Metro-Haul: Enabling 5G Services across Disaggregated Multi-Layer Transport Networks

Ongoing Challenges for NFV Orchestration across Metro Networks

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Outline

- Introduction
  - Towards new Metro Networks: the Metro-Haul project
    - ✓ Metro-nodes with low-cost optical switching and transmission and computing / storage
    - ✓ 5G and Network Services spanning Metro networks
- Challenge: Disaggregated Transport Networks
  - SDN Control with Model-Driven development
- Challenge: NFV Orchestration and 5G Network slicing over Transport Networks
  - Optical Network Virtualization
  - NFV Network slicing

Introduction and goals

- To architect and design cost-effective, energy-efficient, agile and programmable metro networks that :
  - Are scalable for heterogeneous 5G access and future requirements,
  - Address the anticipated capacity increase and its specific characteristics e.g. mobility, low latency, low jitter,
  - Support a wide variety of services and use cases with special emphasis on services from various industries vertical to the ICT

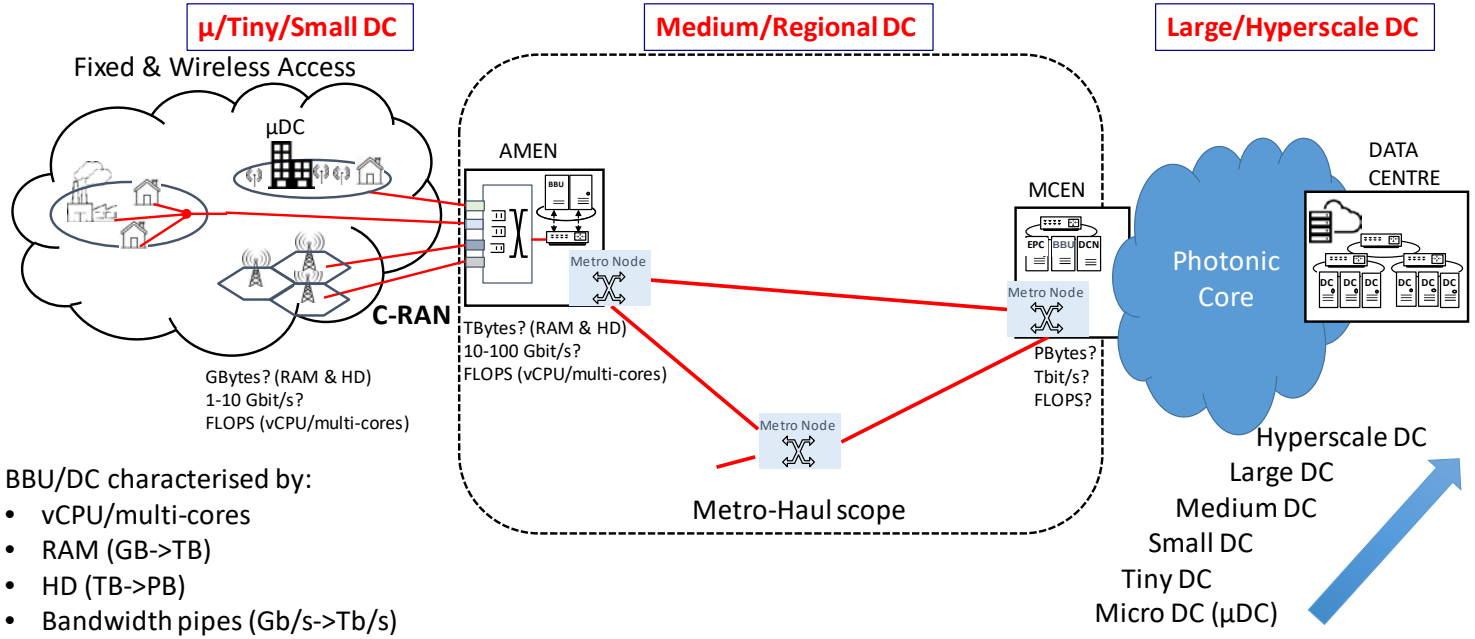
- Encompassing the design of **optical metro-nodes** (including full compute and storage capabilities), which:
  - Interface effectively with both 5G access and multi-Tbit/s elastic core networks,
  - Combine heterogeneous resources (processing, storage and networking) in variable sized-pools.

- And the design of a **control, orchestration and management subsystem** that relies on:
  - Existing SDN/NFV Frameworks,
  - Unified information and data modelling across devices, infrastructures and services.

Metro-Haul Research project

Project Name: METRO High bandwidth, 5G Application-aware optical network, with edge storage, compUte and low Latency

Acronym: METRO-HAUL Call identifier: H2020-ICT-2016-2 RIA (Research and Innovative Action)
Grant Agreement Number: 761727
Project Coordinator: British Telecom - Duration: 36 months - Budget: ~ 8M€
Number of Partners: 20
Start Date: 1st June 2017 - End Date: 31st May 2020



BBU/DC characterised by:

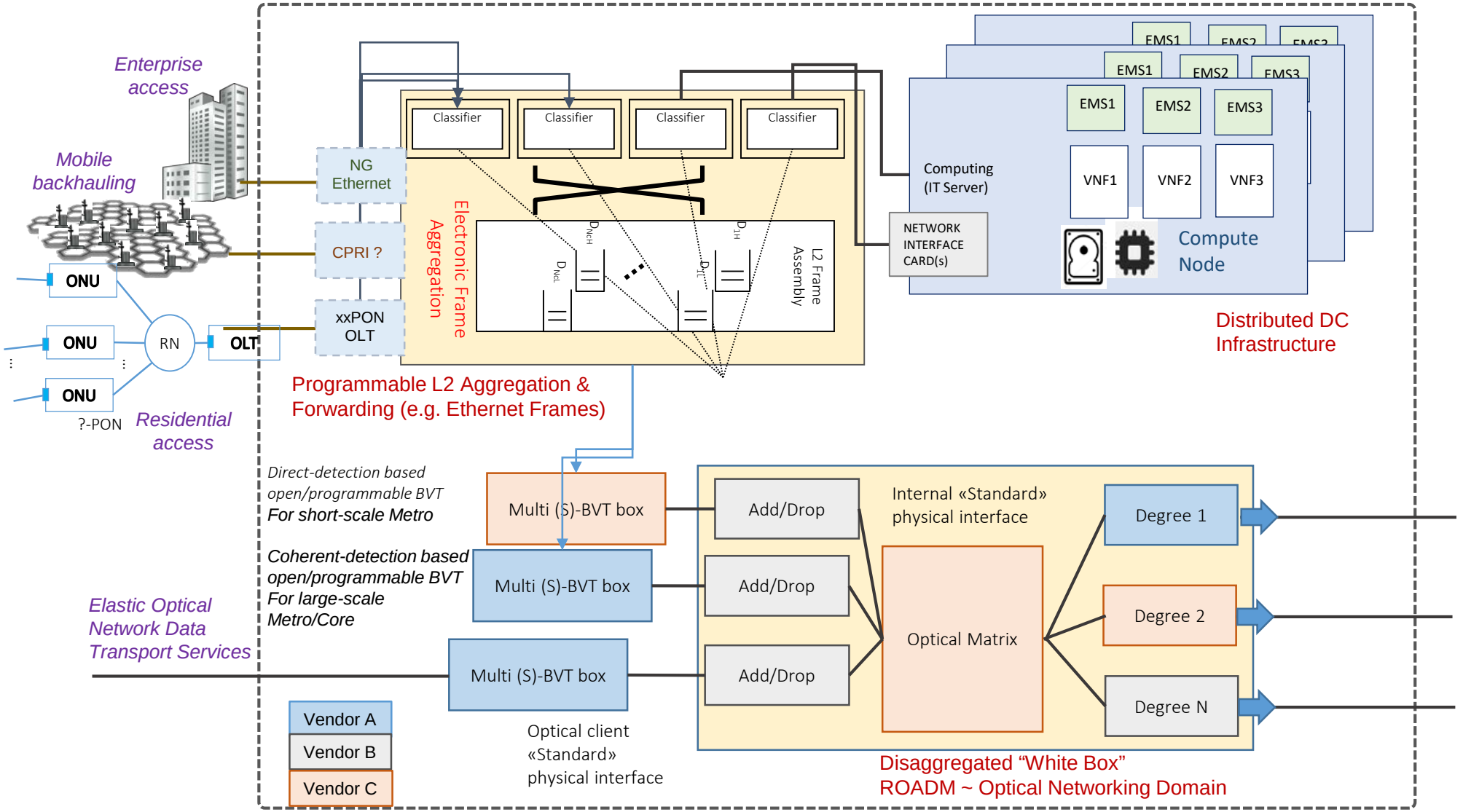
- vCPU/multi-cores
- RAM (GB->TB)
- HD (TB->PB)
- Bandwidth pipes (Gb/s->Tb/s)

It is expected the huge DC-DC traffic growth (all DC sizes included) will have a big impact on the Metro Networks

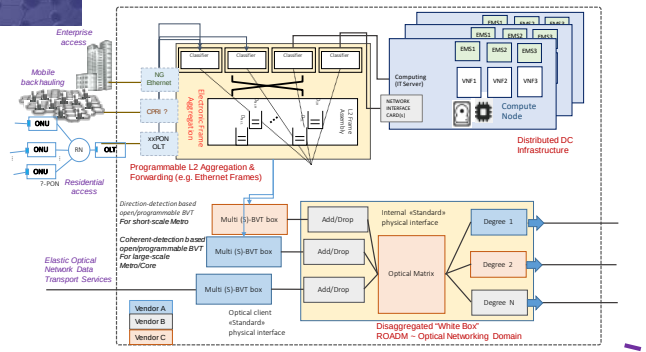
Can we expect C-RAN BBU dimensioning to increase by factor x4 from 2015-2020; and further x4 to 2025?

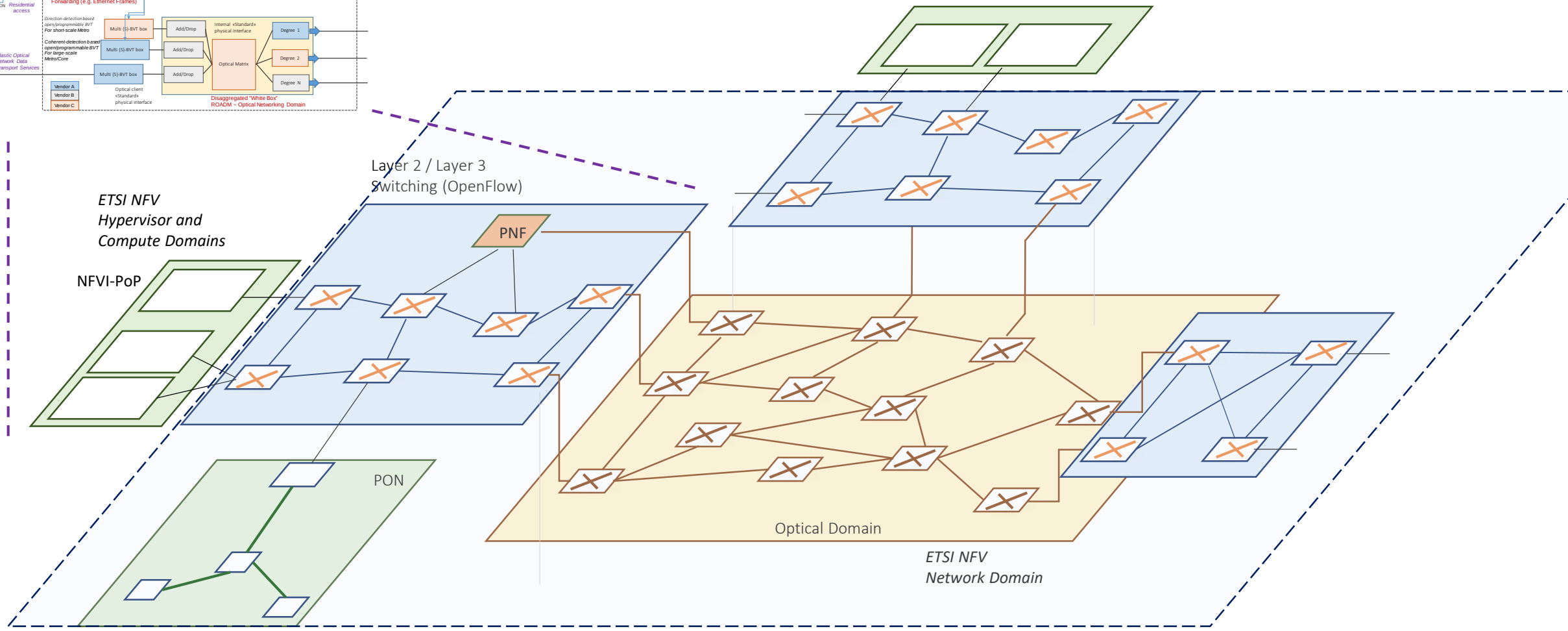
https://metro-haul.eu

Designing optical/cloud nodes: Access-Metro Edge Node

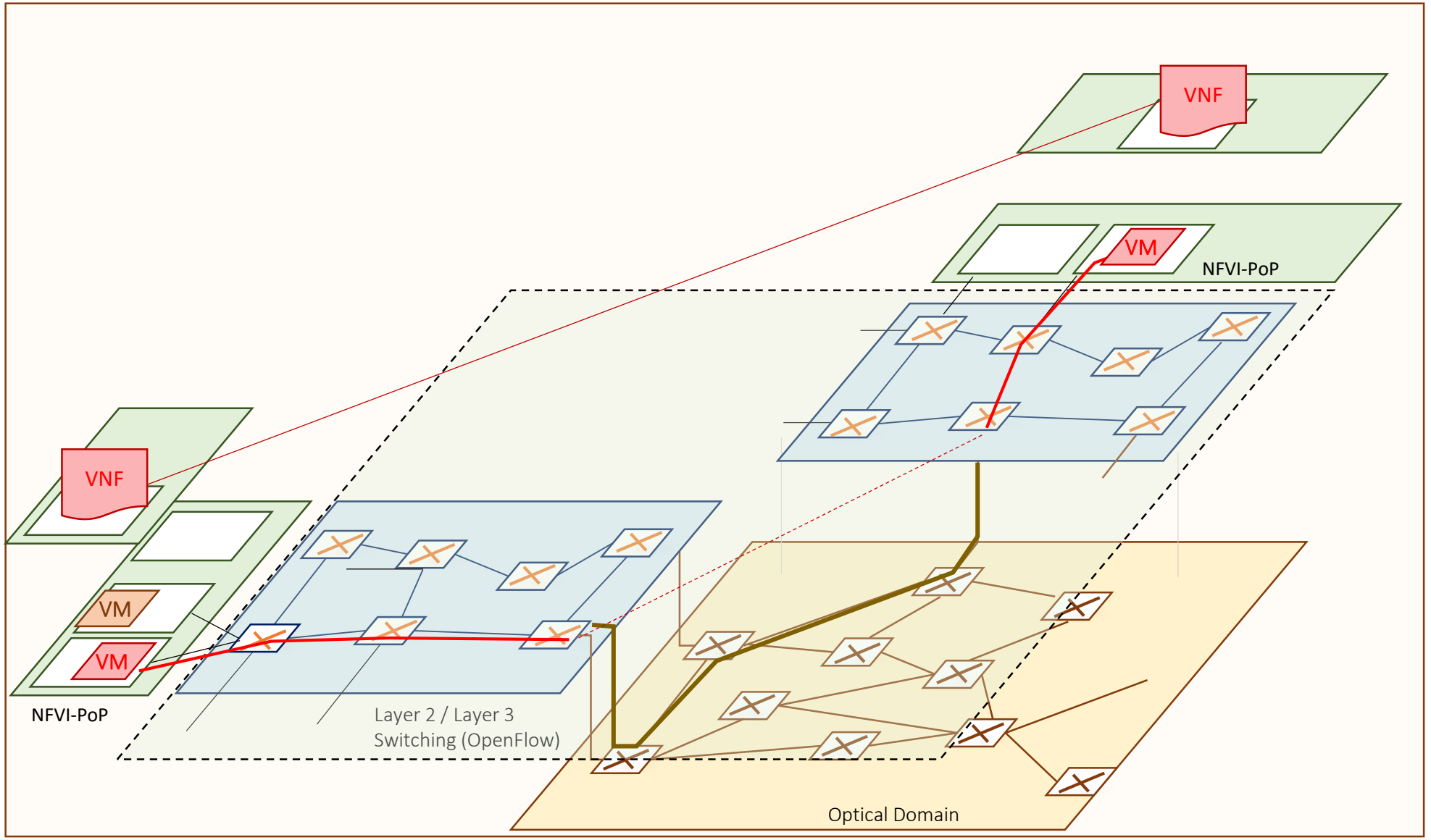


Metro-Haul Infrastructure





NS (VNF) Placement across distributed Data-Centers



Challenge: SDN Control of Disaggregated Optical Networks

- Traditional optical transport networks are proprietary, integrated and closed
  - Act as a single vendor managed domain. They can export high-level interfaces and open NBI, yet the internal details and interfaces are hidden from the operator.

- **Disaggregation** - Composing and assembling open, available components, devices and sub-systems.
  - Partial or total (down to each of the optical components)
  - *Driven by the mismatch between the needs of operators and the ability to deliver adapted solutions by vendors; the increase in hardware commoditization; the different rate of innovation for different components; the promised acceleration on the deployment of services and the consequent reduction in operational and capacity expenses…*

- Opportunities:
  - New degree of flexibility, allowing component migration and upgrades without vendor lock-in.
  - Short term disaggregation will involve common functions adhering to open standards and interfaces, yet allowing vendor specific extensions and high-performance solutions with added value.

- Challenges:
  - Disaggregated optical nodes may not have the same level of integration and performance.
  - Control and Management?

- Control and management : use case for open interfaces exporting programmability.
  - **OpenROADM** multi-source agreement covers pluggable optics, transponders and ROADMs.
  - **OpenConfig**, a collaborative effort by network operators, has published a set of models providing a configuration and state model for terminal optical devices within a DWDM system, including both client- and line-side parameters

Challenge: SDN Control of Disaggregated Optical Networks

- **Unified information and data modeling language** to describe a device capabilities, attributes, operations to be performed on a device or system and notifications
  - A common language with associated tools
  - Enabling complex models with complex semantics, flexible, supporting extensions and augmentations
  - Including "best-practice" guidelines for model authors → YANG

- **An architecture for remote configuration and control**
  - Client / Server, supporting multiple clients, access lists, transactional semantics, roll-back, … → NETCONF

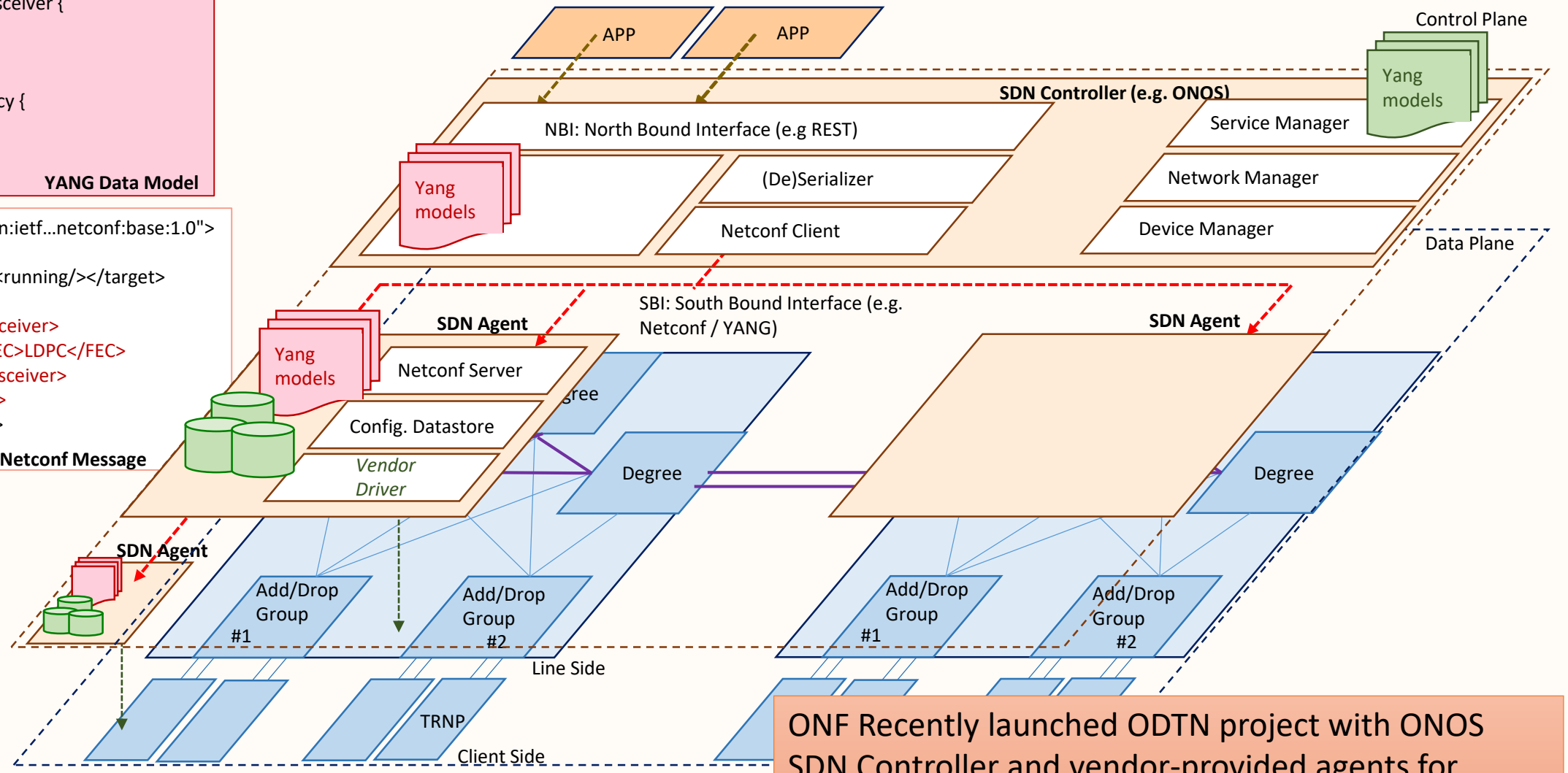
- An **associated transport protocol** provides primitives to view and manipulate the data, providing a suitable encoding as defined by the data-model.
  - Flexible, industry adopted → NETCONF
  - *Ideally, data models should be protocol independent*

- **Standard, agreed-upon models for devices**
  - Hard to reach consensus (controversial aspects)
  - Some models do exist. Most stable ones cover mature aspects (interface configuration, RIB, BGP routing)

Disaggregated Optical Networks

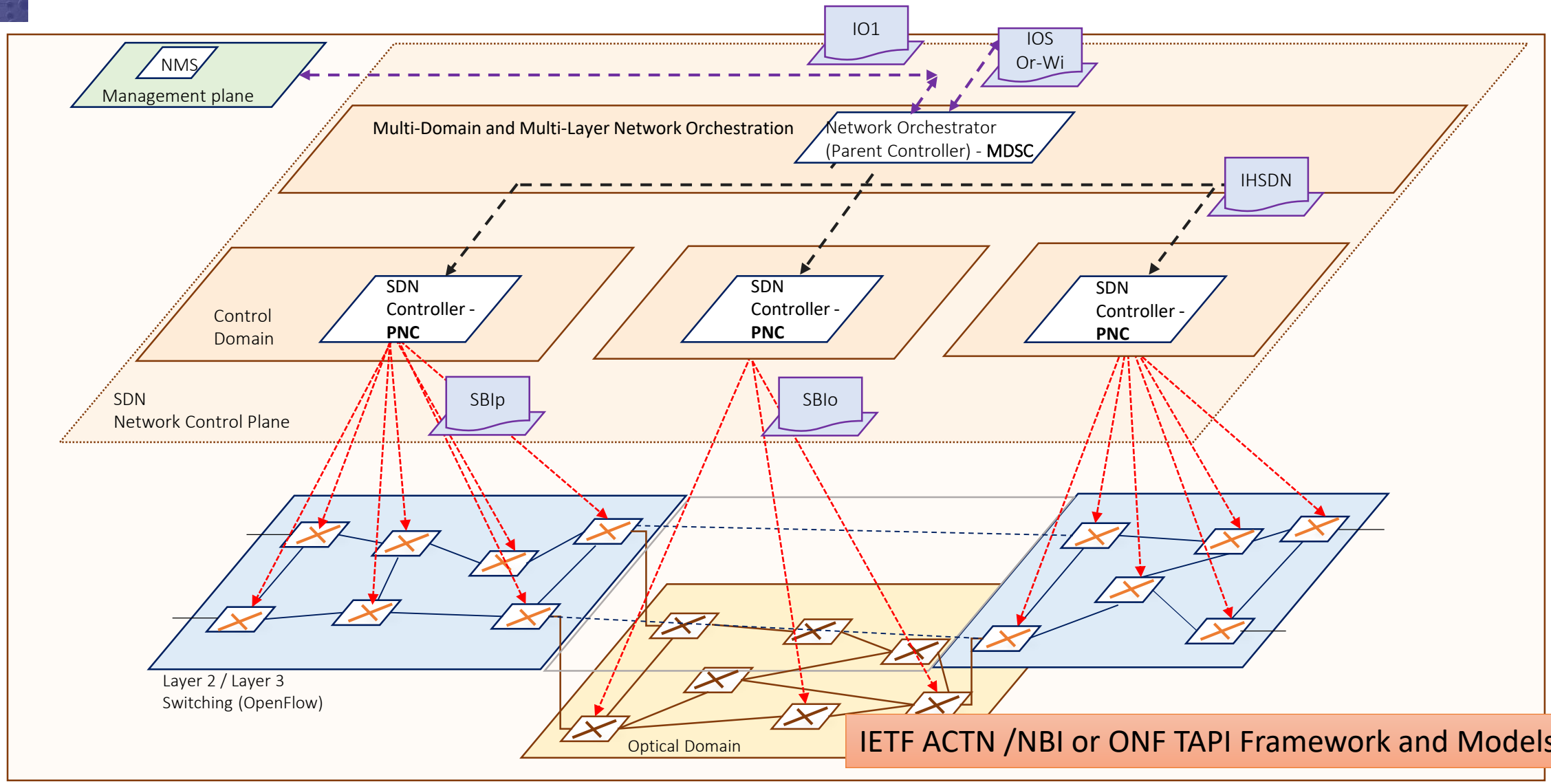
```
module cttc-transceiver {
 container transceiver {
    leaf FEC {
      type enum;
    }
    leaf frequency {
      type float;
    }
 }}
```
YANG Data Model

```
<rpc xmlns="urn:ietf…netconf:base:1.0">
  <edit-config>
      <target><running/></target>
      <config>
        <transceiver>
          <FEC>LDPC</FEC>
        </transceiver>
      </config>
  </edit-config>
</rpc>
```
Netconf Message

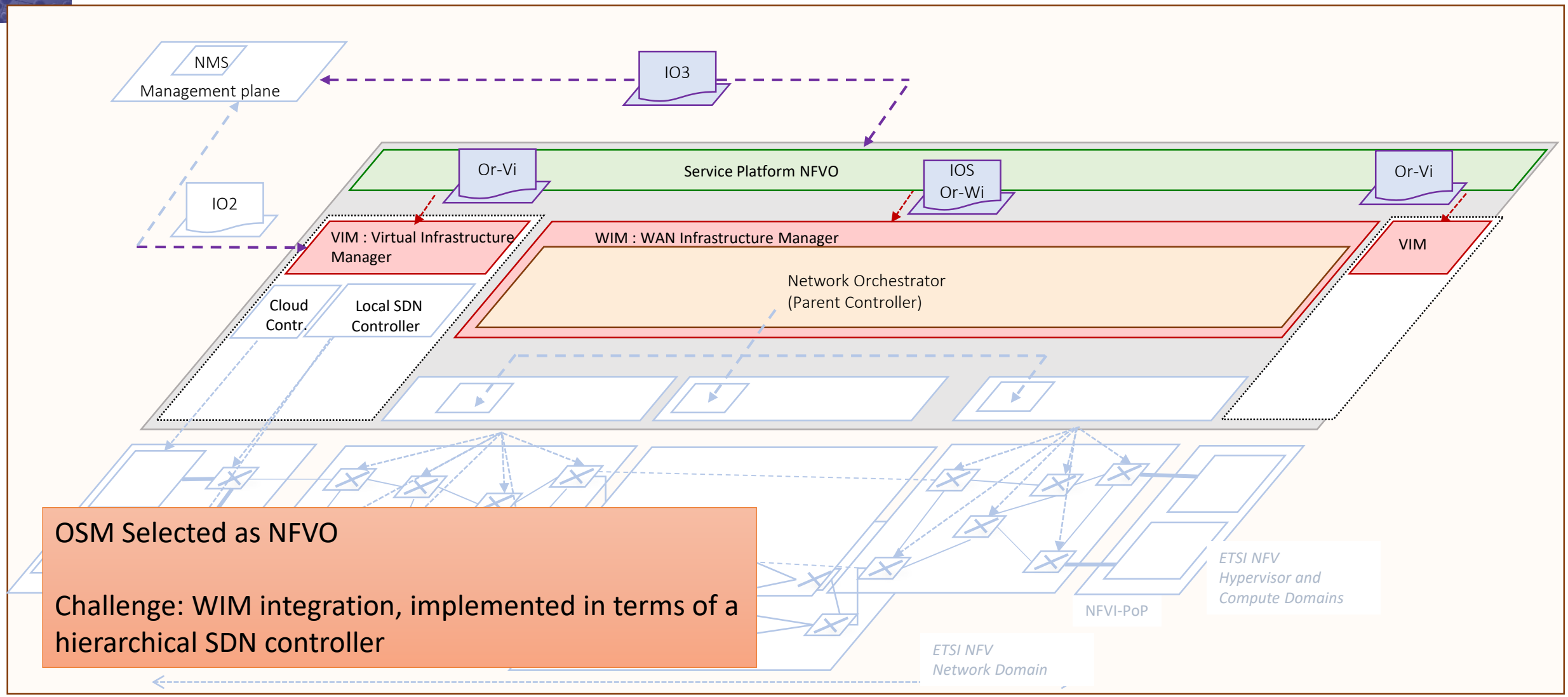


ONF Recently launched ODTN project with ONOS SDN Controller and vendor-provided agents for Terminal Devices and Open Line Systems.

Network Orchestration for Packet over Optical SDN



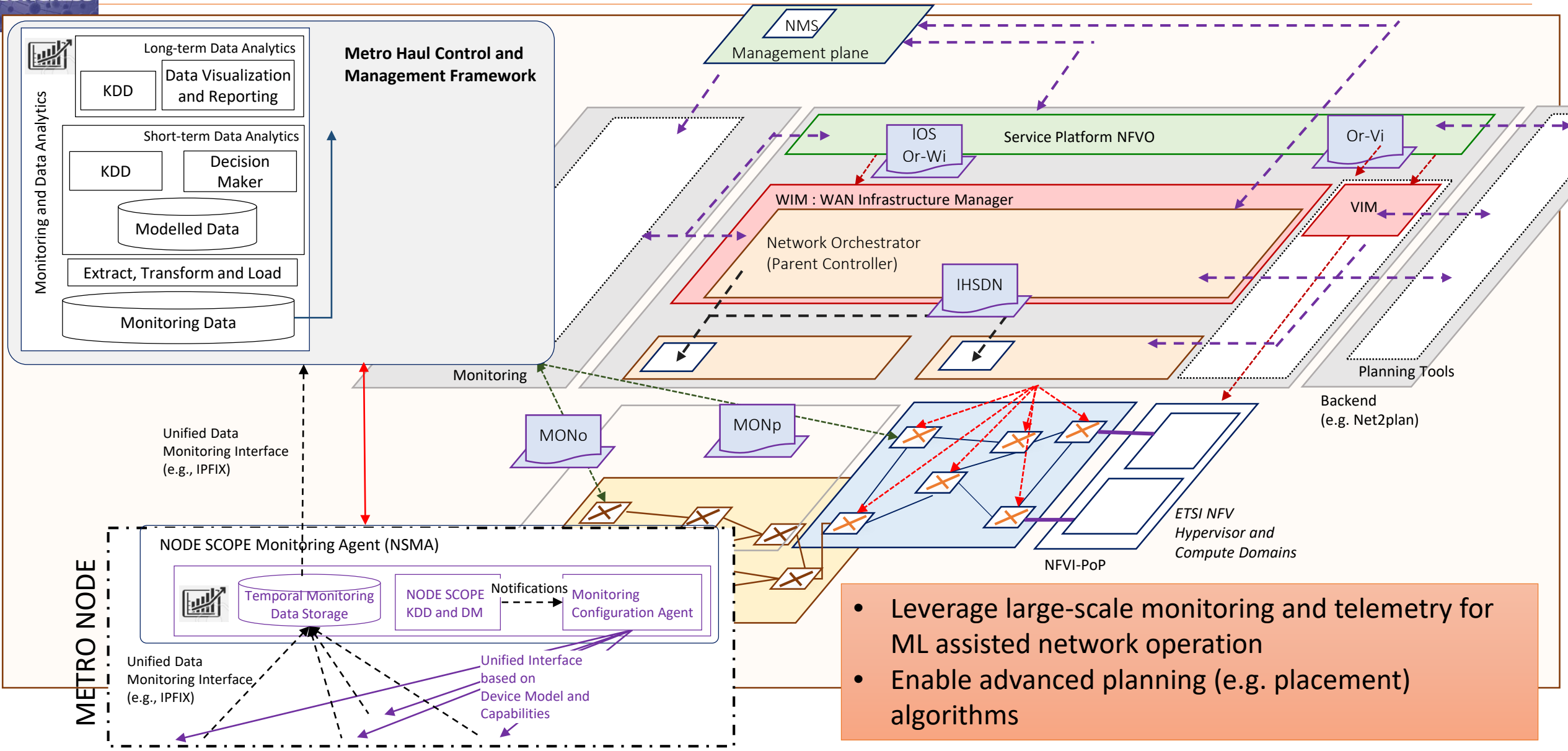
Challenge: Metro-Haul Service Platform based on ETSI NFV MANO



OSM Selected as NFVO

Challenge: WIM integration, implemented in terms of a hierarchical SDN controller

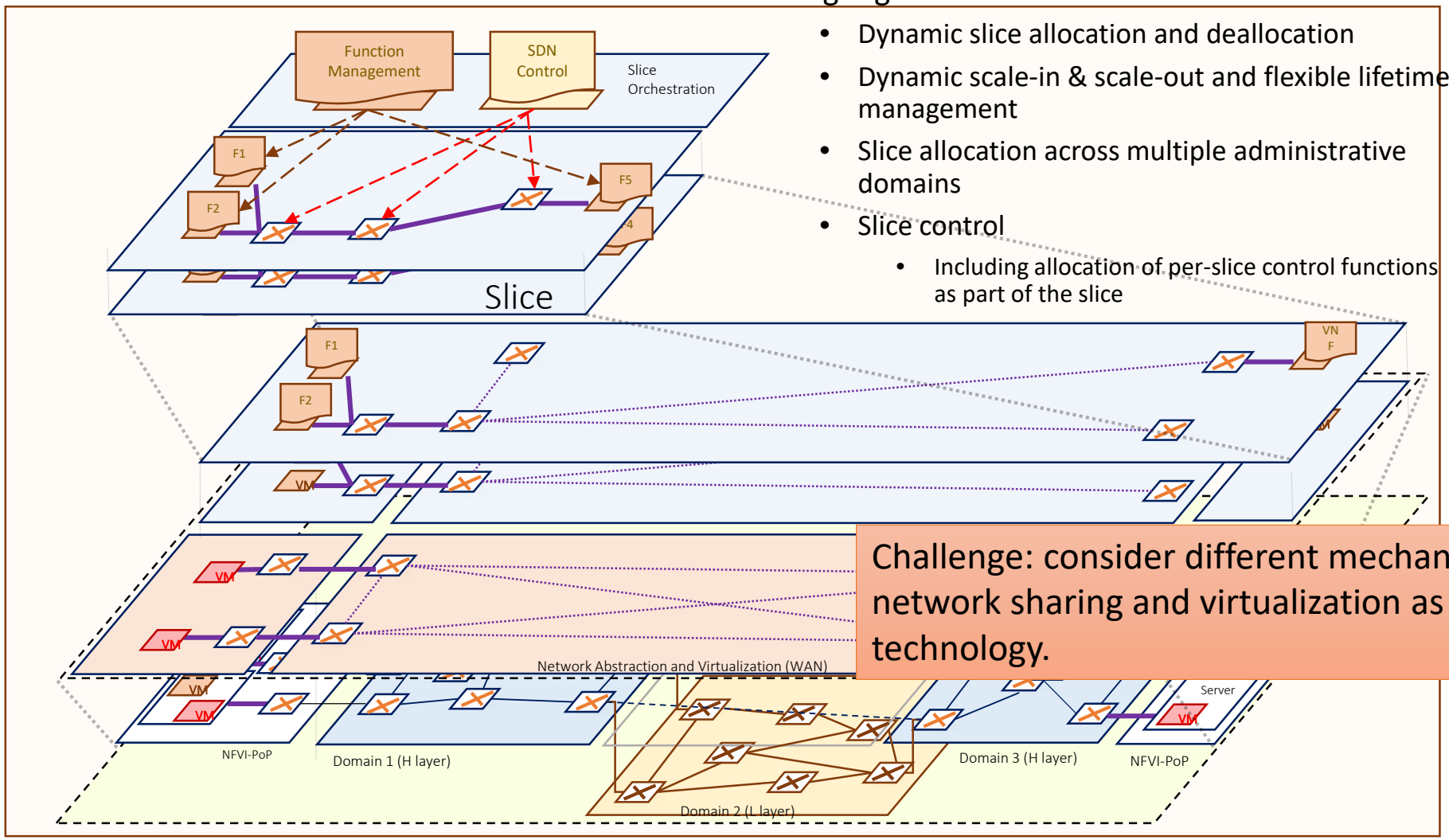
Metro-Haul Service Platform (cont'd)



- Leverage large-scale monitoring and telemetry for ML assisted network operation
- Enable advanced planning (e.g. placement) algorithms

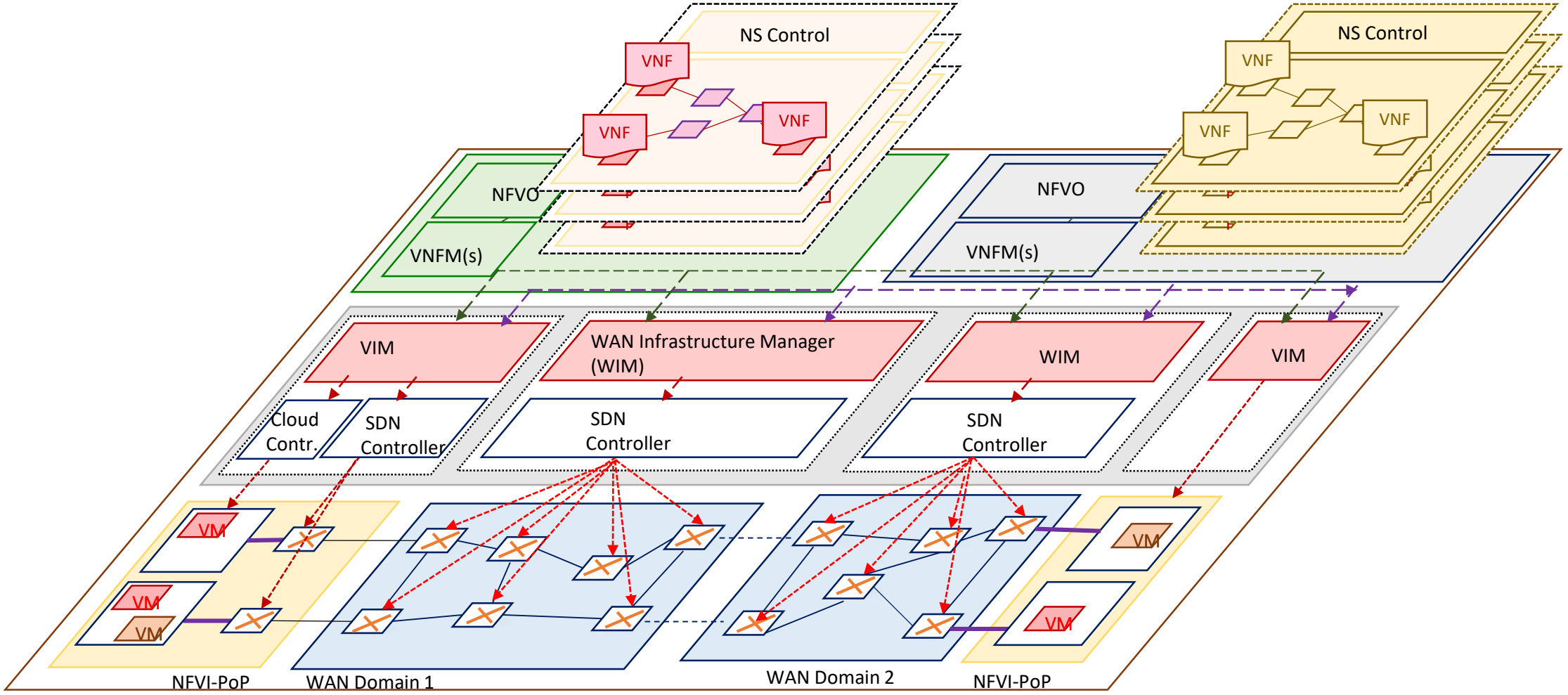
Supporting multi-tenancy and network slices over a disaggregated net.

- Target goals:
  - Dynamic slice allocation and deallocation
  - Dynamic scale-in & scale-out and flexible lifetime management
  - Slice allocation across multiple administrative domains
  - Slice control
    - Including allocation of per-slice control functions as part of the slice



Challenge: consider different mechanisms for optical network sharing and virtualization as a supporting technology.

Supporting multi-tenancy and network slices over a disaggregated net.



Final Conclusions and Take-away messages

- The provisioning of services (involving heterogeneous resources) needs to be automated, with stringent requirements in terms of quality of service, latency, bandwidth
  - This automation needs to happen in an heterogeneous environment across multiple technological and administrative domains, spanning multiple network segments with growing complexity.
  - The NFV Framework provides a suitable basis to develop on.
  - This includes the transport network

- Wider over-arching control and Orchestration,
  - Hierarchical network control systems, including the SDN control of Optical Disaggregated Networks.
  - Integration with Open / standard APIs and frameworks, unified modelling
  - Slow (but progressive) adoption, including vendor interoperability events.

- ETSI NFV MANO and Model-Driven SDN for Multi-Layer and Multi-Domain Transport Networks as key components of this vision,
  - Towards better integration of T-SDN and NFV-O / WIM functional elements along with advanced transport network planning and telemetry.

Thank you…. Questions?

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http://metro-haul.eu