

Network Slicing - Management Challenges

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- Network Slicing Concepts
- Network Slicing Usage Scenarios
- Network Slicing Management Challenges
- Concluding Remarks

References:

- (1) “Perspectives on Network Slicing – Towards the New ‘Bread and Butter’ of Networking and Servicing” Alex Galis – January 2018 <https://sdn.ieee.org/newsletter/january-2018/perspectives-on-network-slicing-towards-the-new-bread-and-butter-of-networking-and-servicing>
- (2) “Network Slicing Tutorial” at IEEE NetSoft 2018, Montreal 29th June 2018 - Alex Galis & Kiran Makhijani - <http://discovery.ucl.ac.uk/10051374/>
 - Key Slicing concepts and history
 - Slicing Key Characteristics & Usage scenarios & Value Chain
 - Multi-Domain Network Function Virtualisation
 - Review of Research projects and results in network and cloud slicing (Projects: SONATA, 5GEX, NECOS, 5G TRANSFORMER, 5G PAGODA, 5G NORMA, 5G SLICENET)
 - Open Source Orchestrators
 - Standard Organization activities & work in progress: NGMN, ITU-T, ONF, 3GPP, ETSI, BBF, IETF.
 - Industrial perspective on Network Slicing8. Review of industry Use Cases
 - Network Slicing Challenges
 - Concluding remarks of Network Slicing
 - Acknowledgements & References (SDO’s references + additional selected references)



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Concepts



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Roles

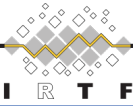
- **Infrastructure Owner** Owns the physical infrastructure (network/cloud/datacentre) and lease them to operators. It becomes an ISP if it lease the infrastructure in network slicing fashion.
- **Infrastructure Slice Provider** – An infrastructure slice provider (ISP), typically a telecommunication service provider, is the owner or tenant of the infrastructures from which network slices can be created.
- **Infrastructure Slice Tenant** – An infrastructure slice tenant (IST) is the user of specific network/cloud/datacentre slice, in which customized services are hosted. Infrastructure slice tenants can make requests of the creation of new infrastructure slice through a service model.

Concepts:

- **Infrastructure Slice** - A set of infrastructure (network, cloud, datacentre) components/network functions, infrastructure resources (i.e. managed connectivity, compute, storage resources) and service functions that has attributes specifically designed to meet the needs of an industry vertical or a service. It is substantially different to traditional VPNs, Virtual Networks or traffic engineering approaches. It focusses mainly on service, management and control planes with a footprint in the dataplane
- **Infrastructure Slicing** - A management mechanism that Infrastructure Slice Provider can use to allocate dedicated infrastructure resources and service functions to Network Slice Tenant.
- **Partition Types**
 - Physical separation (e.g., dedicated backbones) → not cost efficient
 - *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.*
 - *Underlays / overlays, in the form of VPN as overlay solution → not flexible nor agile*
 - Slicing, through network resource allocation → dedicated resources per customer/service to ensure isolation on top of the same infrastructure

Driving issue: *It is inefficient and expensive to build a separate infrastructure for each service.*

Slices Usage Scenarios



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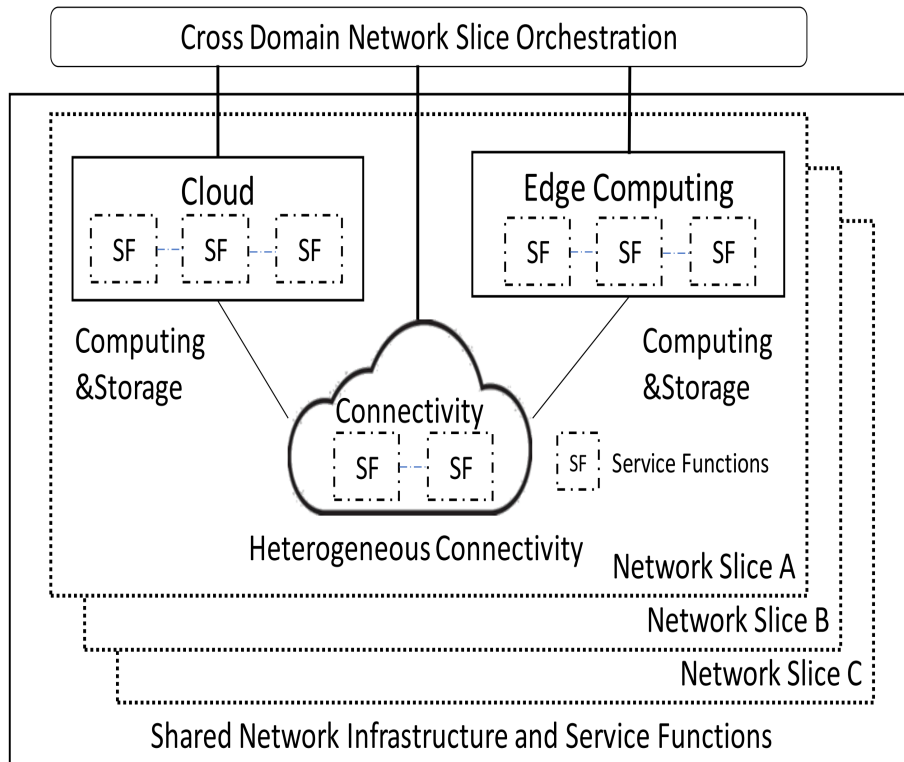
- High Precision Networks (i.e. guaranteed KPIs, QoS)
- Mission-critical Ultra low latency communication
- Massive-connectivity machine communication (e.g. Smart metering, Smart grid and sensor networks)
- Extreme QoS
- Independent QoS isolation design
- Independent operations and management
- Independent autonomic management functionality
- Independent cost and/or energy optimization
- Independent multi-topology routing
- Sharing infrastructure safely and efficiently (Multi-tenants, non-IP architectures)

Examples of High Level Architecture & Interfaces Network and Cloud Slicing



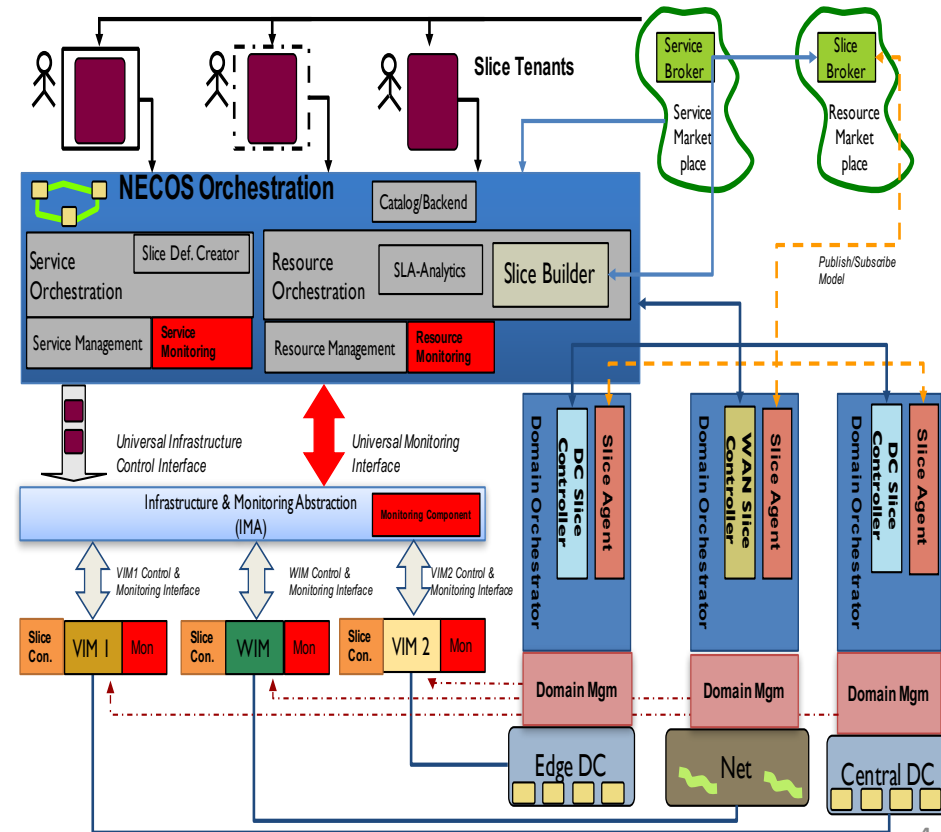
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Proposed Framework @ IETF



NECOS Project

<http://www.h2020-necos.eu>

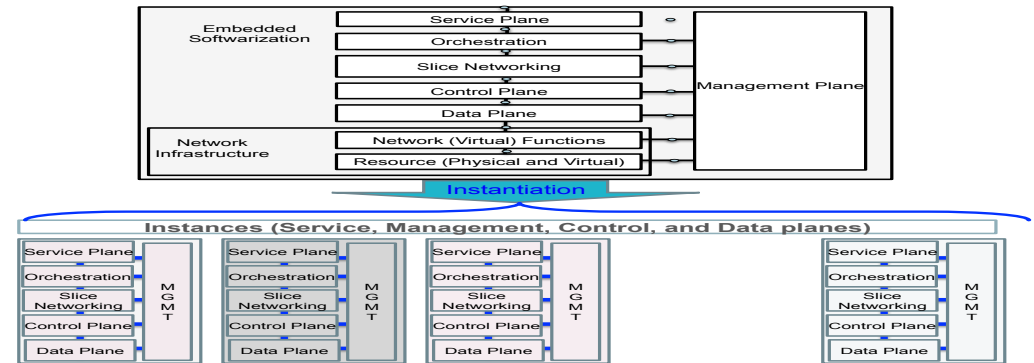


Challenges (1): Network Slice Management and E2E Network Orchestration



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Comprehensively study all management aspects and APIs of network slices.

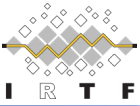


NS Life Cycle Management: (1) The management plane creates the grouping of network resources (physical, virtual, or a combination thereof), it connects with the physical and virtual network and service functions, and it instantiates all of the network and service functions assigned to the slice. (2) Template/NS repository assists life cycle management; (3) Resource Registrar manages exposed network infrastructure capabilities; (4) NS Manager oversees individual slice (with capability exposure to NS Tenant).

E2E Orchestration (1) Coordination of any number of inter-related resources in a number of subordinate domains, and assurance of transactional integrity as part of the triggering process; (2) **Autonomic control of slice life cycle management**, including concatenation of slices in each segment of the infrastructure (in data, control, and management planes); (3) **Autonomic coordination and triggering of slice elasticity and placement**; (4) **Coordination and (re)-configuration of resources** by taking over the control of all the network functions.

Challenges (2) : Monitoring and Discovery; Autonomic Slice Management; Service Mapping Single Domain / Cross-Domain; Slice stitching

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Monitoring and Discovery: (1) Monitoring Subsystem is responsible for **monitoring continuously the state all components of a NS**; (2) Monitoring Subsystem receives the detailed service monitoring requests with references to resource allocation and Network functions instances in a NS. (3) **Discovery and monitoring probes are needed of all NS components** and NS itself and for dynamic discovery of service with function instances and their capability. (3) **FCAPS** (Fault, Configuration, Accounting, Performance, Security)

Autonomic slice management: (1) Network slice is a dynamic entity with autonomic characteristics of its lifecycle and operations. (2) The problem of allocation of resources between slices combined with real-time optimization of slice operations can only be solved by continuous autonomic monitoring of slice performance and making continuous autonomic adaptations of the resources allocated to them.

Service / data model & mapping : (1) service mapping **enables on-demand processing anywhere in the physically distributed network**, with dynamic and fine granular service (re)-provisioning; (2) It includes a **slice-aware information model** based on **necessary connectivity, storage, compute resources, network functions, capabilities exposed and service elements**.

Slice stitching : The stitching of slices is an operation that **modifies functionality of an existing slice by adding and merging functions of another slice** (i.e. enhancing control plane properties by functions defined in another slice template). Stitching of slices is used to enrich slice services: (1) Slice stitching operations are supported by uniform slice descriptors; (2) Efficient stitching/ decomposition (vertically, horizontally, vertically + horizontally).

Challenges (3) Realising Network Slicing Capabilities



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Network Slicing Scalability: Scalability: In order to partition network resources in a scalable manner, it is required to clearly define to what extent slice customers can be accommodated or not on a given slice. The application of different SLAs on the offered capabilities of management, control and customization of slices will directly impact the scalability issue.

Uniform Slice lifecycle management : Slice lifecycle management including creation, activation / deactivation, protection, elasticity, extensibility, safety, and sizing of the slicing model per network and per network cloud for slices in access, core and transport networks; for slices in data centres/clouds/

Network Slicing Optimisation: namely methods for automatic selection of network resources for NS; global resource views; global energy views; Network Slice deployment based on global resource and energy efficiency

Network Slicing Dimensioning: Over-dimensioning has been the normal way in the past for avoiding any kind of congestion. With slicing the traffic sources and destinations become much less predictable, if at all. Appropriate planning, dimensioning and enforcement are needed to make sustainable the transition to this new form of service .

Network Slices with guaranteed QoS / KPIs characteristics - Precision Network Services

Concluding Remarks: Overall Context

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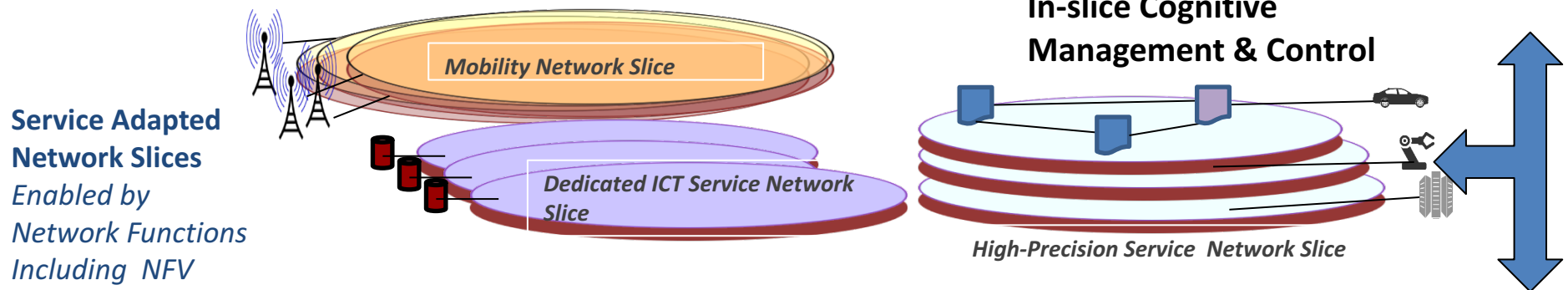


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- Transition from network devices to integrated network & service functions with inbound management
- Dynamically adapting the network to meet future service demands
- Creating the dynamic, configurable, programmable, resilient, safe and cost effective E2E network
- A programmable network fabric system with simple interface to the infrastructure (smart network fabric)

E2N Multi-Domain Orchestration

E2E coordination, conflict resolution, multi-domain information exchange



Light Weight Smart Network Fabric –Network Abstraction, Allocate (virtual) network resources/ slices, Maintain network state, Ensure network Reliability in a multi domain environment

Smart Cloud & Network Fabric
Enabled by
Programmability
Including SDN



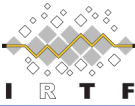
What could be the NMRG next Steps



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- *While its scope and definition continue to evolve, there is reasonable level common understanding of the key central role Network Slicing will play in future network and service management scenarios.*
- *NMRG can be the place for researching all details including frameworks, orchestration functions and APIs of management of network slices.*
- *Feedback is requested on the above!*

Acknowledgement & References



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Projects:

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2. NECOS – H2020 project “Novel Enablers for Cloud Slicing” -<http://www.h2020-necos.eu>

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- Network management framework for IMT-2020 (O-047) – 40 pp
- IMT-2020 network management requirements (O-046) - 25 pp

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- NetSlices Management Use cases draft-qiang-coms-use-cases-00
- NetSlices Information Model draft-qiang-coms-netslicing-information-model-02
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ONF Recommendation TR-526 (2017) “Applying SDN architecture to Network Slicing”

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5G Slicing Association - Position Whitepaper : ‘5G Network Slicing for Cross Industry Digitization’ http://www-file.huawei.com/-/media/CORPORATE/PDF/white%20paper/5G-Network-Slicing-for-Cross-Industry-Digitization-Position-Paper.pdf?source=corp_comm

Q&A

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