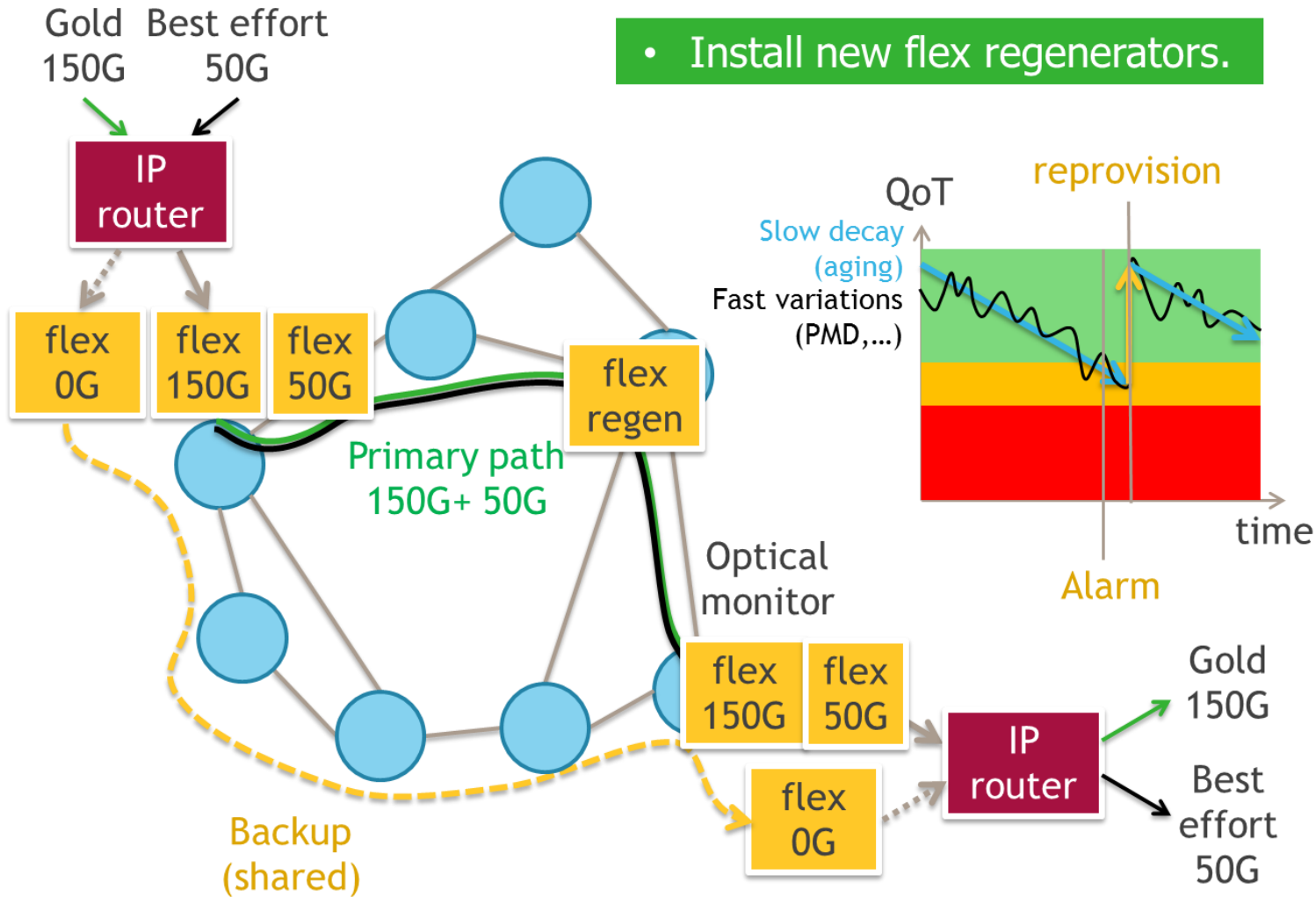
Proactive Network Operation

- Re-provision network to increase margin
- Install new flex terminals.

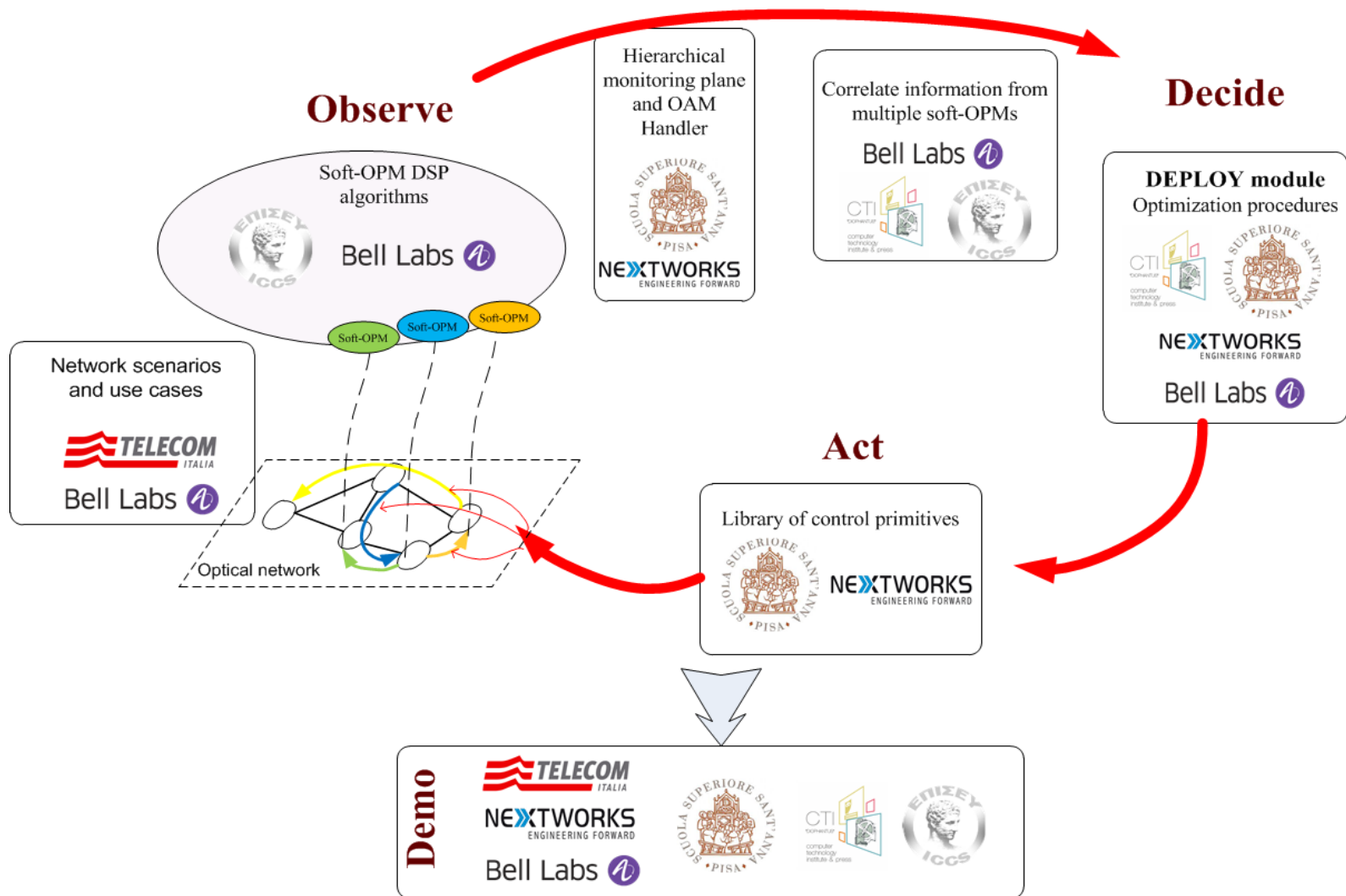


Postpone Regenerator Provisioning

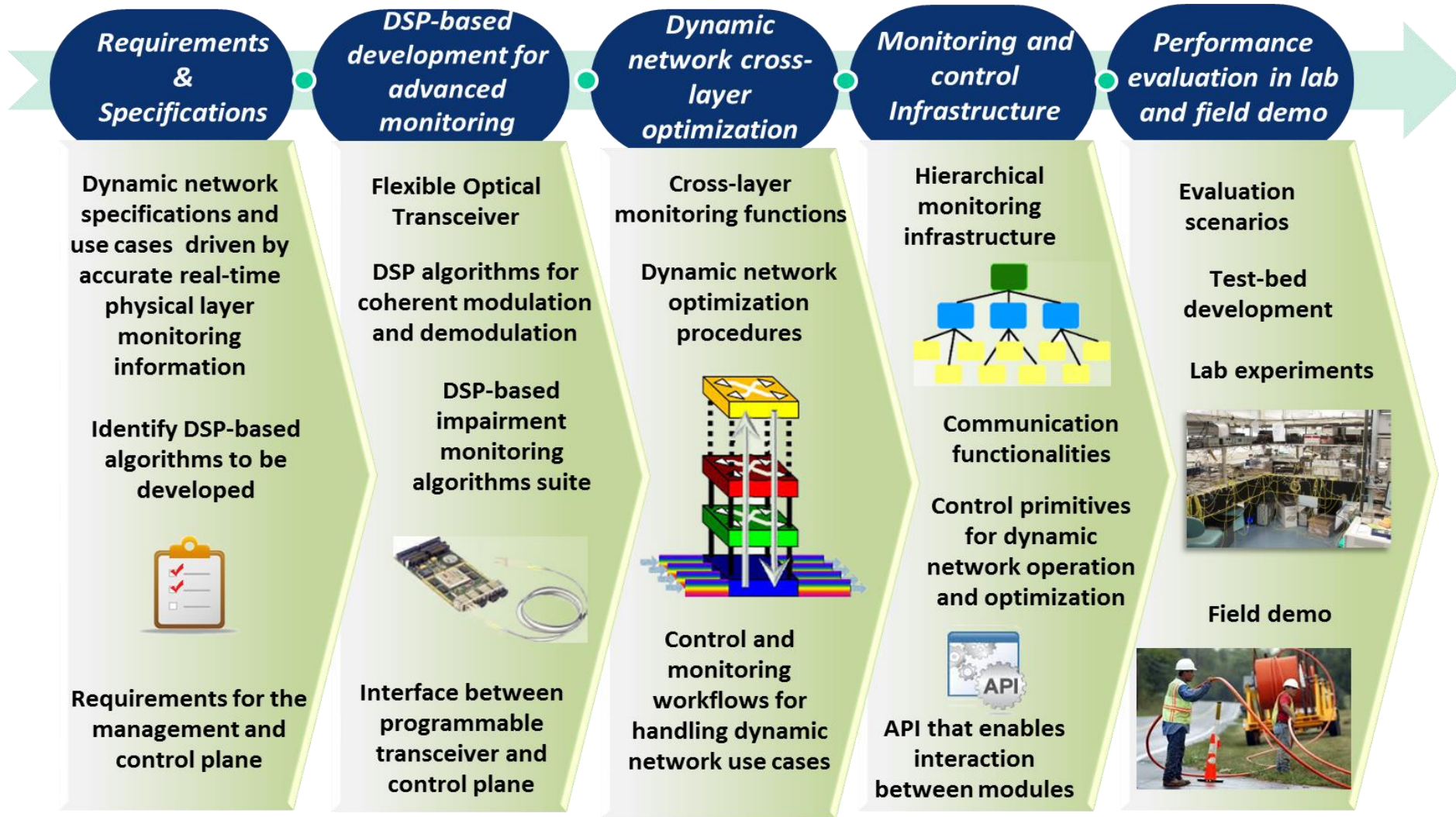
- Install new flex regenerators.

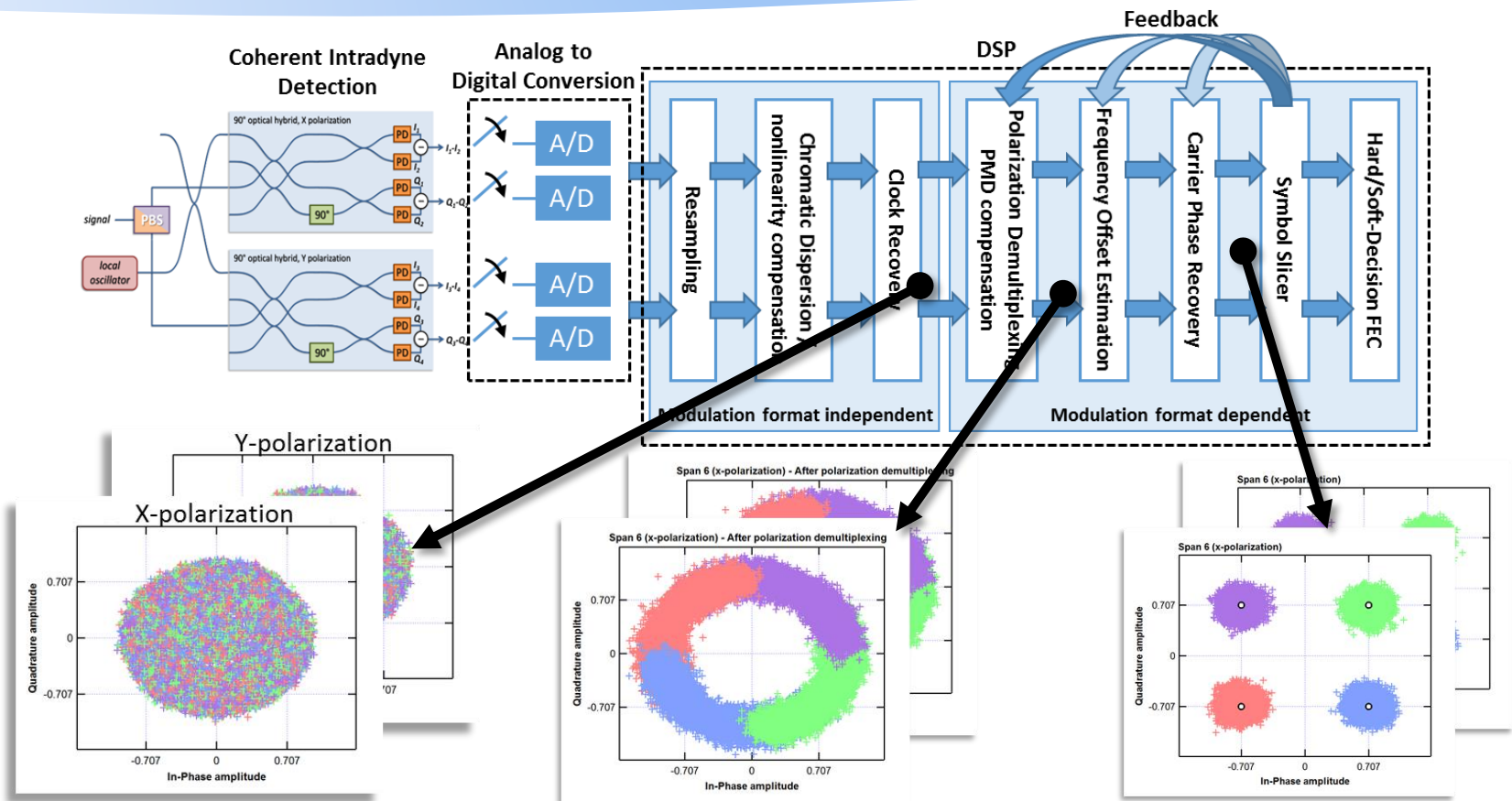


Partner Roles



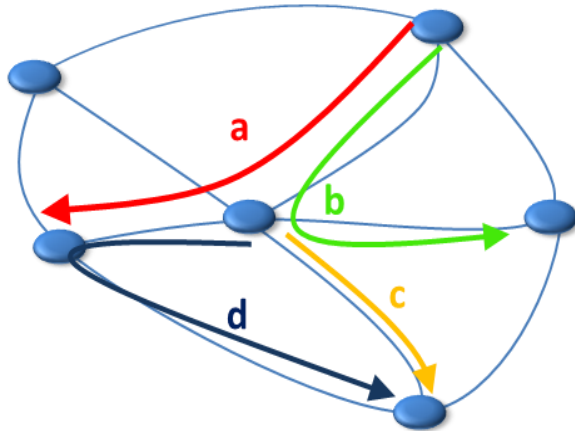
Overall Approach





ORCHESTRA will advance the state-of-the-art and develop a DSP-based physical-layer multi-impairment monitoring algorithm suite, enabling OSNR and NLIs measurements

ORCHESTRA will prototype an adaptable transceiver to showcase dynamic network operation combined with physical layer awareness



Impairment information from multiple monitors will be correlated to provide even more knowledge of the physical layer

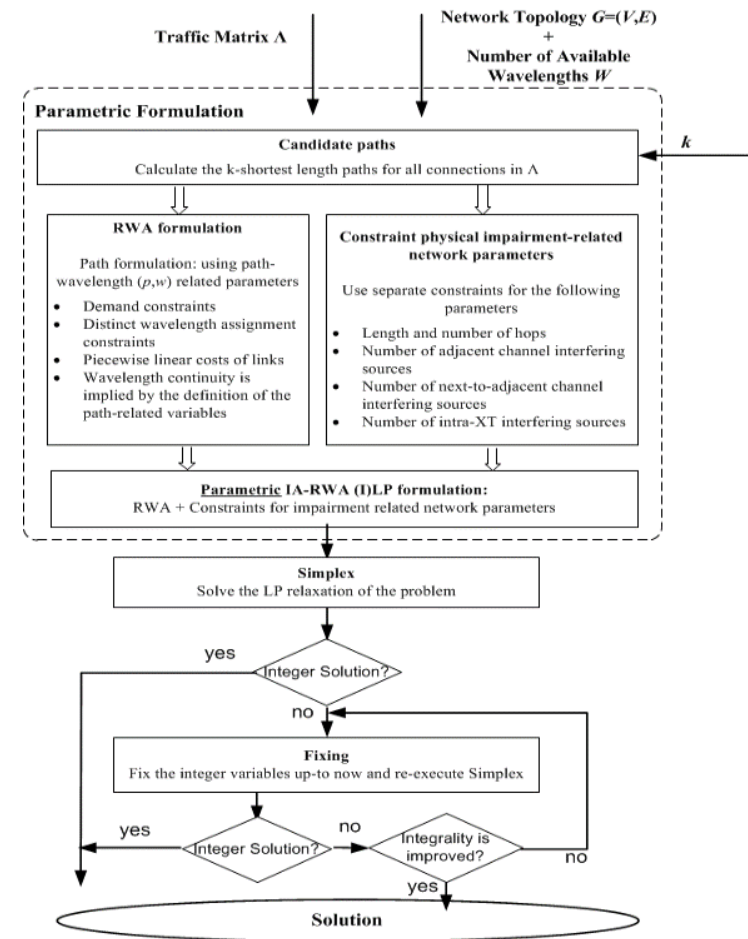
Correlation algorithms such as network kriging and norm minimization will be use to

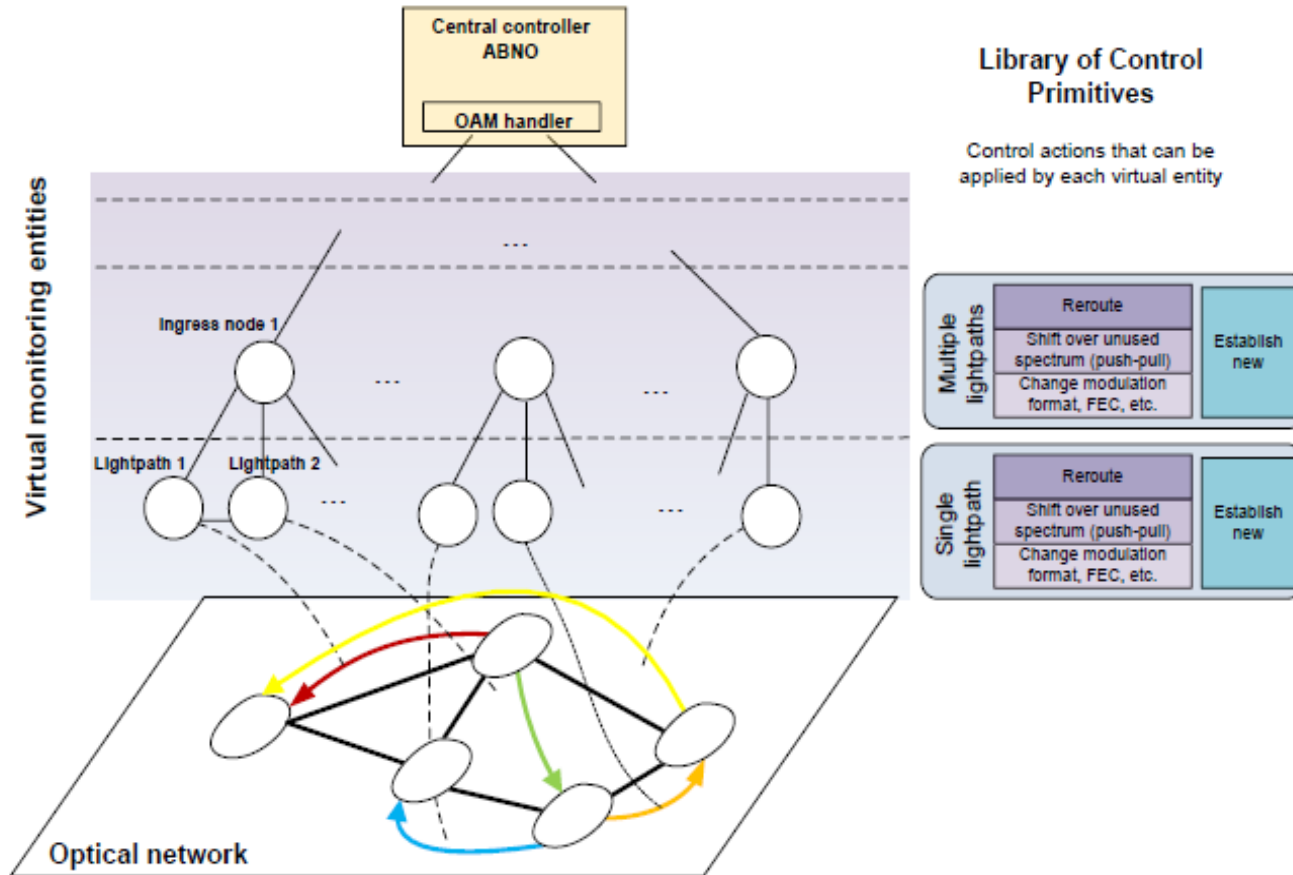
- Improve accuracy of measured (monitored) values
- Predict QoT of new (unestablished) lightpaths and its effect on established ones
- Identify and localize soft- and hard-failures

Accurate knowledge of the physical layer enables **true-cross layer optimization**, reducing margins and increasing the efficiency of the system, which can be translated to savings in CAPEX and OPEX

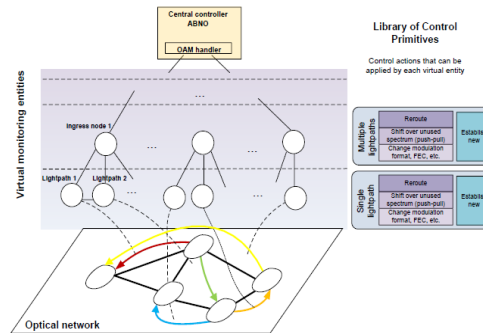
ORCHESTRA will develop algorithms for

- Pro-active network planning with close-to-begin-of-life margins
- Dynamic network operation
 - Dynamic adaptation to network changes: establishment of new connections, change of rate
 - Efficient hard- and soft-failures handling





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



- Monitoring plane
 - Develop a **hierarchical** monitoring infrastructure: consist of virtual entities and agents, with the Operation Administration and Maintenance (OAM) handler of the ABNO controller placed at the root
 - Support active and passive monitoring functions
 - Hierarchy: effective processing of **monitoring information** (filter, correlation) and **fault management**, avoiding bottleneck issues of centralized approaches
- Control plane
 - Actions organized in a **library of control primitives**: tuning of transmission parameters (changing mod. form, FEC, bandwidth, power), shift over unused spectrum (push-pull), rerouting, for a single or multiple lightpaths
 - Centralized and hierarchical control plane approaches will be examined

- ❑ ORCHESTRA relies on information provided by coherent transceivers that can be extended, almost for free, to operate as software-defined optical performance monitors
- ❑ ORCHESTRA will develop
 - Novel advanced DSP algorithms for real-time multi-impairment monitoring
 - A novel hierarchical monitoring plane to handle monitoring information in an efficient and scalable manner
 - Correlation algorithms for impairment information from multiple soft-OPMs, to provide an even better understanding of the physical layer
 - Optimization algorithms that exploit the advanced monitoring functions to enable true cross-layer optimization
- ❑ To yield unprecedented network capacity efficiency and higher network availability



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