FLEX-SCALE

Flexibly Scalable Energy Efficient Networking

FLEX-SCALE - SUSTAINABLE CONTROL OF PACKET & OPTICAL TRANSPORT NETWORKS FOR 6G

6G Series Workshop by HEXA-X-II, 14th February 2024

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INTRODUCTION TO THE FLEX-SCALE PROJECT

FLEX-SCALE PROJECT CONSORTIUM

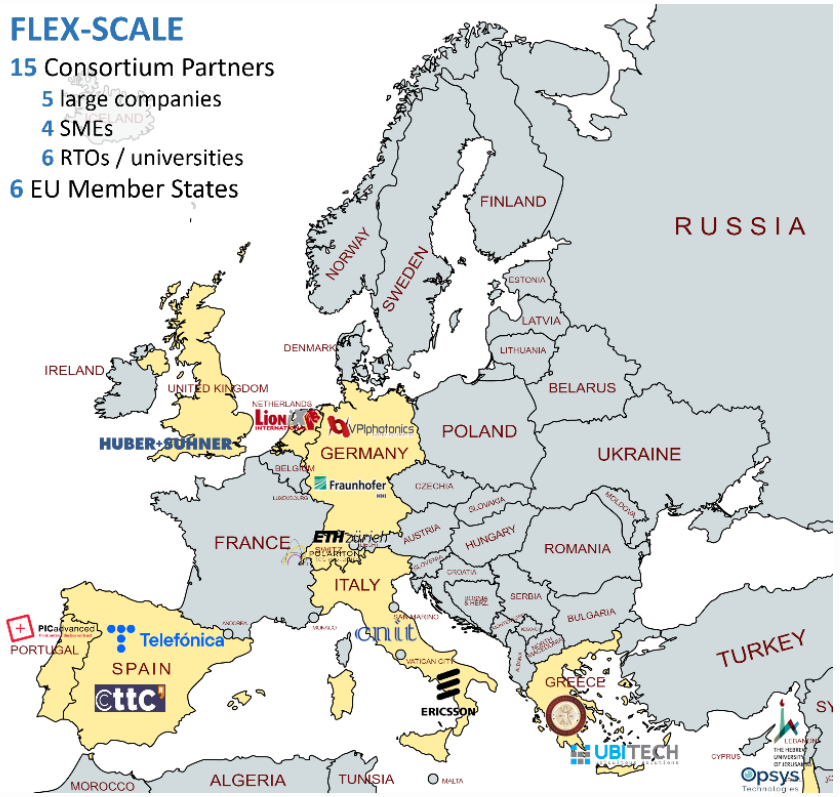
Work programme	HORIZON-JTI-SNS-2022
Programme Topic	STREAM-B-01-03
Type of action	HORIZON-JU-RIA
Project acronym:	FLEX-SCALE
Contact person:	Prof. Ioannis Tomkos (UPAT)
List of participants:	

UNIVERSITY OF PATRAS
CONSORZIO NAZIONALE INTERUNIVERSITARIO PER LE TELECOMUNICAZIONI
CENTRE TECNOLOGIC DE TELECOMUNICACIONS DE CATALUNYA
HUBER+SUHNER POLATIS LIMITED
FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
THE HEBREW UNIVERSITY OF JERUSALEM
LIONIX INTERNATIONAL BV
OPSYS SENSING TECHNOLOGIES LTD
PICADVANCED, SA
ERICSSON TELECOMUNICAZIONI SPA
TELEFONICA INVESTIGACION Y DESARROLLO SA
UBITECH
VPIPHOTONICS GMBH
EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH
POLARITON TECHNOLOGIES AG

FLEX-SCALE

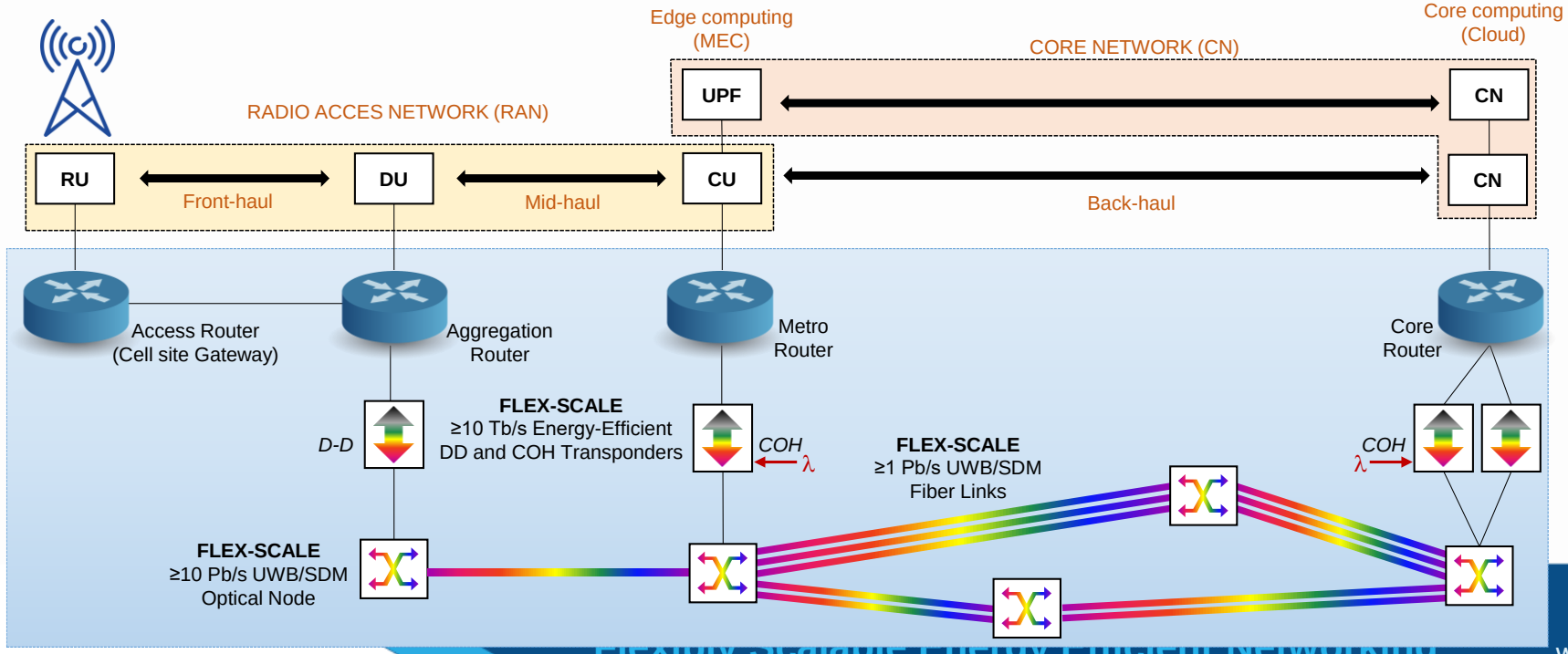
15 Consortium Partners
- **5** large companies
- **4** SMEs
- **6** RTOs / universities

6 EU Member States



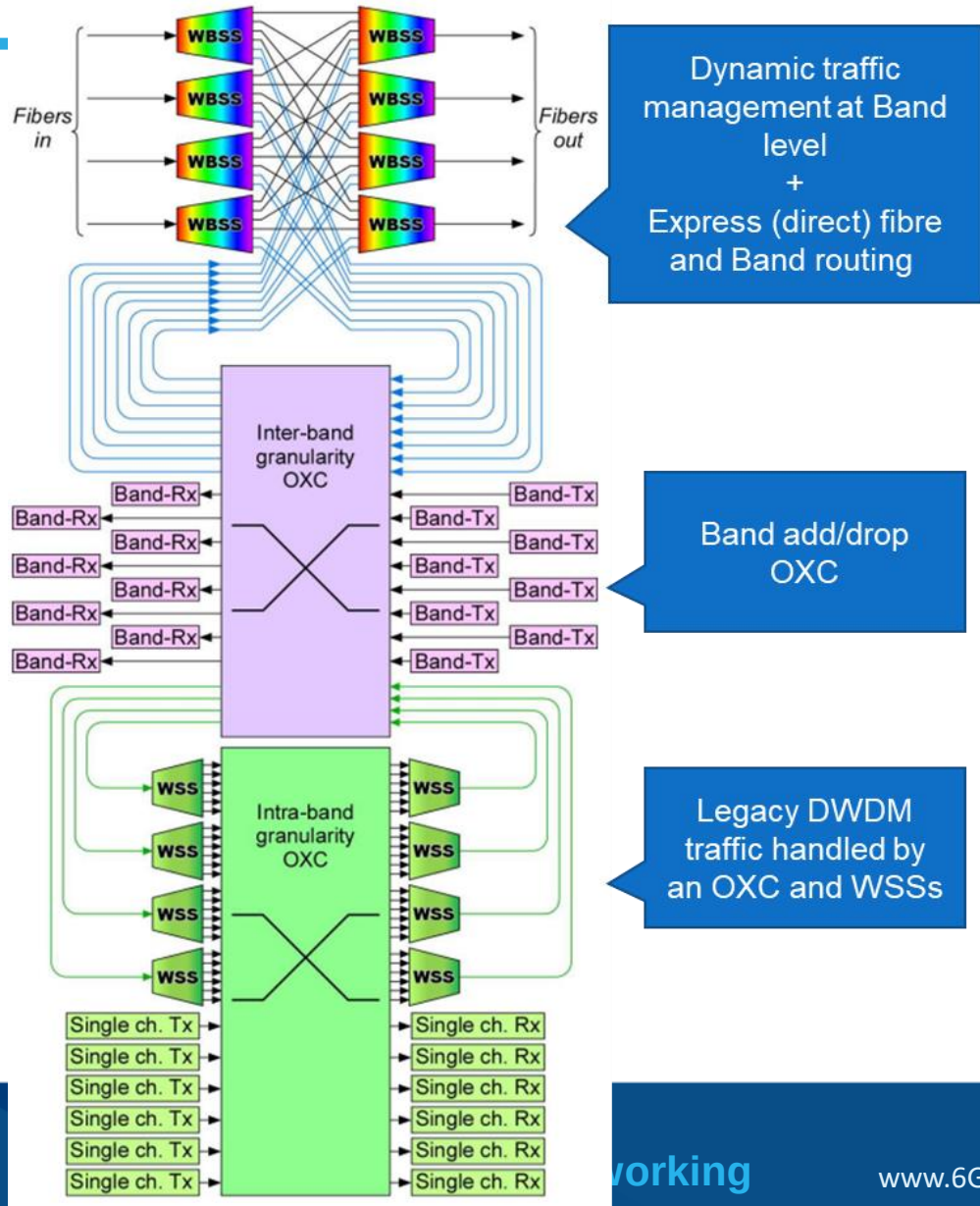
EC-FUNDED PROJECT FLEX-SCALE SCOPE: 6G OPTICAL MID/BACK-HAUL

- FLEX-SCALE consortium develops innovations that will enable flexible capacity scaling of 6G x-haul networks, while ensuring security and reducing costs & energy consumption per packet-flows, by utilizing:
  - Optoelectronic interfaces of line-systems to scale to ≥10 Tb/s,
  - Network link capacities to scale ≥1 Pb/s by utilizing UWB/SDM multiplexing schemes
  - Optical switching node capacities to scale to ~tens Pb/s
  - SDN automation of packet-optical x-haul network operation



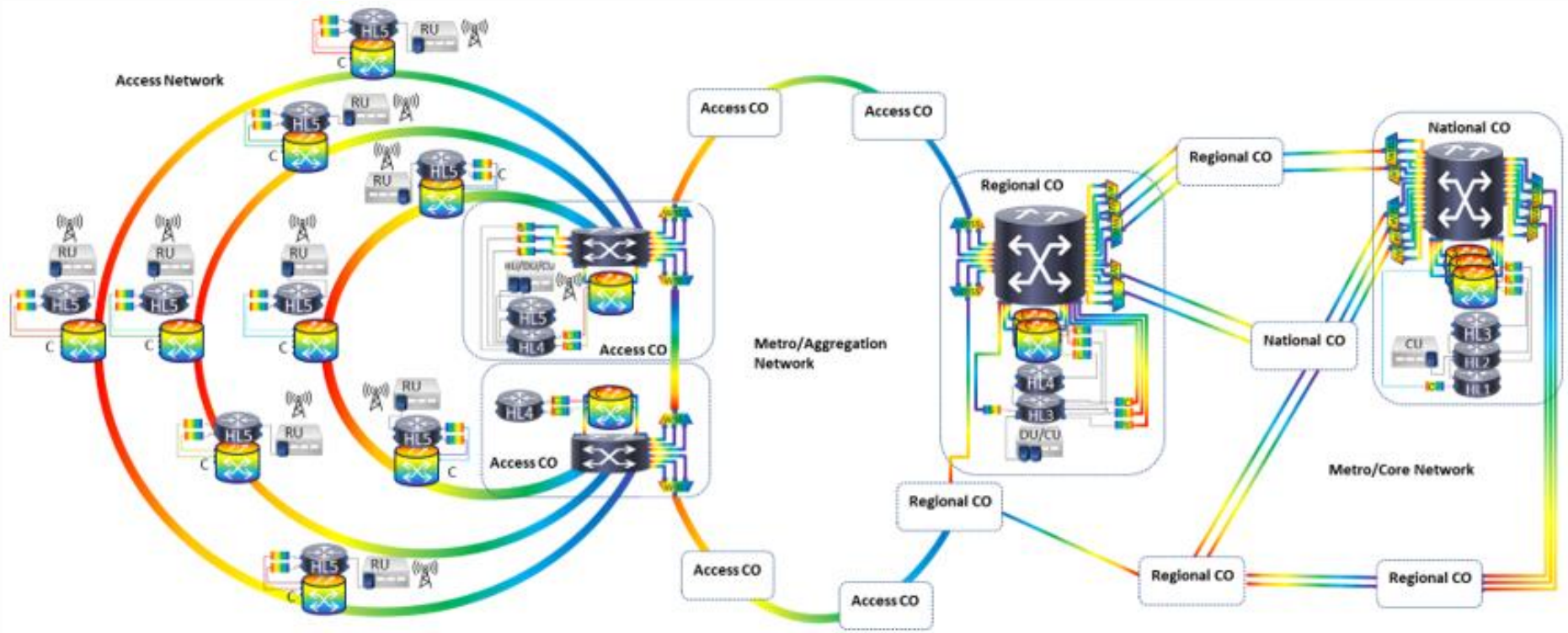
FLEX-SCALE MULTI-GRANULAR OPTICAL NODE ARCHITECTURE

- The FLEX-SCALE Optical Switching Node architecture is based on a novel Multi-Granular architecture (MG-ON) and a new switching subsystem that can realize reconfigurable WaveBand-Selective Switching (WBSS), in addition to Spatial (i.e. fibers) and Spectral (i.e. wavelengths) Lanes switching using enhanced Optical Xross Connects (OXCs) and Wavelength Selective Switching (WSS)
  - The WBSS is implemented as a compact programmable and rapidly reconfigurable PIC that is capable of dynamically processing the entire UWB WDM optical spectrum and as demanded dynamically carve portions of the spectrum into flexibly-defined, continuous and flat spectral bands, which are subsequently switched to multiple output ports.



FLEX-SCALE REFERENCE NETWORK ARCHITECTURE

- 6G Traffic aggregation at different network segments



OXC for full fibre switching

Waveband Selective Switch

Intraband OXC

Router

Band transponder

CPU

BBU Broadband Baseband Unit

DWDM transponder

Band transponder

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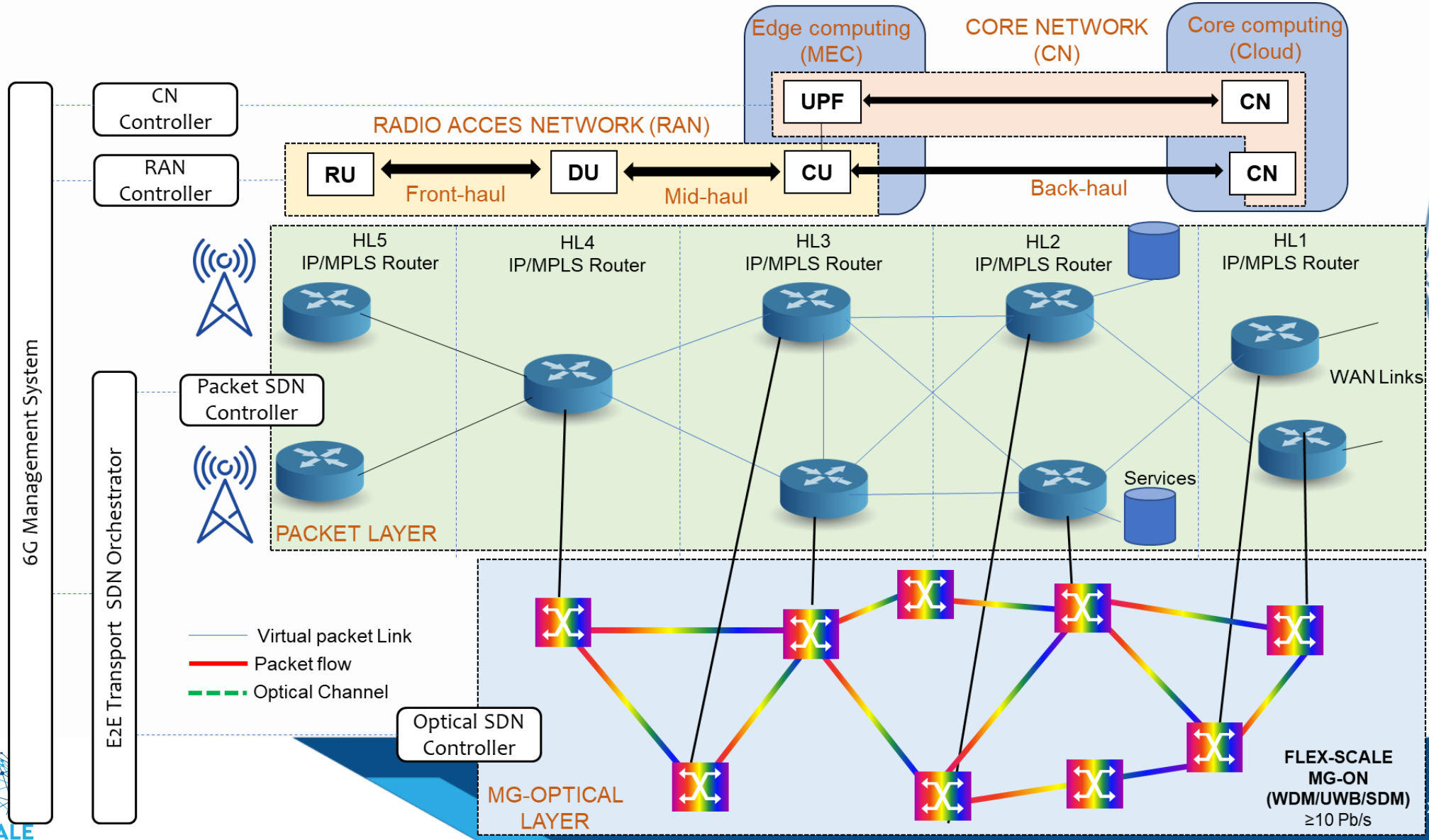
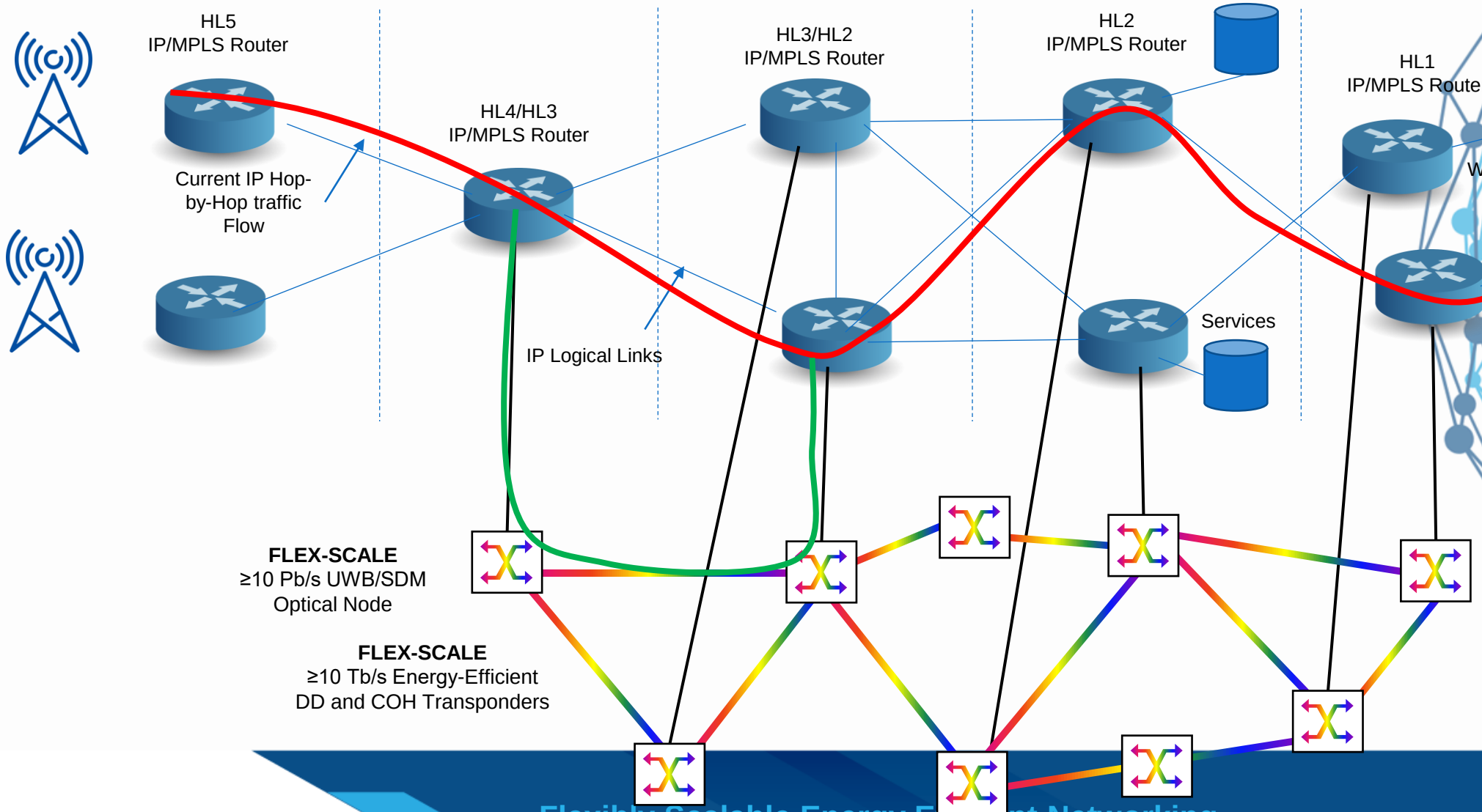
SUSTAINABLE CONTROL OF PACKET & OPTICAL TRANSPORT NETWORKS FOR 6G

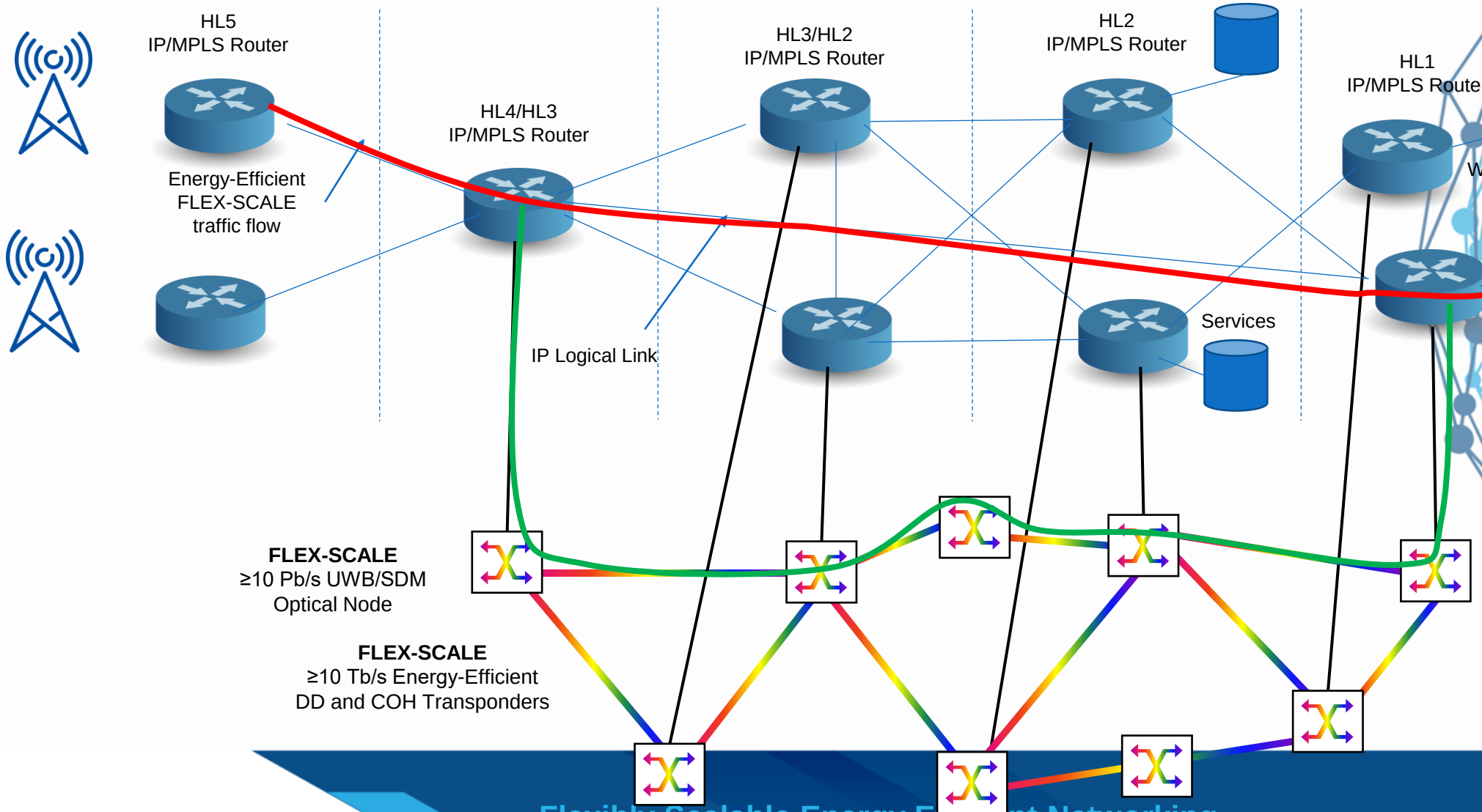
FLEX-SCALE 6G TRANSPORT NETWORK AND CONTROL SCENARIO



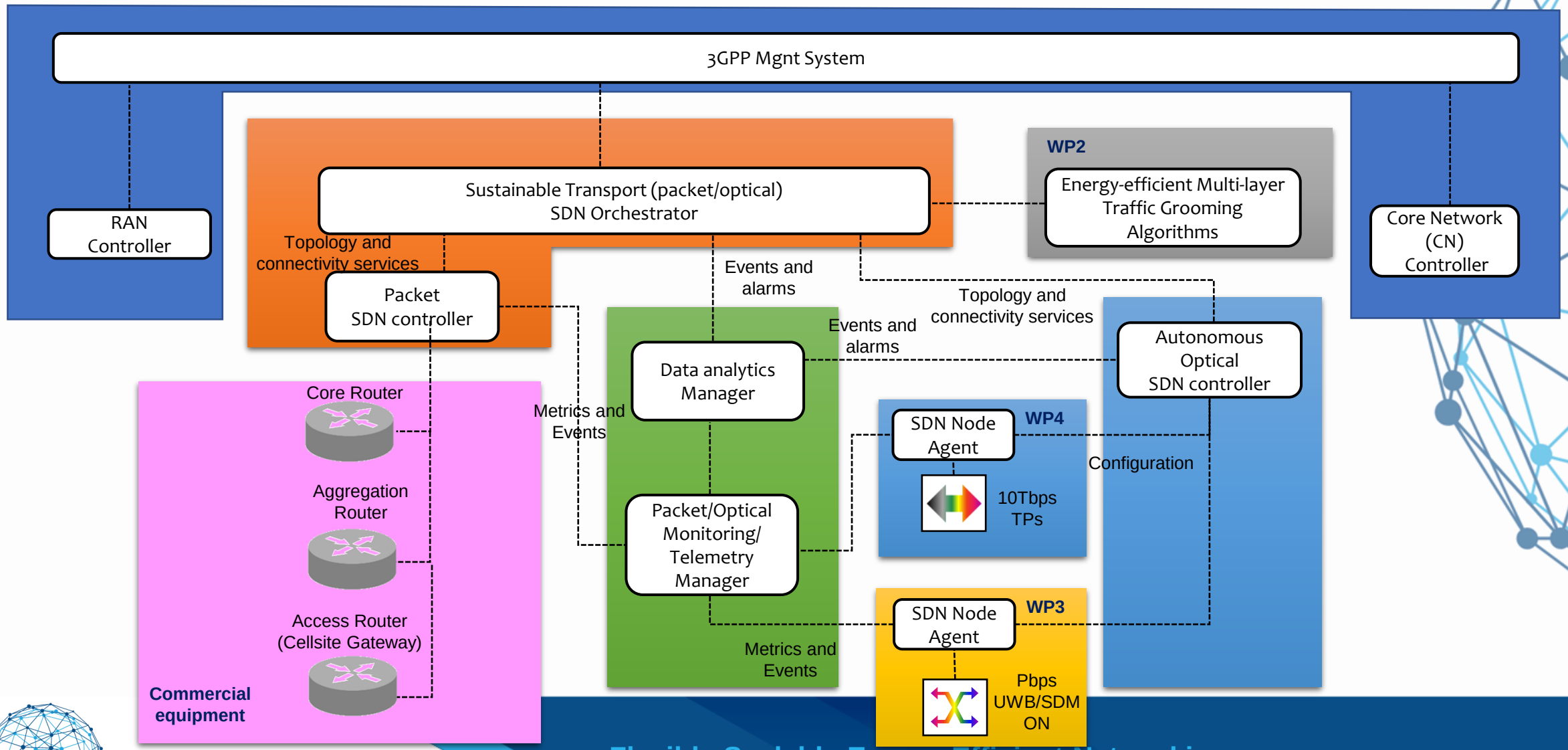
ENERGY-EFFICIENT MANAGEMENT OF TRAFFIC FLOWS WITH QoS: HOP-BY-HOP IP ROUTING



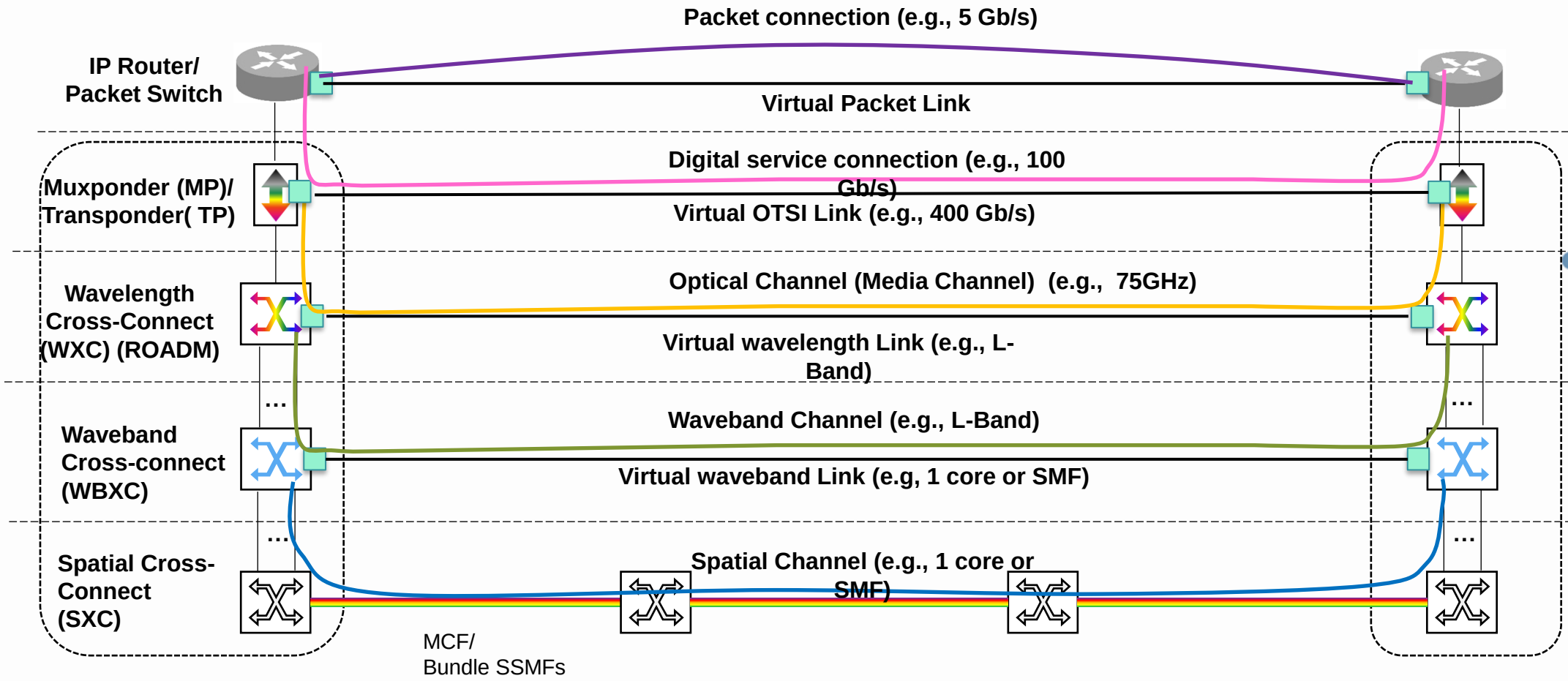
ENERGY-EFFICIENT MANAGEMENT OF TRAFFIC FLOWS WITH QoS: BYPASSING HL3/H2 IP ROUTERS



FLEX-SCALE TRANSPORT SDN CONTROL FUNCTIONAL ARCHITECTURE



MULTI-GRANULAR OPTICAL NETWORK ARCHITECTURE: VIRTUAL NETWORK TOPOLOGY MANAGEMENT



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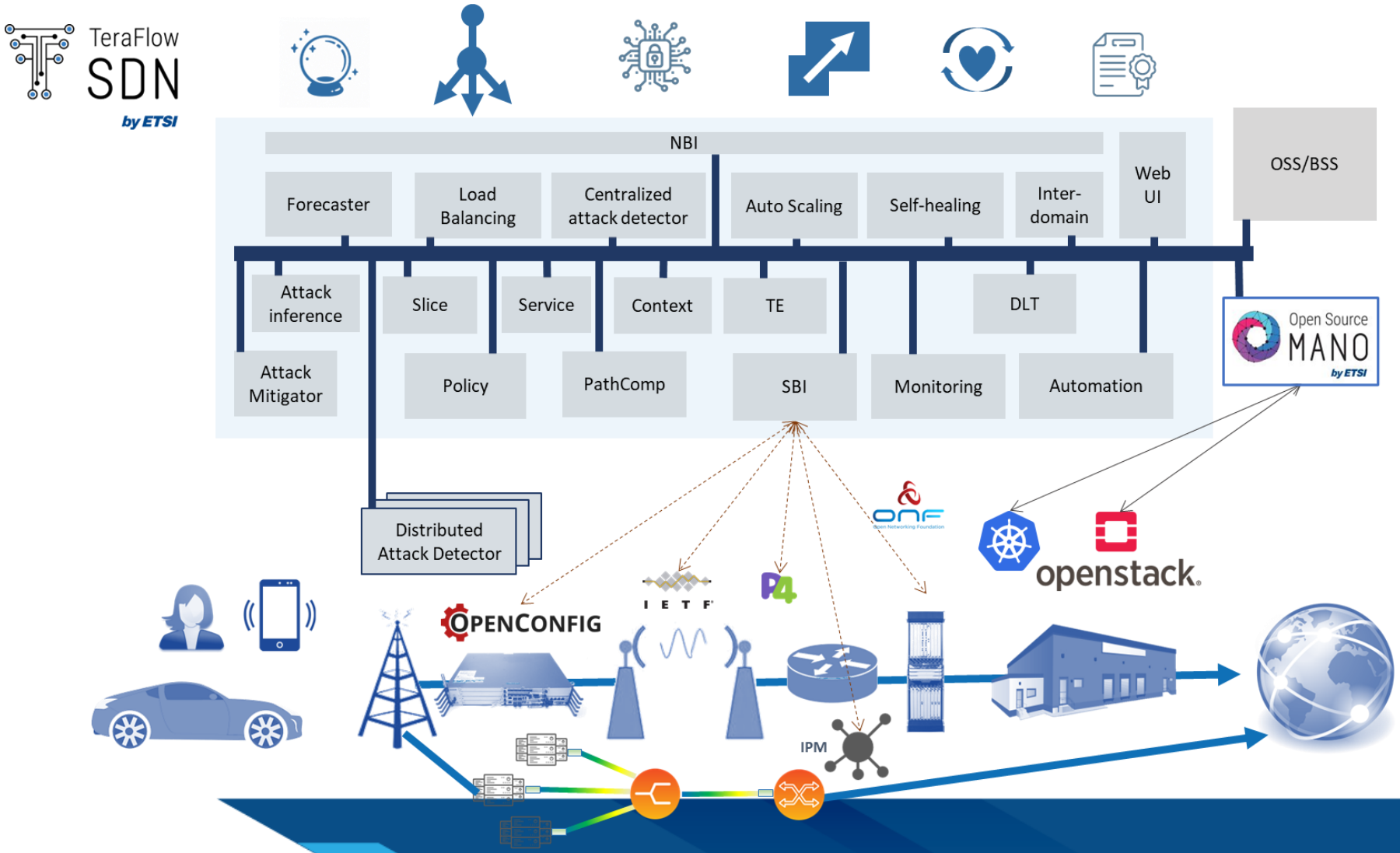
TERAFLOW SDN (TFS) CONTROLLER AND PROPOSED ADAPTATIONS FOR FLEX-SCALE

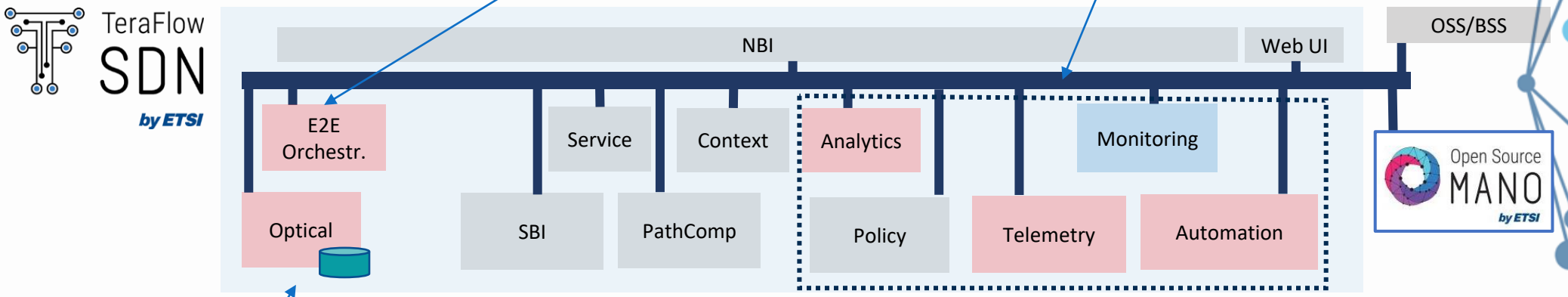
TFS ARCHITECTURE FOR RELEASE 2



NEW FUNCTIONALITIES AND REQUIRED EXTENSIONS FOR TFS

Multi-Layer support for packet and Optical

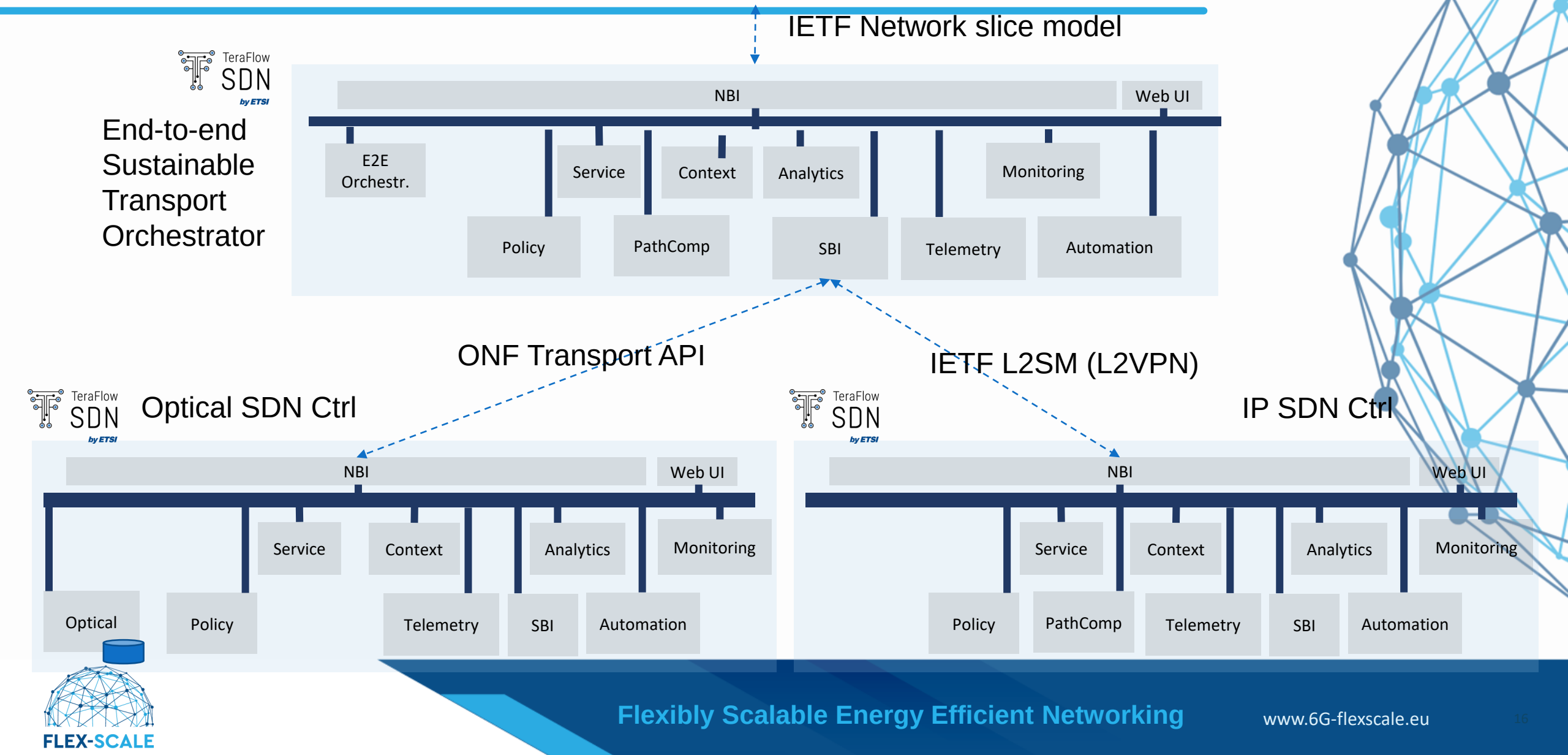
Energy efficiency monitoring and telemetry



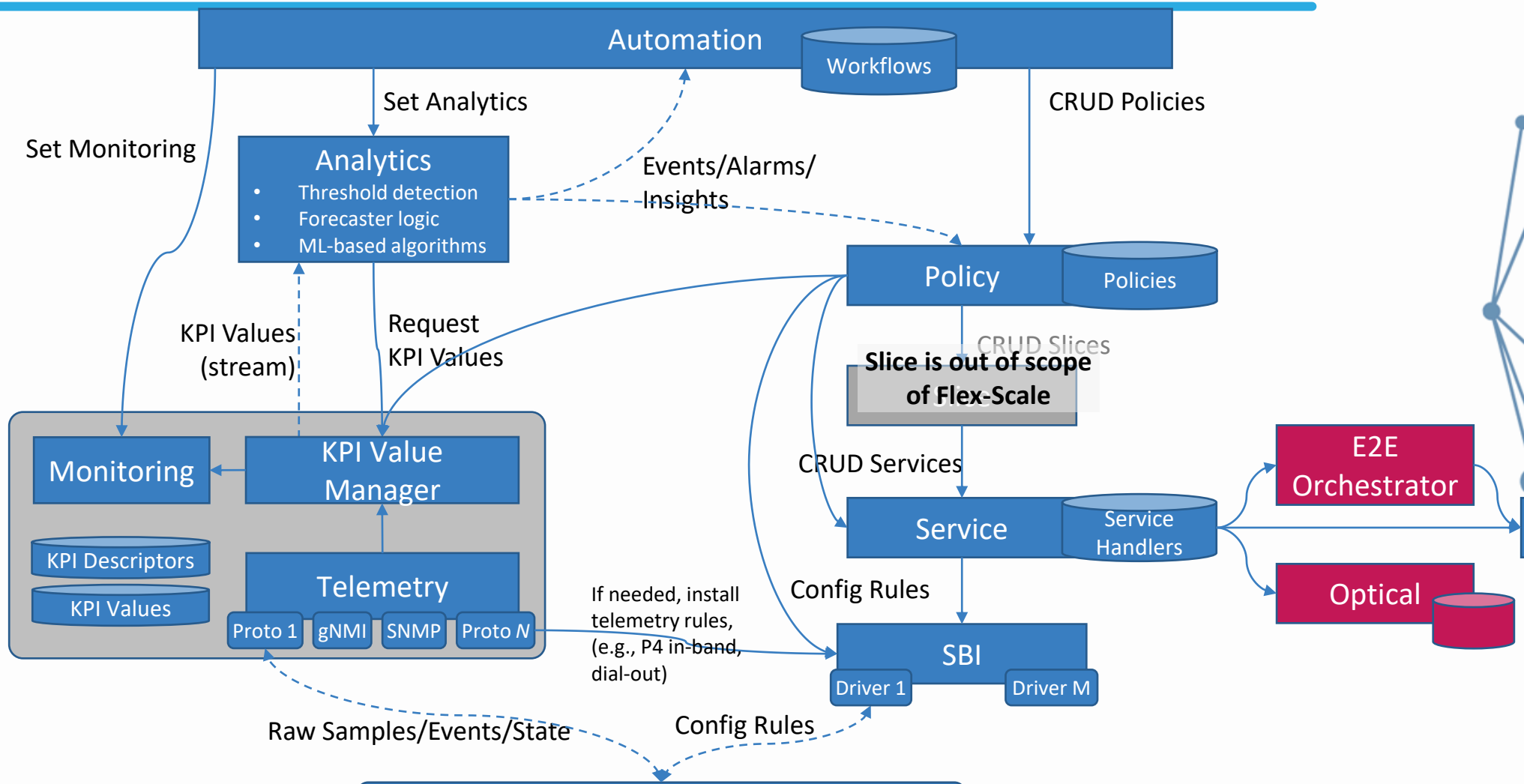
Multi-granular Optical support (WDM/UWB,SDM)

Automation loop: data collection (monitoring and telemetry), Analytics, and decision

FLEX-SCALE SUSTAINABLE TRANSPORT (PACKET/OPTICAL) CONTROL ARCHITECTURE DEVELOPED IN TFS

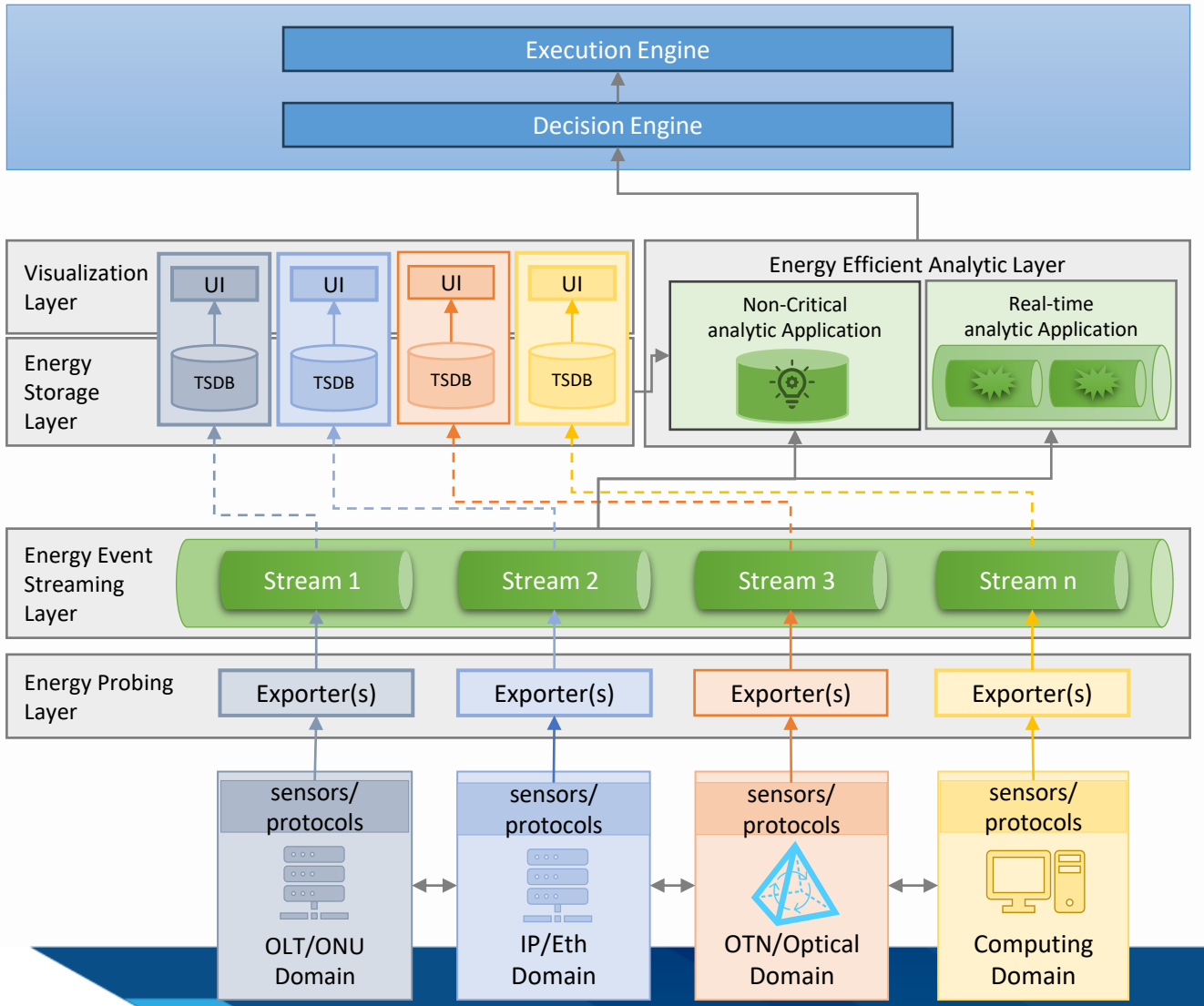


ZSM-ALIGNED MONITORING-ANALYTICS-AUTOMATION LOOP ARCHITECTURE

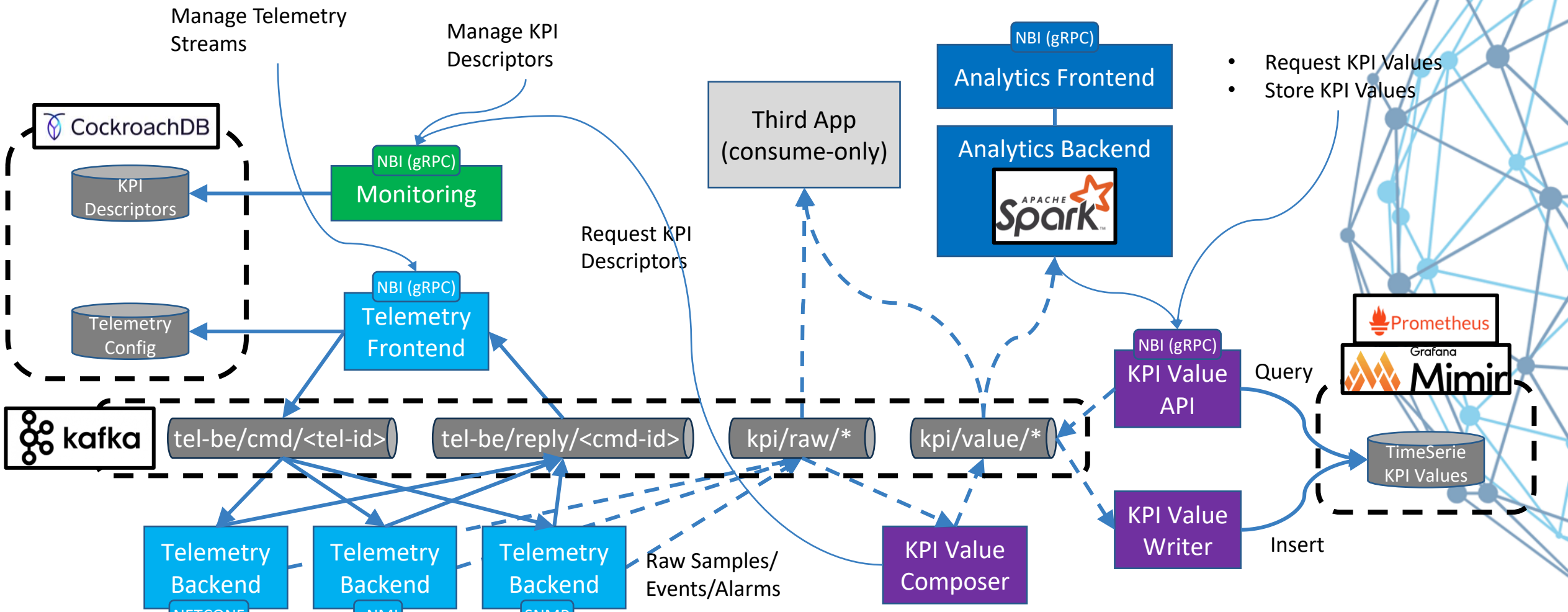


ENERGY-EFFICIENCY MANAGEMENT

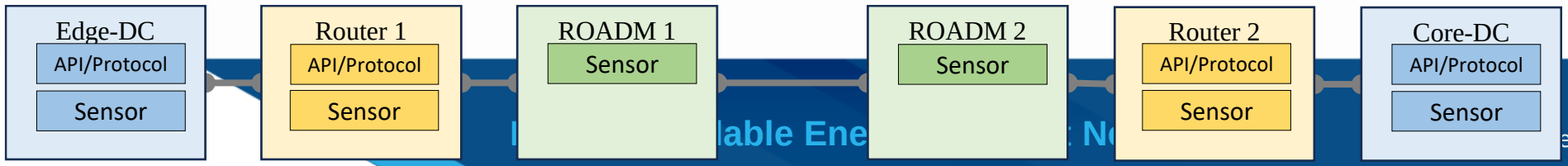
ENERGY-EFFICIENCY MANAGEMENT ARCHITECTURE



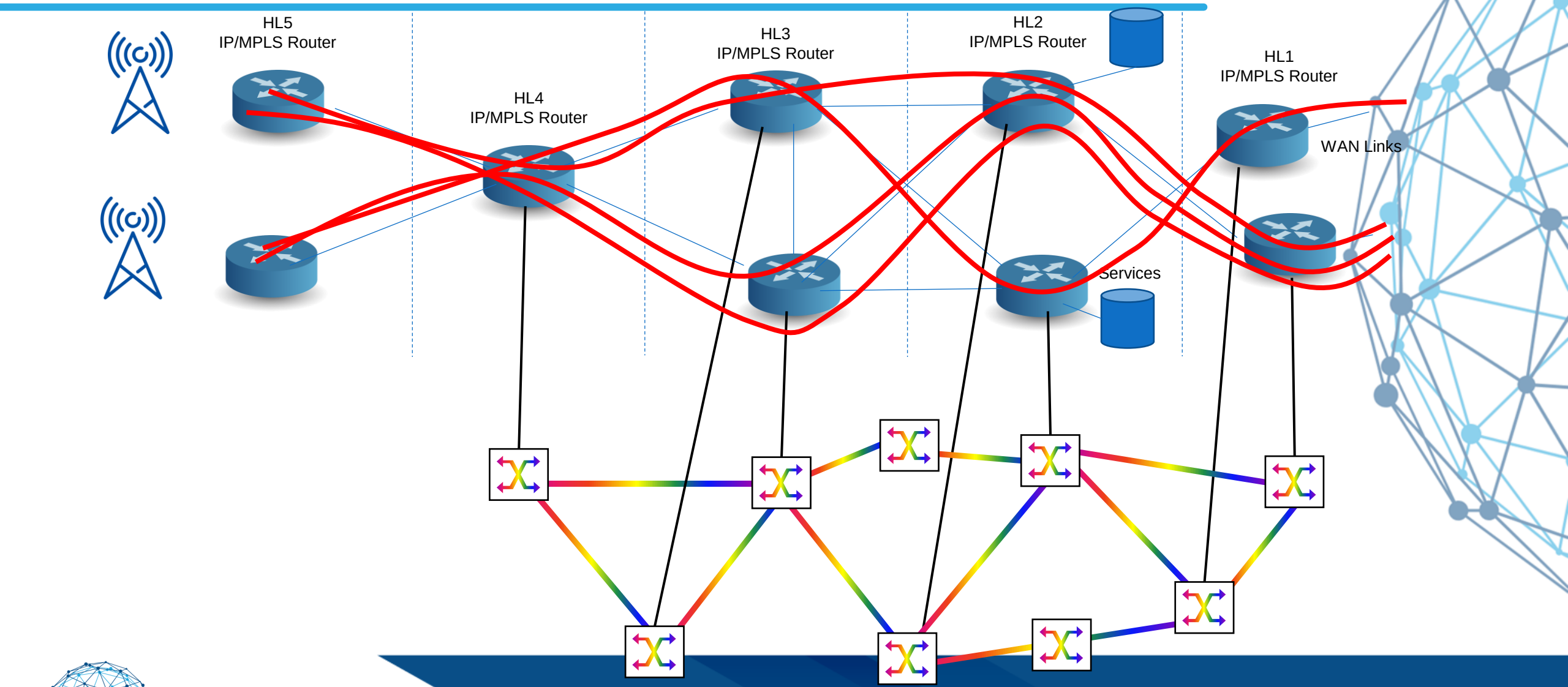
DETAILED ENERGY-EFFICIENCY MONITORING AND TELEMETRY ARCHITECTURE



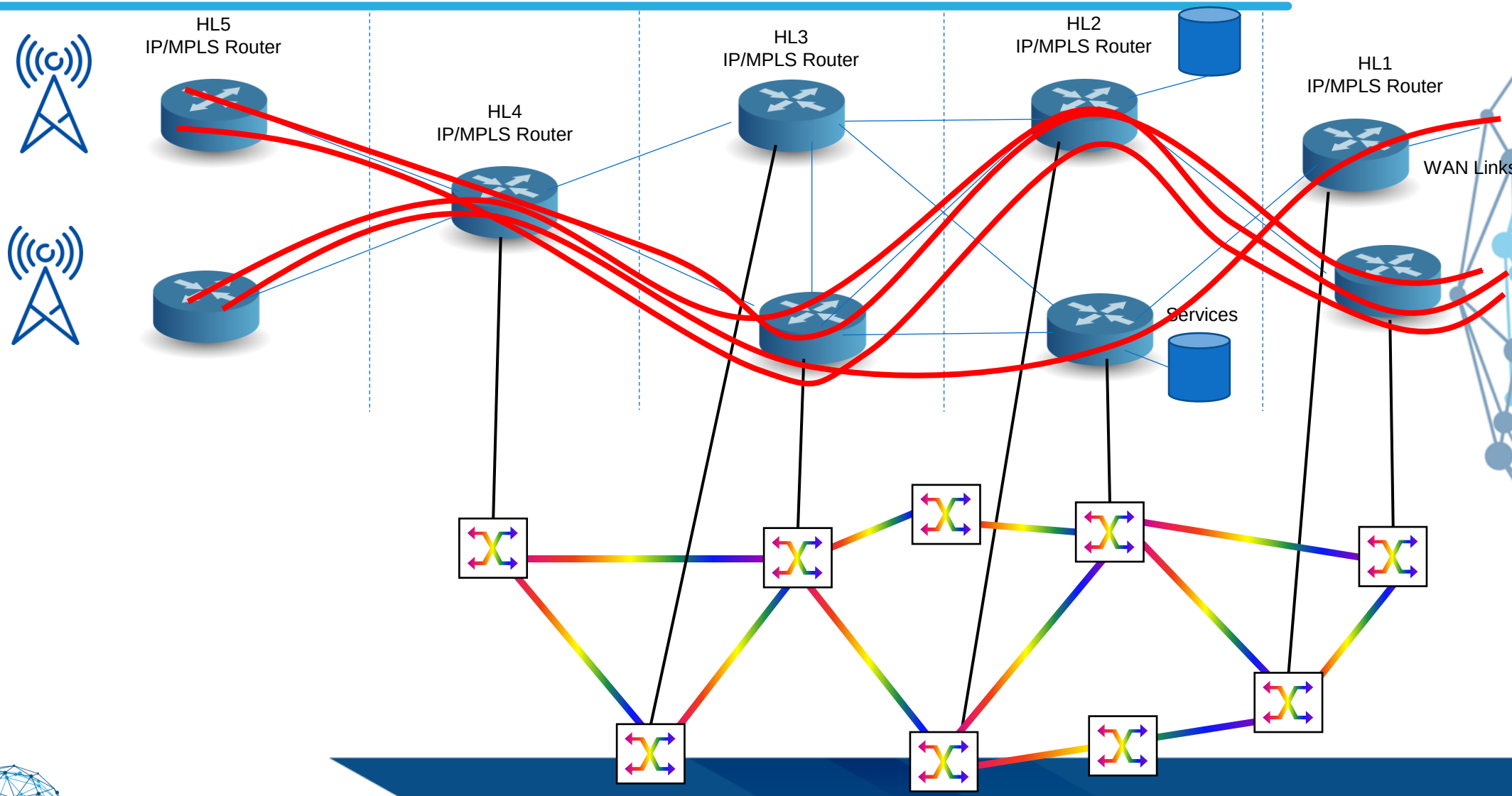
RESULTS (BASED ON POWER CONSUMPTION METRIC)



TEST CASE ON AUTONOMOUS ENERGY-EFFICIENCY MANAGEMENT



TEST CASE ON AUTONOMOUS ENERGY-EFFICIENCY MANAGEMENT: REOPTIMIZATION OF IP FLOWS, SWITCHED OFF OF IP INTERFACES AND REMOVAL OF OPTICAL CHANNELS.



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THANK YOU FOR YOUR ATTENTION

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THANK YOU ON BEHALF OF THE ENTIRE FLEX-SCALE CONSORTIUM!