A Research Perspective for SDN Orchestration

Ricard Vilalta, Raul Muñoz, Arturo Mayoral, Ramon Casellas, Ricardo Martínez

Network Virtualization Forum, Madrid, 2015

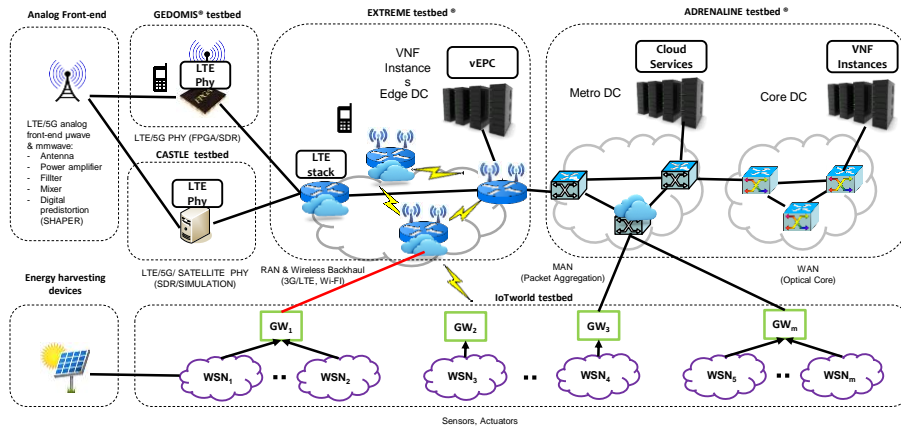## A Research Perspective for SDN Orchestration

- The value of Experimental Research

- SDN Orchestration

- SDN Orchestration for Verticals

- Standards vs OpenSource: Getting the benefits from both worlds

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2

## The value of experimental research: the CTTC 5G testbed

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Underlying Infrastructure to be complex & heterogeneous

- To support new advanced city services and satisfactory user experience, the underlying communications infrastructure needs to evolve, grow and adapt, resulting in heterogeneous technologies (both at the data and control plane).

  - 5G and beyond networks: 4G / 5G / mmWave /…
  - Net & Functions Virtualization, Fog & Cloud computing (local/remote processing)…

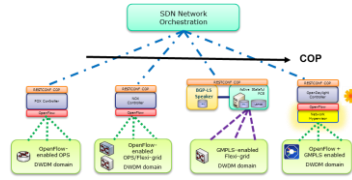- *This network complexity needs to be managed*
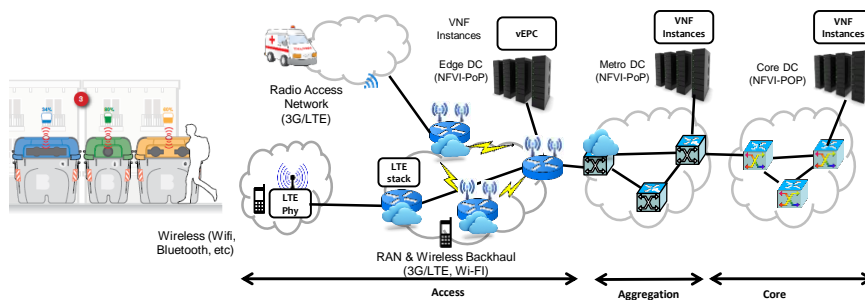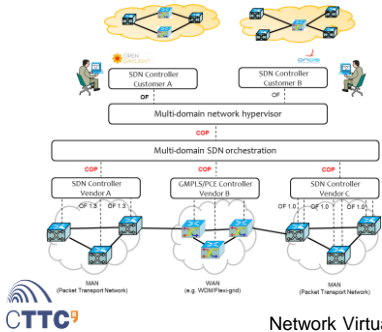
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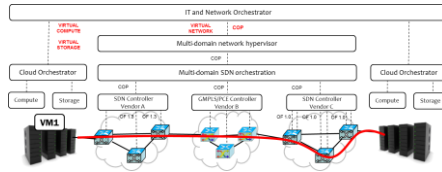## Managing Complexity with SDN Orchestration

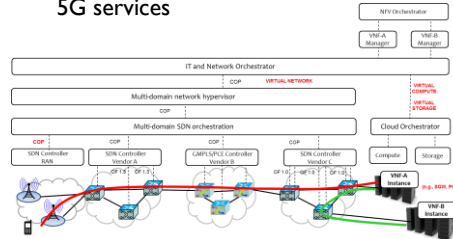- SDN Orchestration

- Multi-domain network virtualization

- Integrated orchestration of IT and Transport Network resources


- Network Function Virtualization for 5G services

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Abstracted network topology and Distributed Path Computation

- Each domain controller is responsible for computing an abstract network topology and expose it to the SDN orchestrator.
- The PCE calculates a path through the abstracted multi-layer and multi-domain topology (domain sequence selection)
- Each domain controller performs the actual computation of the strict path within each domain based on the complete TE information (path segment expansion)
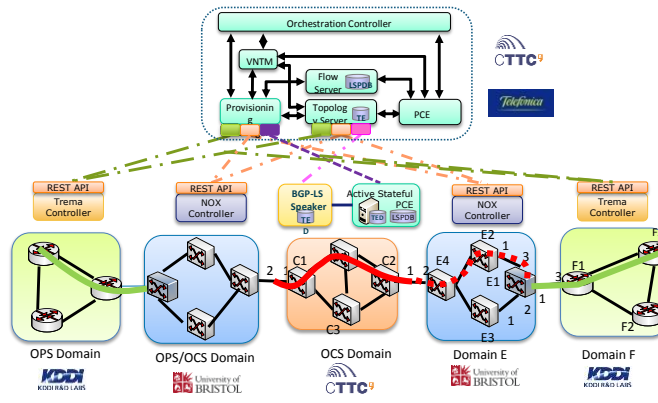

R. Muñoz, et al., Experimental Assessment of ABNO-based Network Orchestration of end-to-end Multi-layer (OPS/OCS) Provisioning across SDN/OpenFlow and GMPLS/PCE Control Domains , ECOC 2014, September 21-25, 2014 Cannes (France).

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Multi-domain network virtualization

- The dynamic creation, modification and deletion of end-to-end virtual network slices in response to application demands

- Representing the abstracted topology of each end-to-end virtual network to the corresponding customer SDN controller.

- Allowing the customer SDN controller to control the virtual transport network through a well-defined interface (e.g., OpenFlow protocol), as the virtual transport networks were real physical transport networks.
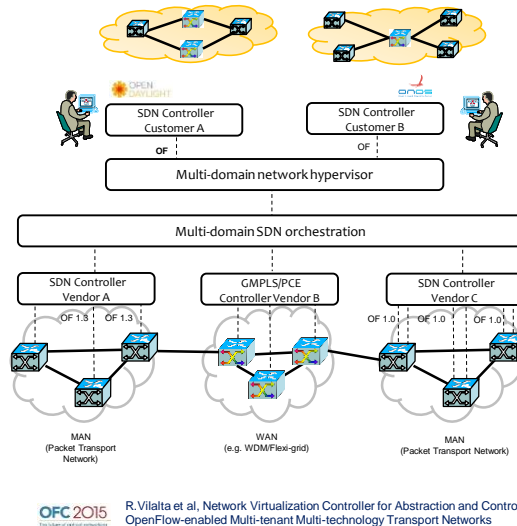
OFC 2015   R. Vilalta et al, Network Virtualization Controller for Abstraction and Control of OpenFlow-enabled Multi-tenant Multi-technology Transport Networks

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7

Integrated orchestration of IT and Transport Network resources

- The interconnection of different DC sites that are physically dispersed, but logically centralized is one of the major challenges to face in order to provide global end-to-end cloud services.

- COP enables the integrated orchestration of IT resources (compute and storage) with network resources
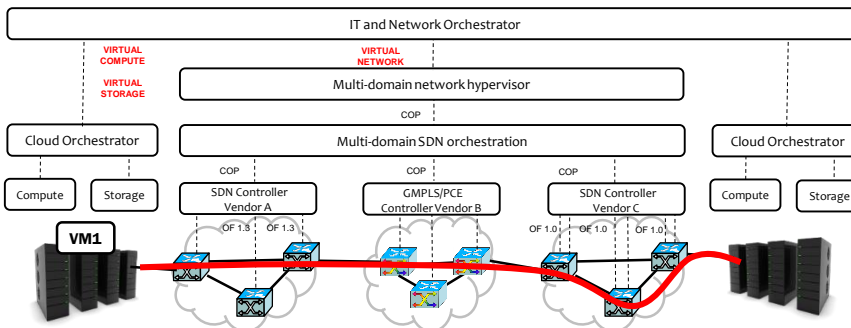
OFC 2015   A. Mayoral et al, Experimental Seamless Virtual Machine Migration Using an Integrated SDN IT and Network Orchestrator

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Network Function Virtualization for 5G services

- NFV for 5G services requires the integration of all network segments (radio access, aggregation and core) with heterogeneous wireless and optical technologies.

- SDN orchestration enables the integration of Radio Access Networks with heterogeneous control planes and technologies (5G, mmWave, LTE/LTE-A, Wi-Fi, etc.)

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9
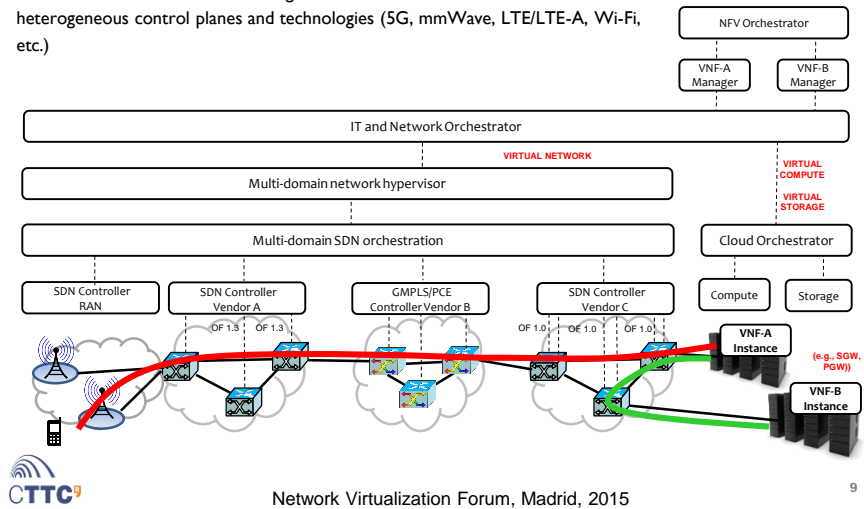
SDN Orchestration for emerging markets (verticals)

- SDN Orchestration role in:

  - End-to-End connectivity

  - Open Integrated Architecture: integration of platforms in an event-driven and service oriented architecture

  - Security by design

  - Semantic-driven analytics

- To be provided in: IoT, Cloud and Big Data

  - Smart Energy

  - Smart Transport

  - Smart Manufacturing

  - Smart Government

  - Smart Health

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10

5

The need for generic control functions and a Transport API

- The NBI of the SDN/OpenFlow or GMPLS/ PCE Controllers are typically technology and vendor dependent.
  - The multi-domain SDN orchestrator shall implement different plugins for each of the specific controller's NBI.
- The STRAUSS project defines a generic functional model of a control plane for the provisioning of connectivity, topology dissemination and path computation, and defines an associated protocol (the Control Orchestration Protocol - COP-)

https://github.com/ict-strauss/COP

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11
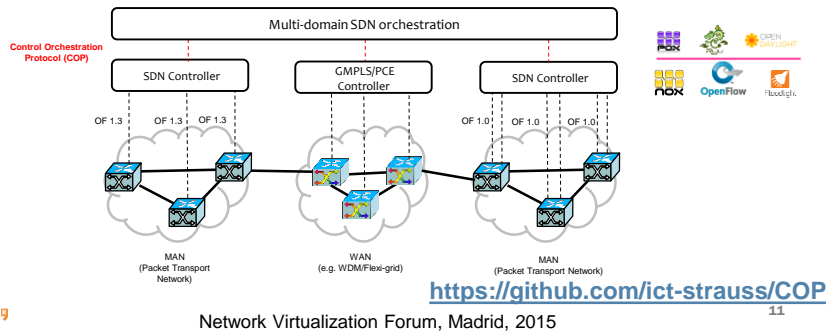
YANG and RESTCONF

- YANG is a modeling language designed to create data models for the NETCONF protocol and more recently to RESTCONF. YANG is capable to define configuration and operational state data, remote procedure calls (RPCs) and Notifications.

- RESTCONF is a REST-like protocol that provides a HTTP-based API to access the data, modeled by YANG. The REST-like operations are used to access the hierarchical data within a datastore. The information modeled in YANG is structured in the following tree:
  - /restconf/data : "Data (configuration/operational) accessible from the client but not editable"
  - /restconf/modules : "Set of YANG models supported by the RESTCONF server"
  - /restconf/operations : "Set of operations (**YANG-defined RPCs**) supported by the server"
  - /restconf/streams: "Set of notifications supported by the server"

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Transport API RESTConf Connectivity

>> *Create call*

Request:

**curl -X PUT -u admin:admin -H "Content-type:application/json"
http://localhost:8080/restconf/config/calls/call/call-1**

Content:

```
-d '{"call":{
    "call_id":"call-1",
    "aEnd":{
        "endpoint_id":"ep-1",
        "router_id":"10.10.0.1",
        "interface_id":"1"
    },
    "zEnd":{
        "endpoint_id":"ep-2",
        "router_id":"10.10.0.2",
        "interface_id":"1"
    },
    "transport_layer":{
        "layer":"eth"
    },
    "connections":[
        {"connection":{
            "connection_id":"con-1",
            "aEnd":{
                "endpoint_id":"ep-1"
            },"zEnd":{
                "endpoint_id":"ep-2"
            },"path":[
                {"id":"1","topo_component":"vertex-1"},
                {"id":"2","topo_component":"vertex-2"}
            ]}
        ]}
    }
}
```
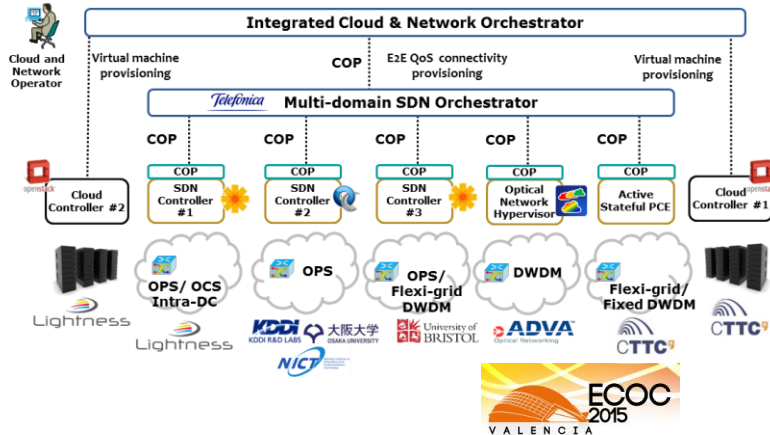
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BREAKINGNEWS

First experimental demonstration of distributed cloud and heterogeneous network orchestration with a common Transport API for E2E services provisioning and recovery with QoS , submitted as a PDP at ECOC 2015
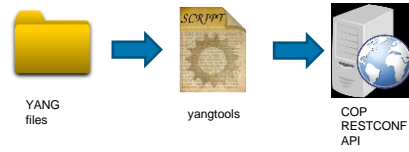

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Open Source Transport API

- Set of open source YANG tools developed:
    - Swagger RESTconf API documentation
   - Swagger code generator
    - Python code generator

- A draft COP definition and YANG tools are open for discussion and can be downloaded and contributed to at:

https://github.com/ict-strauss/COP

YANG files

yangtools

COP RESTCONF API

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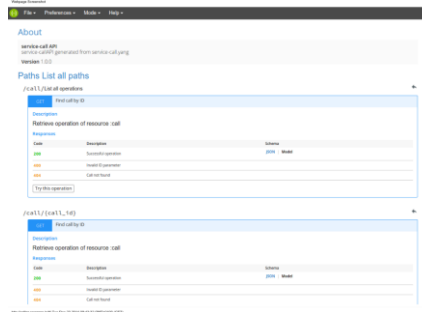
Standardization vs. open-source – which one do you choose?

- Standard and open-source are complementary.

- ONF is in transition from "pdf to python"

- OpenSource SDN:
    - Portal
    - Community
    - Github

Open Source

Standard Setting

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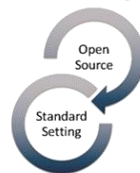
What are the risks associated with open-source solutions? Does the reward offset the risk?

- Vendor dominated Open-Source is the new Vendor lock-in
  - Community and Governance is important!

- Companies often have little clue about the extent of third-party code in the enterprise or the risks it poses.

- Who's to blame?

Conclusion

- Importance of Experimental Research

- How to manage complexity with SDN Orchestration

- SDN Orchestration for emerging markets (verticals)

- The need of a Transport API

- Open Source vs Standardization

Thank you! Questions?

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