Adapting OpenFlow to control the optical devices

the results of the work of the Optical Task Force in OFELIA project

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Agenda

1. OFELIA in a nutshell.
2. Challanges to be addressed
   - why do we need GMPLS,
3. Evolution
   - virtual Ethernet switch,
   - extended OpenFlow protocol,
   - extended OpenFlow controller,
4. Final approach
   - milestone 1 – loose paths,
   - milestone 2 – explicit paths,
   - milestone 3 – experimental support for switching constraints,

OFELIA in a nutshell

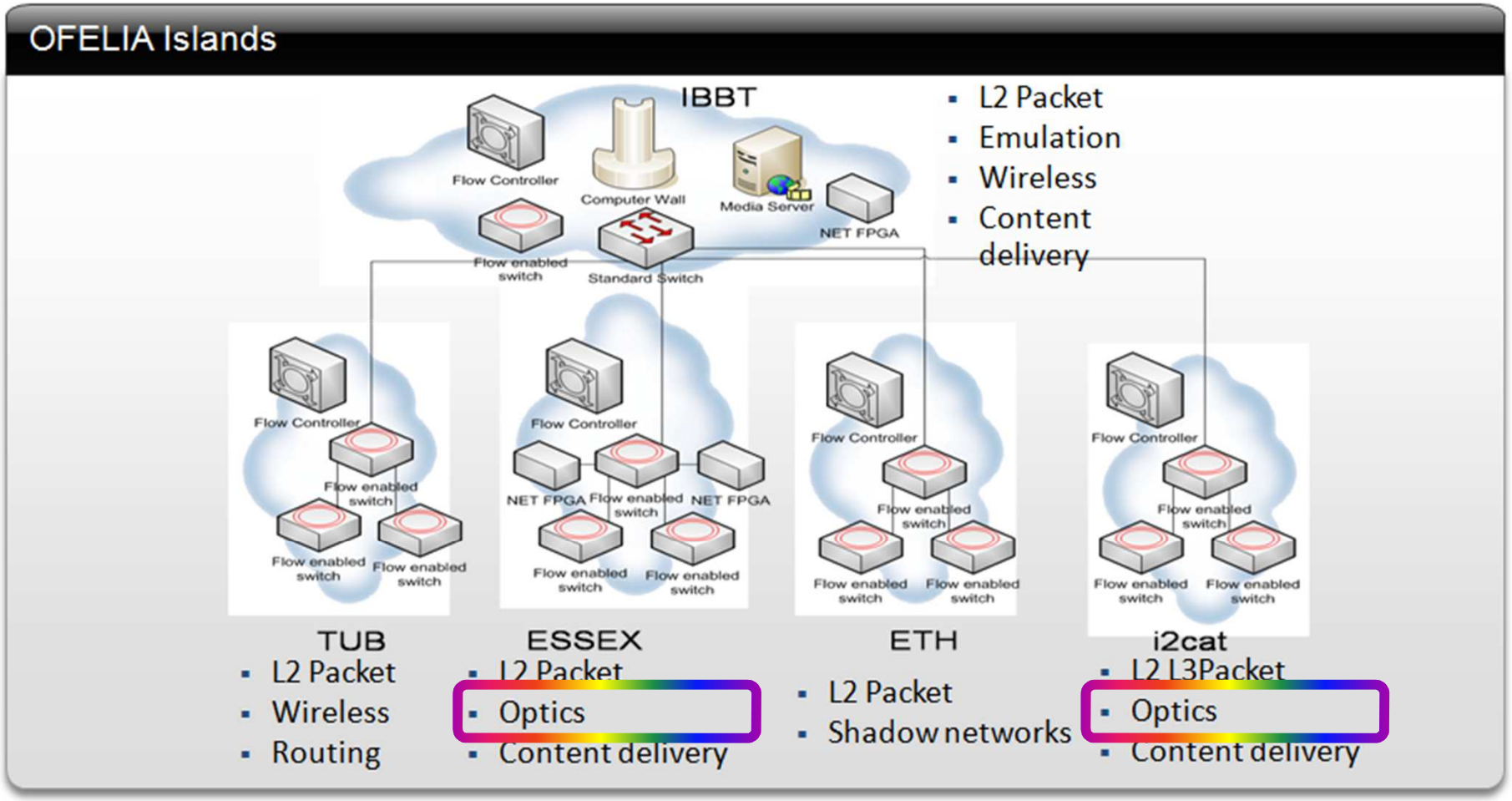
overview

- **O**pen**F**low in **E**urope – **L**inking **I**nfrastructure and **A**pplications
- The goal is to create **a unique experimental facility** that allows researchers to not only **experiment on a test network** but to **control the network itself** precisely and dynamically.
  - The OFELIA facility is based on **OpenFlow** that allows virtualizing and controlling the network environment through secure and standardized interfaces.
  - OFELIA belongs to the **second wave** of **FIRE** projects under FP7
    - FIRE: “Experimentally validating highly innovative and revolutionary ideas”

- EC contribution:€ 4,450,000
- Project start date: 1 October 2010
- Duration: 36 months (3 years)

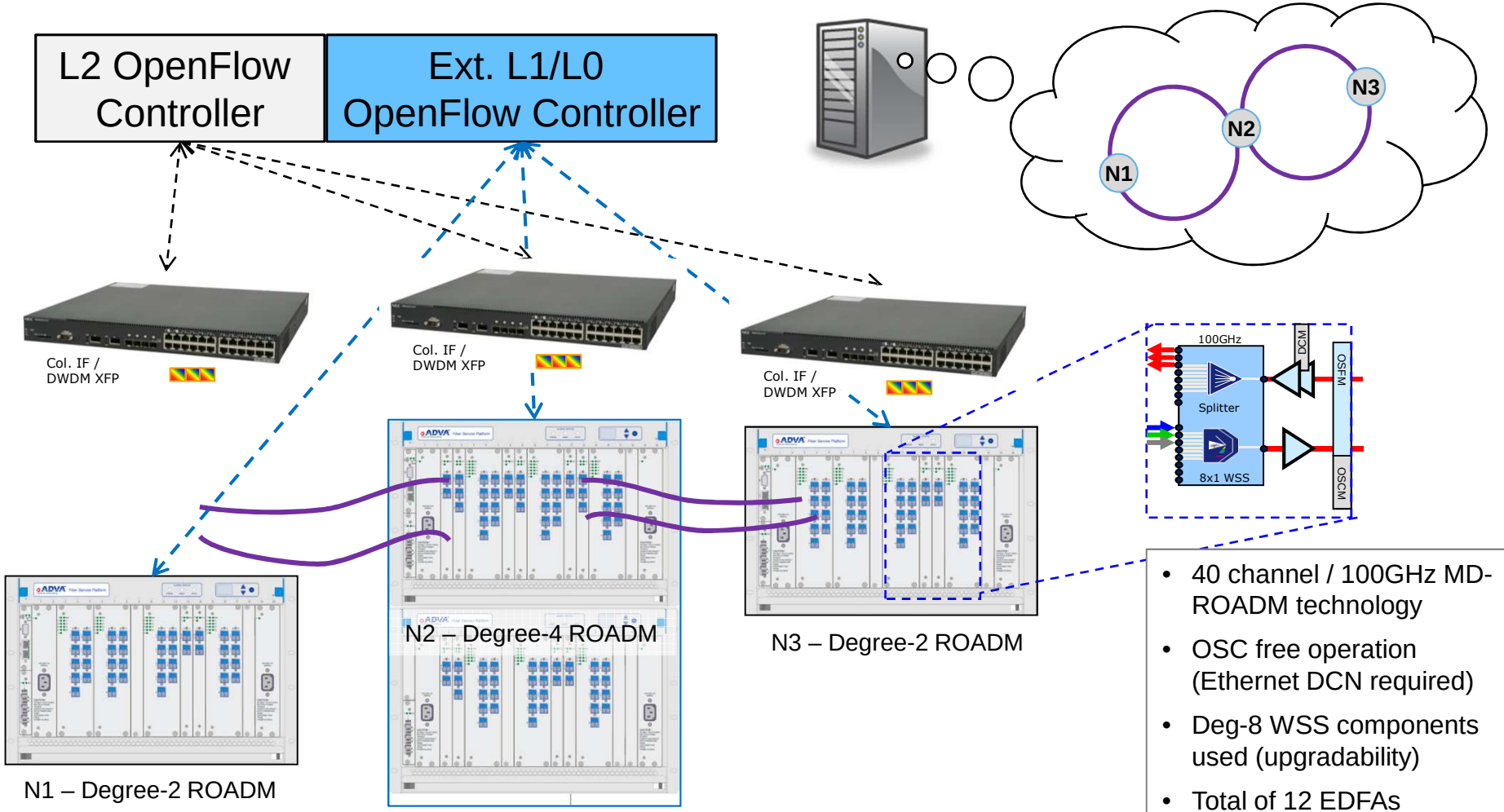
OFELIA in a nutshell

islands



OFELIA in a nutshell

University of Essex testbed



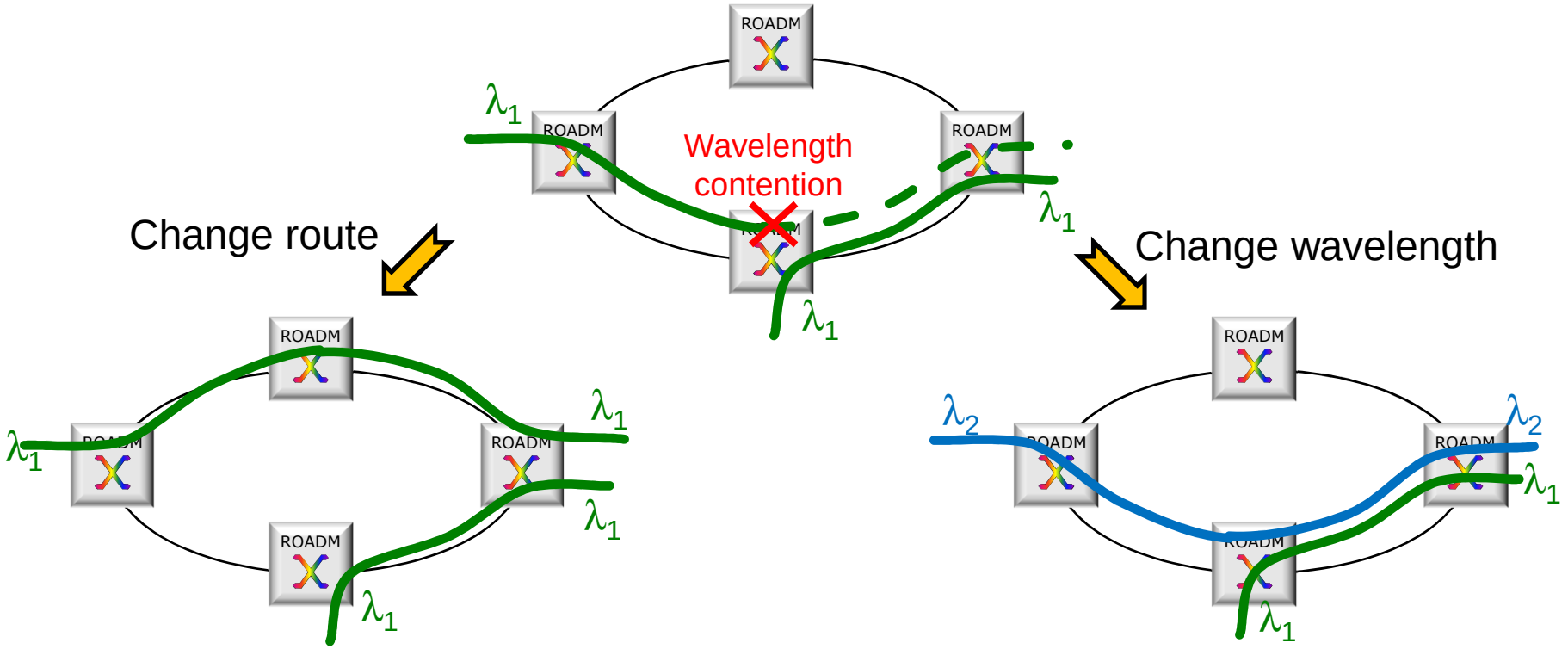
- 40 channel / 100GHz MD-ROADM technology
- OSC free operation (Ethernet DCN required)
- Deg-8 WSS components used (upgradability)
- Total of 12 EDFAs
- Tunable DWDM interfaces in client equipment

N1: eROADM, 40ch fixed a/d
N2: deg4-ROADM, 8ch c&d-less add/drop
N3: deg2-ROADM, 8ch c&d-less add/drop

Challanges to be addressed

optical networks are constrained

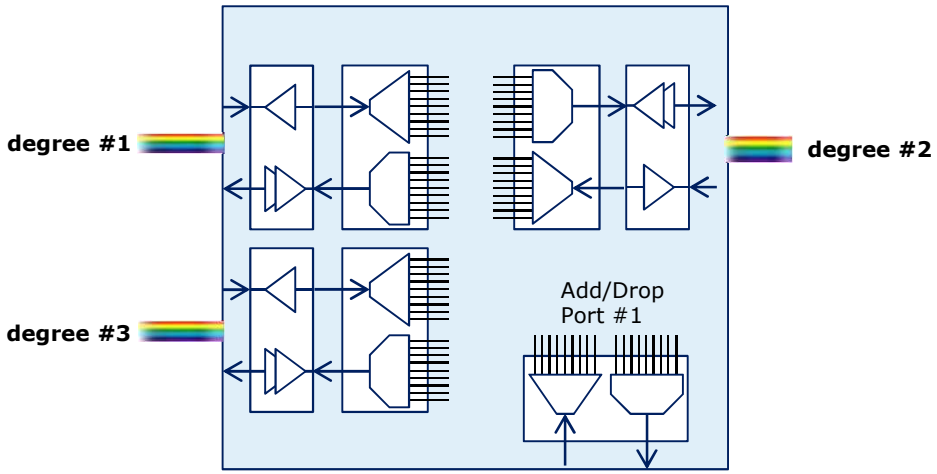
- Lightpath continuity must be guaranteed
  - ingress and egress with fixed ports,
  - ingress and egress with tunable ports,
  - more complex path computation for the systems with lamda conversions



Challenges to be addressed

switching constraints

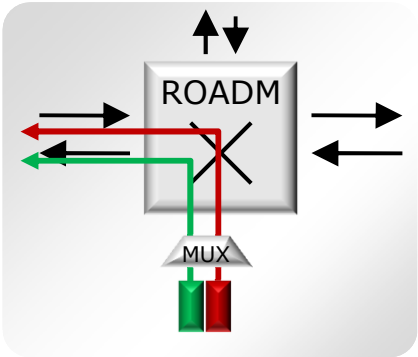
- Switching constraints
  - map of internal connections and dependancies in digested form,
  - updated per each operation in transport plane,
  - used (together with topology graph) as an input for path computation,
- Huge variety of different hardware configurations
  - FOADM,
  - ROADM (directed, directionless, directionless and colorless),
  - support for 40 and 80 channel grids (interleved and non-interleved),
  - regenerators,



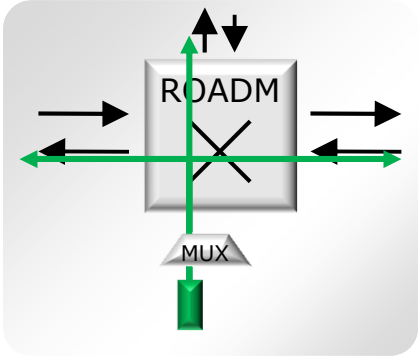
Challenges to be addressed

switching constraints

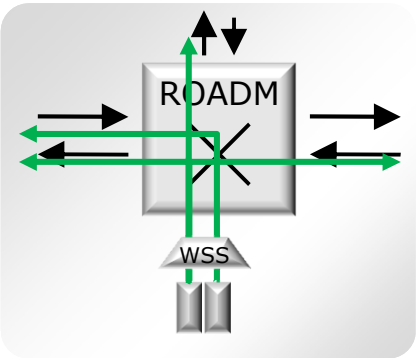
Fixed



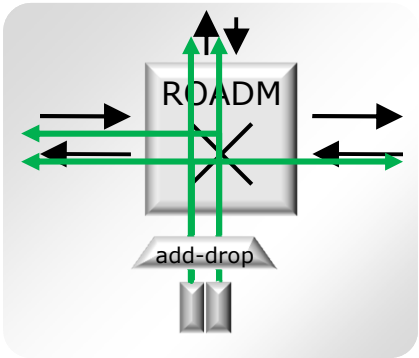
Directionless



Dir-/Colorless



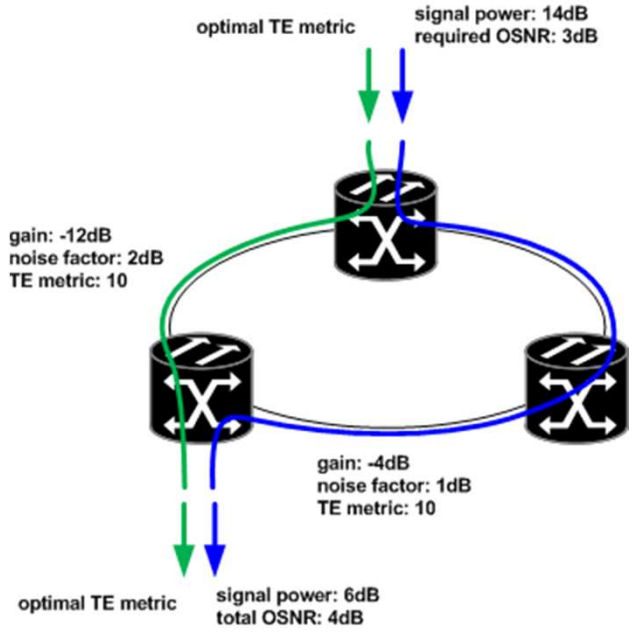
Contentionless



Challenges to be addressed

path computation with optical impairments

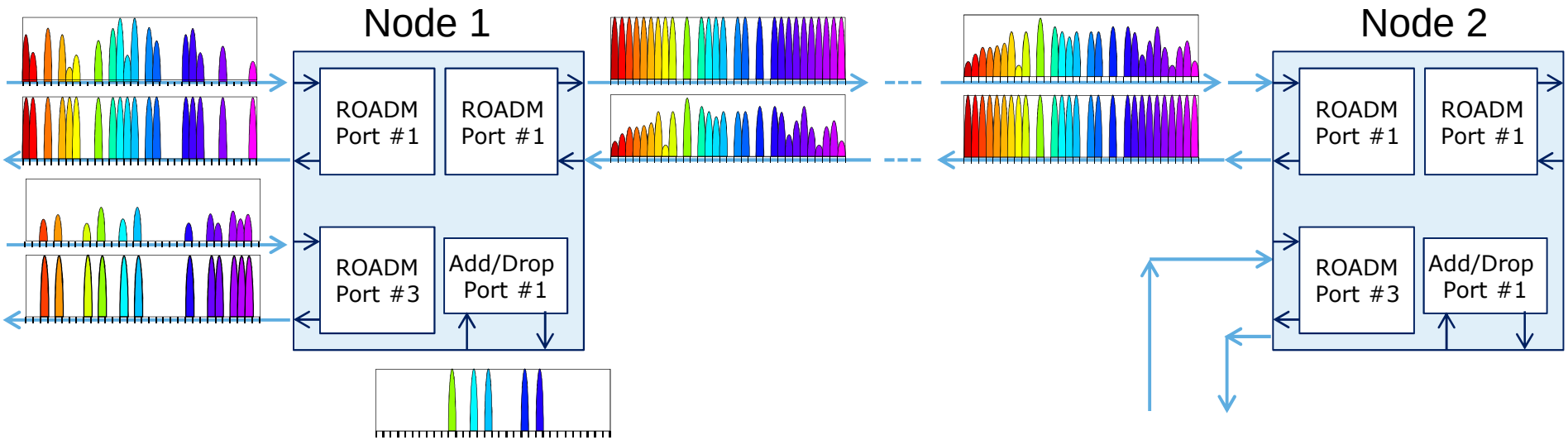
- The objective is to compute an optimal path satisfying given set of constraints
- Transmission parameters depend on wavelength
- Physical attributes depend on the direction within the optical link
- Node-level and path-level calculations required



Challenges to be addressed

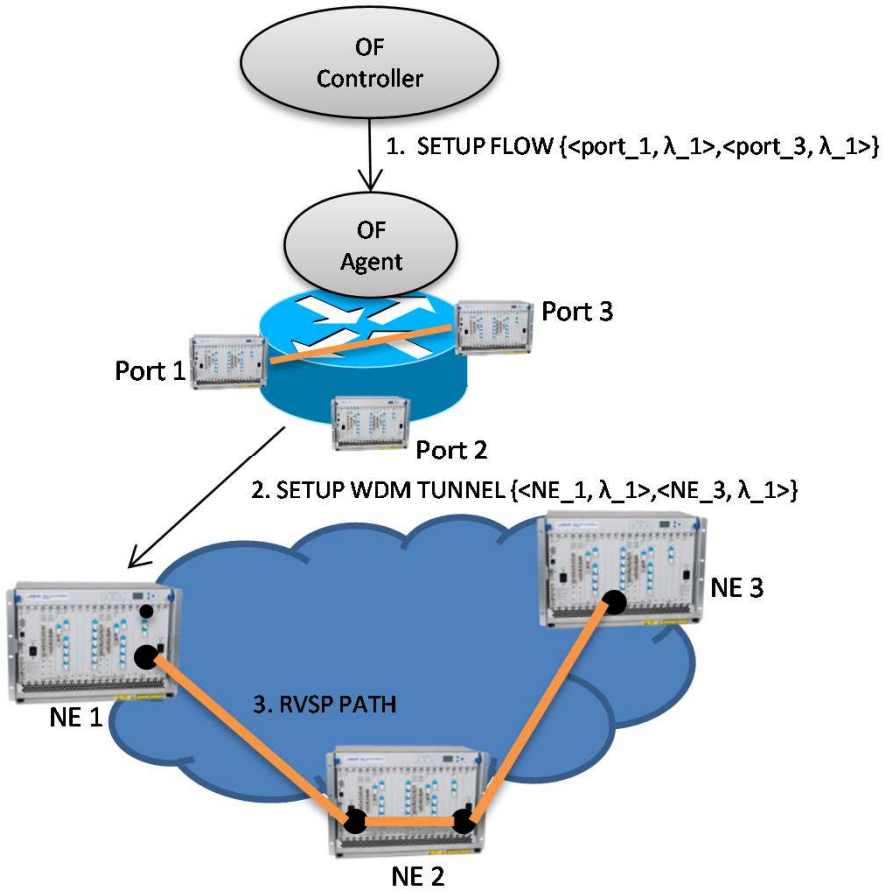
power equalization

- Allow to measure and adjust individual wavelength power values
- Maintain the wave-lengths within an adjustment band
- Adding a new lambda results in correction in the whole spectrum
- Power equalization process is bi-directional
- Control plane automates the process by means of RSVP-TE



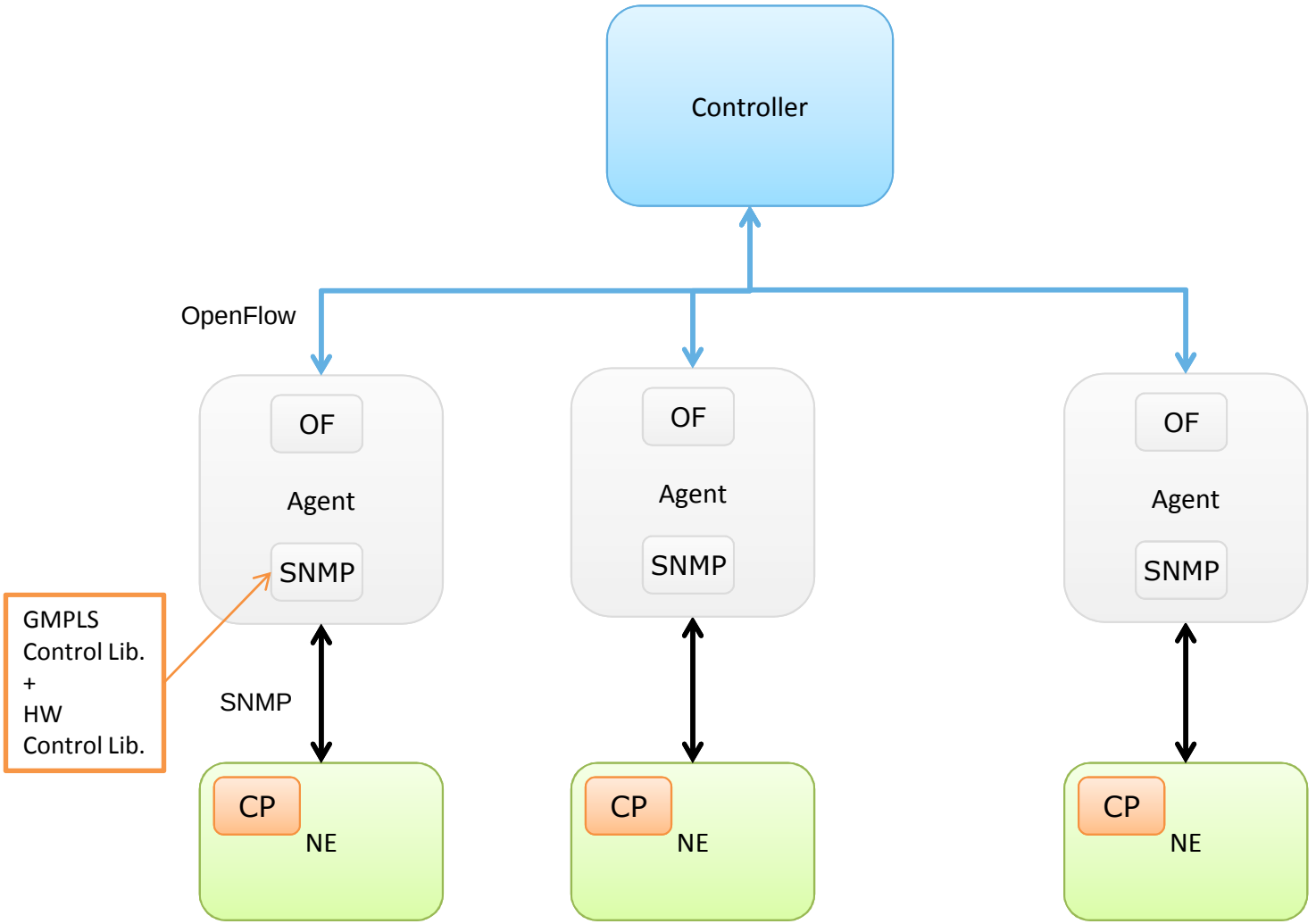
Evolution

virtual Ethernet switch



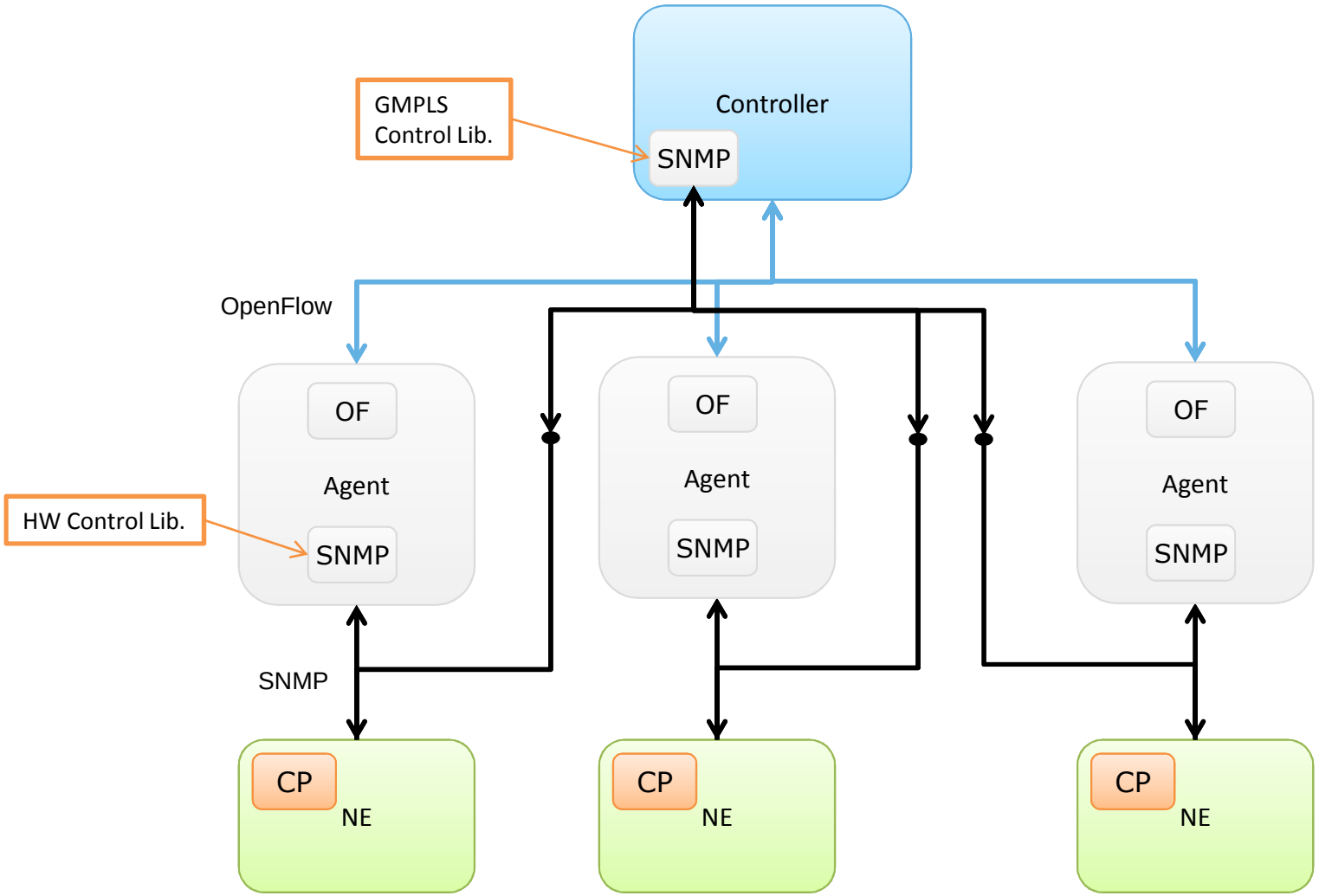
Evolution

extended OpenFlow Protocol



Evolution

enhanced OpenFlow Controller



Final approach

the summary of the milestones

- Final architectural approach
  - extended OpenFlow Controller,
  - GMPLS control library embedded in the controller not agent
  - extensions to OpenFlow protocol are still planned to be used to cover experimental supprot for switching constraints,

- Extended OpenFlow Controller
  - two milestones,
  - milestone 1 – loose paths
  - milestone 2 – explicit paths

- Extended OpenFlow Protocol
  - milestone 3 – experimental support for switching constraints

Final approach

loose paths

- Short characteristics
  - basic functionality
    - agent can establish an OpenFlow channel with a controller
    - agent can establish SNMP connection with the NE
    - agent provides switch description and handles CFLOW_MODs
    - controller can issue CFLOW_MODs
  - a lightpath between ingress and egress is computed by ADVA control plane software,
  - user application provides to the Controller
    - ingress IP, egress IP
    - ingress port identifier, egress port identifier,
  - user application in this stage does not provide ERO,
  - ERO as well as RRO can be extracted thorugh GMPLS control library,
  - some capabilities of ports may be faked (e.g. port operational status, bandwidth),
  - handling and generating OF error messages or notifications may be not fully implemented (e. g. PORT_STATUS),

Final approach

explicit paths

- Short characteristics
  - at this stage a lightpath between ingress and egress is provided (or computed) by the user application,
  - user application provides to the Controller
    - ingress IP, egress IP
    - ingress port identifier, egress port identifier,
    - full explicit path (as a sequence of nodes or outgoing interfaces)
  - GMPLS control library translates explicit path to MIB format,
  - before the signaling process starts given explicit path is verified by PCE on the devices,
  - identify and advertise useful port capabilities,
  - support for error messages and asynchronous notifications in the OF,

Final approach

switching constraints

- Short characteristics
  - reference documents
    - RFC6163,
    - draft-ietf-ccamp-general-constraint-encode,
    - draft-ietf-ccamp-gmpls-general-constraints-ospf-te
  - the most experimental topic,
    - curcuit switching extensions,
    - extensions for exposing switching constraints,
    - synthetizing constraints from the raw map of inetrnal NE connections
  - puts higher expectations on user application (must be able to consume switching constraints),
  - GMPLS control library translates explicit path to MIB format,
  - before the signaling process starts given explicit path is verified by PCE on the devices,

Thank you

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