

Towards Integration of Slice Networking in NFV

draft-gdmb-netslices-intro-and-ps-02
draft-galis-anima-autonomic-slice-networking-02

V3.0 – 30th March 2017

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1. Slices - Background and Context
2. Initial Reference Models – Slices Integration in NFV
3. Further Work in NFVRG
4. Summary & Concluding Remarks & Acknowledgement

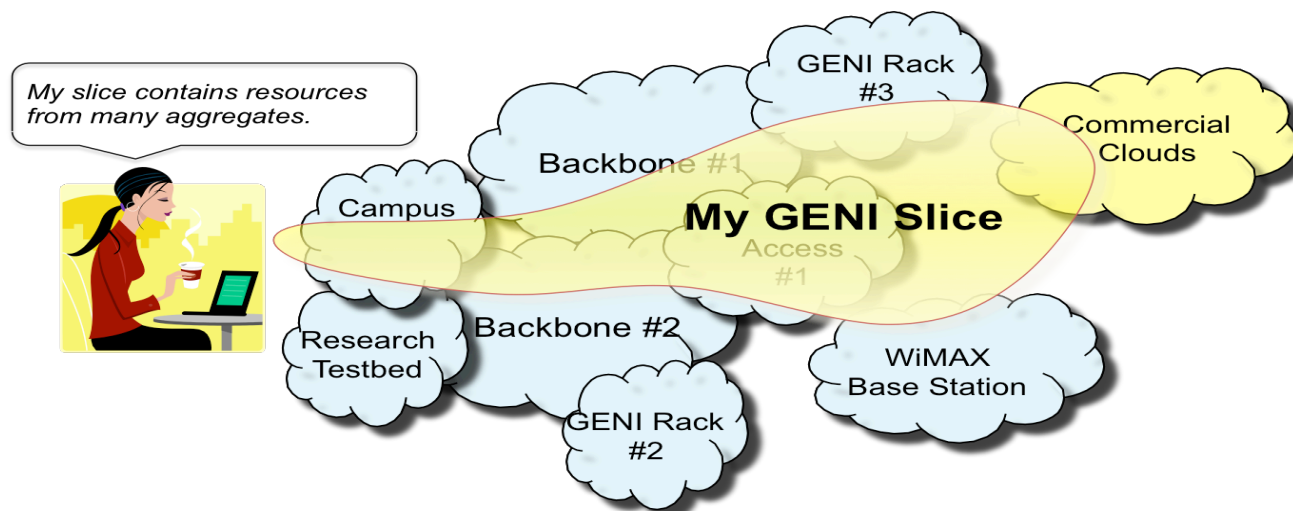
Definitions of Network Slicing & References (I)

Active / Programmable Networks research: node operating systems & resource control frameworks (1995 -2005) (*)

Federated Testbed research : Planet Lab USA (2002), PlanetLab EU (2005), OneLab EU (2007), PlanetLab Japan (2005), OpenLab EU (2012)

GENI Slice (2008): “GENI is a shared network testbed i.e. multiple experimenters may be running multiple experiments at the same time. A GENI slice is:

- The unit of isolation for experiments.
- A container for resources used in an experiment. GENI experimenters add GENI resources (compute resources, network links, etc.) to slices and run experiments that use these resources.
- A unit of access control. The experimenter that creates a slice can determine which project members have access to the slice i.e. are members of the slice.



(*) Galis, A., Denazis, S., Brou, C., Klein, C. (ed) –“Programmable Networks for IP Service Deployment” ISBN 1-58053-745-6, pp 450, June 2004, Artech House Books, <http://www.artechhouse.com/International/Books/Programmable-Networks-for-IP-Service-Deployment-1017.aspx>

Definitions of Network Slicing & References(II)

Slice capabilities (2009) “Management and Service-aware Networking Architectures (MANA) for Future Internet”
– A. Galis et al - Invited paper IEEE 2009 Fourth International Conference on Communications and Networking in China (ChinaCom09) 26-28 August 2009, Xi'an, China, <http://www.chinacom.org/2009/index.html>

3 Slices Capabilities

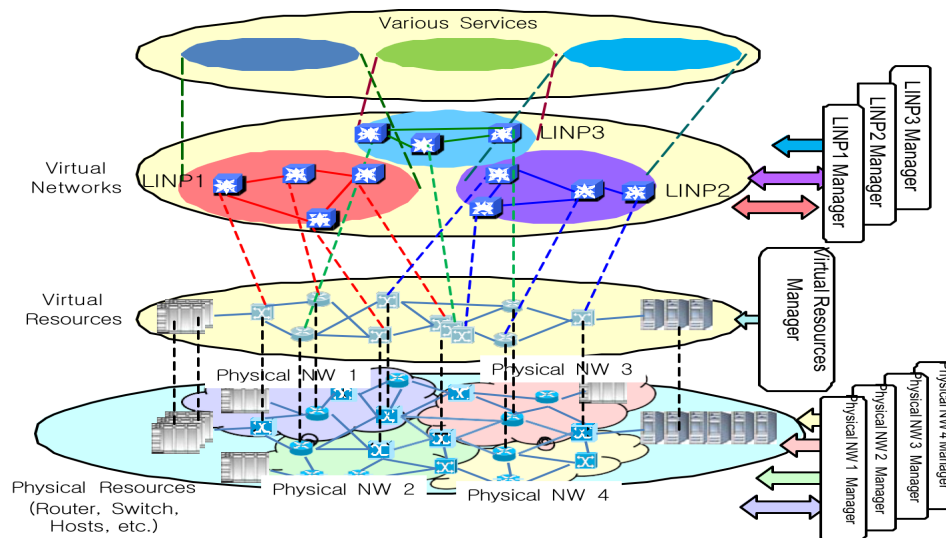
- “Resource allocation to virtual infrastructures or slices of virtual infrastructure.”
- “Dynamic creation and management of virtual infrastructures/slices of virtual infrastructure across diverse resources.”
- “Dynamic mapping and deployment of a service on a virtual infrastructure/slices of virtual infrastructure.”

17 Orchestration capabilities

19 Self-functionality mechanisms

14 Self-functionality infrastructure capabilities

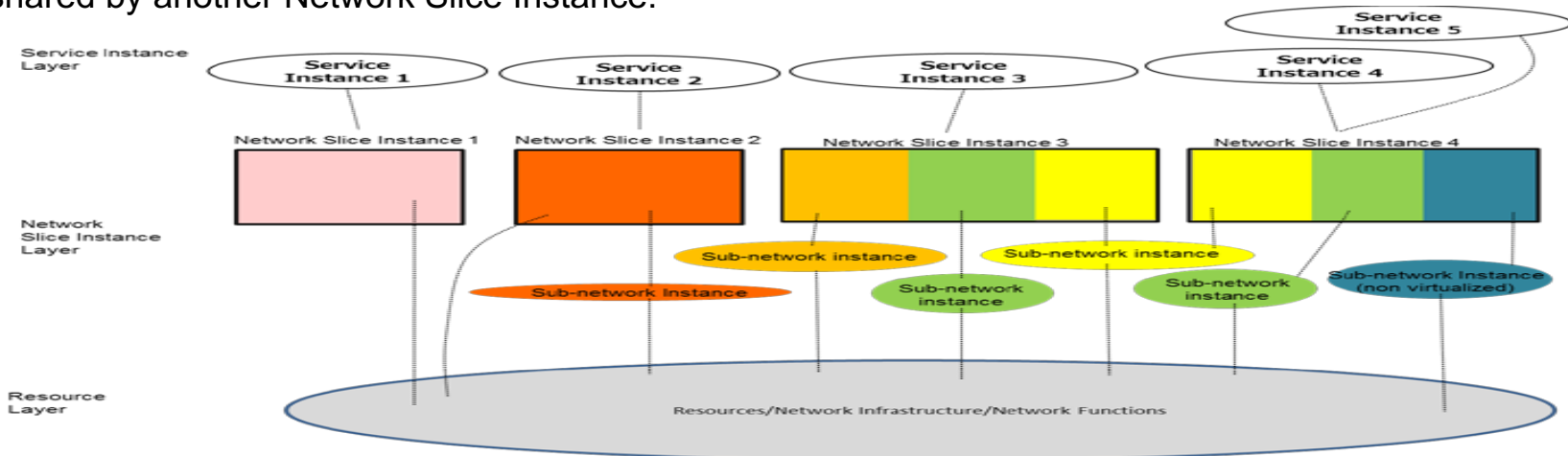
ITU-T Slicing (2011) as defined in [ITU-T Y.3011], [ITU-T Y.3012] is the basic concept of the Network Softwarization. Slicing allows logically isolated network partitions (LINP) with a slice being considered as a unit of programmable resources such as network, computation and storage.



Definitions of Network Slicing & References(III)

NGMN Slice capabilities (2016) - consist of 3 layers: 1) Service Instance Layer, 2) Network Slice Instance Layer, and 3) Resource layer.

- The Service Instance Layer represents the services (end-user service or business services) which are to be supported. Each service is represented by a Service Instance. Typically services can be provided by the network operator or by 3rd parties.
- A Network Slice Instance provides the network characteristics which are required by a Service Instance. A Network Slice Instance may also be shared across multiple Service Instances provided by the network operator.
- The Network Slice Instance may be composed by none, one or more Sub-network Instances, which may be shared by another Network Slice Instance.



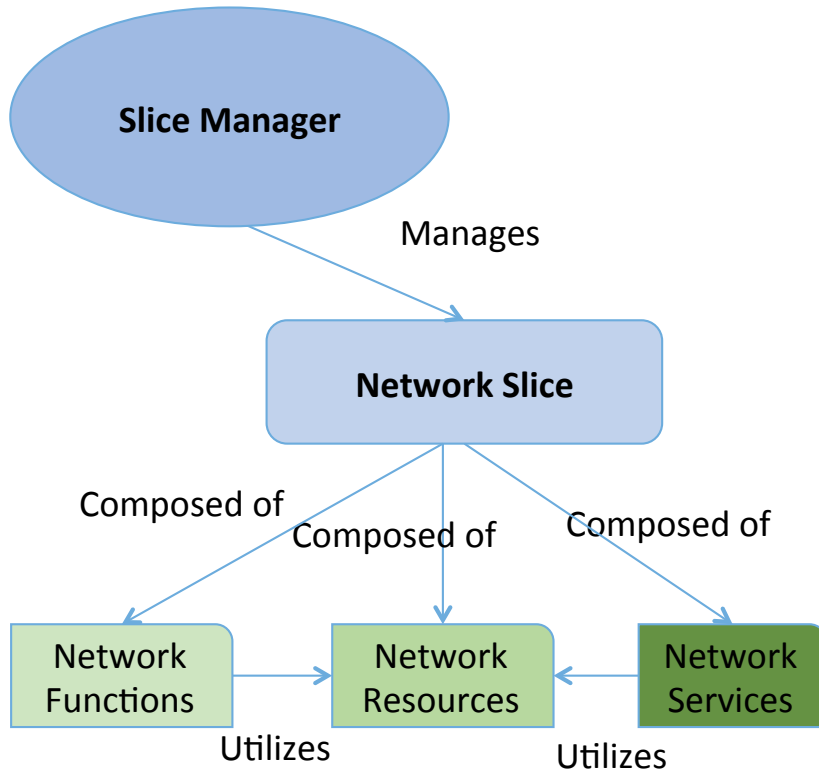
3GPP TR23.799 Study Item “Network Slicing’ **2016**

ONF Recommendation TR-526 “Applying SDN architecture to Network Slicing” **2016**

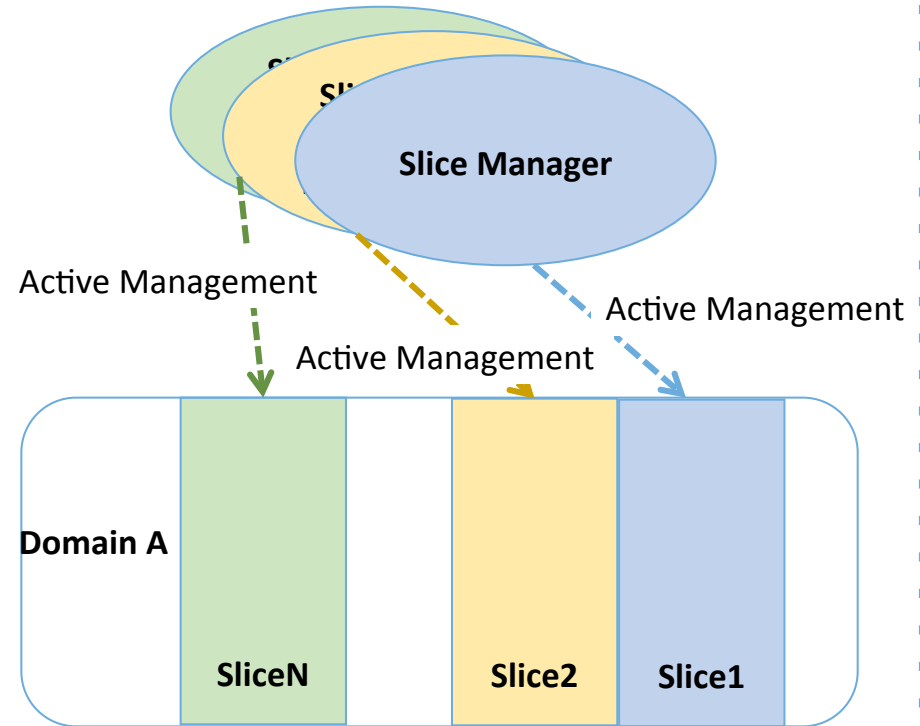
EU 5GPPP

- **15 Large Scale Research projects – all based on Network Slicing** (<https://5g-ppp.eu>) (**2015- 2018+**)
- **White Paper on 5G Architecture centered on network slicing** (<https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-5G-Architecture-WP-July-2016.pdf>) (**2016**)

Network Slicing Models



Slice as a union of subsets of resources & NFVs at a given time



(Proposal) Unified Slice definition

Slice as a union of subsets of resources & NFVs at a given time

(1) The Service Instance component

- represents the end-user service or business services.
- an instance of an end-user service or a business service that is realized within or by a NS.
- would be provided by the network operator or by 3rd parties.

(2) A Network Slice Instance component

- represented by a set of network functions, and resources
- forms a complete instantiated logical network to meet certain network characteristics required by the Service Instance(s).
- provides network characteristics which are required by a Service Instance.
- may also be shared across multiple Service Instances

(3) Resources component – it includes: *Physical, Logical & Virtual resources*

- *Physical & Logical resources* - An independently manageable partition of a physical resource, which inherits the same characteristics as the physical resource and whose capability is bound to the capability of the physical resource. It is dedicated to a Network Function or shared between a set of Network Functions;
- *Virtual resources* - An abstraction of a physical or logical resource, which may have different characteristics from that resource, and whose capability may not be bound to the capability of that resource.

(4) Slice Capability exposure component

- allow 3rd parties to access via APIs information regarding services provided by the slice (e.g. connectivity information, QoS, mobility, autonomicity, etc.)
- allow to dynamically customize the network characteristics for different diverse use cases within the limits set of functions by the operator.
- it includes a description of the structure (and contained components) and configuration of the slice instance.

NS Key Characteristics → No1 Engineering Priority in 5G

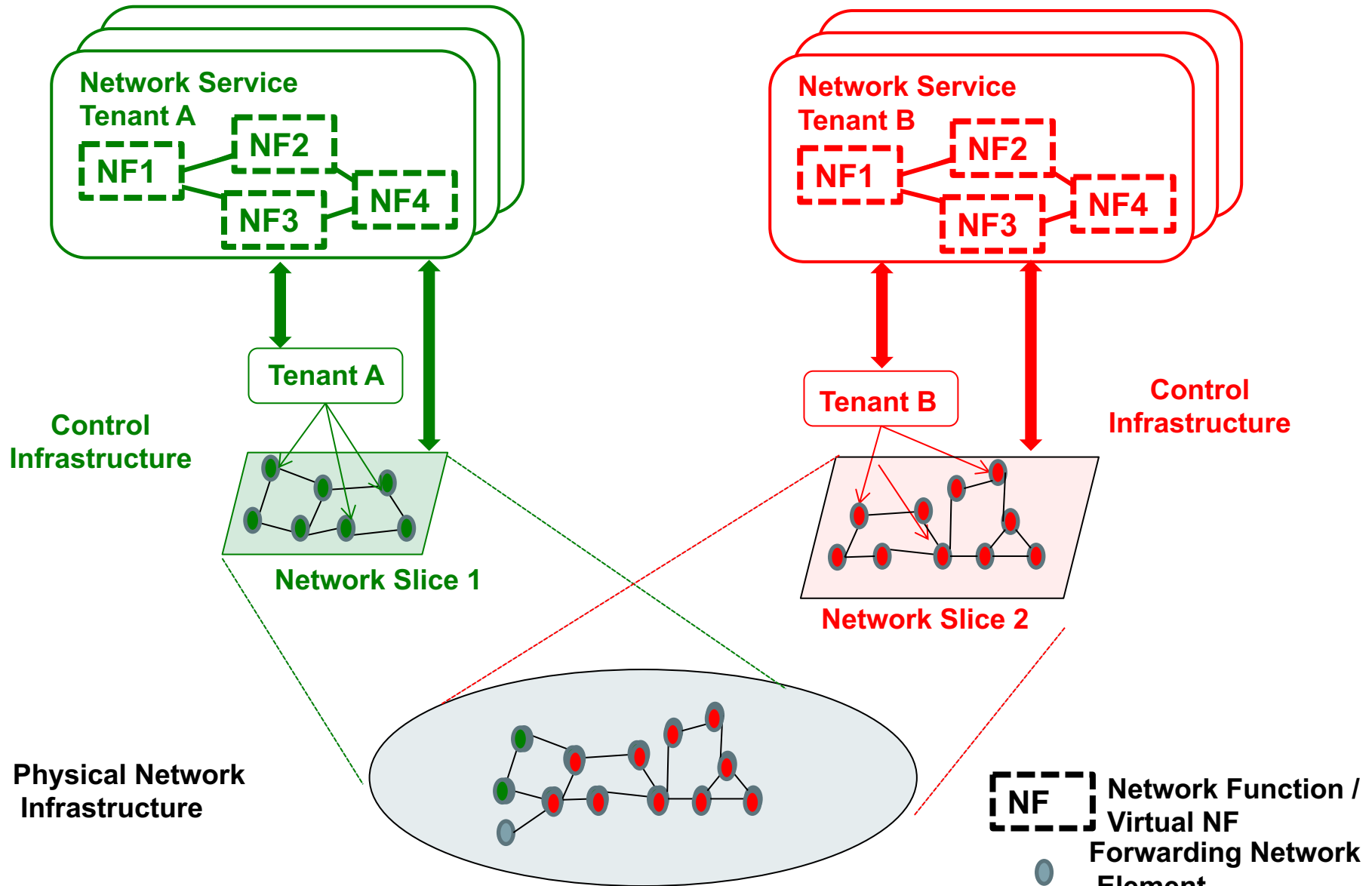
- **A managed group of infrastructure resources, network functions and services** (e.g. Service Instance component, A Network Slice Instance component, Resources component , Slice Capability exposure component).
- **NS is programmable and has the ability to expose its capabilities.** The behaviour of the network slice realized via network slice instance(s).
- Concurrent deployment of **multiple logical, self-contained and independent, shared or partitioned networks on a common infrastructure platform.**
- Supports **dynamic multi-service support, multi-tenancy** and the integration means for vertical market players.
- **Service customized Network Slices (enabled by NFV principles) + Smart Network Fabric for coordinating/orchestration, control of network resource**
- **NSs** simplifies the provisioning of services, manageability of networks and integration and operational challenges especially for supporting communication services.
- **Network operators/ ISP can exploit network slicing** for
 - reducing significantly operations expenditures, allowing also programmability necessary to enrich the offered tailored services.
 - means for network programmability to OTT providers and other market players without changing the physical infrastructure.
- **Considerably transform the networking perspective** by
 - abstracting, isolating, orchestrating and separating logical network behaviors from the underlying physical network resources.

Network Slice Usage Scenarios

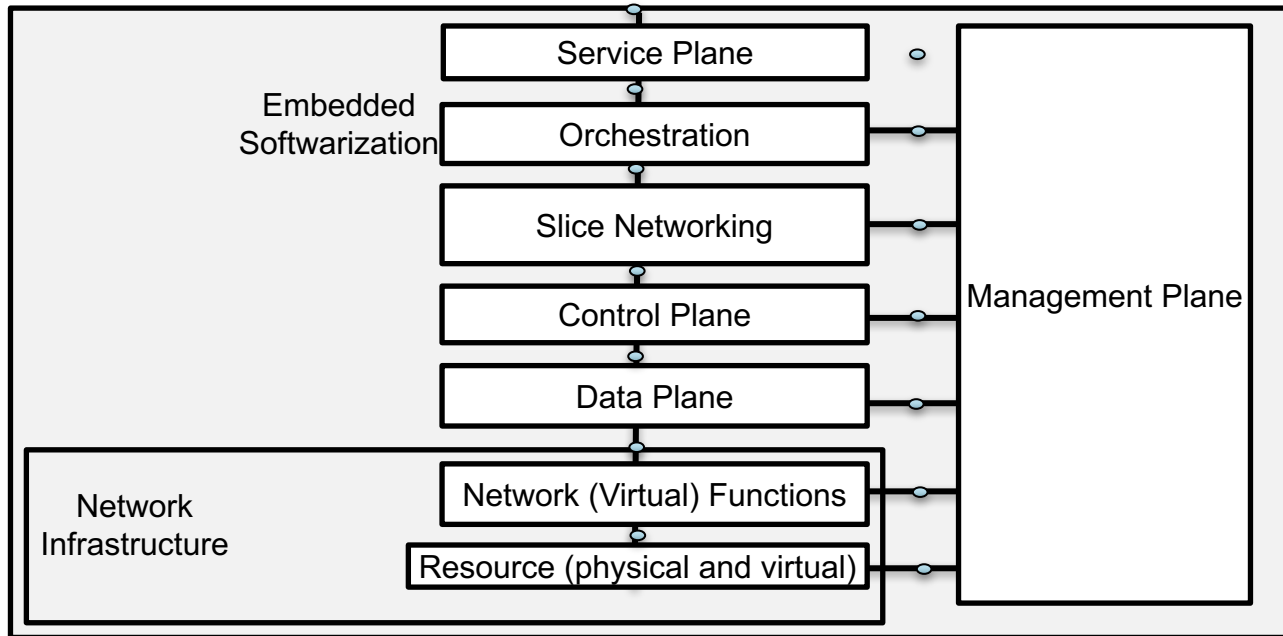
- Mission-critical Ultra low latency communication
- Massive-connectivity machine communication (e.g. Smart metering, Smart grid and sensor networks)
- Extreme QoS
- Independent QoS isolation design
- Independent operations and management
- Independent autonomic management functionality
- Independent cost and/or energy optimisation
- Independent multi-topology routing
- Sharing Infrastructure: Enablers for sharing infrastructure safely and efficiently (Multi-tenant)

Network Slice Representation

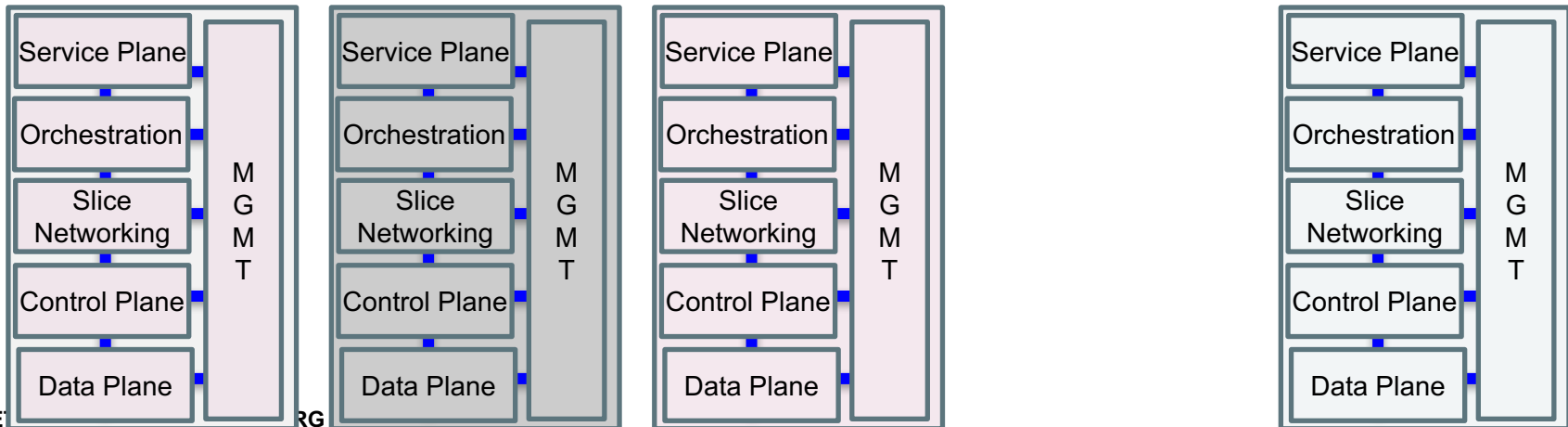
Slice as a union of subsets of resources & NFVs



Network Slice Life Cycle Management



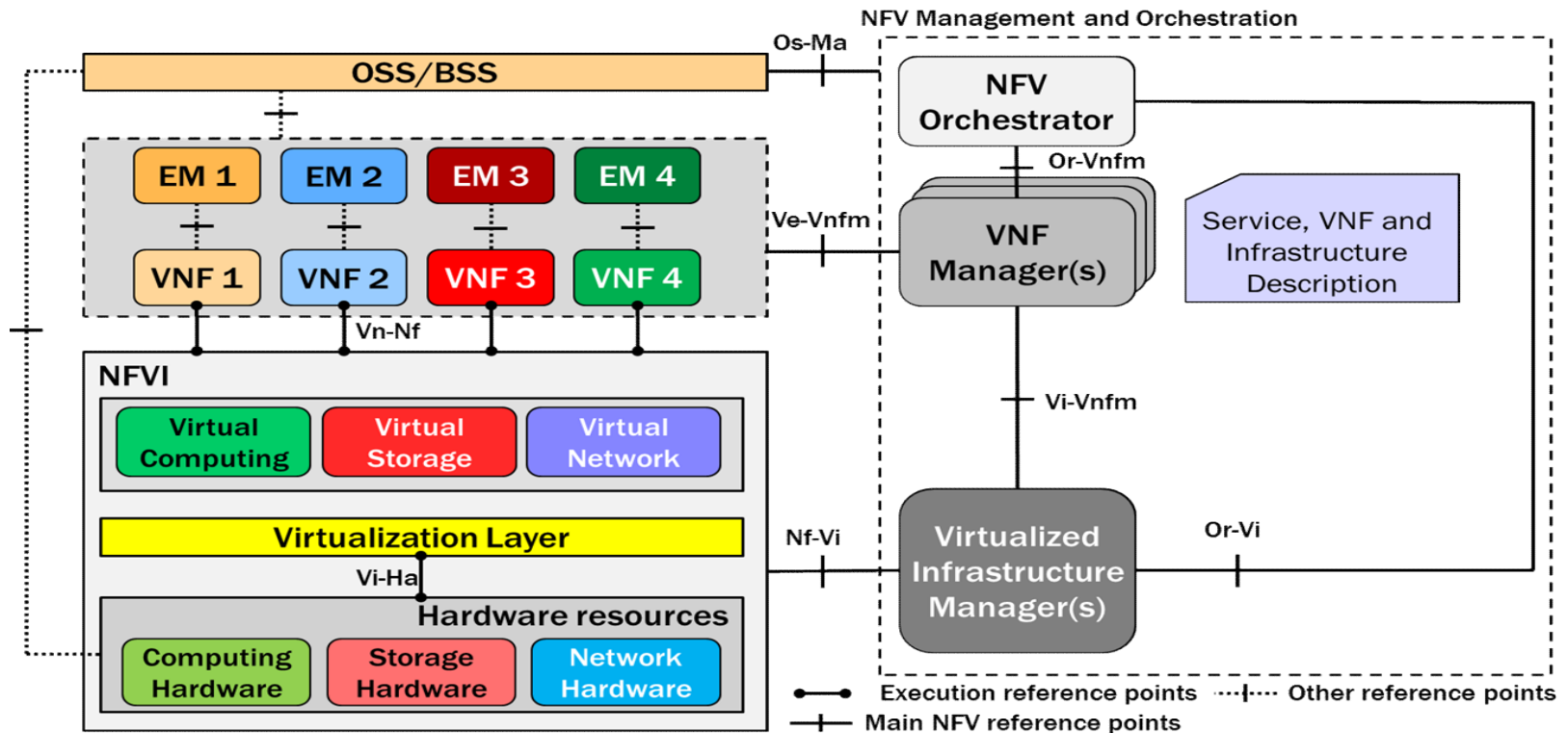
Instances (Service, Management, Control, and Data planes)



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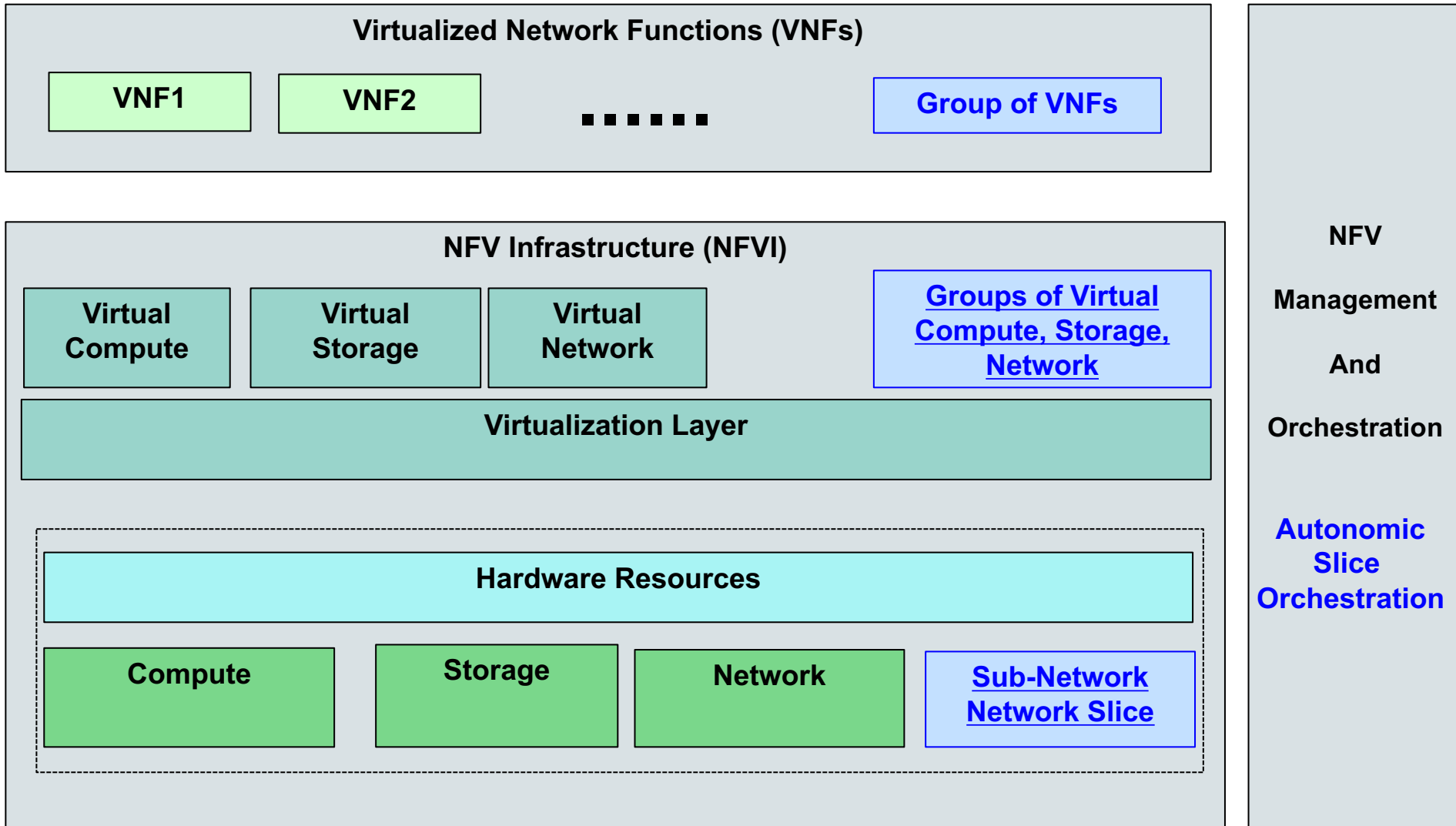
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NFV Reference Model according to ETSI

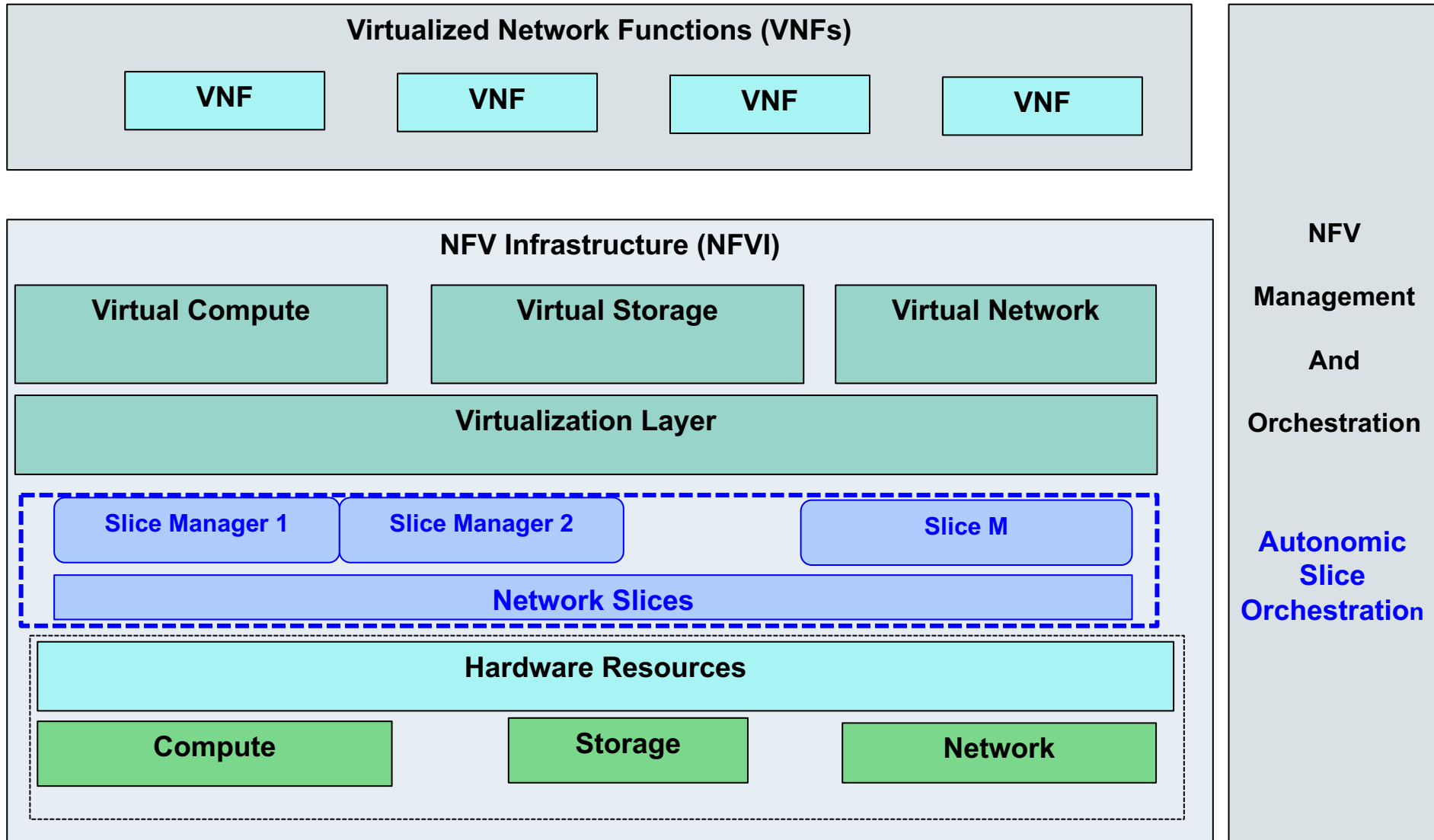


- Interfaces to sub-networks / groups of subnetworks not present in the original architecture
- Deployability enables are not present in the original architecture
- Opportunity to integrate Network Slice itself and Slice manager across almost all the layers in NFV architecture

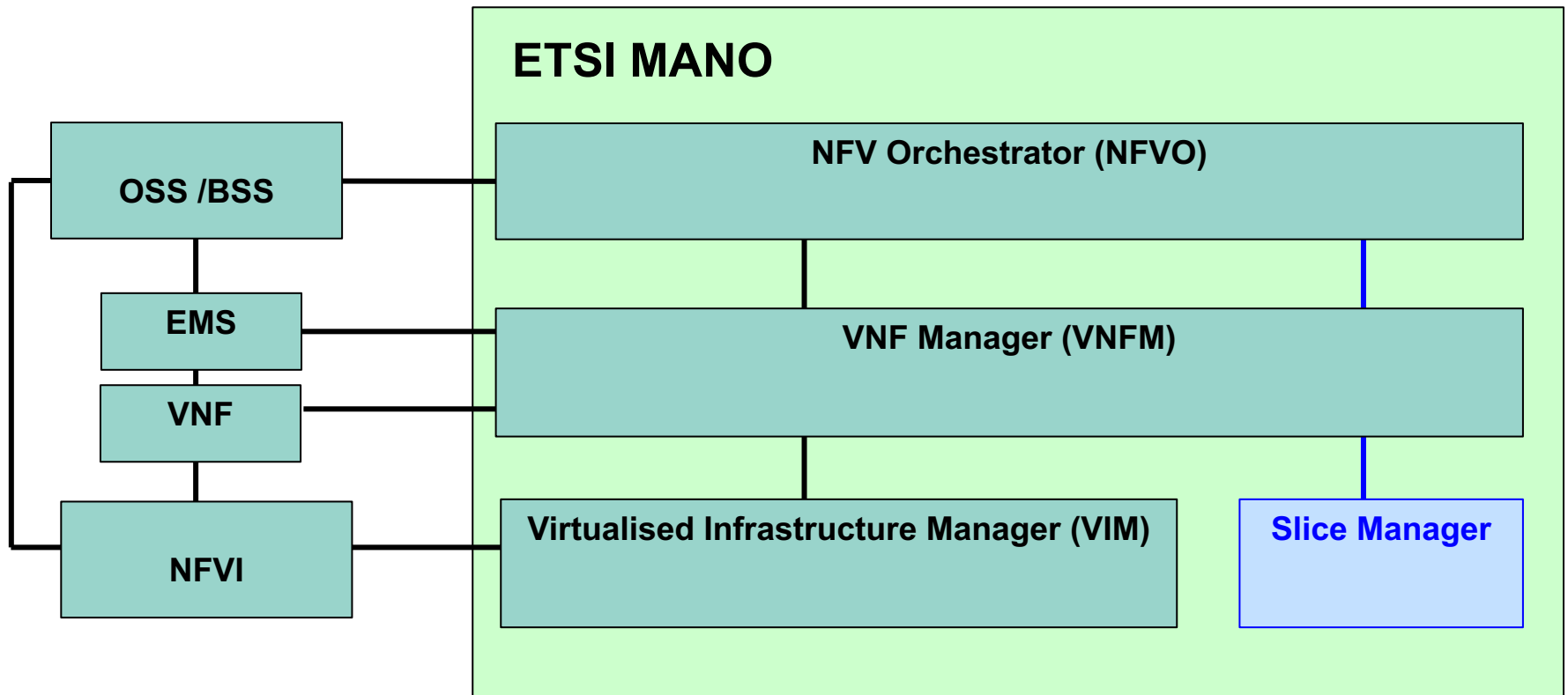
Revisited ETSI NFV Framework– Reference Model(1)



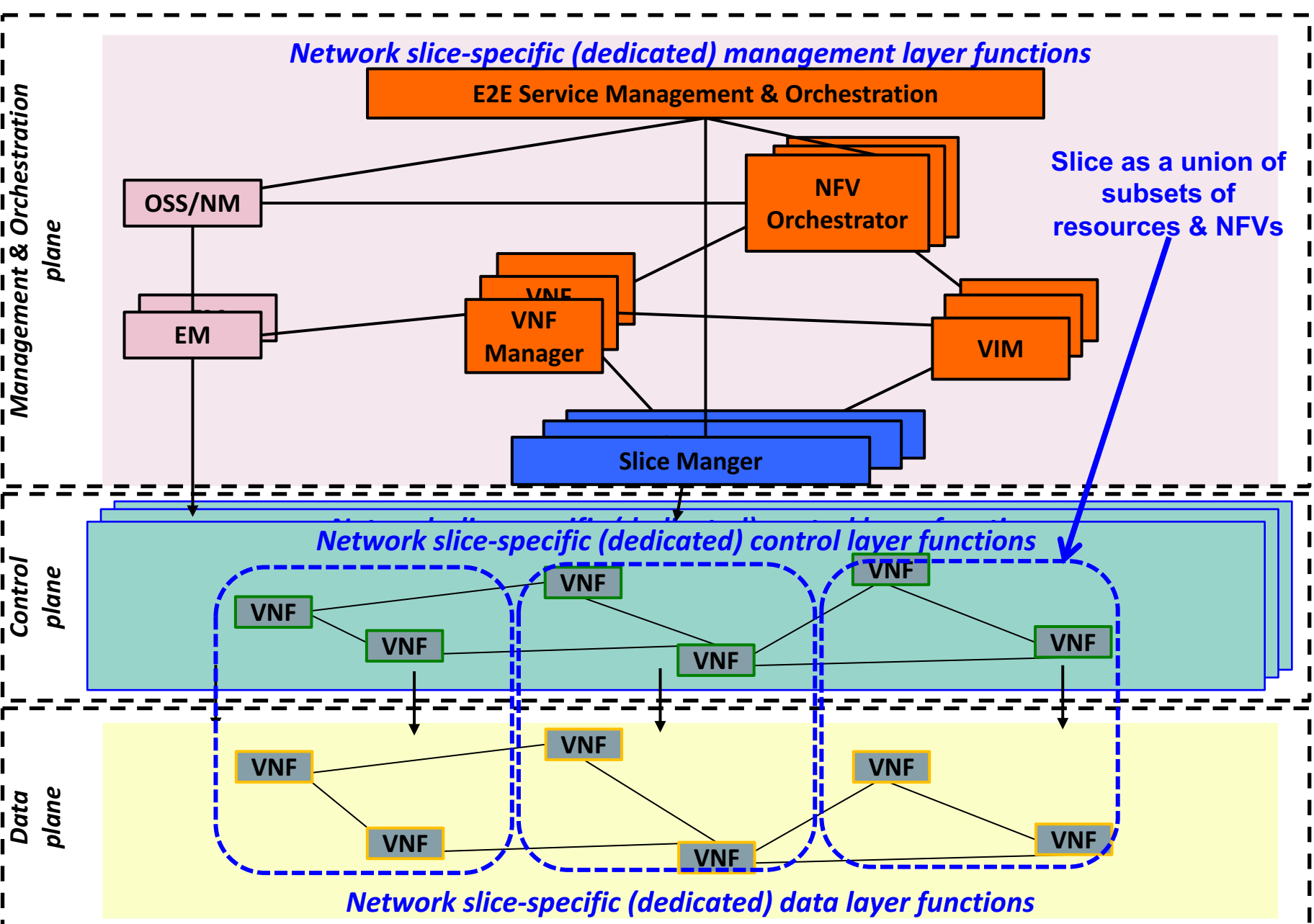
Revisited ETSI NFV Framework – Reference Model(2)



Revisited ETSI MANO Framework– Slice Manager (3)



Revisited ETSI NFV Framework – Slice Manager (4)



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Network Slicing Work Problems

- (1) **Uniform Reference NFV Model for Network Slicing (Architecture document):** Describes all of the functional elements and instances of a network slice in NFV. Describes shared non-sliced network parts. Establishes the boundaries to the basic network slice operations
- (2) **Review common scenarios / Use Cases** from the requirements for operations and interactions point of view. Describes the roles (owner, operator, user) which are played by entities with single /multiple entities playing different roles.
- (3) **Network Slice capabilities in NFV environment :**
 - Enablers for **safe, secure and efficient multi-tenancy in slices.**
 - Methods to **guarantee/manage for the end-to-end QoS of service in a slice.**
 - Recursion: methods for **NS segmentation allowing a slicing hierarchy** with parent - child relationships.
 - Optimisation: **Mapping algorithms & methods for network resources automatic selection for NS ;** global resource view formed; global energy view formed; Network Slice deployed based on global resource and energy efficiency.
 - **Monitoring status and behaviour of NS** in a single and/or multi-domain NFV environment.
- 5) **Network slice operations in an NFV environment:**
 - **Slice life cycle management** including creation, activation / deactivation, protection, elasticity, extensibility, safety, sizing and scalability of the slicing model per network and per network clouds.
 - **Slice management and operation:** namely configuration, composition, monitoring, optimisation, elasticity are carried as part of the slice protocols.
 - **E2E Slice stitching / composition in an NFV environment:** having enablers and methods for efficient stitching /composition/ decomposition of slices:
 - vertically (service + management + control planes) and/or
 - horizontally (between different domains part of access, core, edge segments) and /or
 - vertically + horizontally.

Summary & Concluding Remarks

- **NS is potentially No1 Engineering Priority in 5G**
 - **Service customized Network Slices enabled by NFV principles + Smart Network Fabric for coordinating/orchestration, control of network resource**
- **Slice Networking would considerably *transform the networking perspective and enhance NFV architecture* by**
 - **abstracting,**
 - **Isolating at a sub-network level,**
 - **separating logical network behaviours from the underlying physical network resources.**
 - **dynamic management of network resources by managing resource-relevant slice configuration; simplification and reduction of operations expenditures**
 - **Support for rapid service provisioning**
 - **Support NFV deployment**
- **Invitation to participate in the Slice Networking related to NFV drafts**

Acknowledgement

5GPPP EU Research Projects:

- **5GEx – “5G Multi-Domain Exchange” <https://5g-ppp.eu/5gex/>**
- **5G SONATA – “Service Programming and Orchestration for Virtualized Software Networks in 5G” <https://5gppp.eu/sonata/>.**

Thank you

Q&A

