

Network Slicing – Research Management Challenges

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- Network Slicing Usage Scenarios
- Network Slicing Management Research 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

(Driving Issue: It is inefficient and expensive to build a separate infrastructure for each service)



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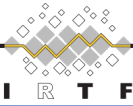
Roles

- **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 data plane
- **Infrastructure Slicing** - A management mechanism that Infrastructure Slice Provider can use to allocate dedicated infrastructure resources and service functions to Network Slice Tenant.
- **NS are significantly different from traditional: VPNs or a Virtual Network or Traffic Engineering**
- **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

Slices Usage Scenarios

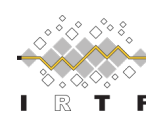


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- High Precision Networks (i.e. guaranteed KPIs, QoS)
- Mission-critical Ultra low latency communication
- Massive-connectivity machine communication (e.g. Smart metering, Smart grid and sensor networks)
- Extreme QoS
- Independent QoS isolation design
- 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

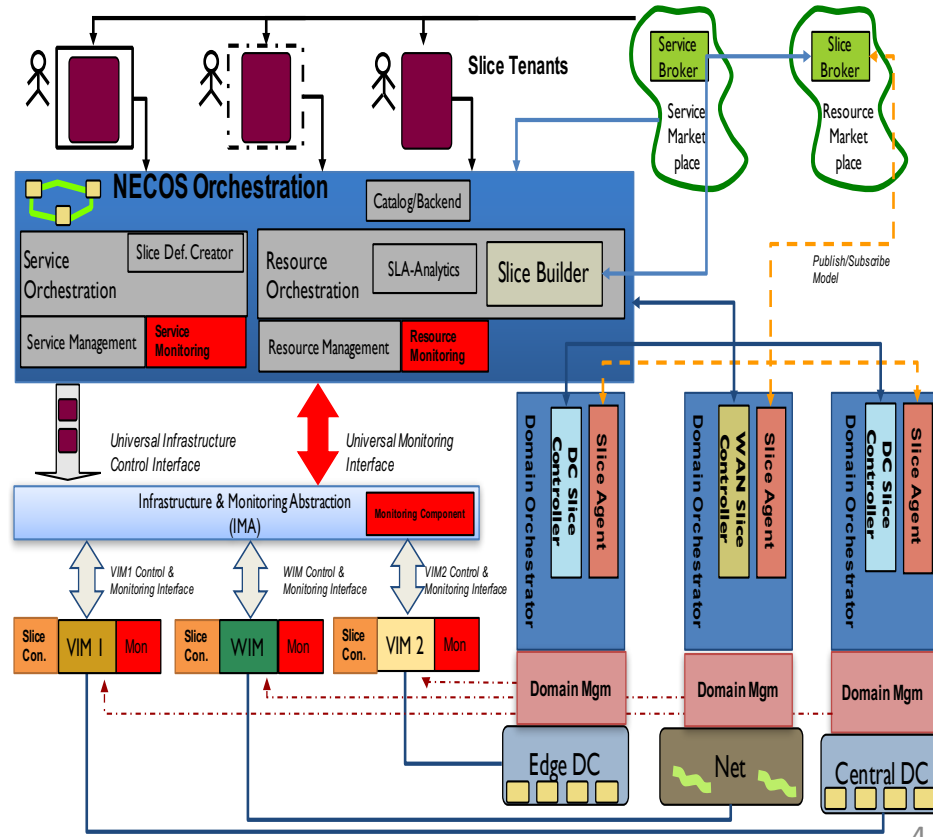
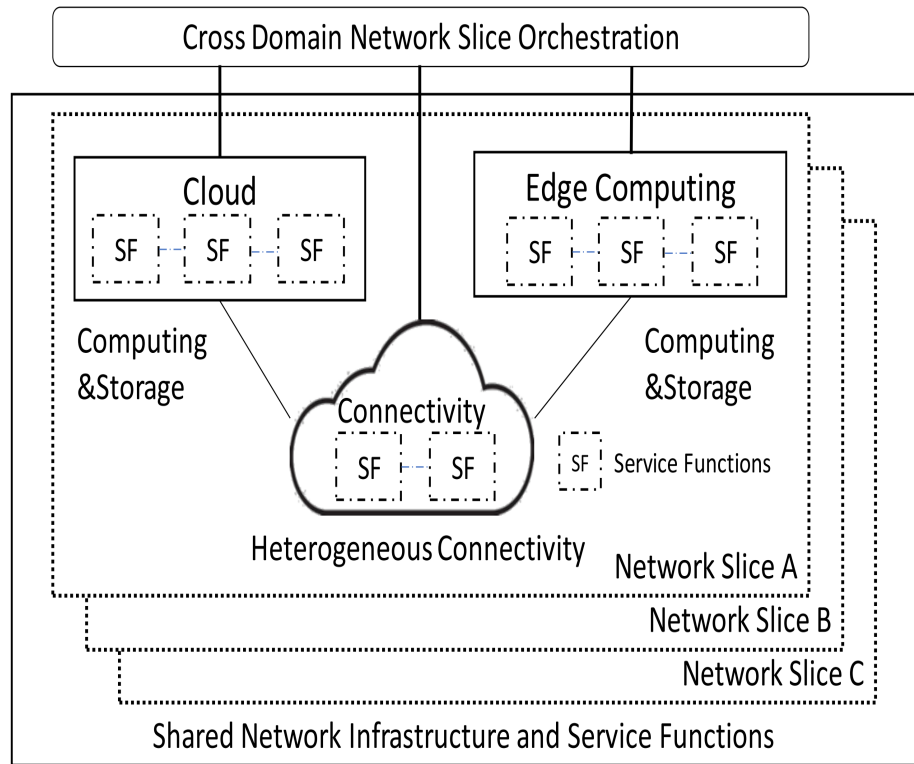


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Proposed Framework @ IETF

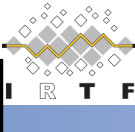
NECOS Project

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

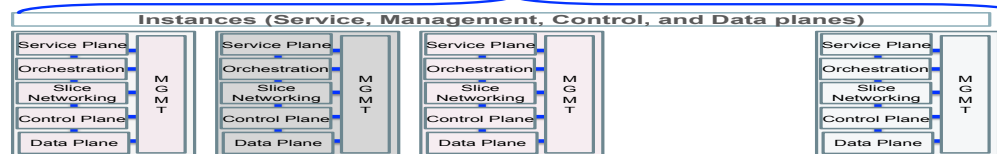


Research Challenges (1): E2E Network Slice Management and Orchestration

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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).; (5) **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/

E2E multi-domain 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.

Research Challenges (2) : Autonomic Slice Management

Service Mapping Single Domain; Slice composition



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Full NS FCAPS: (1) Fault, Configuration, Accounting, Performance, Security; (2) Monitoring Subsystem is responsible for **monitoring continuously the state all components of a NS**; 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.

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 composition / decomposition : 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 be 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).

Research Challenges (3) Key Network Slicing Capabilities



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E2E 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 management scalability issue.

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

Concluding Remarks: Overall Context

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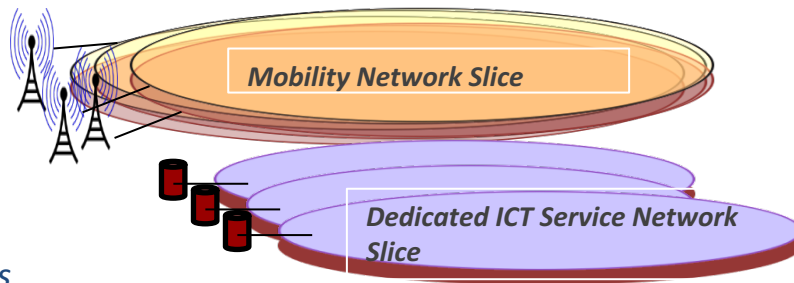


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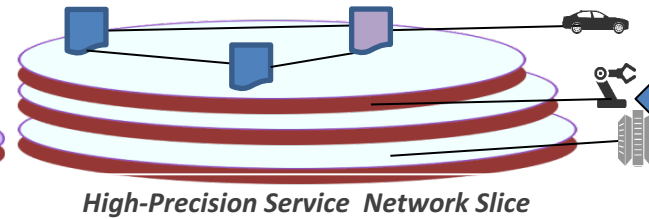
- Transition from network devices to integrated network & service functions with inbound management
- Dynamically adapting the network to meet future service demands
- Creating the dynamic, configurable, programmable, resilient, safe and cost effective E2E network
- A programmable network fabric system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

E2N Multi-Domain Orchestration
E2E coordination, conflict resolution, multi-domain information exchange

Service Adapted Network Slices
 Enabled by Network Functions Including NFV



In-slice Cognitive Management & Control



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

Existing Cloud & Network Fabric



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 E2E frameworks, e2e orchestration functions and APIs of e2e 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
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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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