Universidad Carlos III de Madrid
www.uc3m.es

Orchestration of Crosshaul Slices From Federated Administrative Domains: the 5GEx and 5G-Crosshaul approach

Carlos J. Bernardos (UC3M) cjbc@it.uc3m.es

Based on joint work with LM. Contreras, A. de la Oliva, X. Costa-Pérez and R. Guerzoni

"Next Generation fronthaul/backhaul integrated transport networks" workshop

EuCNC 2016, Athens

June 27, 2016

5GEx

http://www.5gex.eu

5GXCrosshaul
the integrated fronthaul/backhaul

http://www.5g-crosshaul.eu

5GEx 5GXCrosshaul the integrated fronthaul/backhaul

European Commission | Horizon 2020 European Union funding for Research & Innovation

5G PPP The 5G Infrastructure Public Private Partnership

Outline

- Introduction
- 5G-Crosshaul areas
- 5G-Exchange as market place for multi-domain services
- Multi-domain composition of 5G-Crosshaul infrastructures
- Conclusions and future work

Introduction: multi-domain and crosshaul

- Crosshaul: the integrated fronthaul and backhaul transport network
  - Adding flexibility to adapt the deployed resources to the concrete demand
  - Combining resources from different InPs can provide further flexibility
- Two possible multi-domain cases
  - Composition of administratively separated Crosshaul domains
  - Composition of end-to-end administratively separated domains (including Core Network, Crosshaul and Radio Access Network)
- Goal: hosting Crosshaul in a multi-domain federated infrastructure
  - Gap: market place where networking and computing facilities are traded

- This work presents an architectural framework enabling the dynamic request of Crosshaul slices through a multi-provider exchange

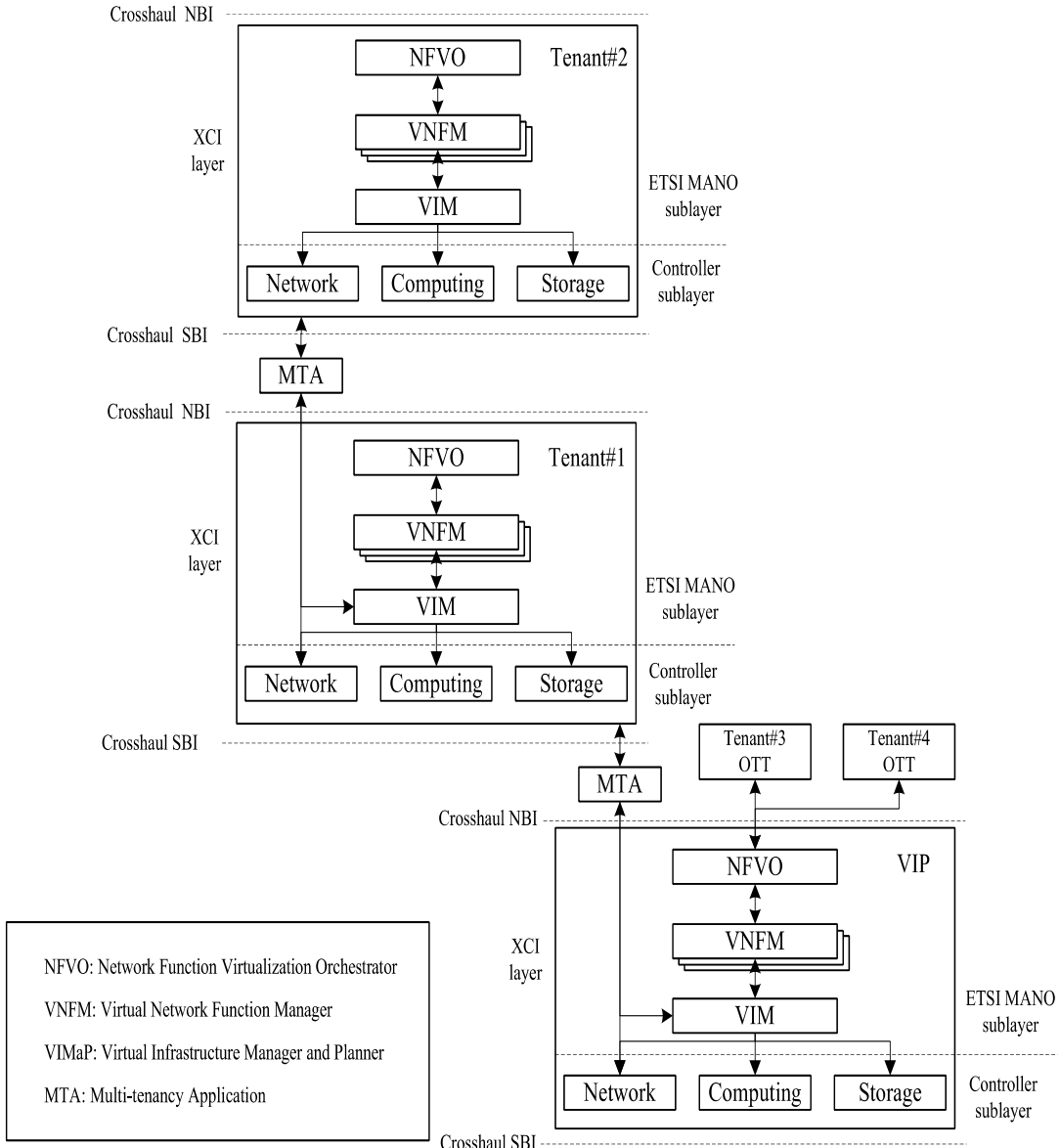
5G-Crosshaul areas

- New transport networks will integrate the fronthaul and backhaul
  - In an integrated network: the **Crosshaul**
  - Multitenancy will be an integral part of the design, reducing CAPEX and OPEX
- 5G-Crosshaul approach is based on three building blocks
  - a control infrastructure using a unified, abstract network model for control plane integration (*Crosshaul Control Infrastructure*, XCI)
  - a unified data plane encompassing innovative high-capacity transmission technologies and novel latency-deterministic switch architectures (*Crosshaul Forwarding Element*, XFE)
  - a set of computing capabilities distributed across the network (*Crosshaul Processing Units*, XPUs)

5G-Crosshaul Multi-MANO architecture

- The transport network envisioned by 5G-Crosshaul will serve as a transport stratum to three kind of tenants:
  - Network Operator, similar to InP role.
  - Mobile Virtual Network Operator, which uses a set of virtualized resources from the Crosshaul to interconnect its infrastructure. May allow reselling of virtual resources.
  - Over The Top provider, which will make use of the transport infrastructure to connect distributed service points (e.g., a company connecting its own datacenters).

- Crosshaul supports these roles through the multi-tenancy application (MTA). In addition, the Multi-MANO architecture is designed in a recursive way, to accommodate different tenant roles.



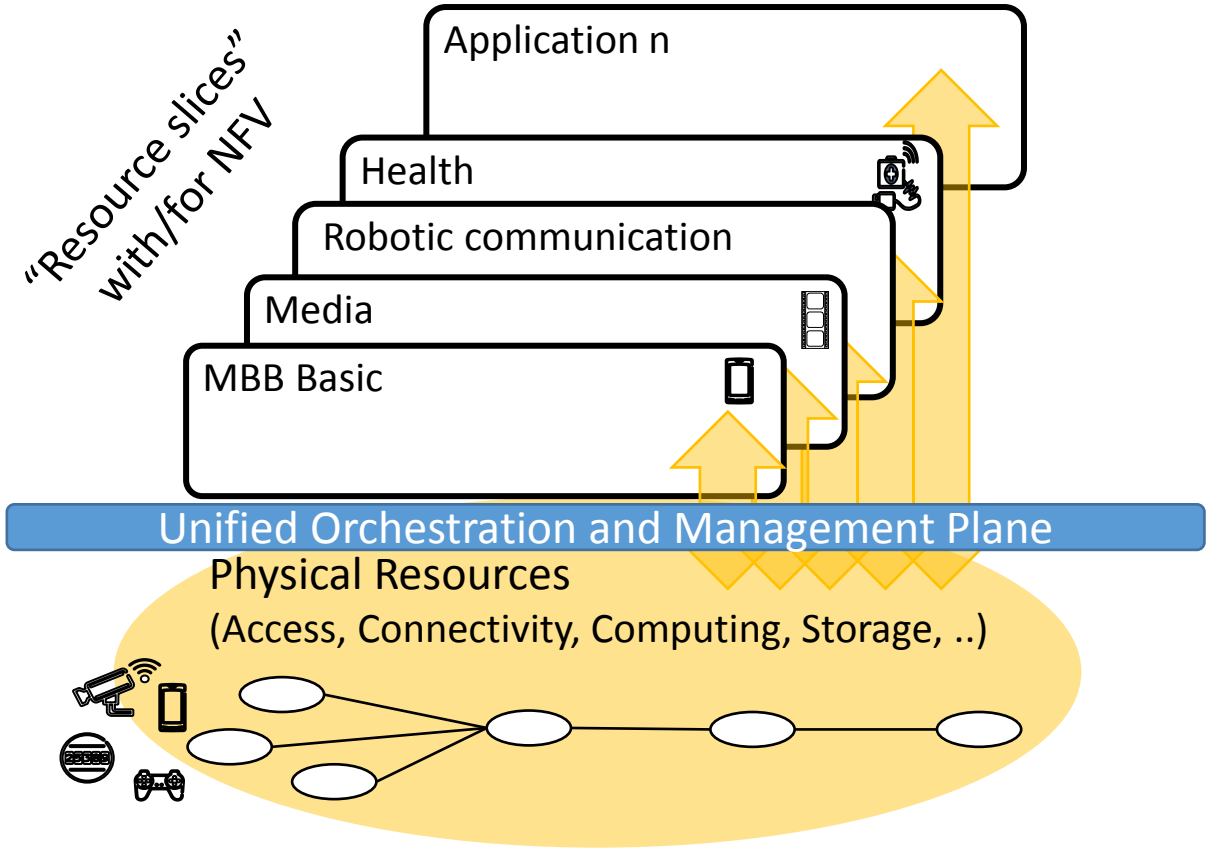
5G-Exchange as market place for multi-domain services

- Deployed solutions to steer and manage traffic not suitable for 5G
  - Lack required flexibility and agility, leading to complex and rigid policies
    - Even worse if multiple domains are involved
- Gap: framework allowing relevant stakeholders to trade resources and service functions in order to flexibly deploy end-to-end services by involving the required providers
  - In particular, need of enabling different 5G-Crosshaul providers to build services encompassing multiple technology and administrative domains
    - The **5GEx project**

5GEx: One 5G Network – Multiple Industries

From dedicated **physical networks with dedicated control and dedicated services and resources** for different applications…

…to a "network factory" where **resources and network functions are traded and provisioned:** new infrastructures and services are "manufactured by SW"



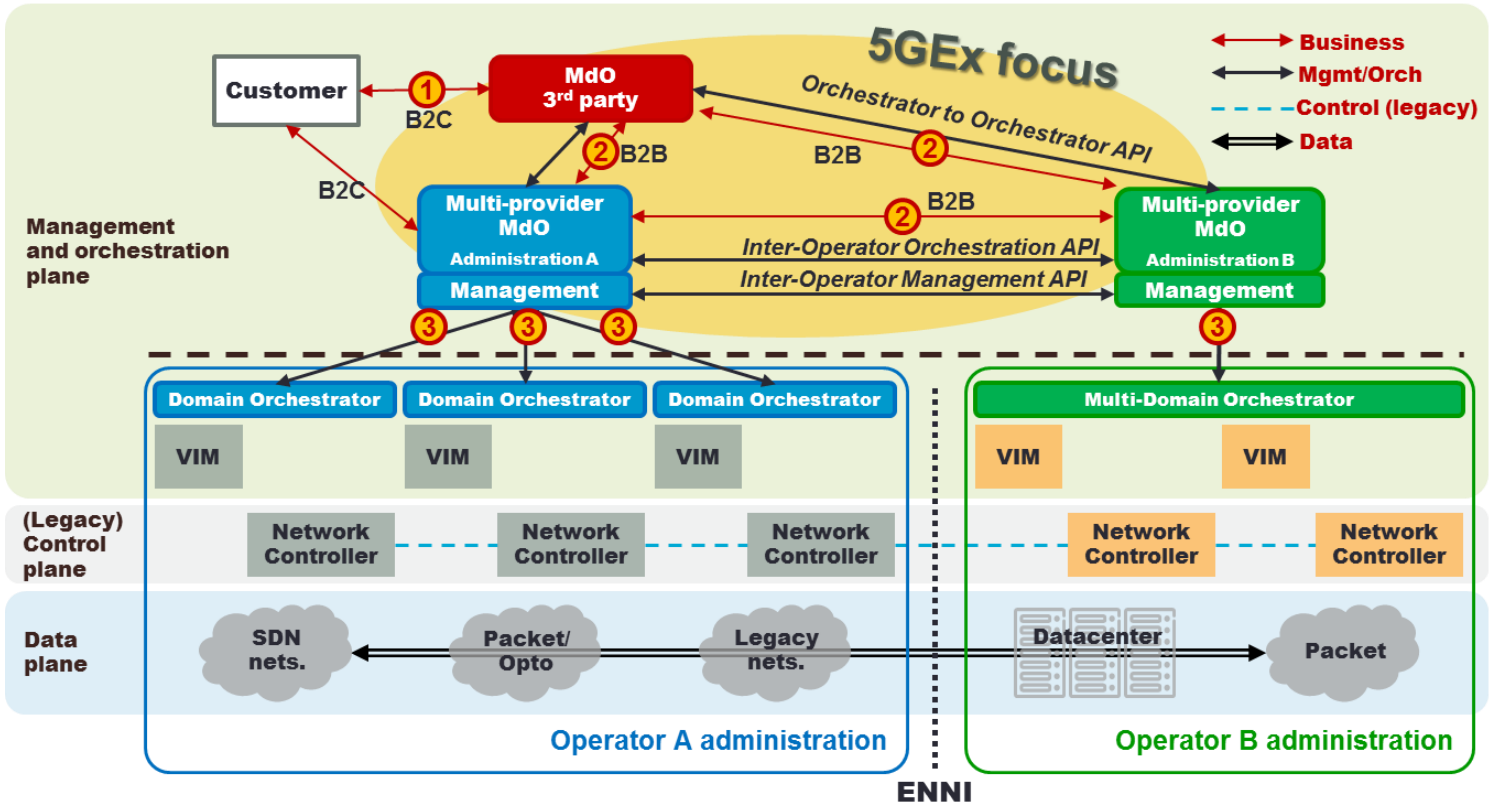
5GEx 5GXCrosshaul the integrated fronthaul/backhaul

EuCNC, June 2016

5GEx: market place for multi-domain services

5GEx Mission:

- enable business and technical **cross-domain service orchestration** over multiple administrations,
- realize **composite services** by combining cross-domain network, computing and storage resources
- develop suitable **business models** for operators to optimally buy, sell, and integrate 5GEx services
- build and deploy a proof-of-concept **system prototype**, implementing the "Sandbox Exchange"
- contribute to relevant **standard forums** and Open Source communities



5GEx 5GXCrosshaul the integrated fronthaul/backhaul

EuCNC, June 2016

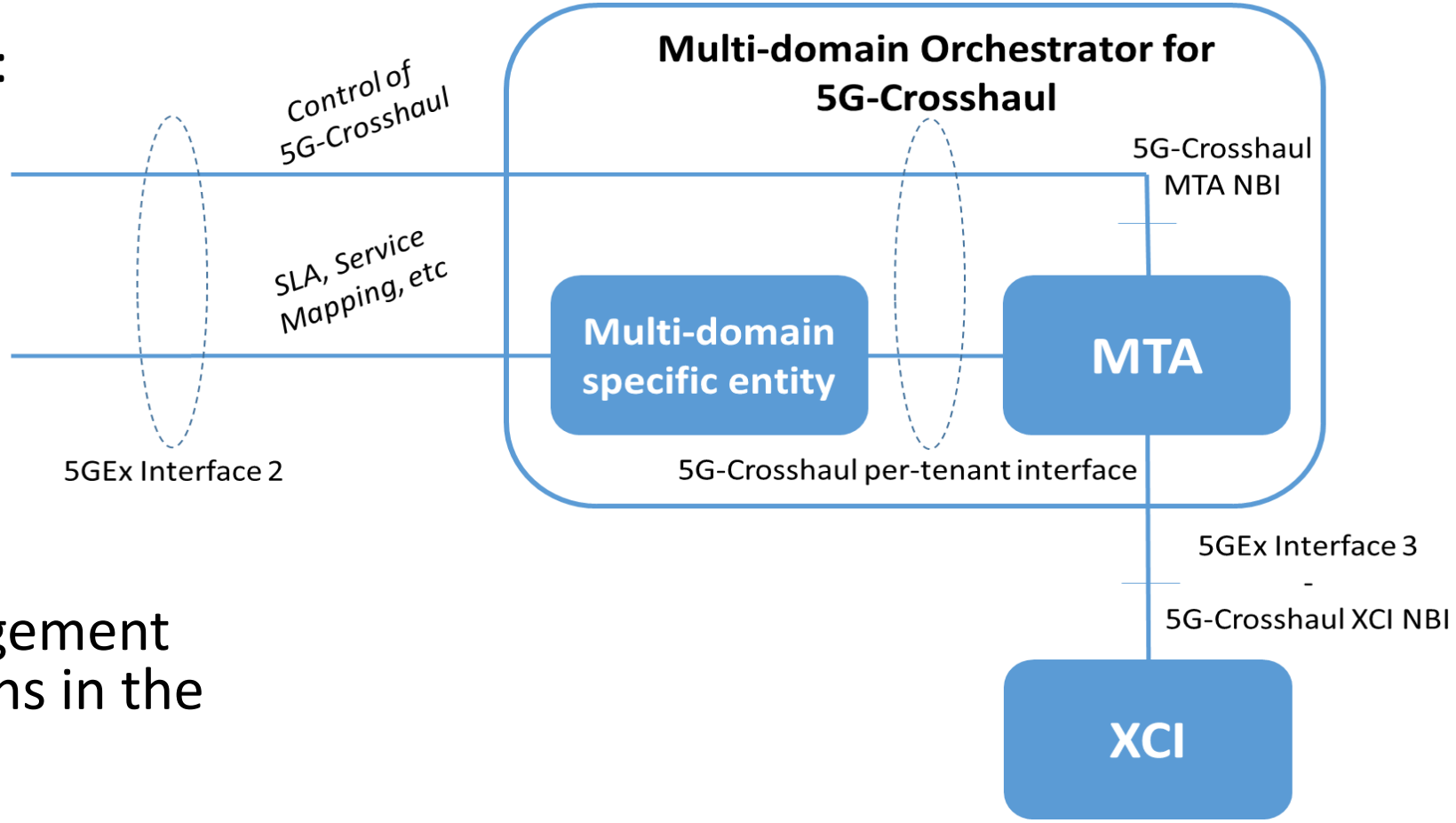
Multi-domain composition of 5G-Crosshaul infrastructures

- 5GEx multi-domain orchestration framework used to realize scenarios involving multiple Crosshaul domains of different operators
- 5G-Crosshaul XCIs play the role of single-domain orchestrators
  - coordinated by 5GEx multi-domain orchestrators
  - XCI orchestrates both networking resources and compute plus storage within a single administrative domain
    - Resources can be offered as dedicated slices in the multi-domain environment
    - Resource slicing is enabled by the 5G-Crosshaul Multi-Tenancy Application (MTA)
      - Acts as a mediation layer between tenants and the shared infrastructure
- Multi-domain Orchestration capabilities are partially supported by the MTA
  - However, additional features in the MTA are required to fully support inter-operator orchestration and management (5GEx Interface 2 support)

Multi-domain composition of 5G-Crosshaul infrastructures

Additional features needed:

- SLA negotiation
- Service mapping mechanisms
- Reporting of Crosshaul metrics, including both the compute and networking substrates
- Proper control and management interfaces to dictate actions in the offered Crosshaul slice



Conclusions and future work

- 5G will accelerate the need of rapid adaptation of the networks to satisfy a changing demand
  - Leveraging on the transformation driven by SDN and NFV
    - Provision of resource slices on demand from different infrastructure providers
- Key to support dynamic composition of multi-domain environments
  - Evolving the concept of “Exchange” to interconnect a variety of resources, in the logical form of slices
    - Appearing as dedicated for the interconnection purposes
    - Achieved by means of virtualization and trading of those resources
- Proposal of an approach to multi-domain Crosshaul composition
  - Combining the architectural frameworks of 5GEx and 5G-Crosshaul projects
    - A new 5G-Crosshaul application proposed to address identified gaps

Thank you!