First ITU Workshop on Network 2030,New York, United States, 2 October 2018

https://www.itu.int/en/ITU-T/Workshops-and-Seminars/201810/Pages/Programme.aspx

On Deep Slicing and Loops in a Loop

Multi-Tenancy and Smart Closed-Loop Control Gone Wild

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INTRIG INFORMATION & NETWORKING TECHNOLOGIES RESEARCH & INNOVATION GROUP

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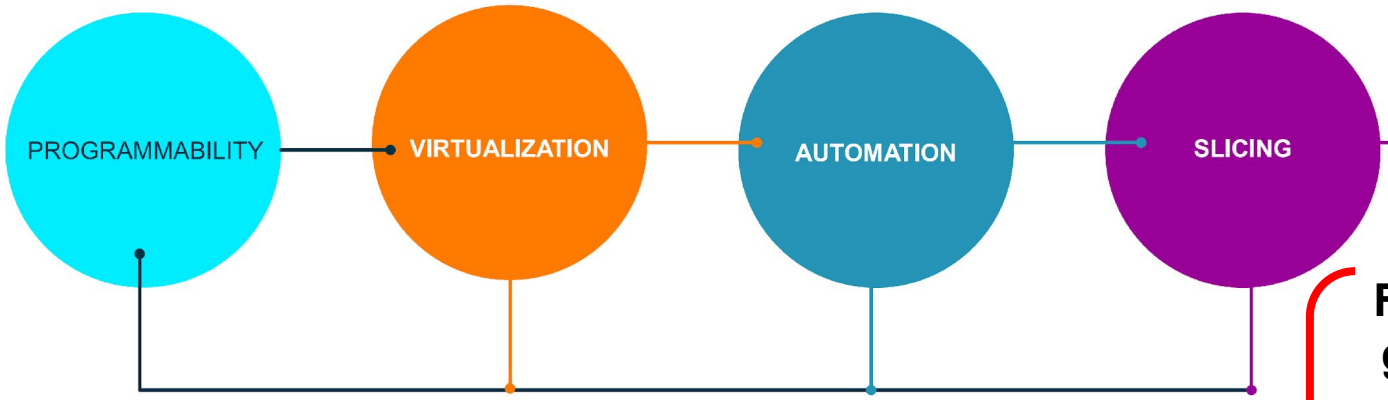
Slicing Journey: from 5G towads 2030



5G

2030

Executive Summary

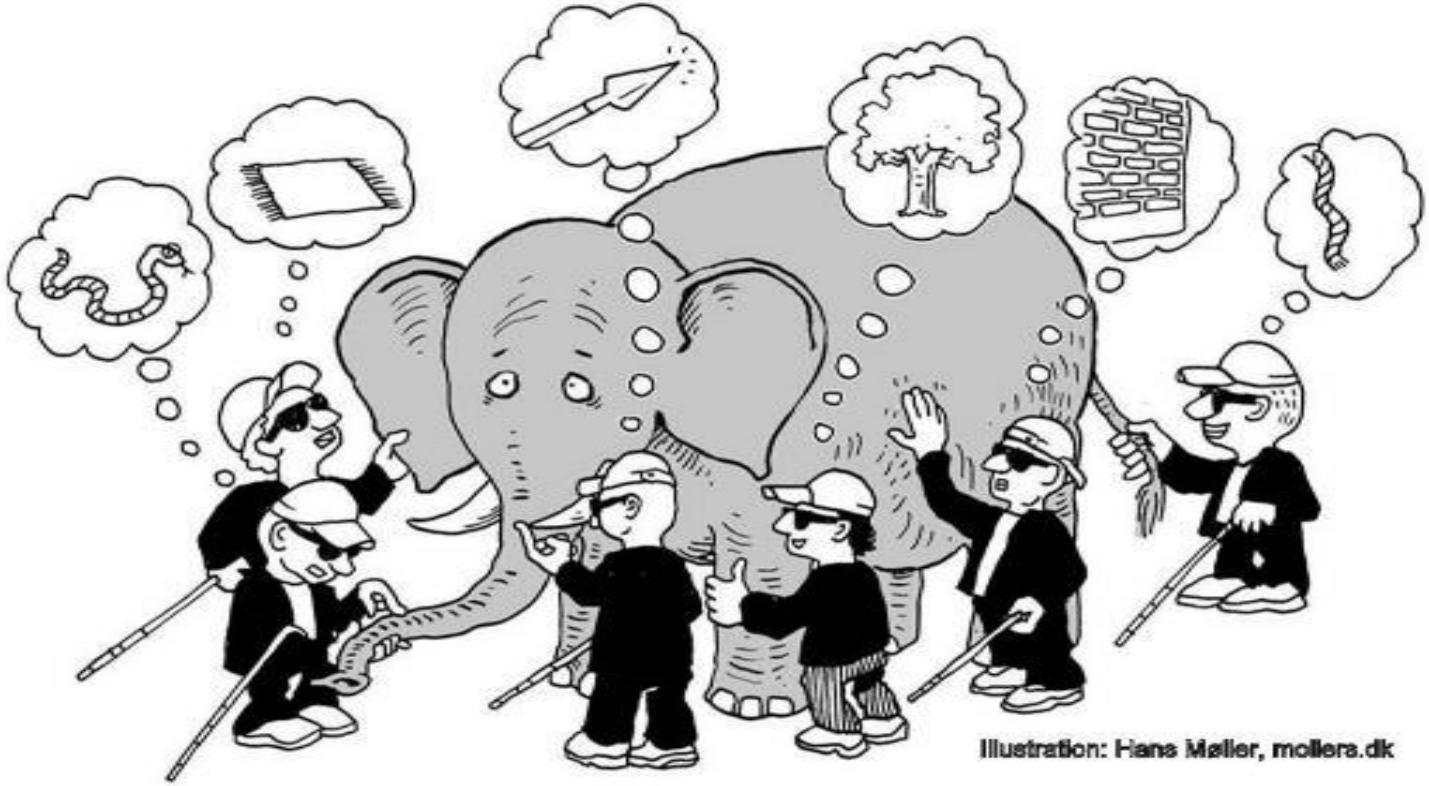
From siloed slices to generalized network cloud slicing

Deep, massive resource sharing & multi-tenancy

New Tenant-Provider relationships and power of choices

Source. Adapted from slide courtesy by Luis M. Contreras, Telefonica

But, wait…., what is a Slice?

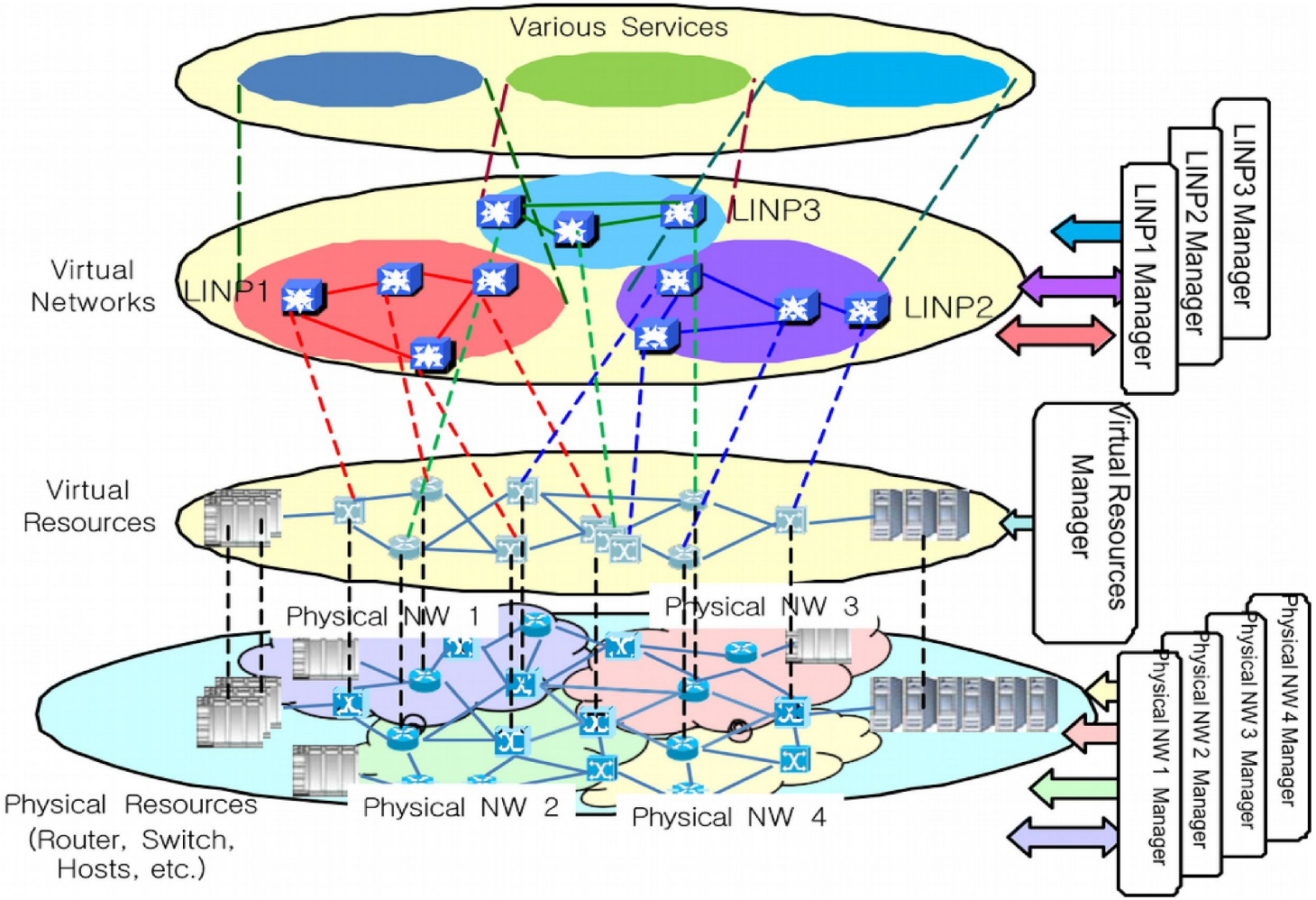


History of Network Slicing

[Not today towards 2030]

- Early references: Programmable Networks research & Federated Testbed research (1995 -2012)
- GENI Slice (2008): “A GENI slice is the unit of isolation for experiments. A container for resources used in an experiment; A unit of access control
- **ITU-T Slicing** (2011) as defined in [ITU-T Y.3011], [ITUTY.3012] Slicing allows logically isolated network partitions (LINP) with a slice being considered as a unit of programmable resources such as network, computation and storage
- Many more...
  - See: Alex Galis, Netsoft 2018 Tutorial:
    "Network Slicing Landscape: A holistic architectural approach"
    http://www.maps.upc.edu/public/presentations/netsoft18_slicingtutorial_v1.0.pdf

ITU-T
LINP


Various Services
Virtual Networks
LINP1
LINP2
LINP3
LINP3 Manager
LINP2 Manager
LINP1 Manager
Virtual Resources
Virtual Resources Manager
Physical NW 1
Physical NW 2
Physical NW 3
Physical NW 4
Physical Resources
(Router, Switch, Hosts, etc.)
Physical NW 4 Manager
Physical NW 3 Manager
Physical NW 2 Manager
Physical NW 1 Manager

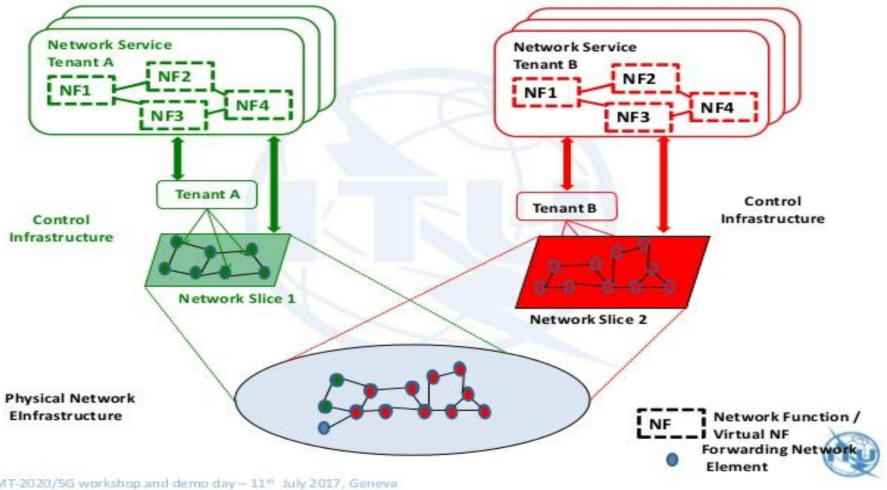
Main relevant standardization related activities to Slicing

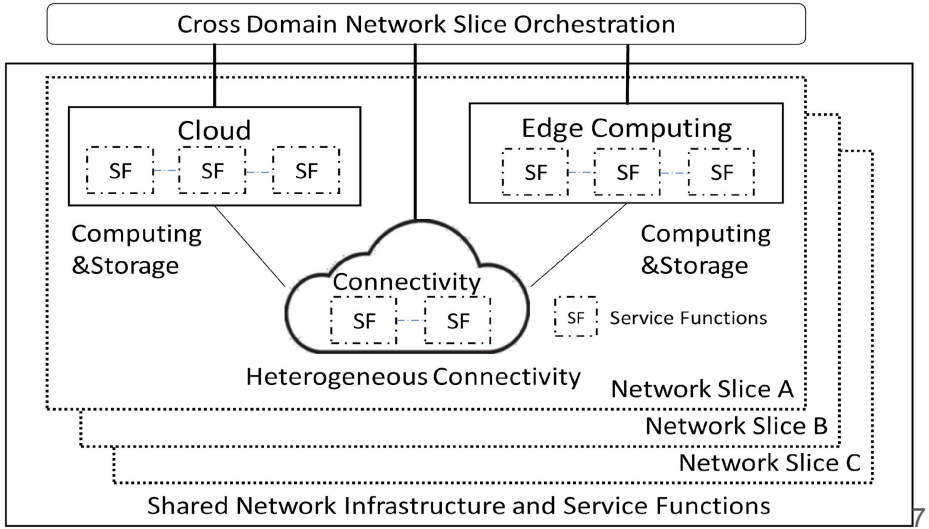
- **NGMN** Slices - consist of 3 layers: 1) Service Instance Layer, 2) Network Slice Instance Layer, and 3) Resource layer (2016).
- **3GPP** - SA2 23.799 Study Item “Network Slicing’ (2016); SA5 TR 28.801Study Item “Network Slicing (2017)
- **ITU-T** IMT2020 - Recommendations: 5G Architecture, Management of 5G, Network Softwarisation and Slicing - (2016 – 2017)
- **ONF** - Recommendation TR-526 “Applying SDN architecture to Network Slicing” (2016)
- **BBF** - Requirements / architecture of transport network slicing SD-406: E2E Network Slicing (2017)
- **ETSI** - NFV priorities for 5G (white paper) (2017). ZSM ISG automation technology for network slice management (2018). MEC support for network slicing (2018)
- **IETF** - No specific WG (despite attempts in 2017-2018).
  draft-galis-netslices-revised-problemstatement-03, draft-geng-netslices-architecture-02, draft-geng-coms-architecture-01, draft-netslices-usecases-01, draft-qiang-coms-use-cases-00, draft-qiang-coms-netslicing-information-model-02, draft-galis-anima-autonomic-slice-networking-04, draft-defoy-coms-subnetinterconnection-03, draft-homma-coms-slicegateway-01

Slicing in Scope

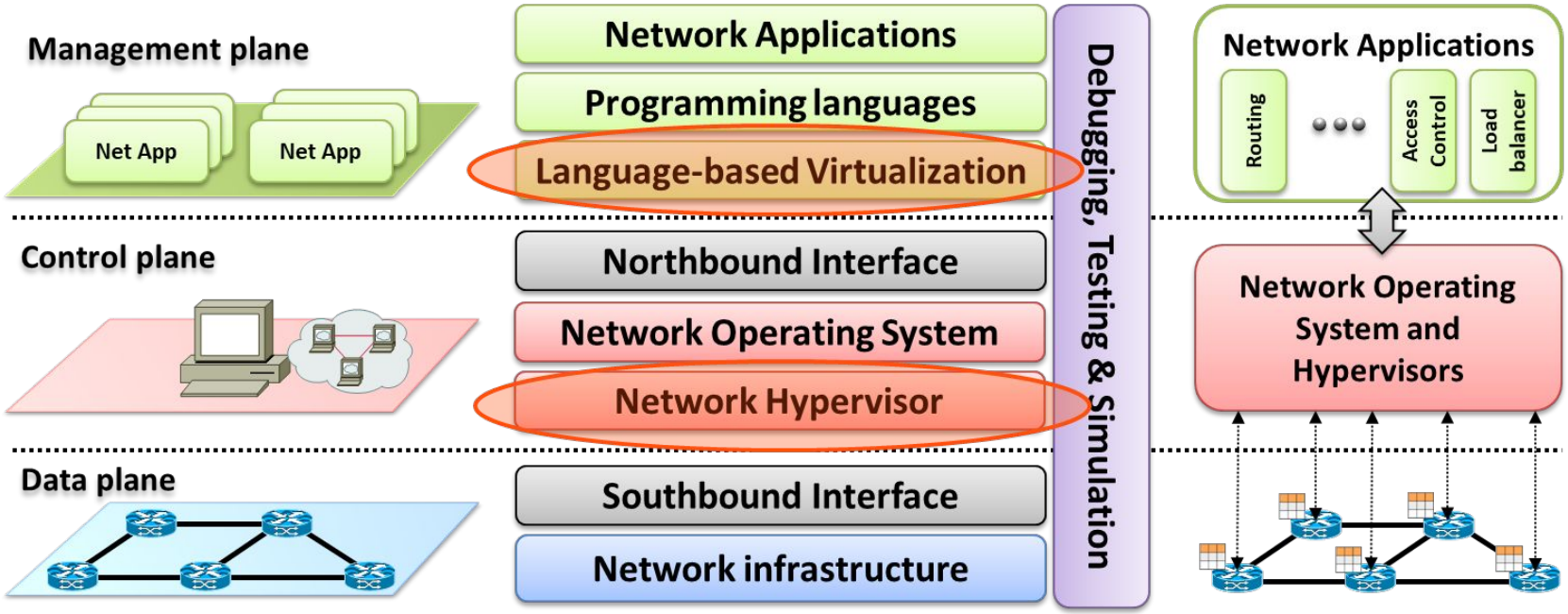
Network Slice – A Network Slice is a **managed group of subsets of resources, network functions / network virtual functions at the data, control, management/orchestration, and service planes at any given time.**

Cross-domain management of network slices in network infrastructure and service functions



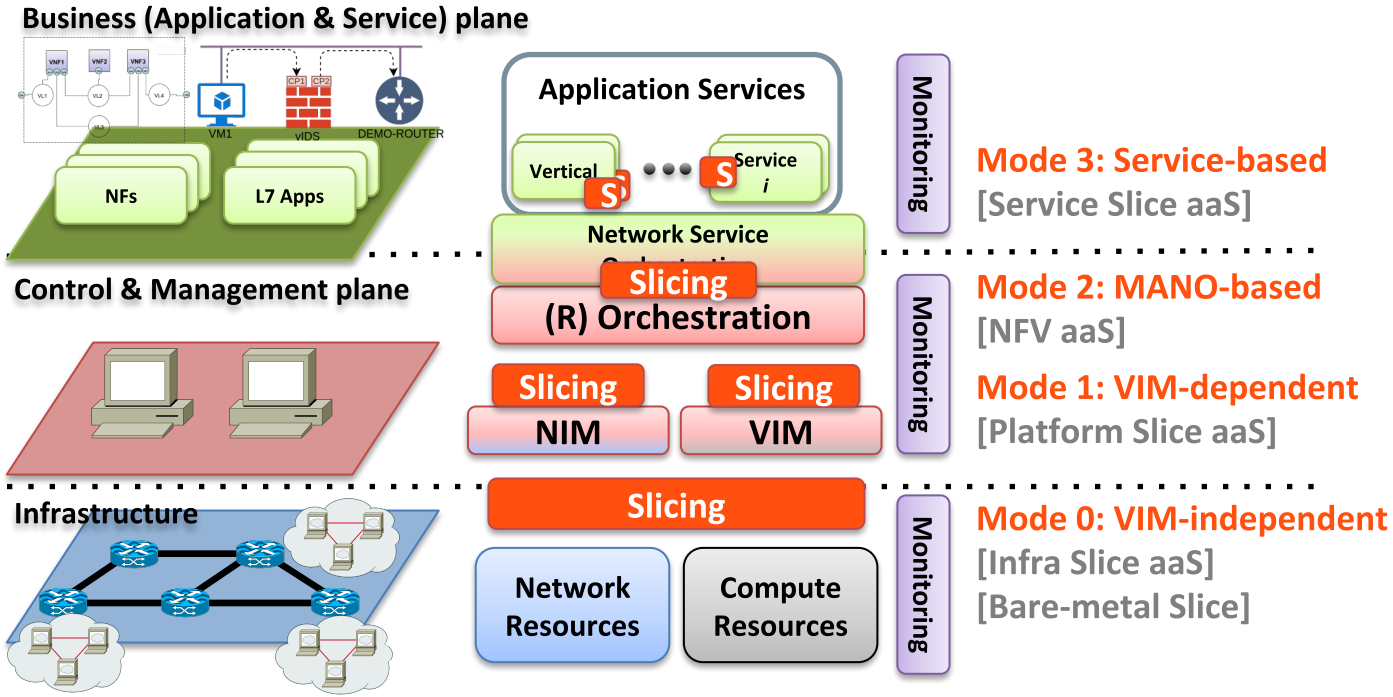


SDN & Virtualization vs Slicing



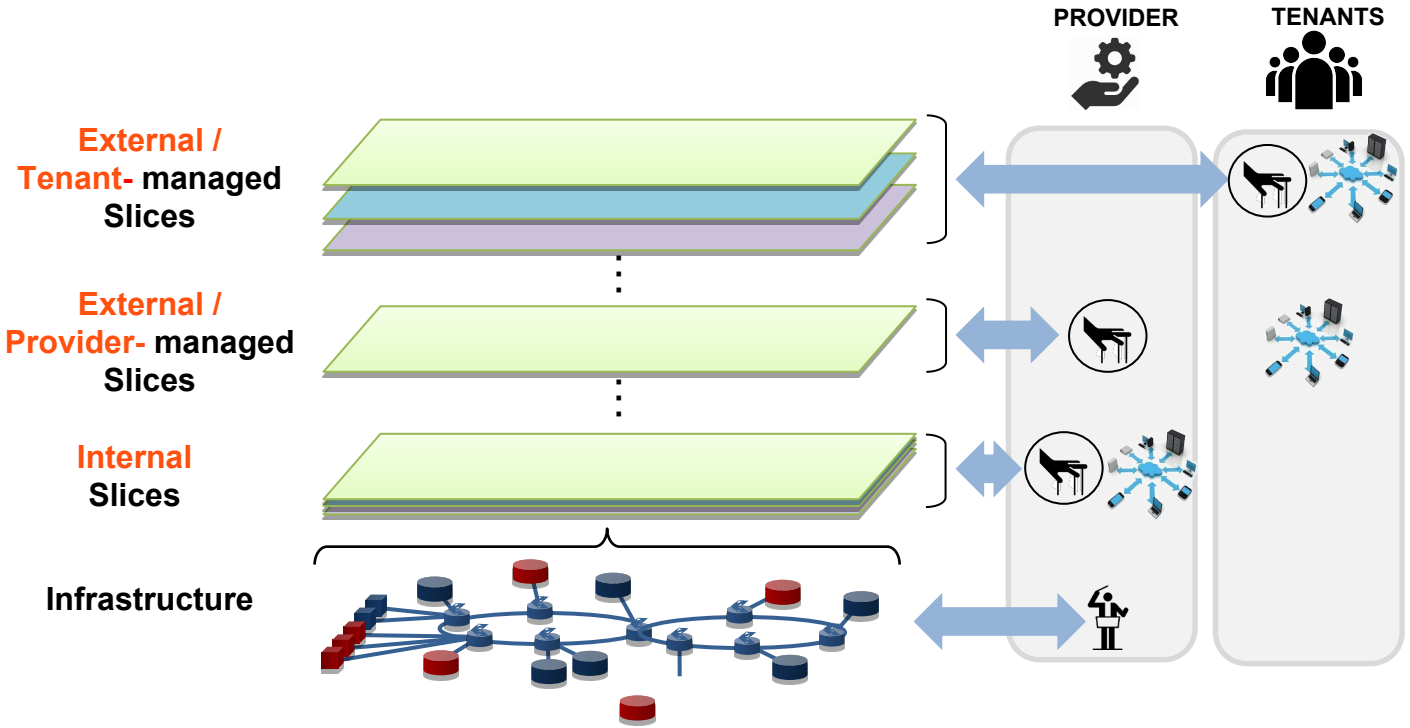
Source: The NECOS project, Novel Enablers for Cloud Slicing. http://www.h2020-necos.eu/

Different Slicing Models & Approaches



Source: The NECOS project, Novel Enablers for Cloud Slicing. http://www.h2020-necos.eu/

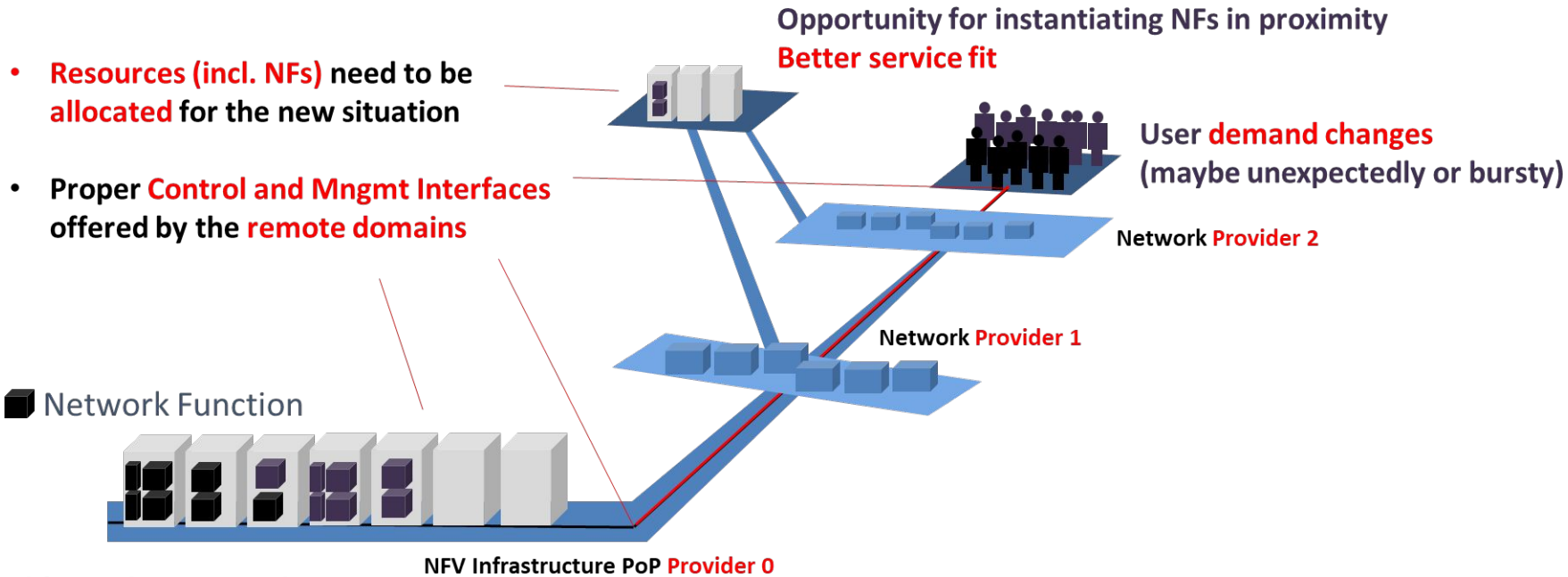
Types of slices and control responsibilities



Source: A Network Service Provider Perspective on Network Slicing. Luis M. Contreras and Diego R. López. IEEE Softwarization, January 2018

Multi-Domain Slicing Scenario

- Resources (incl. NFs) need to be allocated for the new situation
- Proper Control and Mngmt Interfaces offered by the remote domains



Need for scaling NFs in the origin domain could not be sufficient

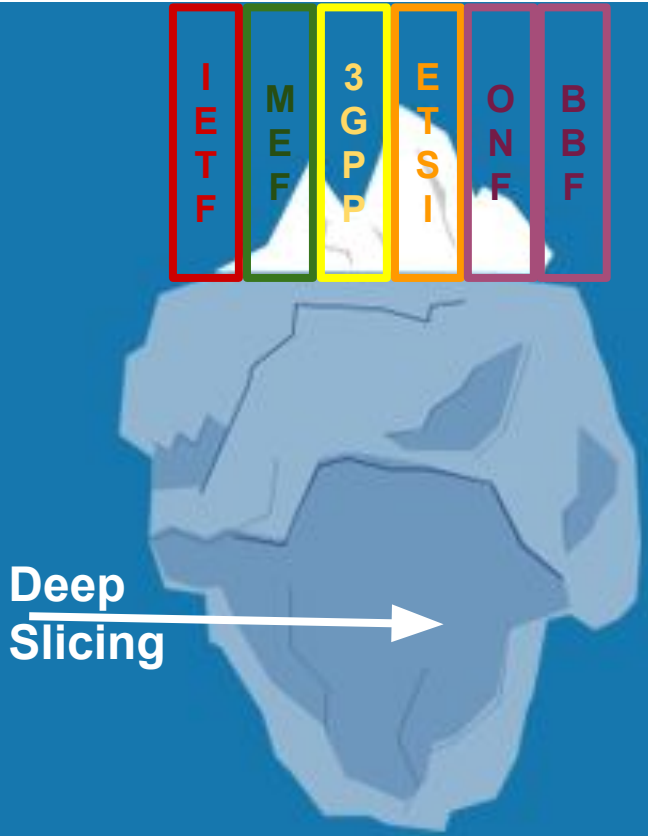
Source: Adapted from slide courtesy by Luis M. Contreras, Telefonica

Why slice-ready federation is needed?

- Vertical customers can request **services** that lay **outside the footprint** of their **primary provider**
- Interaction with other providers are needed but …
  - How we can **charge** and bill for that service?
  - How we can **ensure SLAs** among providers?
  - How we can **know about the capabilities** of other providers for a comprehensive e2e service provision?
- The current interconnection models is **not aware of peer's** network **resources** (i.e., load conditions, etc)
- All these **environments are static**, requiring long interactions for setting up any inter-provider connection
- **Automation** for both the **interconnection** sessions and the **service deployment** on top of that is needed to reach the goal of **flexibility and dynamicity**

Source: Luis M. Contreras, Telefonica

Towards Deep Slices: Observations



Fragmented Standardization

Business challenges

Technological challenges
From infrastructure sharing to any-layer resource sharing (from PHY to APP)

Deep
End-to-End, Multi-Domain
Tenant Choice & Control
Isolation and Dimensioning / Scaling

Deep Slicing: Challenges up front

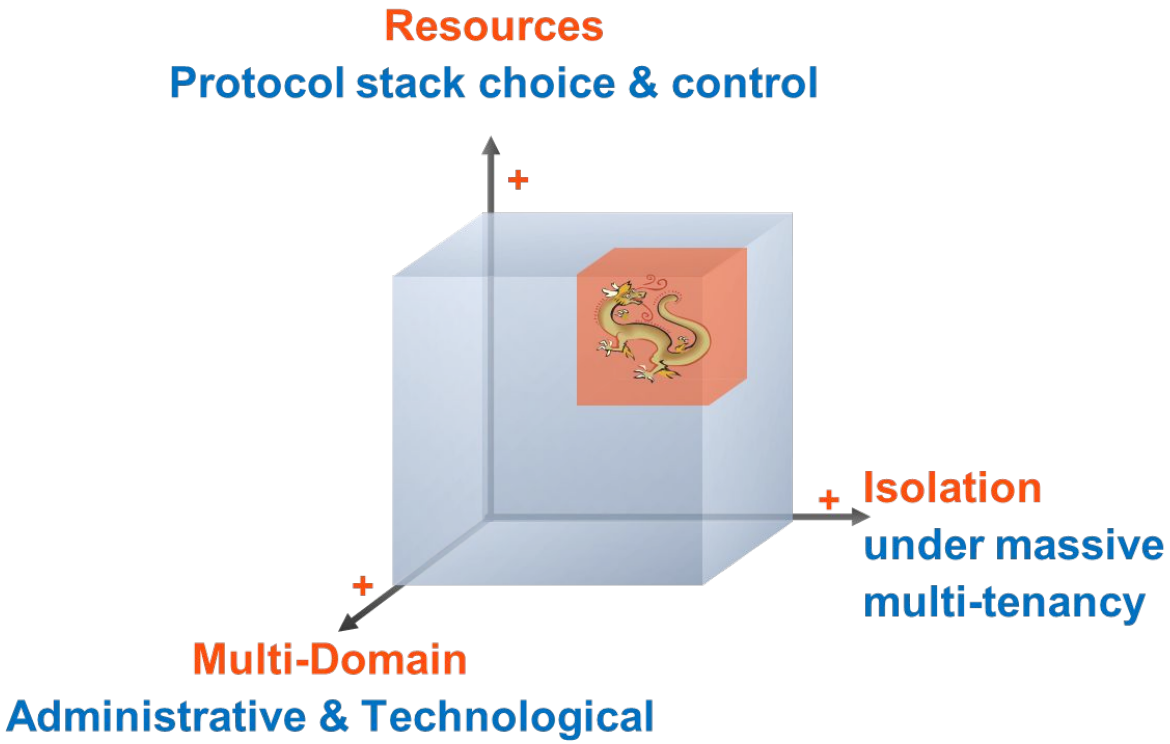
Standardization gap goes hand by hand with a series of **key challenges from provider's perspective** on (i) scalability, (ii) arbitration, (iii) slice planning and dimensioning, and (iv) multi-domain (cf. [FG-NET-Contribution]). Both business and technical implications can be deemed necessary for such multi-operator slice provisioning context.

From the **business** side, some key implications include: (i) coordination models, (ii) inter-provider SLAs, (iii) pricing schemes, (iv) service specification, and (v) customer facing advertisement.

From a **technical** perspective we highlight (i) slice decomposition, (ii) discovery of domains, (iii) common abstraction models, (iv) standard interfaces/protocols, APIs.

Source & further reading: Doc.6 ITU-T FG 2030 contribution: Network 2030 Challenges and Opportunities in Network Slicing
https://extranet.itu.int/sites/itu-t/focusgroups/net-2030/_layouts/15/WopiFrame.aspx?sourcedoc=%7bC4E9266E-1058-4035-AA25-451ABCB5C07B%7d&file=NET2030-I-006.docx&action=default

Deep Slicing: Ambitious Challenges



Source: Inspired by the author (C. Rothenberg) P^3 trade-offs: **P**rogrammability, **P**erformance, **P**ortability.
https://www.slideshare.net/chesteve/ieee-hpsr-2017-keynote-softwarized-dataplanes-and-the-p3-tradeoffs-programmability-performance-portabiilty

- Resources (incl. NFs) need to be allocated for the new situation
- Proper Control and Mngmt Interfaces offered by the remote domains

Opportunity for instantiating NFs in proximity
Better service fit

User demand changes
(maybe unexpectedly or bursty)

Network Provider 2

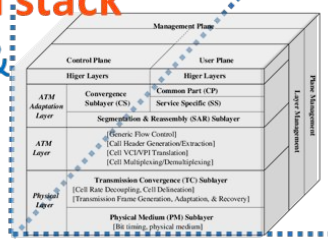
Network Provider 1

Network Function

NFV Infrastructure PoP Provider 0

Need for scaling NFs in the
origin domain could not be sufficient

Protocol stack
Choice &
Control

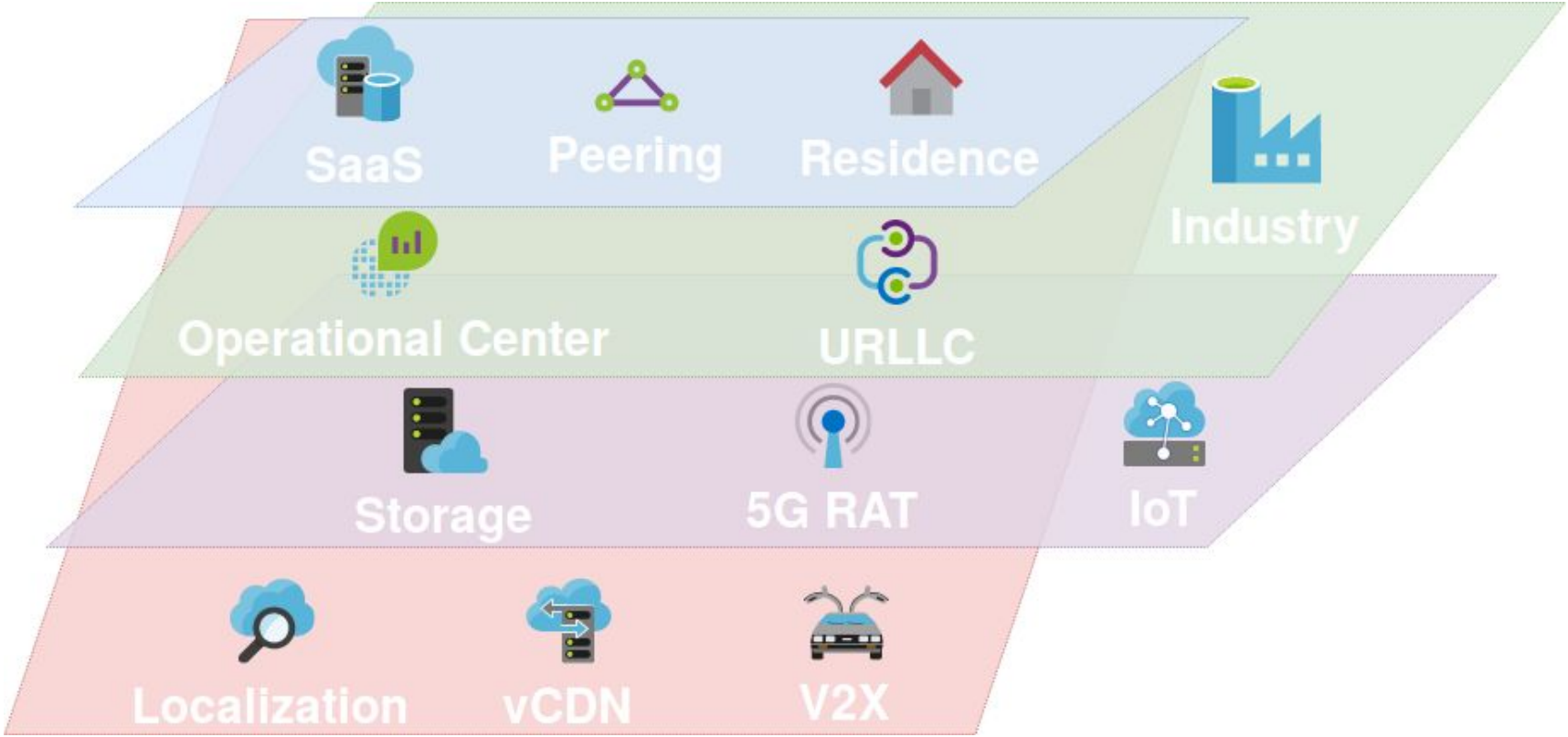


Multi-Domain
Administrative
& Technological

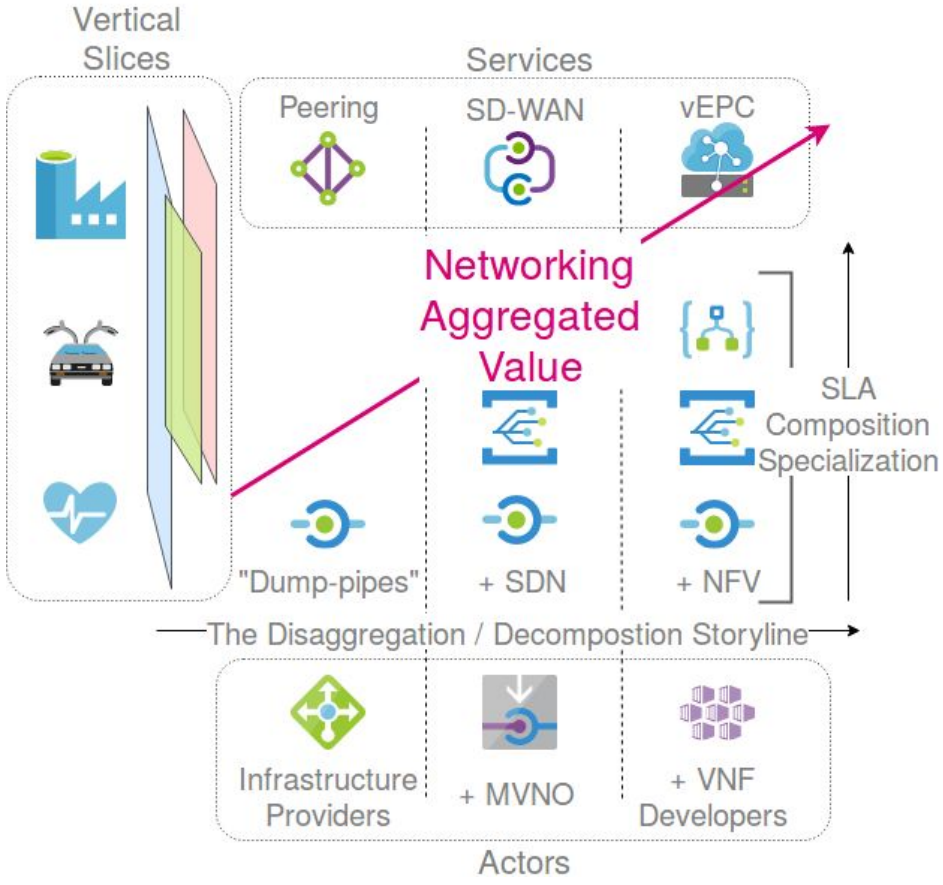
Isolation
under massive multi-tenancy

Source: Adapted from slide courtesy by Luis M. Contreras, Telefonica

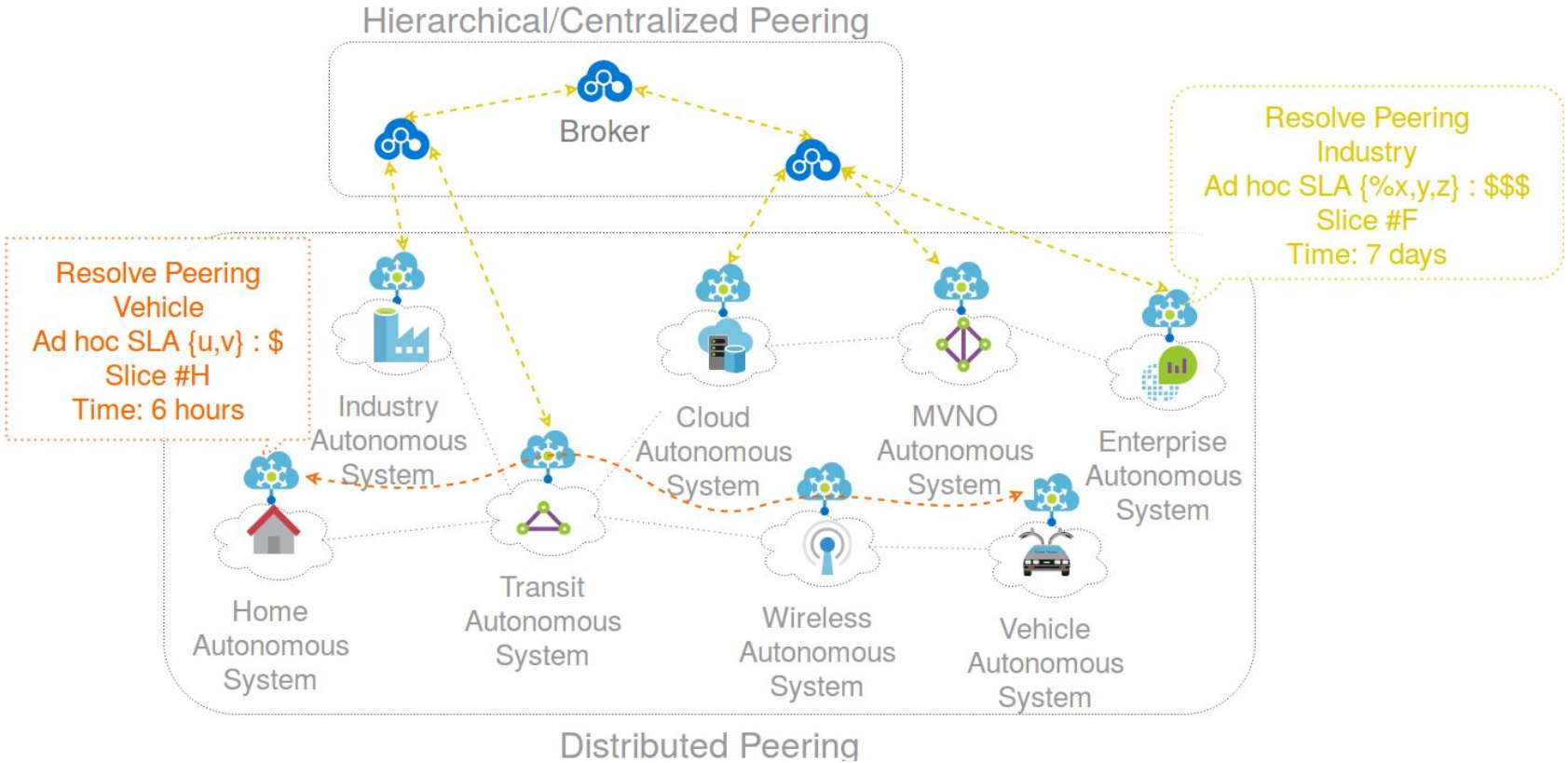
Unfolding Slices through Massive Multi-Tenancy



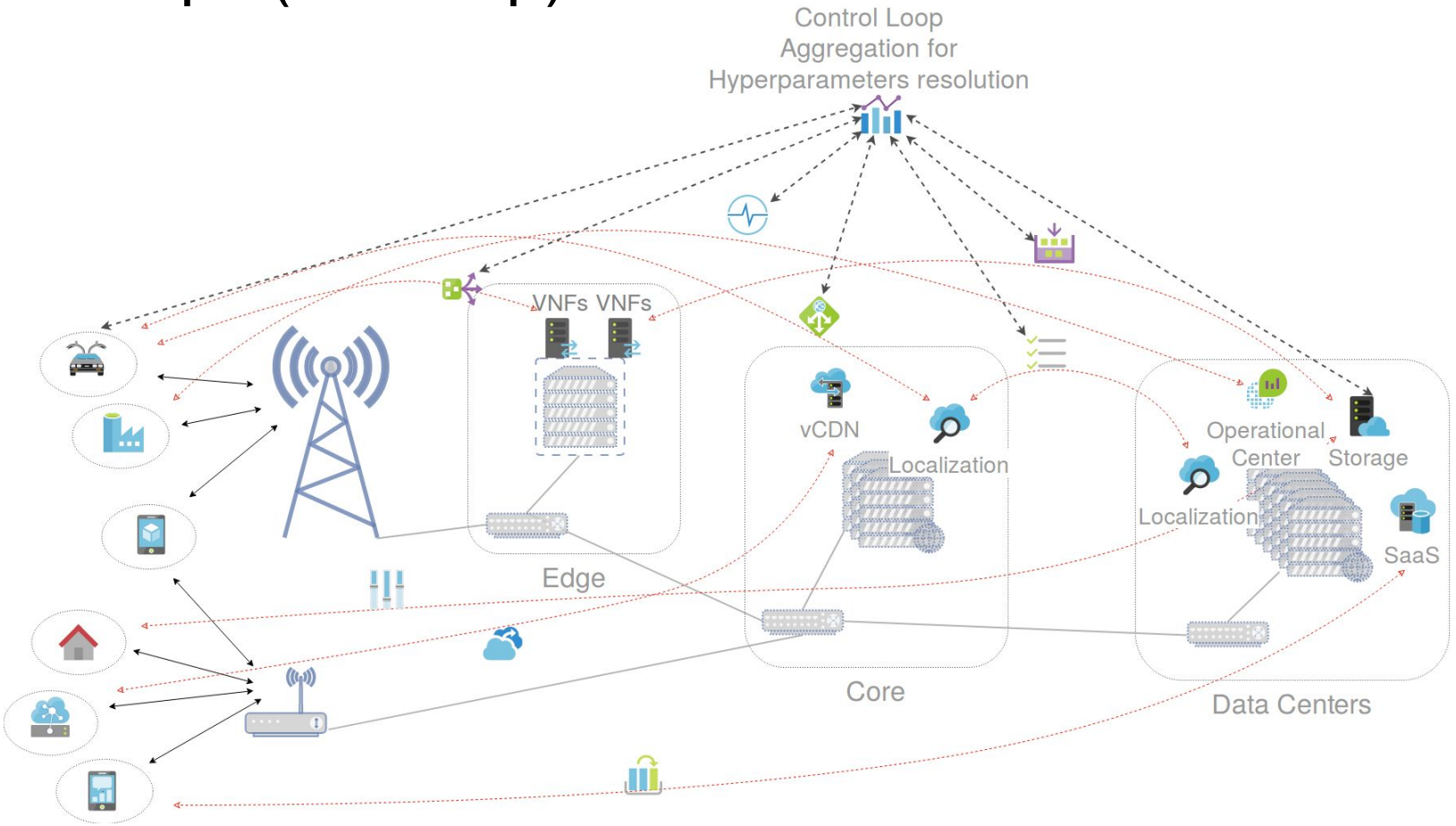
Disaggregated Metrics/Prices: SLA Hazards



Smart Peering for Multi-Domain NS-as-a-S



Control Loops (in a loop)



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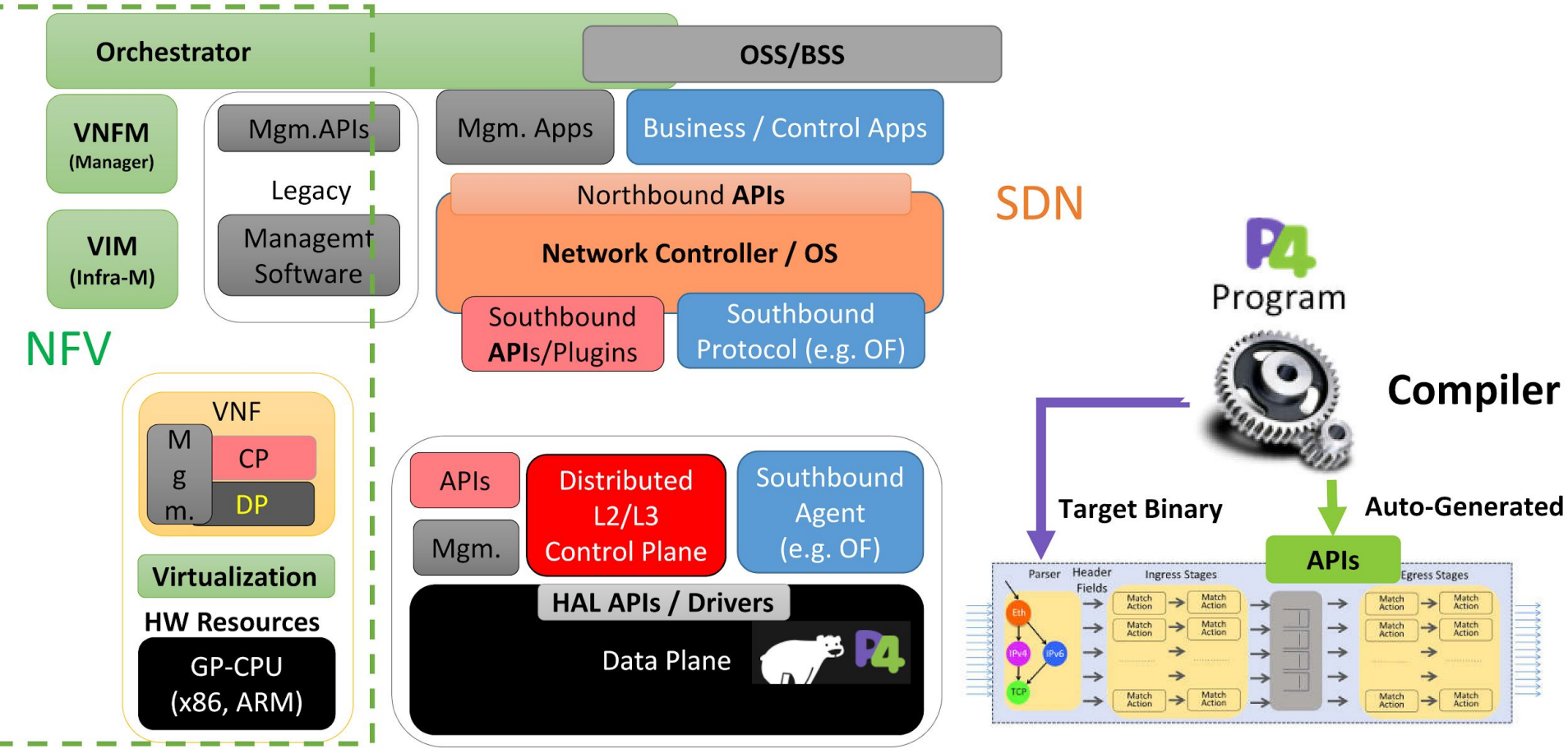
Raphael Rosa (PhD candidate at UNICAMP), for his contributions to the vision around Unfolding Slices, Control Loops (in a Loop), Disaggregated Metrics/Prices, and Smart Peering

BACKUP

Different SDN Models to Program / Refactor the Stack



What do we mean by Network Slices?

Network Slice – A Network Slice is a **managed group of subsets of resources, network functions / network virtual functions at the data, control, management/orchestration, and service planes at any given time.**

The behaviour of the network slice is realized via network slice instances (i.e. activated network slices, dynamically and non-disruptively re-provisioned).

A network slice is programmable and has the ability to expose its capabilities.

→ A network slice supports at least one type of service.

→ A network slice may consist of cross-domain components from separate domains in the same or different administrations, or components applicable to the access network, transport network, core network, and edge networks.

→ A resource-only partition is one of the components of a Network Slice, however on its own does not fully represent a Network Slice.

→ Underlays / overlays supporting all services equally (‘best effort” support) are not fully representing a Network Slice.

Consortium

Participant No	Part. short name	Participant organization name	Country
1 (Overall Co-ordinator)	UPC	Universitat Politècnica de Catalunya	Spain
2	UCL	University College London	UK
3	TID	Telefónica Investigación y Desarrollo	Spain
4	UOM	University of Macedonia	Greece
5 (Brazil Co-ordinator)	UNICAMP	University of Campinas	Brazil
6	UFSCAR	Federal University of São Carlos	Brazil
7	UFU	Federal University of Uberlândia	Brazil
8	UFPA	Federal University of Pará	Brazil
9	UFRN	Federal University of Rio Grande do Norte	Brazil
10	CPqD	CPqD Telecom Research and Development Center	Brazil
11	UFG	Federal University of Goiás	Brazil