

# Towards Slice Networking@IETF

## “Network Slicing - Introductory Document and Revised Problem Statement”

**draft-gdmb-netslices-intro-and-ps-02**

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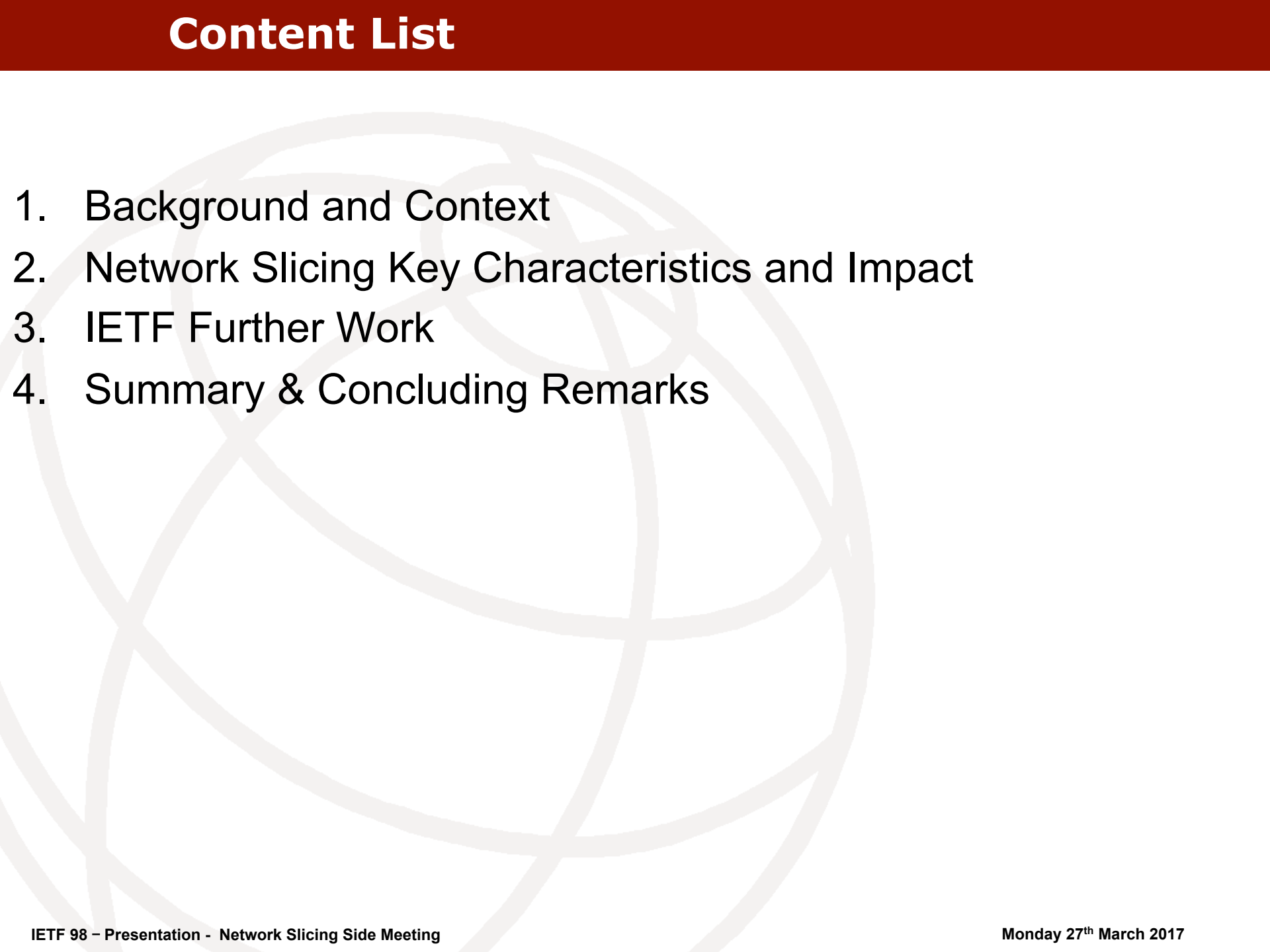
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1. Background and Context
  2. Network Slicing Key Characteristics and Impact
  3. IETF Further Work
  4. Summary & Concluding Remarks

# Network Slicing - Early Definitions & References

**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; A unit of access control)

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

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

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

## EU 5GPPP

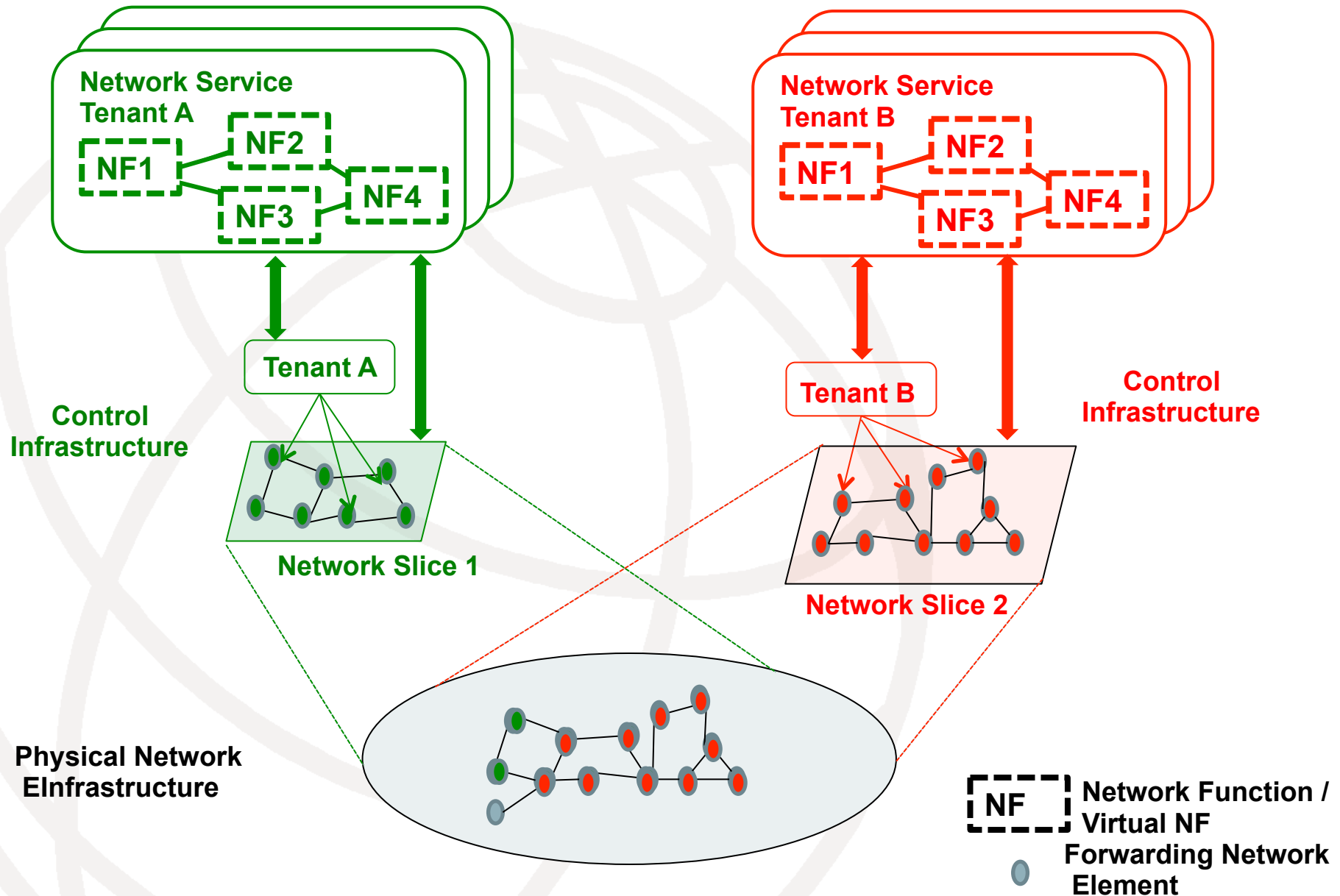
- **15 Large Scale Research projects – all based on Network Slicing** (<https://5g-ppp.eu>);
- **White Paper on 5G Architecture centered on network slicing** (<https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-5G-Architecture-WP-July-2016.pdf>)
- **White Paper on 5G Autonomic Management Architecture centered on NS** [https://5g-ppp.eu/wp-content/uploads/2017/03/NetworkManagement\\_WhitePaper\\_1.pdf](https://5g-ppp.eu/wp-content/uploads/2017/03/NetworkManagement_WhitePaper_1.pdf)

**IETF :** some uncoordinated NS activities (2015+) in TEAS WG, DETNET WG, ANIMA WG, SFC WG, NETCONF WG, SUPA WG, NVO3 WG, DMM WG, Routing Area WG (RTGWG), Network Management Research Group (NMRG) and NFV Research Group (NFVRG)

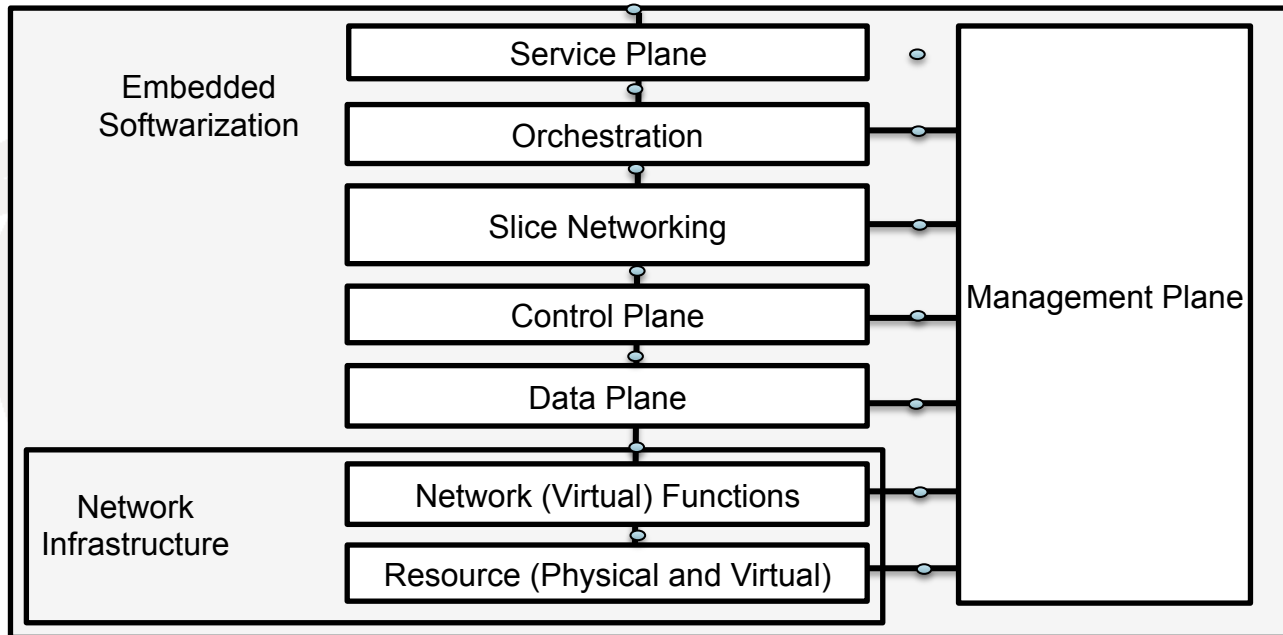
# NS Key Characteristics→ No1 Engineering Priority in 5G

- **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.
- **NS** 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 Representation

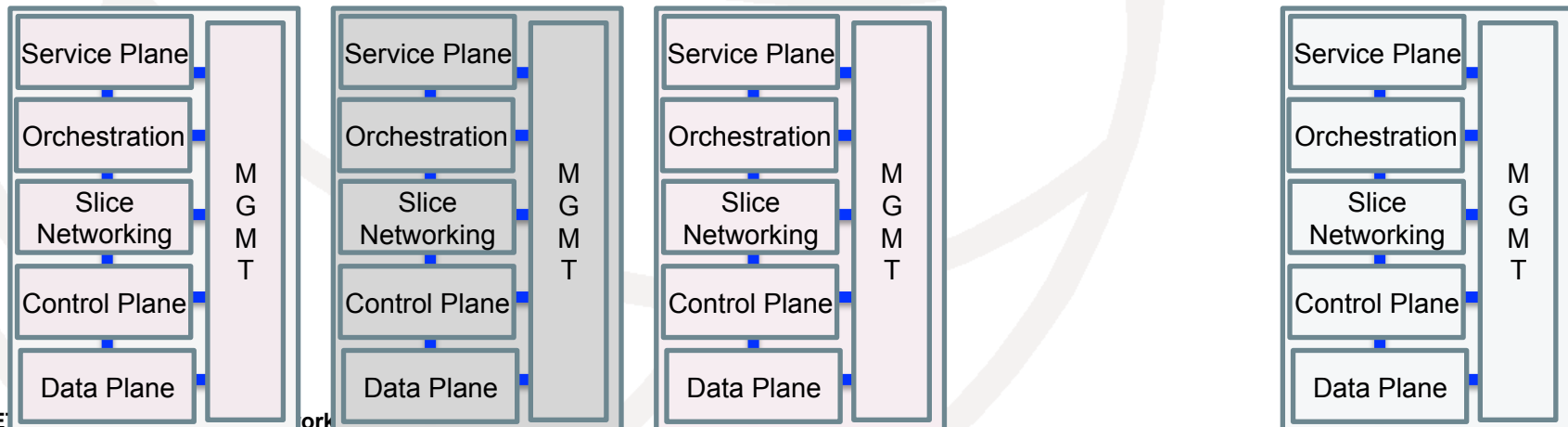


# Network Slice Life Cycle Management



Instantiation

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



# Advanced Network Slicing Work Items @ IETF

- (1) **Uniform Reference Model for Network Slicing (Architecture document):** Describes all of the functional elements and instances of a network slice. Describes shared non-sliced network parts. Establishes the boundaries to the basic network slice operations
- (2) **Slice Templates:** capability exposure + managed partitions of network resources, compute and storage resources), physical and/or virtual network and service functions
- (3) **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.
- (4) **Network Slice capabilities** are expected to be:
  - Four-dimensional efficient slice creation with **guarantees for isolation in each of the Data /Control/ Management /Service planes.**
  - Enablers for **safe, secure and efficient multi-tenancy in slices.**
  - Methods to **guarantee for the end-to-end QoS of service in a slice.**
  - Efficiency in slicing: specifying policies and methods to realize diverse requirements without re-engineering the infrastructure.
  - Recursion: namely methods for **NS segmentation allowing a slicing hierarchy** with parent - child relationships.
  - **Customized security mechanisms** per slice.
  - Methods and policies to manage the **trade-offs between flexibility and efficiency in slicing.**
  - 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 environment; NS interconnection.

## (5) Network slice operations :

- **Slice life cycle management** including creation, activation / deactivation, protection, elasticity, extensibility, safety, sizing and scalability of the slicing model per network and per network cloud: slices in access, core and transport networks; slices in data centres, slices in edge clouds.
- **Autonomic slice management and operation**: namely self-configuration self-composition, self-monitoring, self-optimisation, self-elasticity are carried as part of the slice protocols.
- **E2E Slice stitching / composition**: 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.
- **End-to-end network segments and network clouds orchestration of slices**
- **Service Mapping**: having dynamic and Automatic Mapping of Services to slices; YANG models for slices.

(6) Describe the enablers and methods for the above mentioned capabilities and operations from **different viewpoints on slices** (e.g. slice's owner towards user, towards the physical infrastructure owner)

(7) Efficient enablers and **methods for integration of above capabilities and operations.**



# Summary & Concluding Remarks

- **NS is potentially No1 Engineering Priority in 5G**
- **Suggested Work Priorities** (e.g. priority 1):
  - NS Reference Models / Architecture documents
  - NS Exposure Interface specification and Data model
  - Service Requirement to Network Capability Mapping Data Model
  - Four dimensional efficient slice isolation with guarantees for isolation in each of the Data/ Control/ Management/ Service planes.
  - End-to-end coordination and orchestration of slices.
  - Slice stitching / composition/ decomposition
- **Invitation to participate in the Slice Networking related drafts**
  - reference models, terms and concepts
  - control plane,
  - management plane,
  - signaling protocol,
  - control loops
- **IETF99**: impact of slice networking in the data plane, control plane, management plane, topology, routing, traffic engineering, data models, operations, multi-domain, service chaining, security, life-cycle management of slices (creation, composition, deletion, dimensioning), orchestration, overlays, service chaining, terminology, etc.

# Acknowledgement

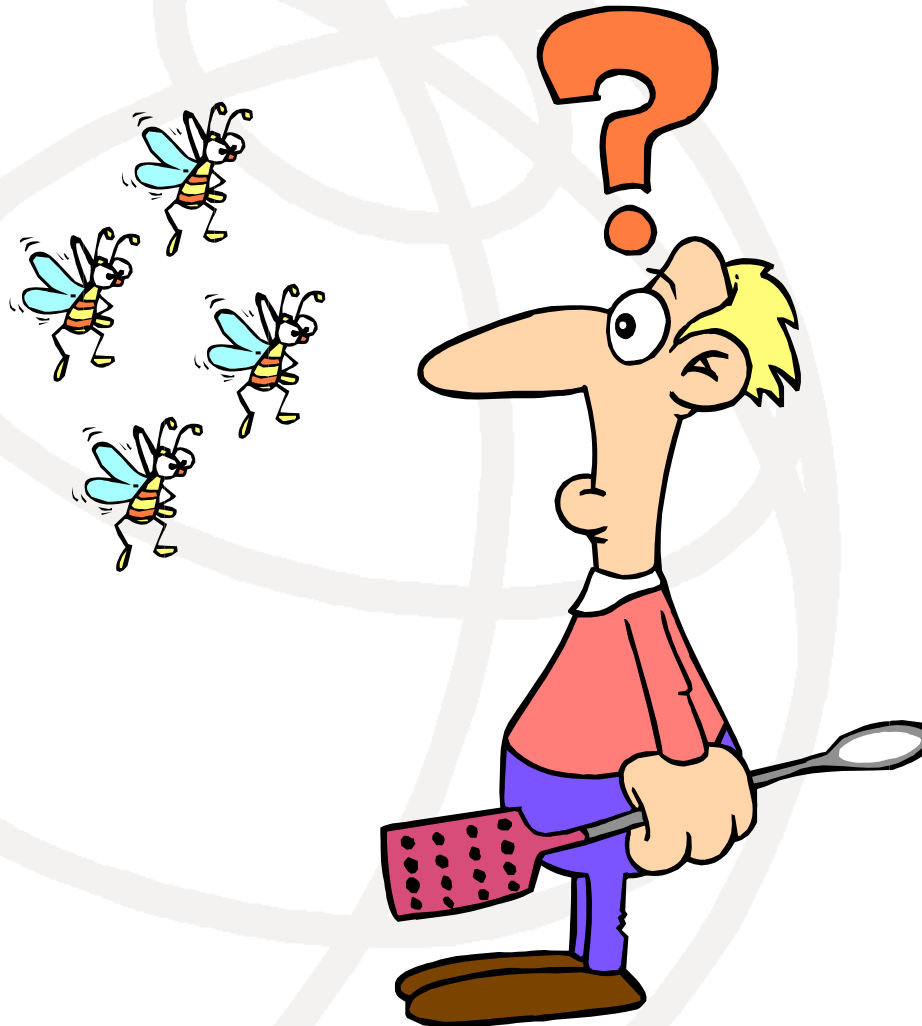
Many thanks to Sheng Jiang (Huawei Technologies), Hannu Flinck (Nokia), Kevin Smith (Vodafone) for reviewing draft “draft-gdmb-netslices-intro-and-ps-02”.

## 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



# Spare Slides



# Early Definitions of Network Slicing

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(\*) 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>

# Unified Slice definition in the context of IETF

## (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 Network Slice.
- 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.

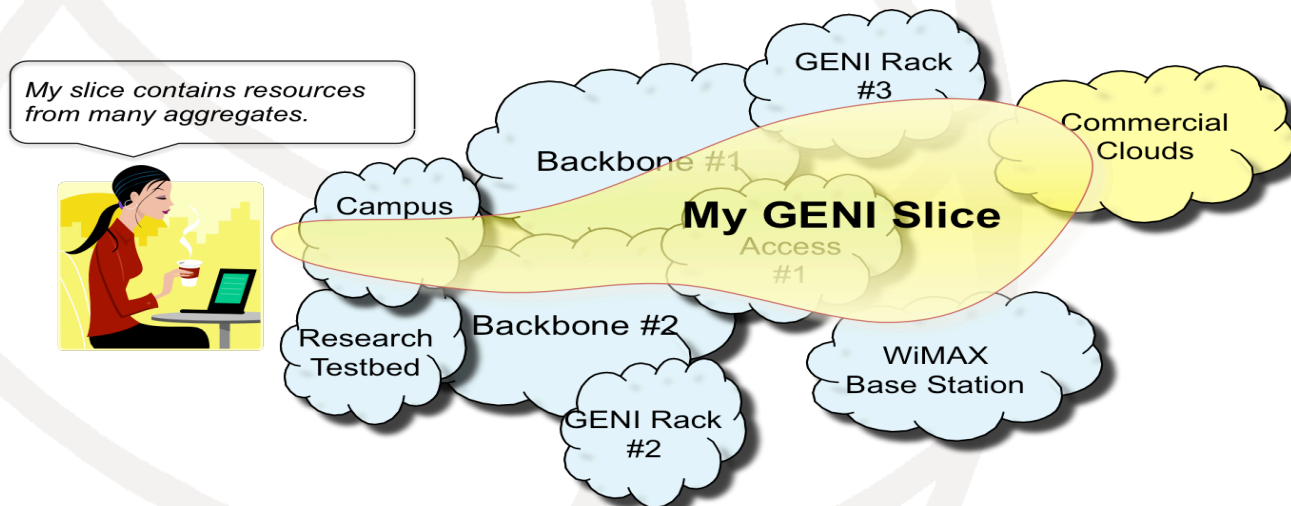
# Definitions of Network Slicing (I)

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**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>

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## 3 Slices Capabilities

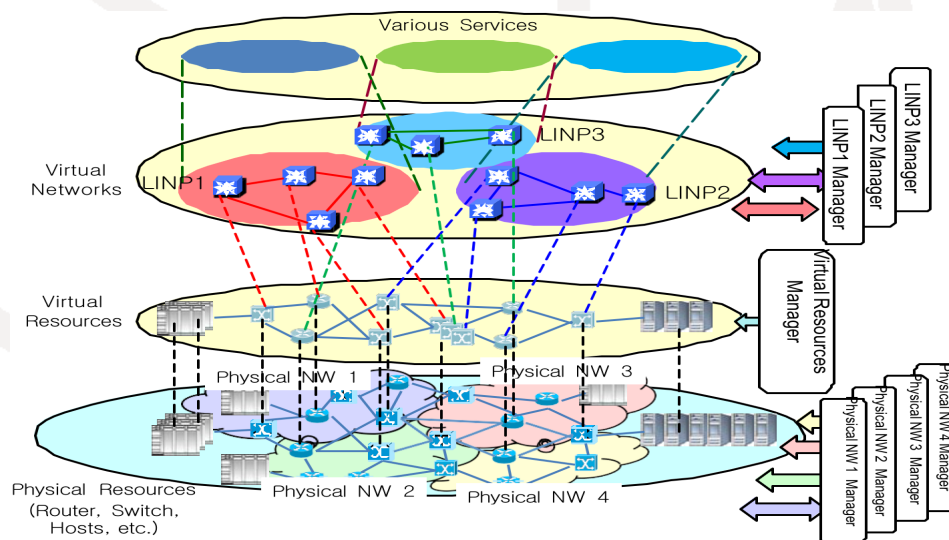
- “Resource allocation to virtual infrastructures or slices of virtual infrastructure.”
- “Dynamic creation and management of virtual infrastructures/slices of virtual infrastructure across diverse resources.”
- “Dynamic mapping and deployment of a service on a virtual infrastructure/slices of virtual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

## 17 Orchestration capabilities

## 19 Self-functionality mechanisms

## 14 Self-functionality infrastructure capabilities

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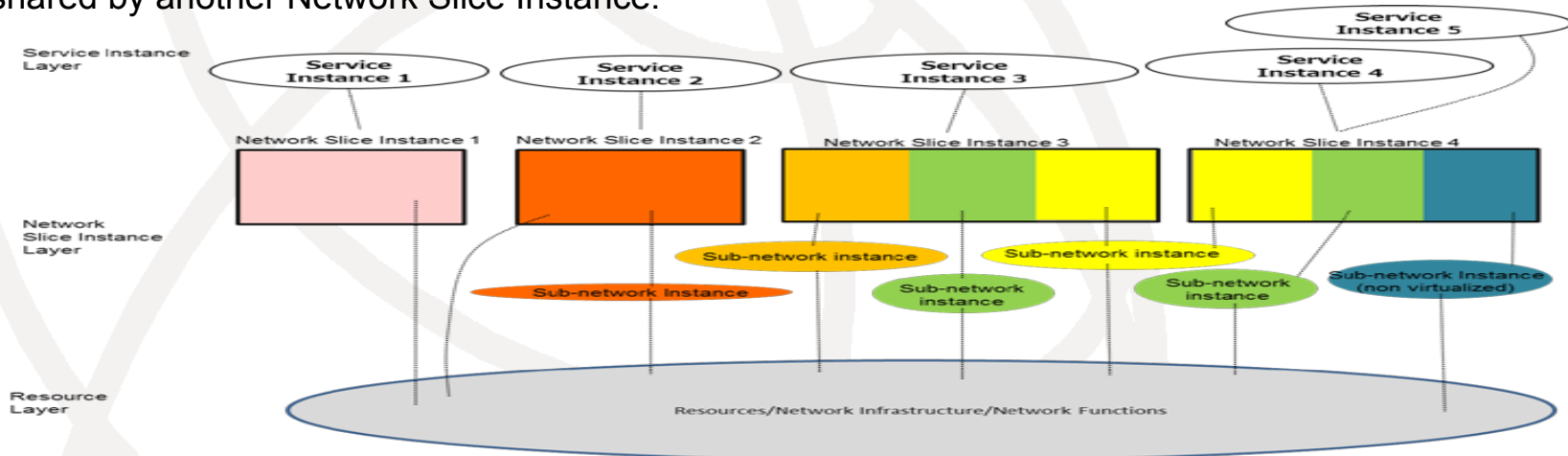




# Definitions of Network Slicing (III)

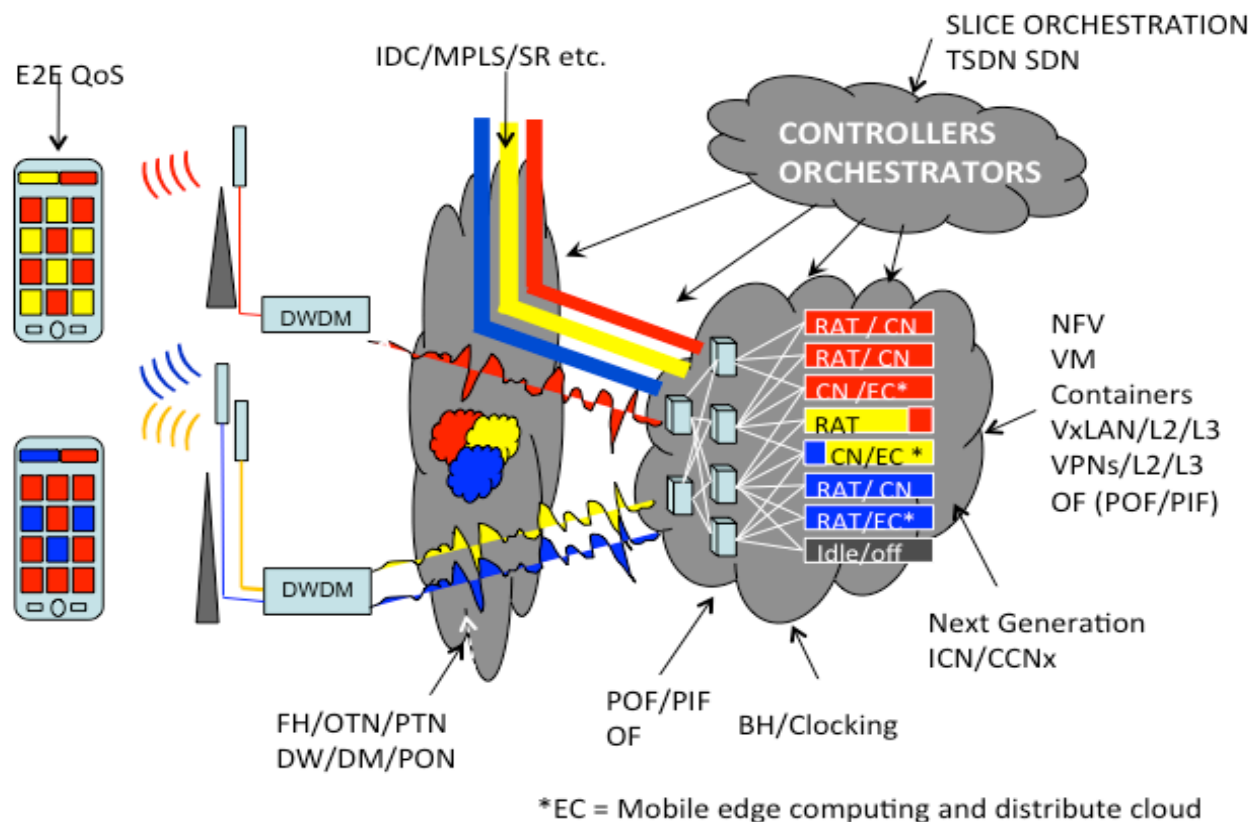
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- The Service Instance Layer represents the services (end-user service or business services) which are to be supported. Each service is represented by a Service Instance. Typically services can be provided by the network operator or by 3rd parties.
- 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.



**Network Service Slices (2016)** A **network service slice** is grouping of physical or virtual (network, compute, storage) resources which can act as a sub network and/or cloud and it can accommodate service components and network (virtual) functions. For slice creation, management planes create virtual or physical network functions and connects them as appropriate and instantiate all the network functions assigned to the slice. On the other hand, for slice creation, the slice control takes over the control of all the virtualised network functions and network programmability functions assigned to the slice, and (re-)configure them as appropriate to provide the end-to-end service.

# C-RAN Virtualization & Slicing under Software Control



## Example of 5G C-RAN network slicing

(Report of Gap Analysis – Focus group on IMT-2020– Nov 15 T13-SG13-151130-TD-PLN-0208!!MSW-E.docx)

# Network Slicing Models

