



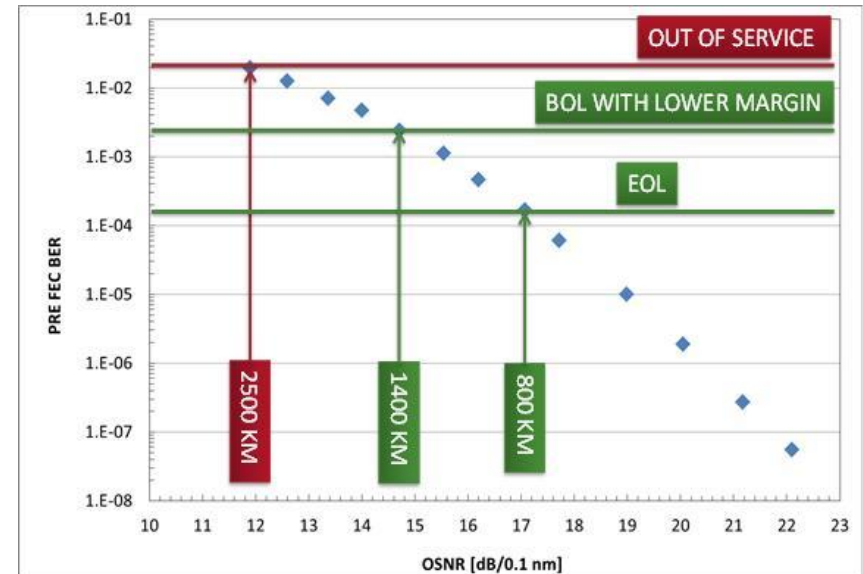
## ORCHESTRA – Optical performance monitoring enabling flexible networking

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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](http://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**)



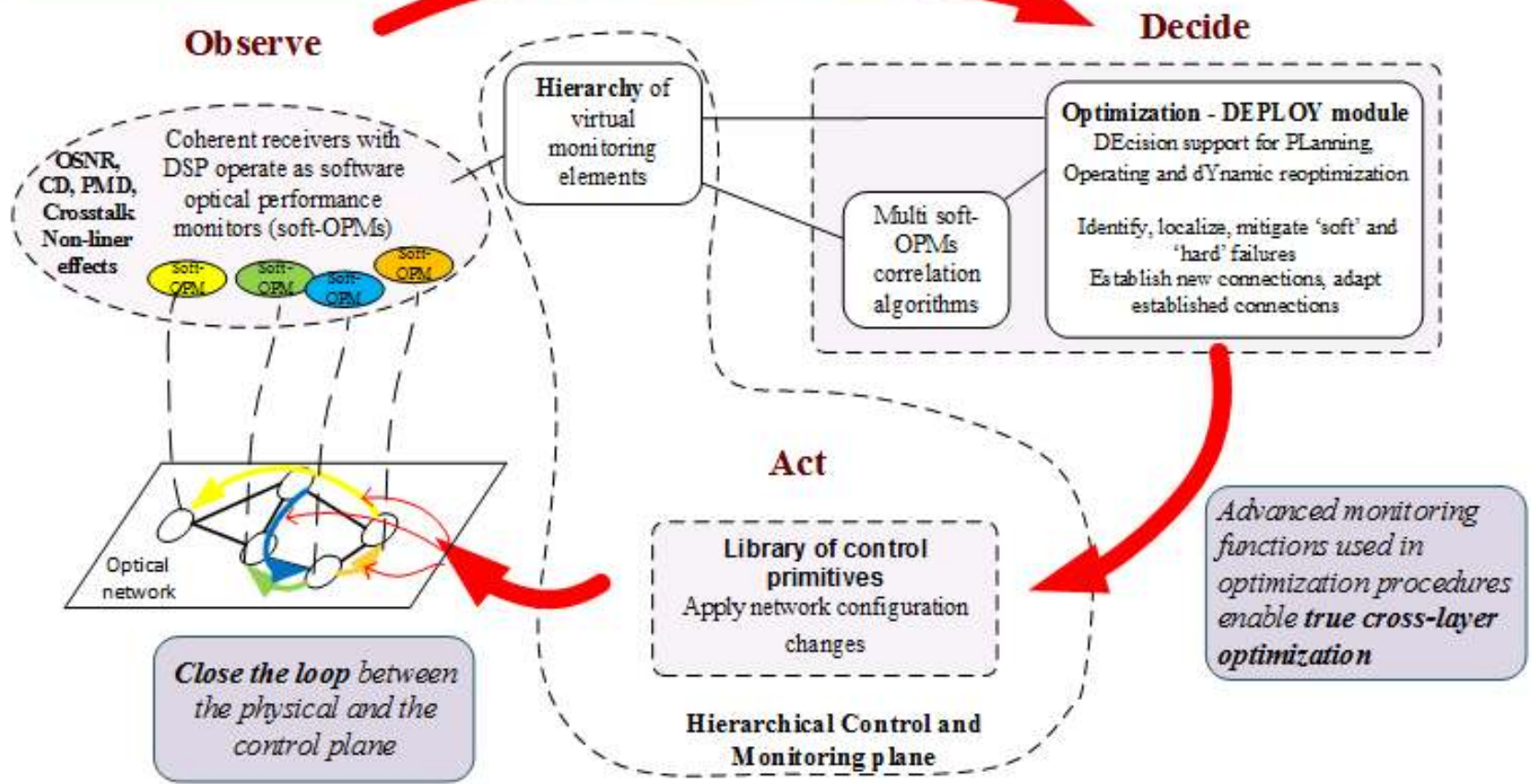
- NEXTWORKS (**NXW**)



# The Big Picture

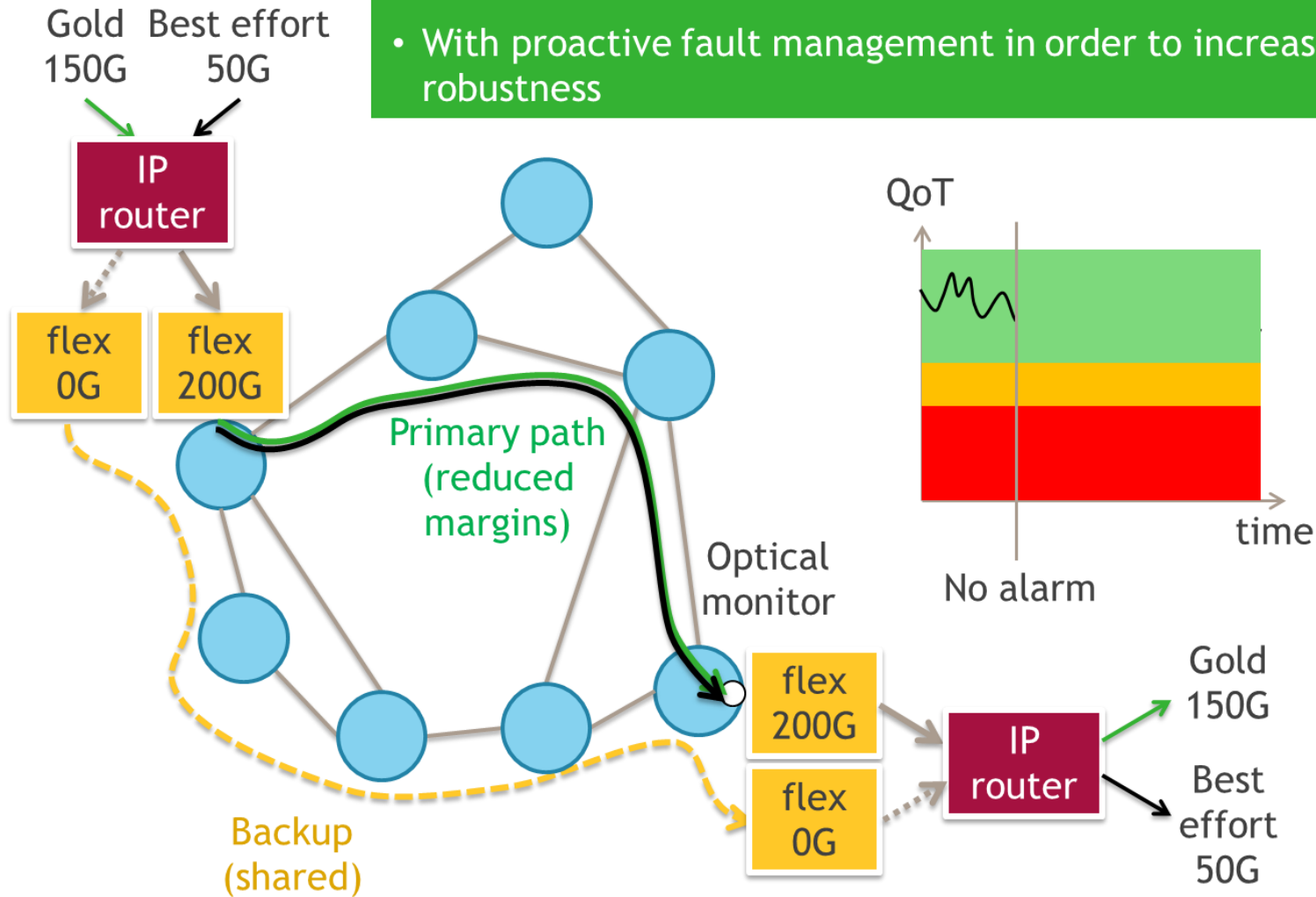
*Advanced DSP algorithms add real-time multi-impairment monitoring capability to coherent receivers  
Monitors operate in a **threshold, periodic, or active** manner*

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

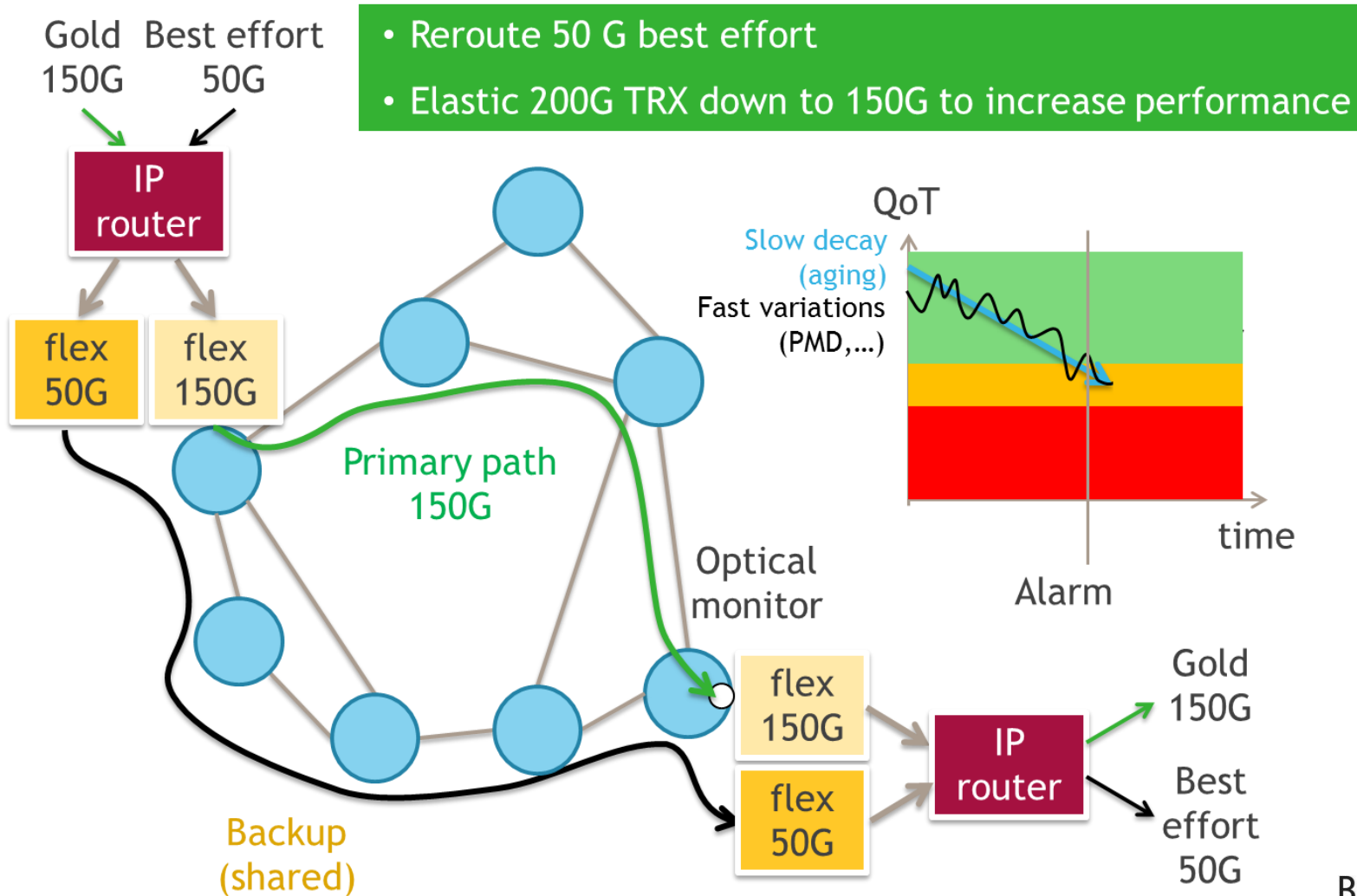


# Postpone Investment

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

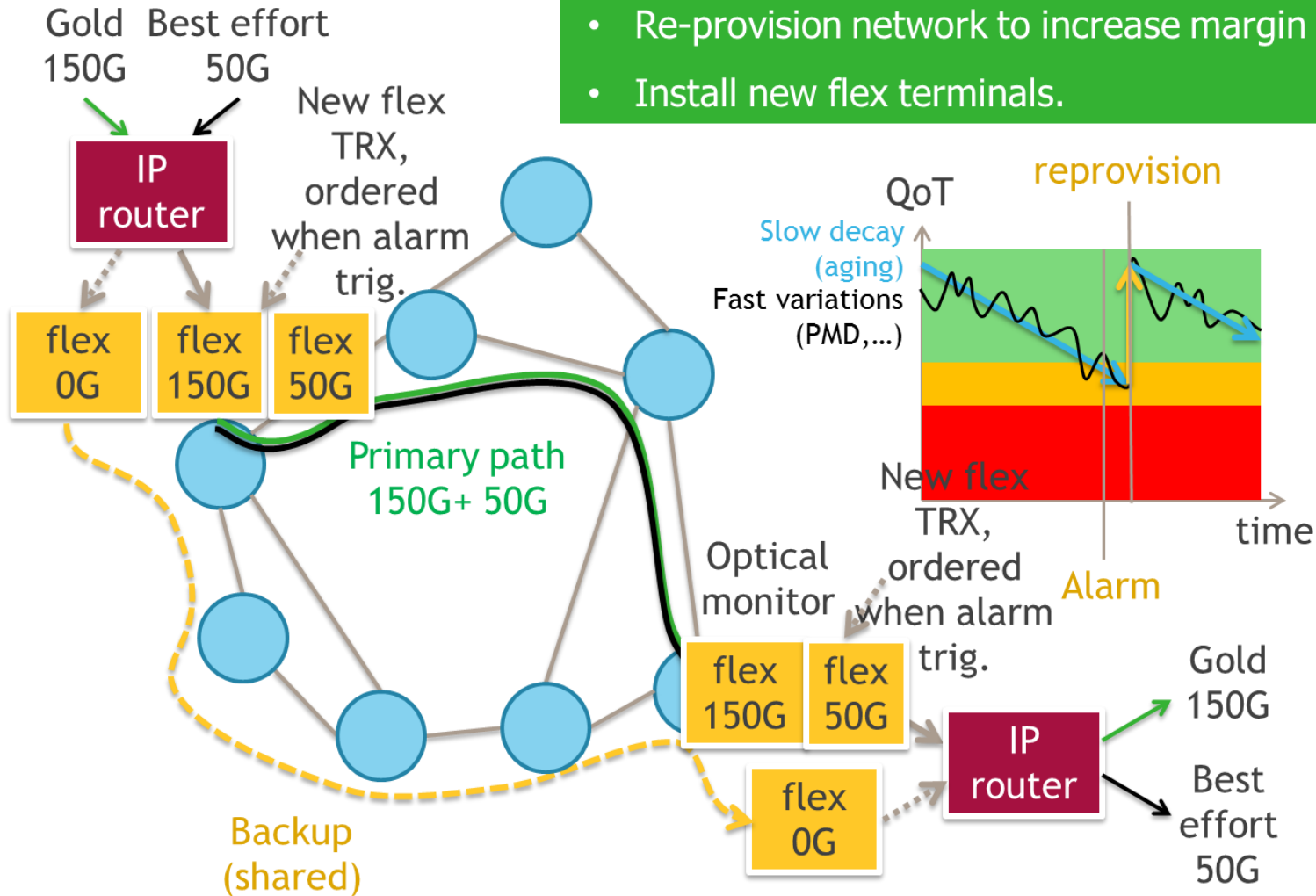


# Routing and Use of Port Flexibility



# Proactive Network Operation

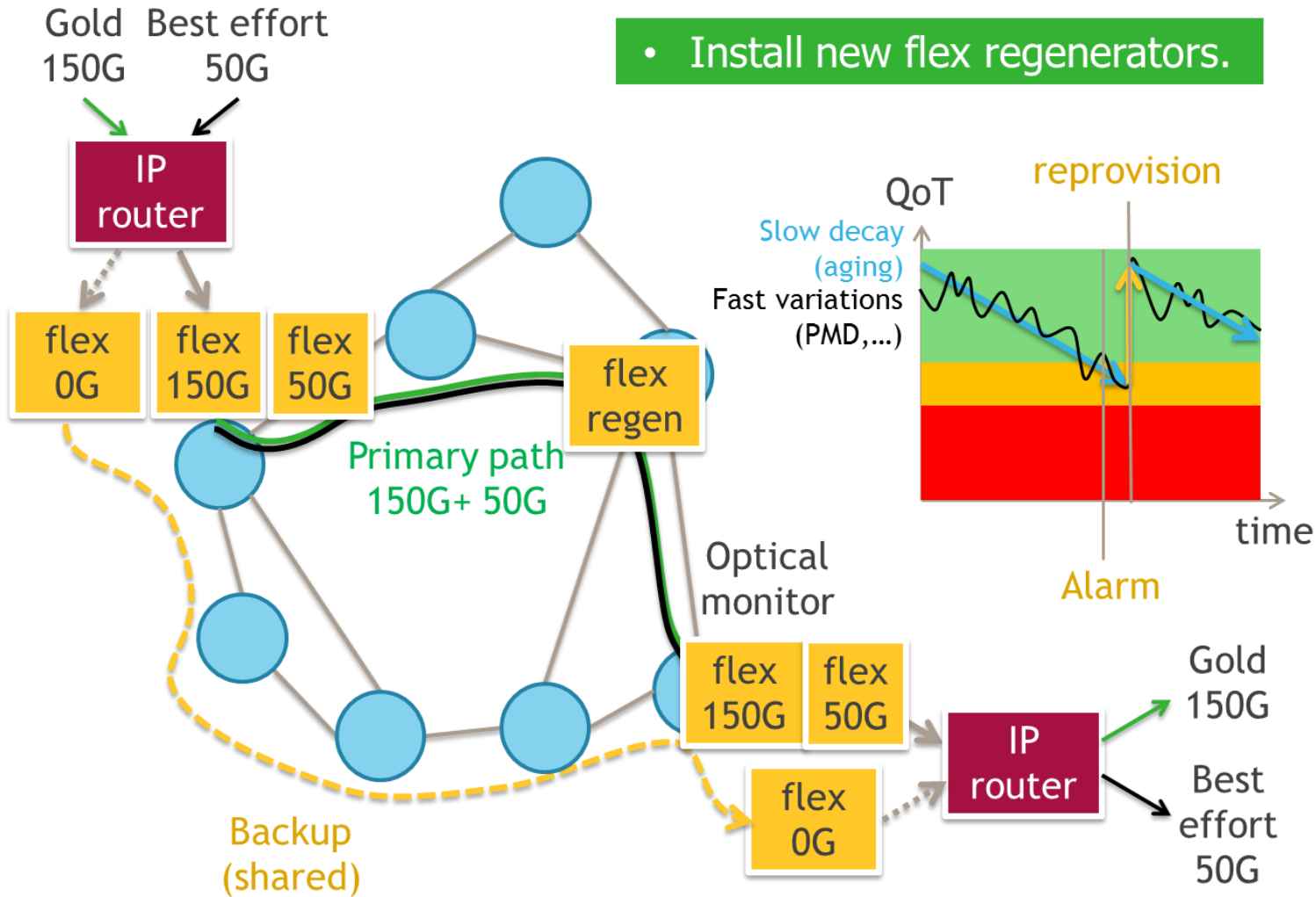
- Re-provision network to increase margin
- Install new flex terminals.

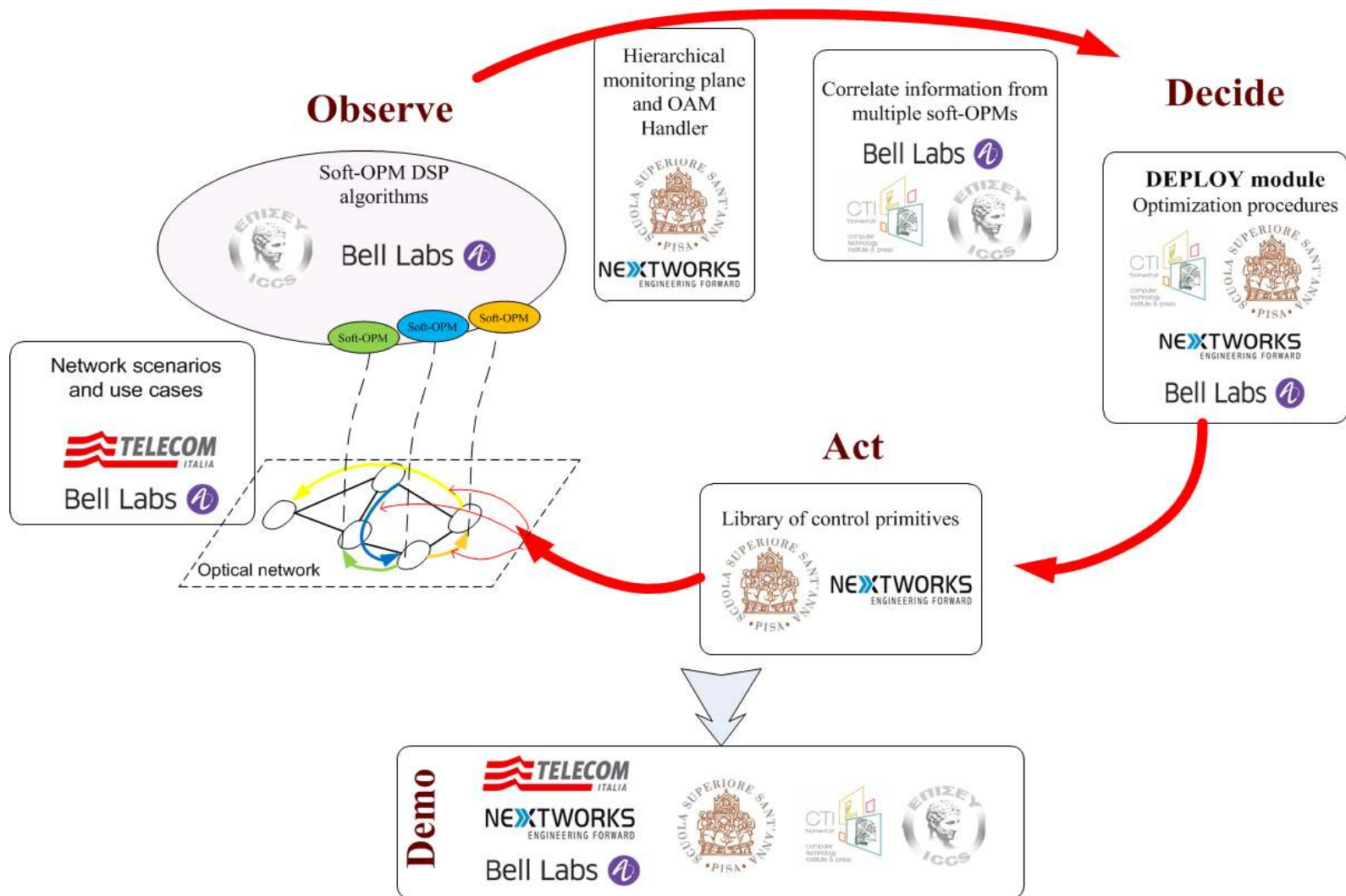




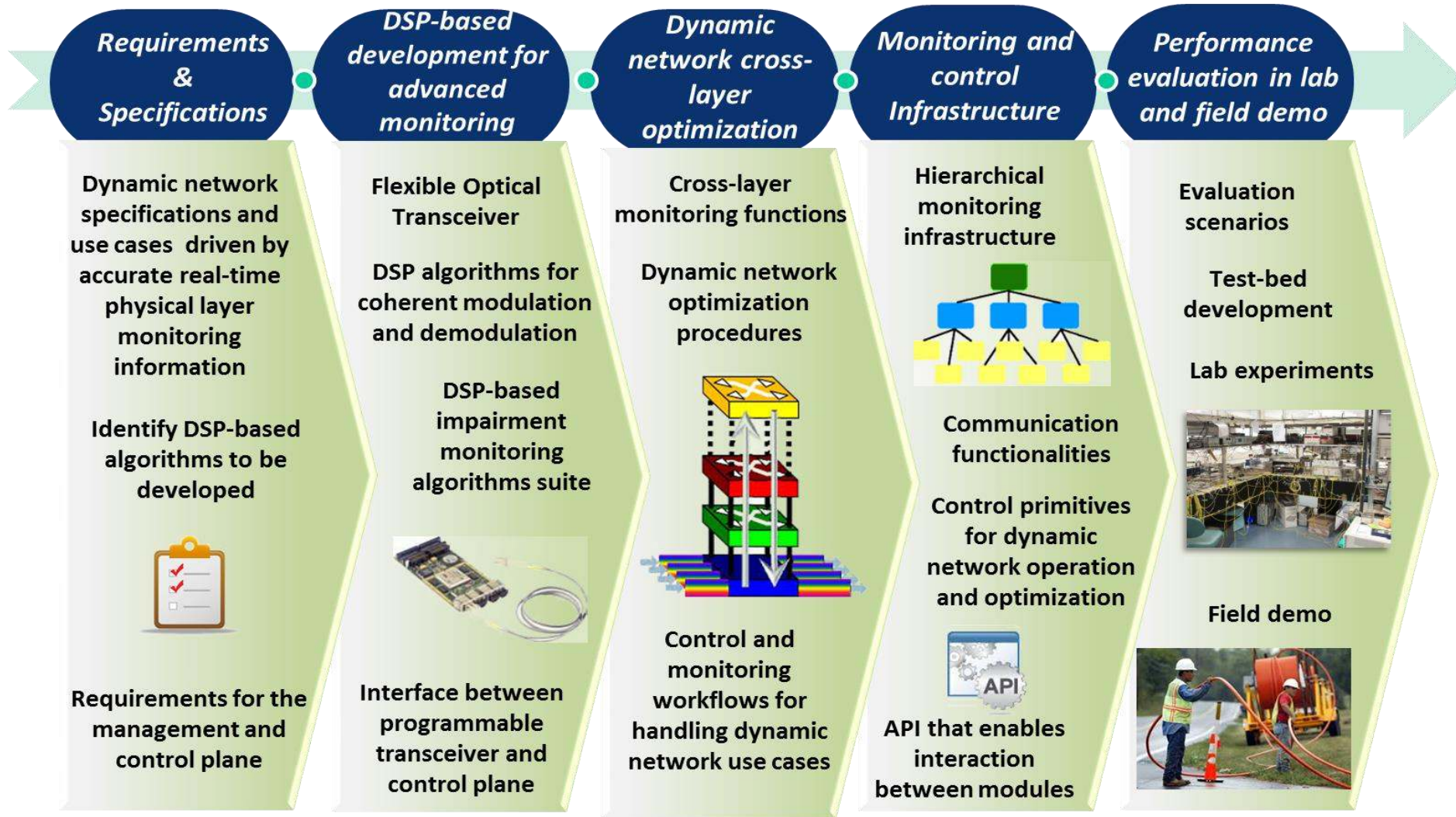
# Postpone Regenerator Provisioning

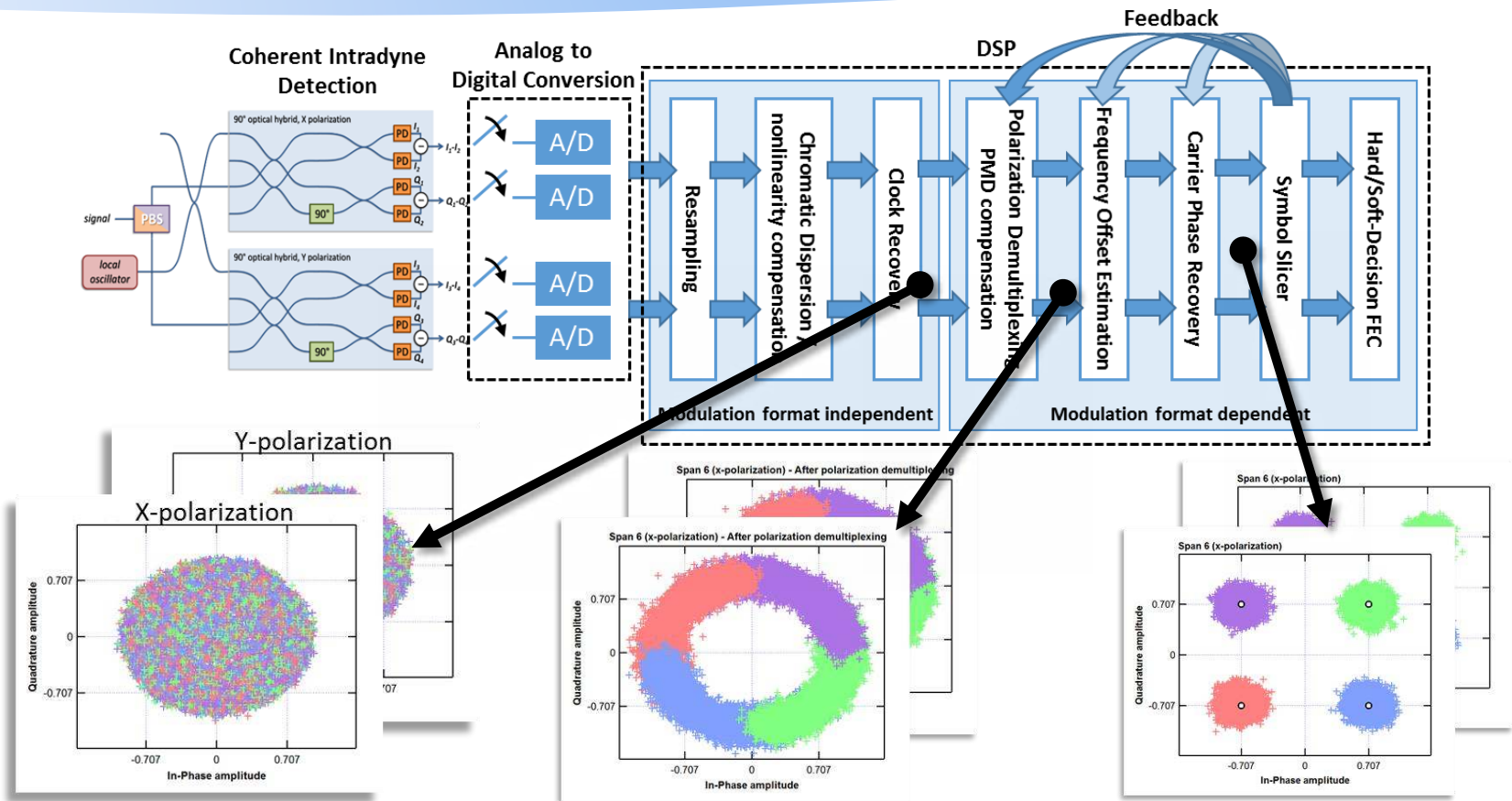
- Install new flex regenerators.





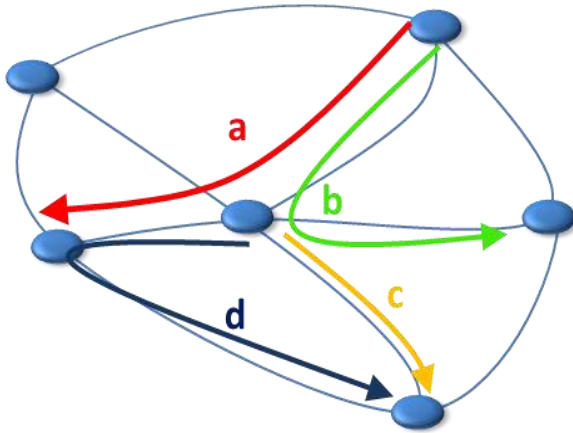
# Overall Approach





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

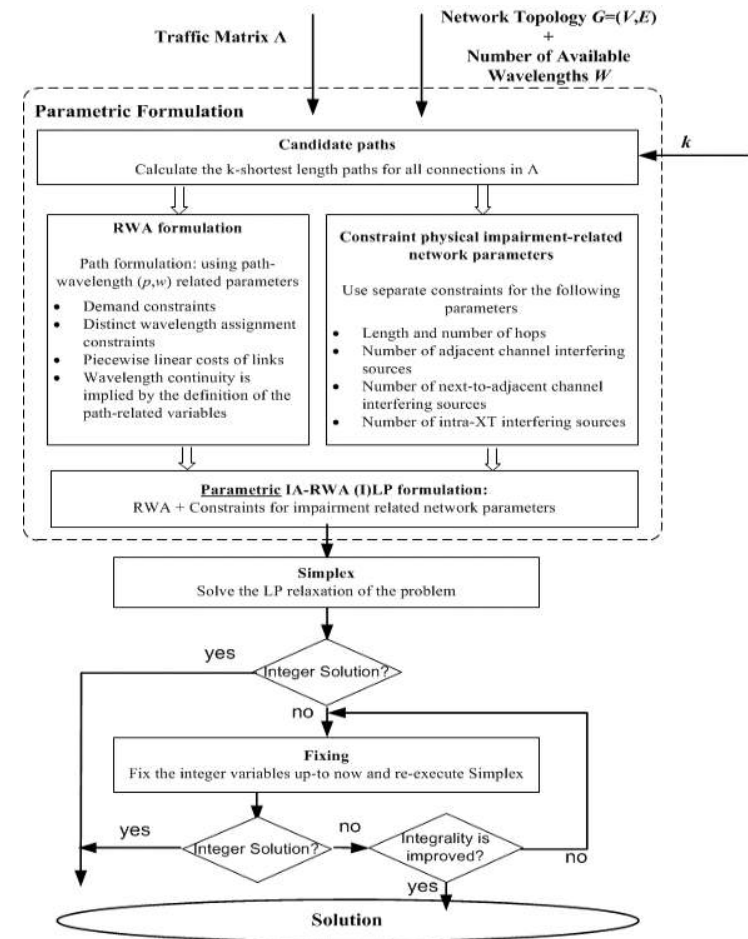
Correlation algorithms such as network kriging and norm minimization will be use to

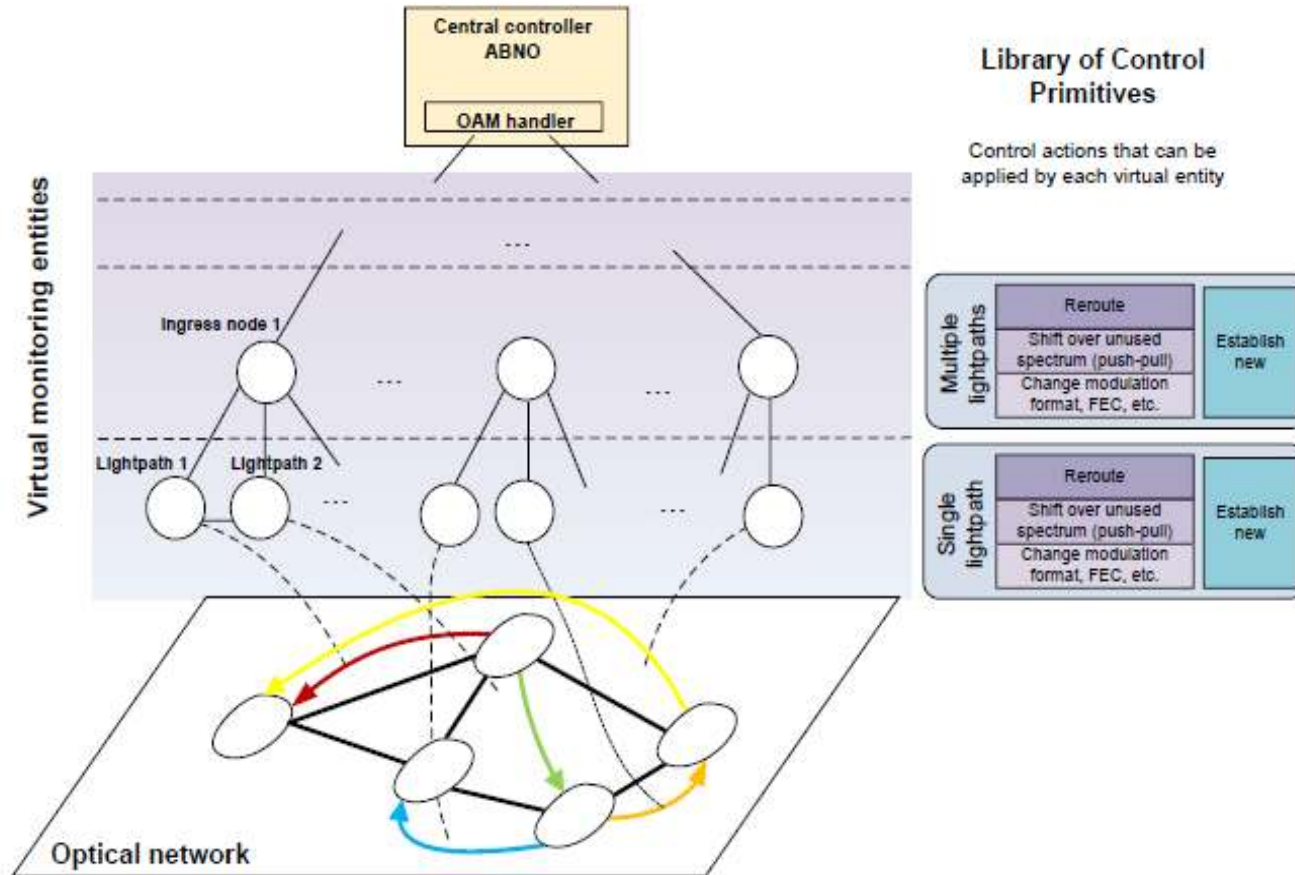
- Improve accuracy of measured (monitored) values
- Predict QoT of new (unestablished) lightpaths and its effect on established ones
- Identify and localize soft- and hard-failures

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

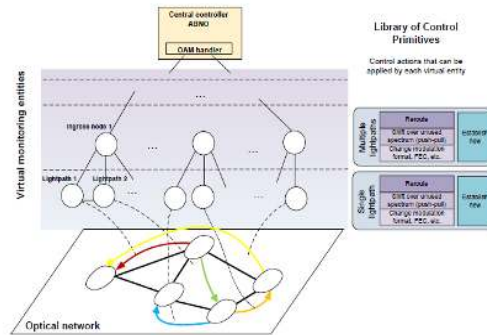
ORCHESTRA will develop algorithms for

- 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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