

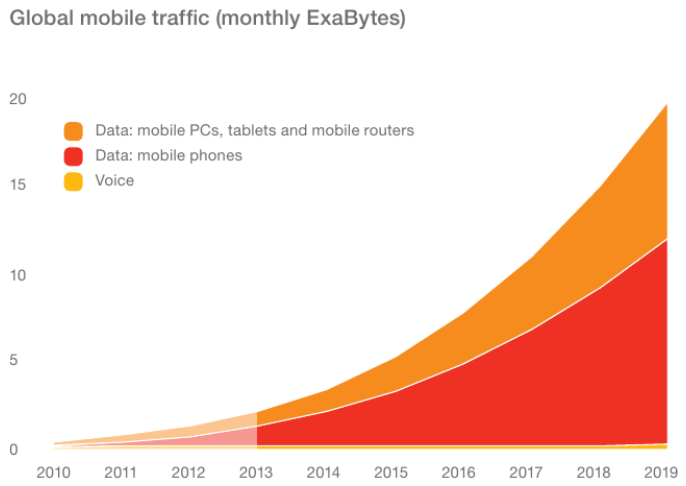

Resource Management in 5G Transport Networks

Domenico Siracusa
Future Networks (FUN)

10 years 2003-2013 CREATE-NET




Need for a better transport



10X

growth in **mobile data traffic** between 2013 and 2019

Mobile traffic generated by mobile phones has exceeded that from mobile PCs, tablets and routers

Source: Ericsson mobility report, June 2014

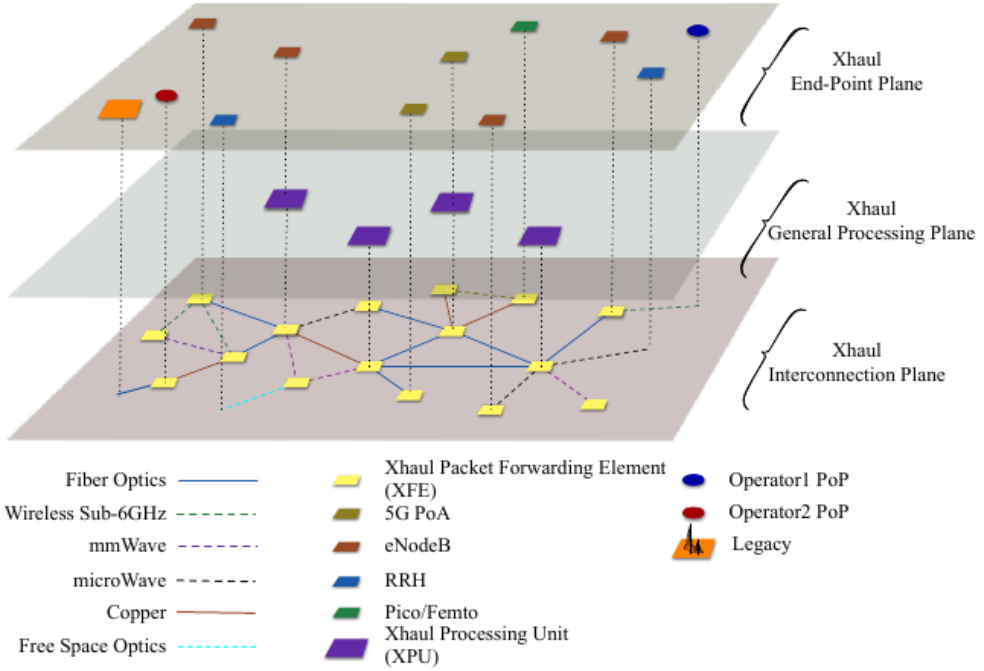
- New service-level KPIs: demand for massive increase of network capacity
- Operators need to reduce CAPEX/OPEX in a scenario with reduced ARPU and increased needs in term of infrastructure
- Transport resources are vastly heterogeneous
- Need for adaptive, sharable, cost-efficient and cloud-based 5G transport
  - Integrating fronthaul and backhaul resources
  - Cooperating with the access and core networks

Xhaul Project

Xhaul EU project
xhaul.eu
@Xhaul_eu

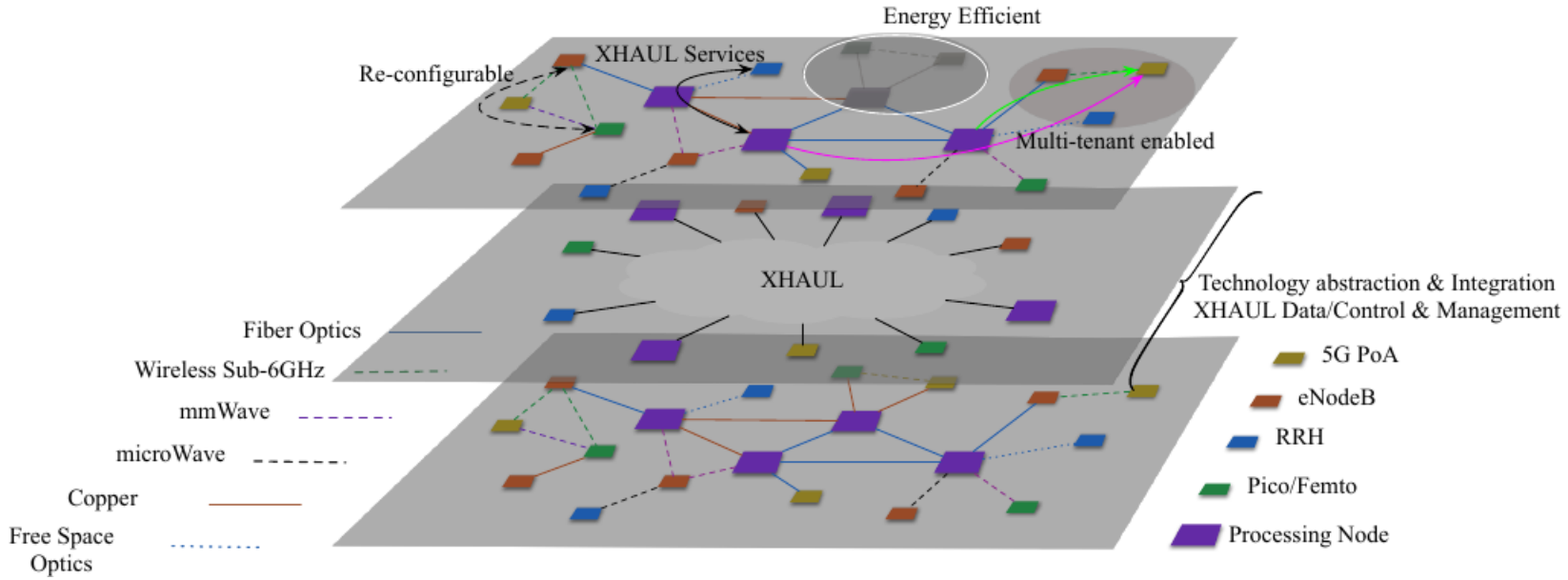
- **Develop novel physical and link layer technologies meeting 5G requirements**
- **Develop a unified data plane for backhaul and fronthaul**
  - Supporting all RAN functional splits
  - Supporting required synchronization
  - With one versatile frame format
  - Requires new packet switch architectures
- **Develop a unified control plane for backhaul and fronthaul based on SDN**
  - Common network model
  - Common set of API functions
  - Resulting in abstraction layer for BH/FH
- **Develop SDN apps on top of abstraction**
  - Monitoring and prediction framework
  - Backhaul/fronthaul infrastructure planning and dimensioning
  - Context-aware resource management (policies, routing, function placement)
  - Network-aware media distribution framework
- **Evaluate the developed Xhaul technologies integrated on a 5G testbed**

Physical Infrastructure of Xhaul



- *Interconnection Plane*
  - **Xhaul Packet Forwarding Elements (XFE)** interconnecting a broad set of novel technologies to create a **packet-based network**
- *General Processing Plane*
  - **Xhaul Processing Units (XPUs)** that carry out the bulk of the operations
- *End-Point Plane*
  - Network Functions and their interconnections with the other planes

Functional Architecture of Xhaul



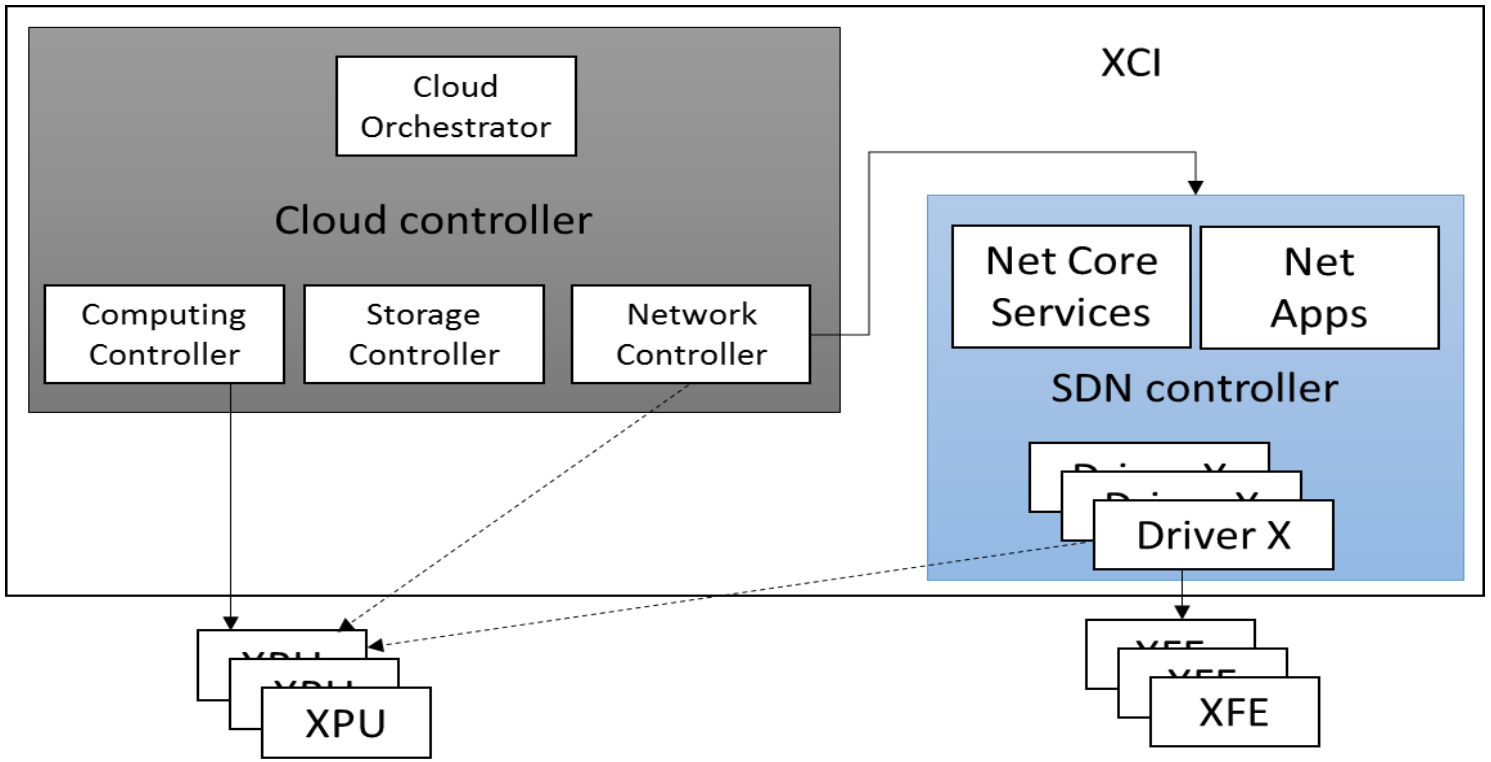
- **Technology abstraction and integration layer**:
  - Integration of the different technologies (including **fronthaul and backhaul**) in a common packet network
  - based on **technology abstraction, unified framing and common data, control and management planes**
- **Xhaul Services Layer** (e.g. Multi-tenancy)

Xhaul Control Infrastructure (XCI)

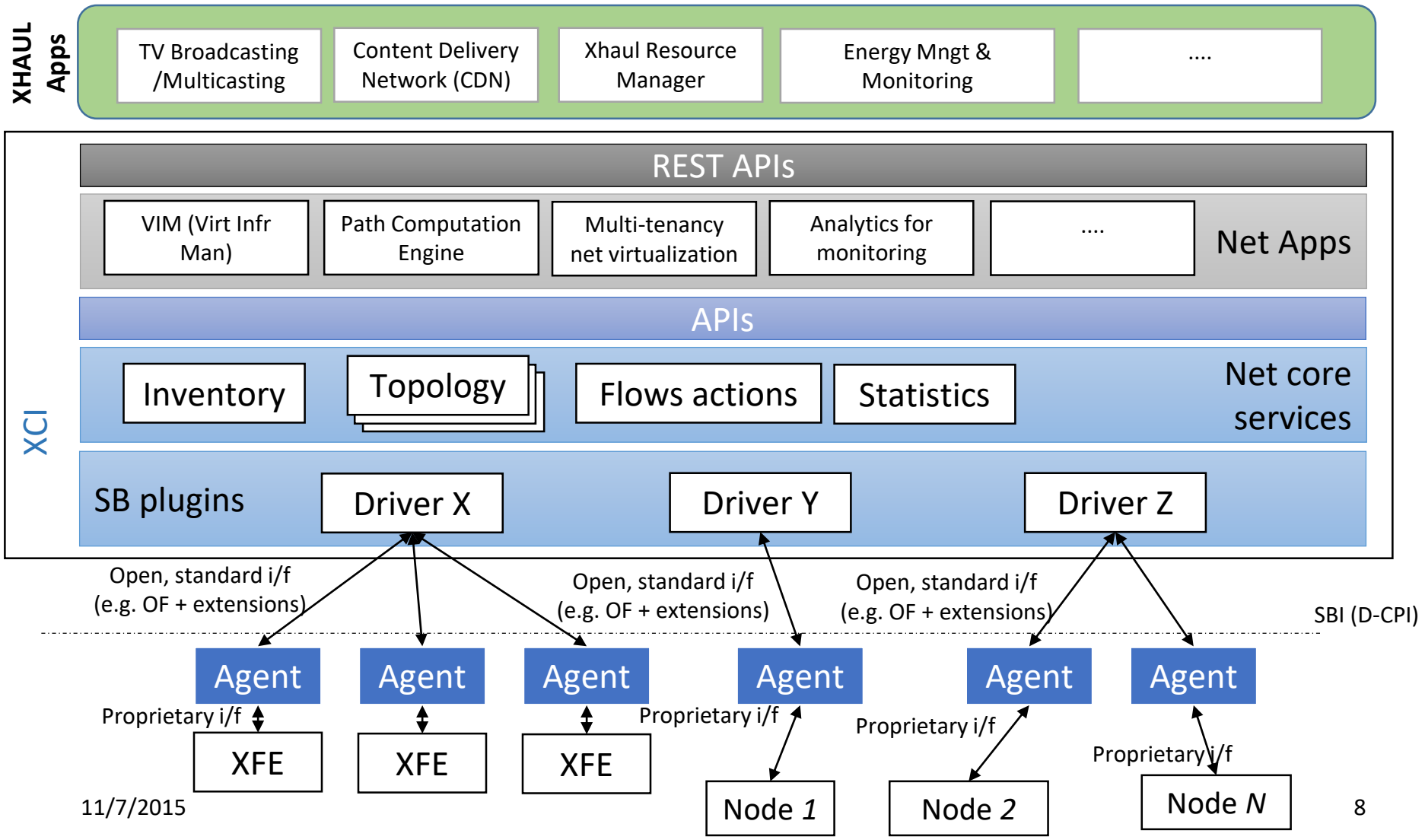
- The Xhaul Control Infrastructure is in charge of:
  - Controlling the forwarding in the network
  - Assigning RRHs to virtual BBUs based on network capacity, multi-tenancy contracts and functional splits
  - Allocating VNFs, such as BBUs, CDN, etc.
  - Orchestrating the networking and IT resources
  - Optimizing the energy consumption of the network
  - …
- It is the **brain of the Xhaul architecture**

High-level vision of the XCI

- Leveraging SDN and NFV standards

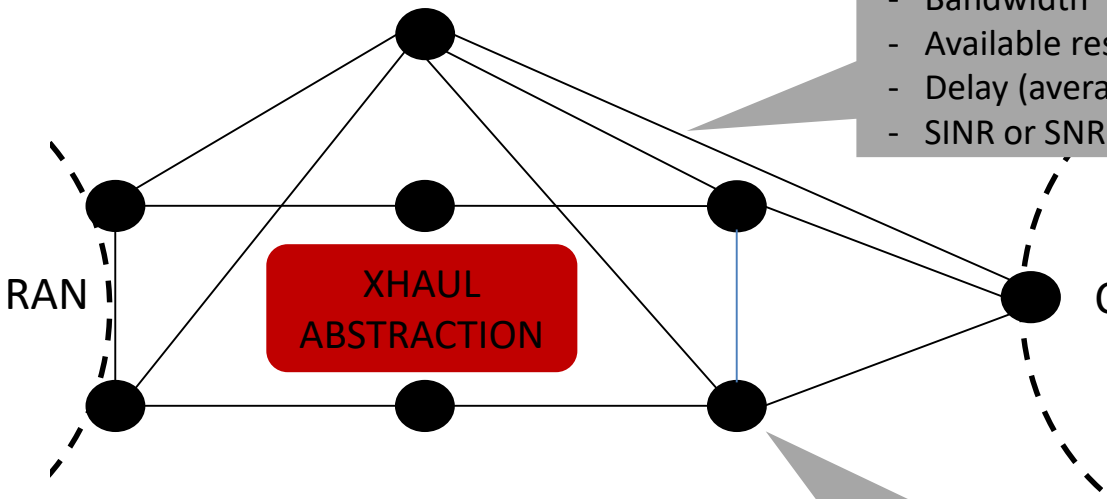


XCI SDN architecture



Xhaul Resource manager

Demand
- Features (uni/multicast, survivability, …)
- Endpoints
- Expected load
- Tolerated delay
- Max Pack loss rate
- User mobility

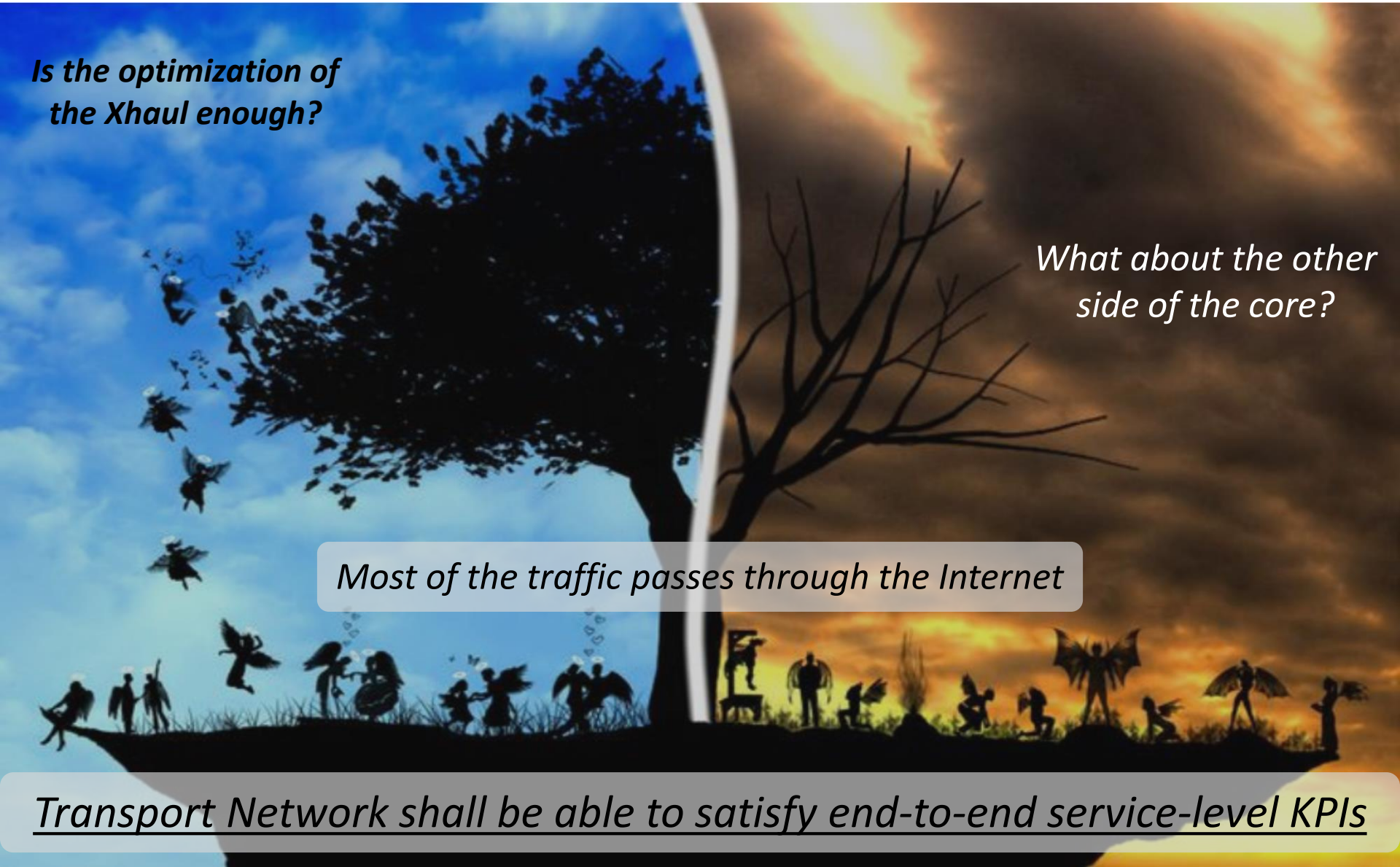


Link
- Bandwidth
- Available resources
- Delay (average, var)
- SINR or SNR (pack loss)

Node
- Index + Location
- Type
- Computation/Storage capacity
- Switching Matrix
- Functions

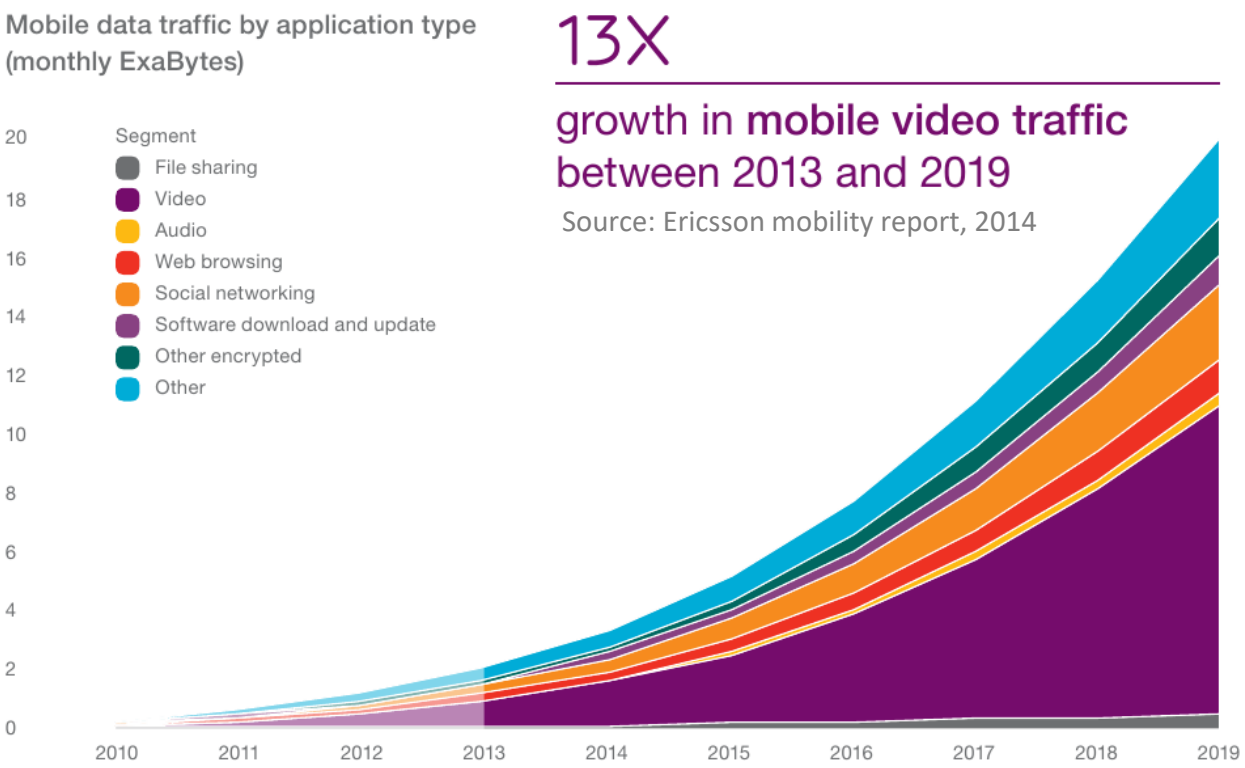
- *Dynamic resource allocation*
  - Selection of the most appropriate technology
  - Function placement
  - Traffic offloading
- *Network adaptation*
  - Modification of physical layer parameters
  - Handling of link failure or degradation

But…



Transport Network shall be able to satisfy end-to-end service-level KPIs

Applications are the driver

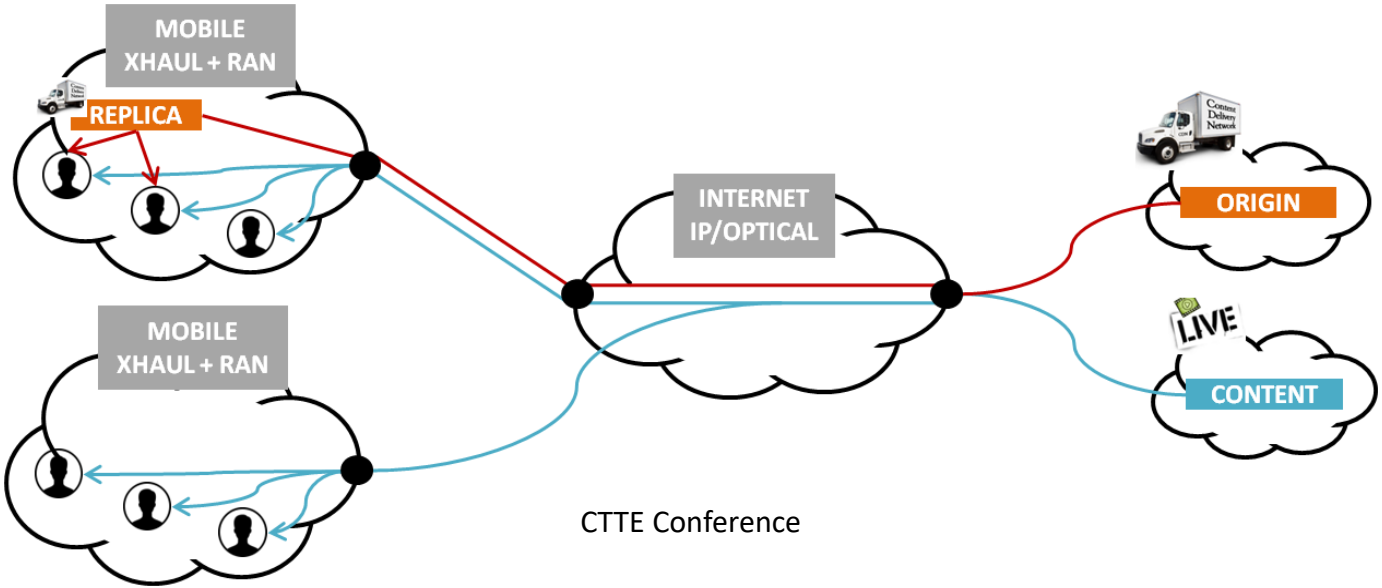


- *Two network applications*:
  - Content Delivery Network (CDN): per-user distribution of video contents, typically on-demand
  - TV broadcasting: broadcasting of video contents, typically live events

Case study: applications and requirements

- *CDN*
  - Unicast connections
    - Origin to replica server
      - Very High BW (massive contents)
      - No strict latency requirements
    - Replica server to customer
      - Moderate BW
      - No strict latency requirements
- *TV broadcasting*
  - Multicast connections
    - Site to production (over IP)
      - Very High BW (e.g. 800 Mbit/s)
      - No packet loss, low jitter
    - Production to customer
      - High BW (40 Mbit/s)
      - No packet loss, low jitter

Need for end-to-end application-centric service in the transport

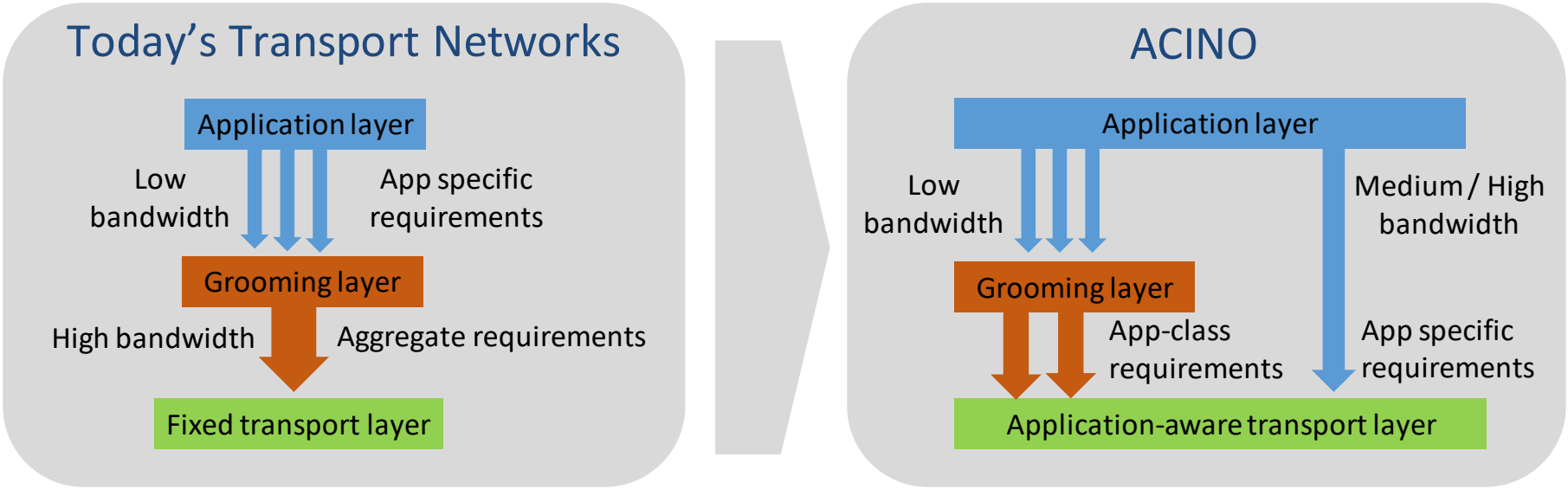


The ACINO approach

ACINO EU project

www.acino.eu

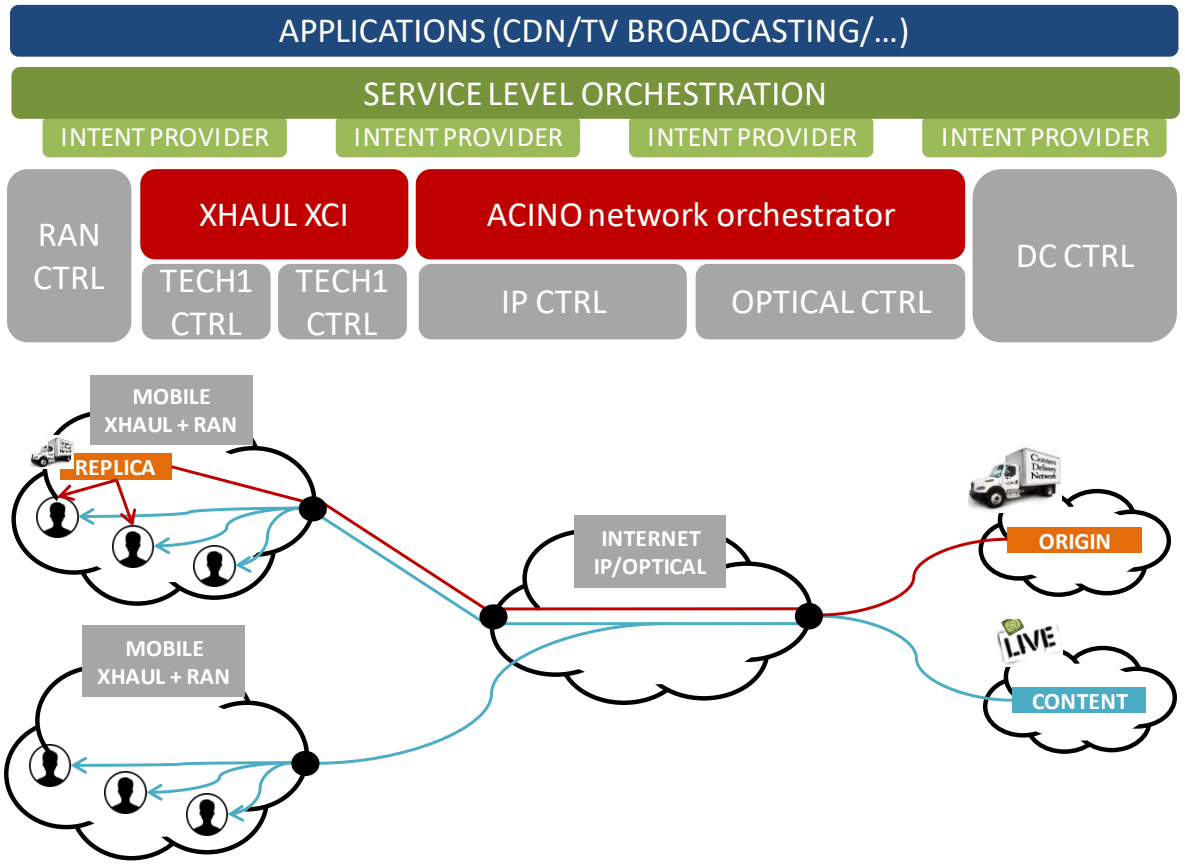
@acinoH2020



- Applied to our case:
  - CDN:
    - Shared optical connection
    - Optical restoration
  - TV broadcasting:
    - Dedicated optical connection (low latency)
    - IP protection

Multi-layer multi-technology (IP/Optical) network orchestration

Transport network: end-to-end vision



- Multi-layer optimization including all transport (L0 to L3) layers
- Hierarchy of controllers

Conclusions

- As of today, fronthaul and backhaul are separate and incompatible network segments
- Xhaul project addresses this issue by proposing integrated control and data planes
  - Enabler for dynamic resource management in 5G transport networks
- Applications require end-to-end perspective
  - Interoperation with the core/metro transport is needed
  - Synergy with ACINO project (application-centric transport)




Thank you for your kind attention!!

domenico.siracusa@create-net.org

@custoz

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