

# 5G end-to-end experimentation by verticals in EU projects

Online workshop 9 June 2020

End-to-end service specification and  
deployment in 5G-VINNI

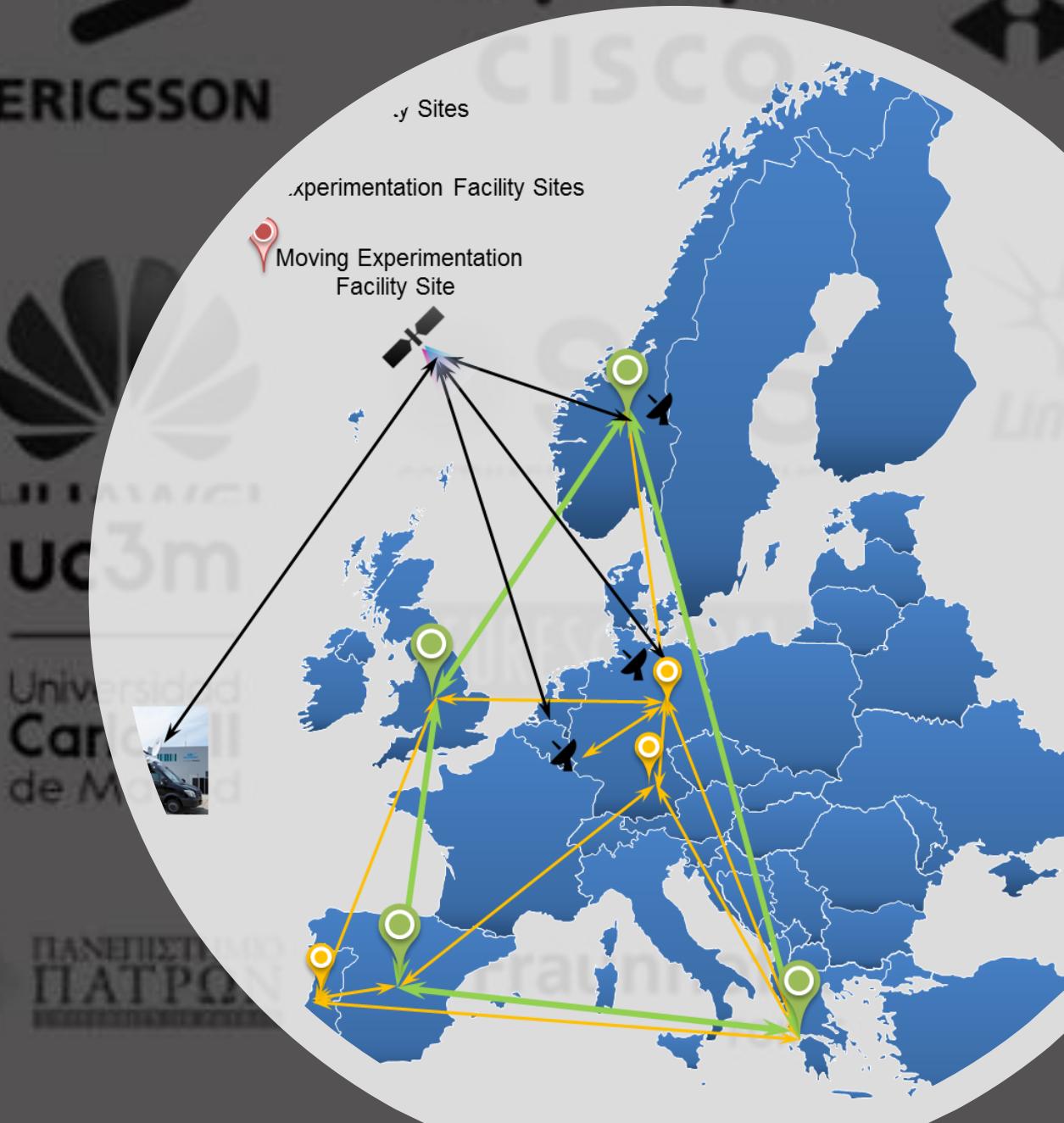
**Christos Tranoris**

University of Patras, Greece

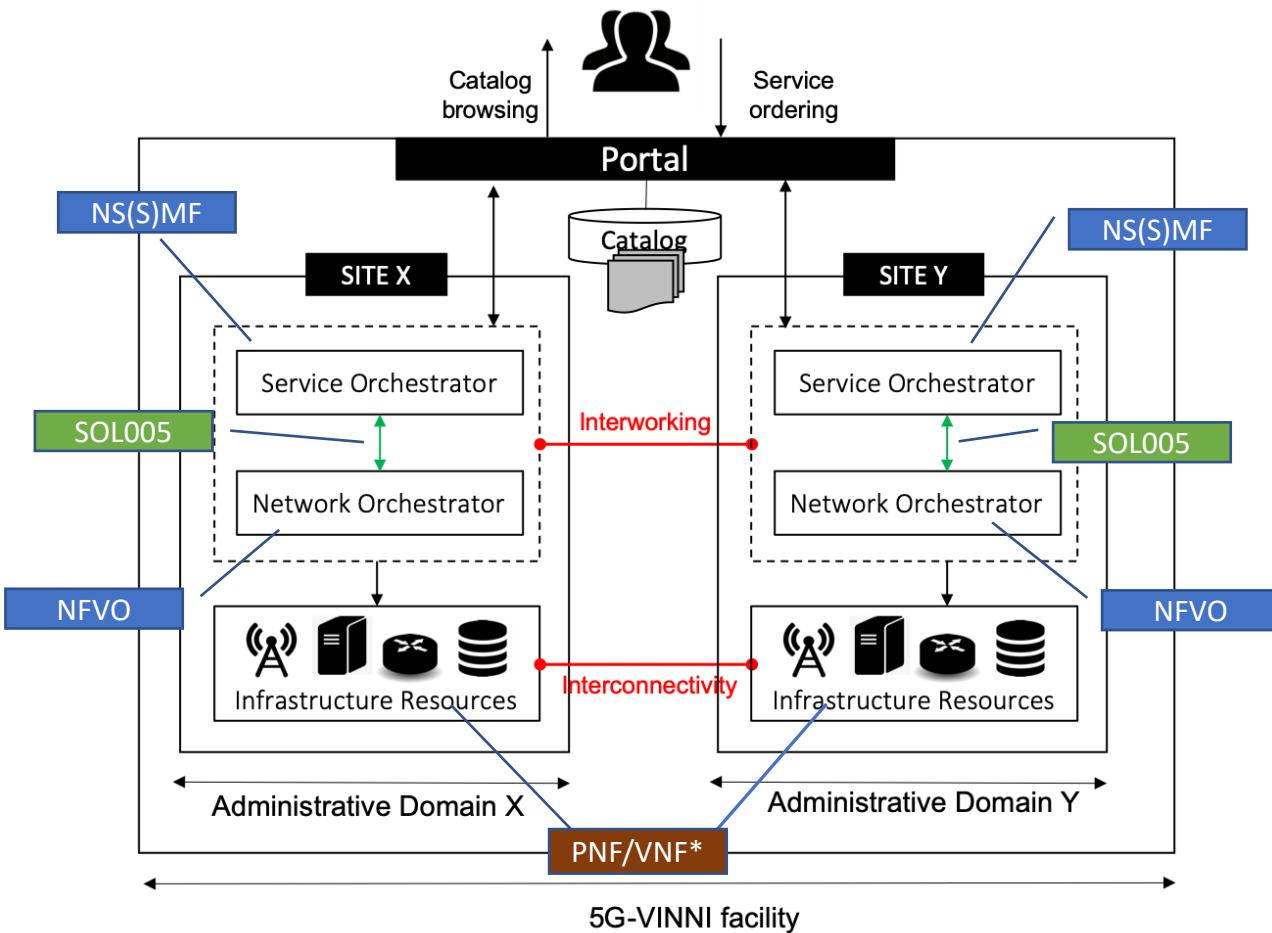
# 5G-VINNI (5G Verticals INNovation Infrastructure)

- Build an open large scale 5G End-to-End facility that can
  - demonstrate that key 5G network KPIs can be met
  - be validated, accessed and used by vertical industries (e.g. in ICT-19 projects) to test use cases and validate 5G KPIs.
  - Provide user friendly zero-touch orchestration, operations and management systems for the 5G-VINNI facility.
  - Validate the 5G KPIs and support the execution of E2E trial of vertical use cases for ICT-19 projects.
- Duration: 3 years, budget: 19,998 M€
- Consortium: 23 partners (operators, vendors, academics, SMEs)

<https://5g-vinni.eu/>



# 5G-VINNI facility



- 5G-VINNI facility site architecture is standards-compliant (e.g. 3GPP; ETSI NFV) to facilitate interoperability in multi-site slicing scenarios
- 5G-VINNI is an E2E facility providing advanced 5G capabilities that are made available to industry verticals for use case trialing.
- 5G-VINNI facility provides every vertical with an isolated service experimentation, in the form of a slice -> Network Slice as a Service (NSaaS).
- 5G-VINNI facility architecture
  - **Catalog:** publication of 5G-VINNI service offerings, i.e. network slice services.
  - **Portal:** single-entry point for the vertical. It allows catalog browsing and service ordering operations.
  - **Multiple interworking sites**, each deployed at a different geographic location and defining a single administrative domain.



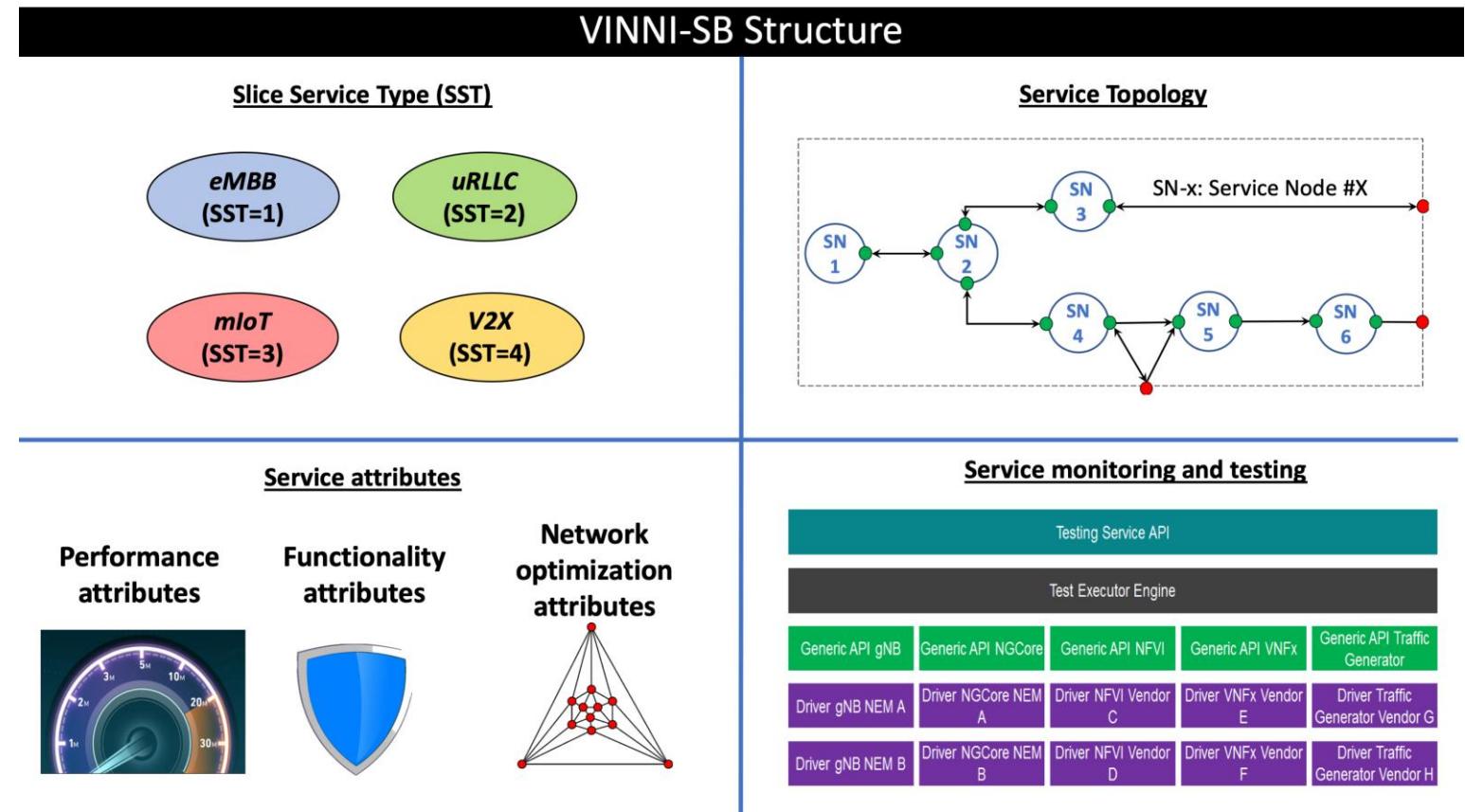
This project has received funding from the EU's Horizon 2020 research and innovation programme under grant agreement No 815279.

(\*) Multi-Vendor Network Functions across domains, e.g. RAN, CN, TN.



# 5G-VINNI Service Blueprint (VINNI-SB)

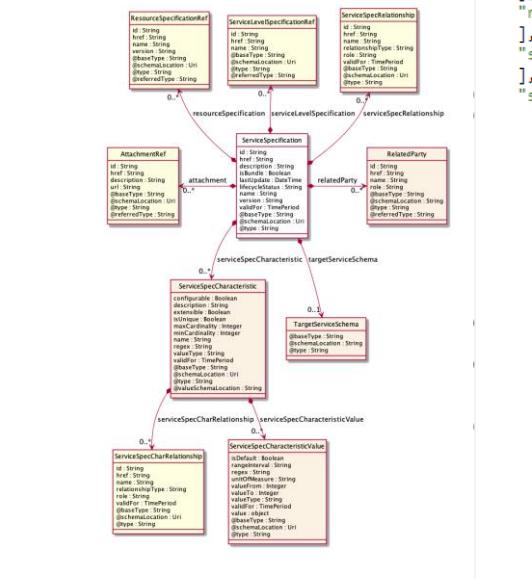
- Model-based service template for service ordering in NSaaS.
- Extending GSMA's Generic Slice Template (GST), including experimentation related attributes:
  - **Monitoring**
  - **Testing**



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# GSMA GST to TMF SID

- Availability
- Area of service
- Delay tolerance
- Deterministic communication
- Downlink throughput per network slice
- Downlink throughput per UE
- Energy efficiency
- Group communication support
- Isolation level
- Location based message delivery
- Maximum supported packet size
- Mission critical support
- MMTel support
- NB-IoT Support
- Network Slice Customer network functions
- Number of connections
- Number of terminals
- Performance monitoring
- Performance prediction
- Positioning support
- Radio spectrum
- Reliability
- Root cause investigation
- Session and Service Continuity support
- Simultaneous use of the network slice
- Slice quality of service parameters
- Support for non-IP traffic
- Supported device velocity
- Synchronicity
- Terminal density
- Uplink throughput per network slice
- Uplink throughput per UE
- User management openness
- User data access
- VX communication mode

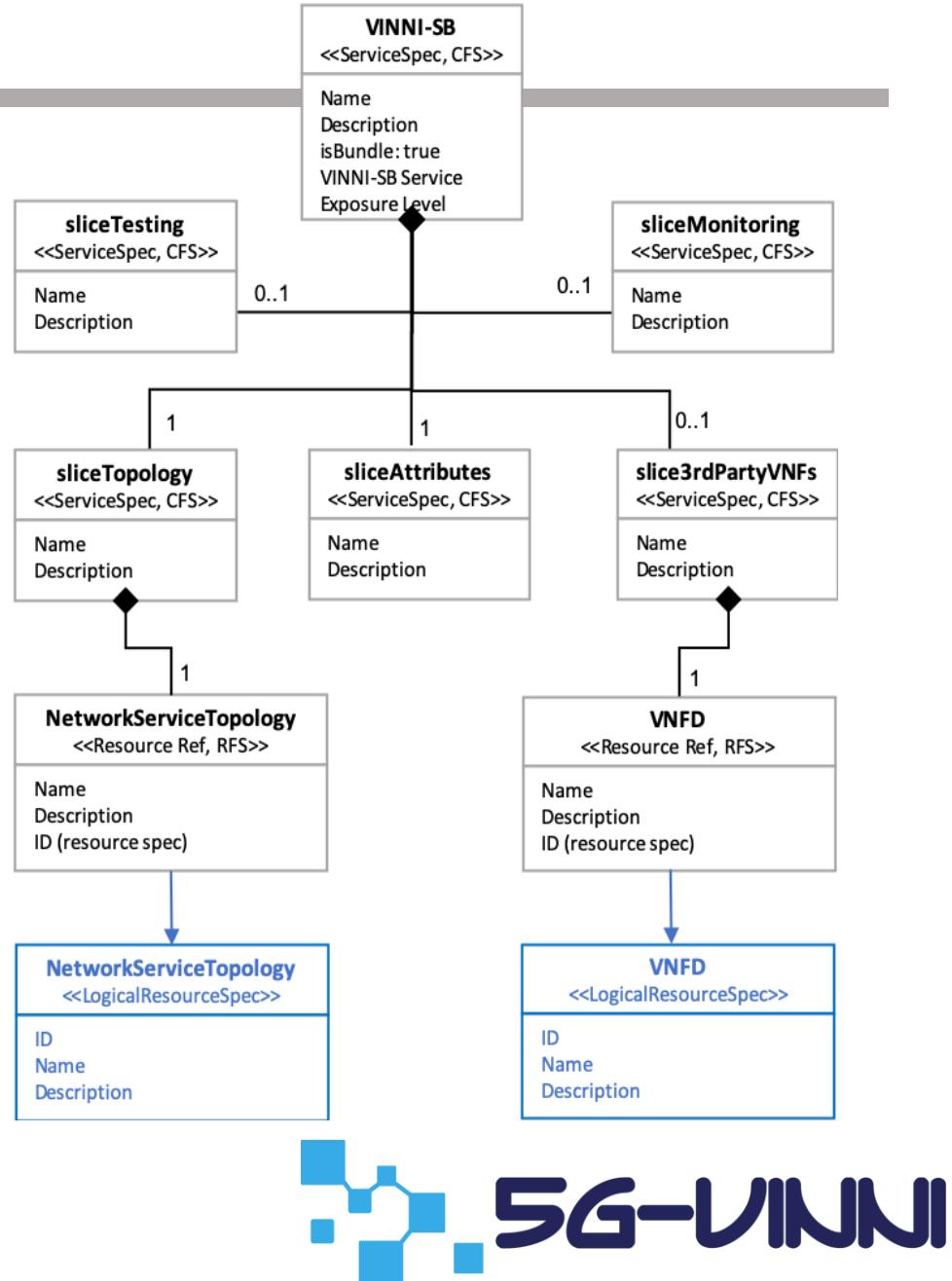


```

{
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    "description": "GST external example",
    "version": "0.4.0",
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    "serviceLevelSpecification": [
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    "serviceSpecCharacteristic": [
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            "name": "Area of Service",
            "configurable": false,
            "description": "This attribute specifies the area where the terminals can access a particular network slice. Therefore, the attribute 'extensible' is set to 'null'. The attribute 'isUnique' is set to 'true' and 'maxCardinality' is set to '1'. The attribute 'minCardinality' is set to '0'. The attribute 'valueType' is set to 'SET'. The attribute 'serviceSpecCharRelationship' is set to an empty array. The attribute 'serviceSpecCharacteristicValue' is set to an empty array.",
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                { "name": "KPI", "role": "tag", "relationshipType": "tag" }
            ],
            "serviceSpecCharacteristicValue": [
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                    "isDefault": true,
                    "rangeInterval": null,
                    "regex": null,
                    "unitOfMeasure": "N/A",
                    "valueFrom": null
                }
            ]
        }
    ]
}
  
```

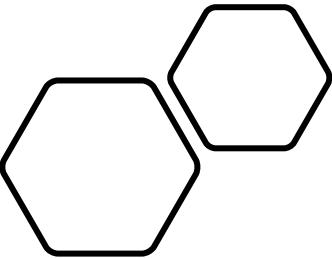
# Model of VINNI-SB

- Definition of a common information model for the entire 5G-VINNI facility:
  - Site-agnostic design of network slices.
  - Ensures **reproducibility** and facilitates **cross-site slice deployments**.
- Model following TM Forum's information Framework (SID)



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# Onboarding a Vertical for 5G experimentation

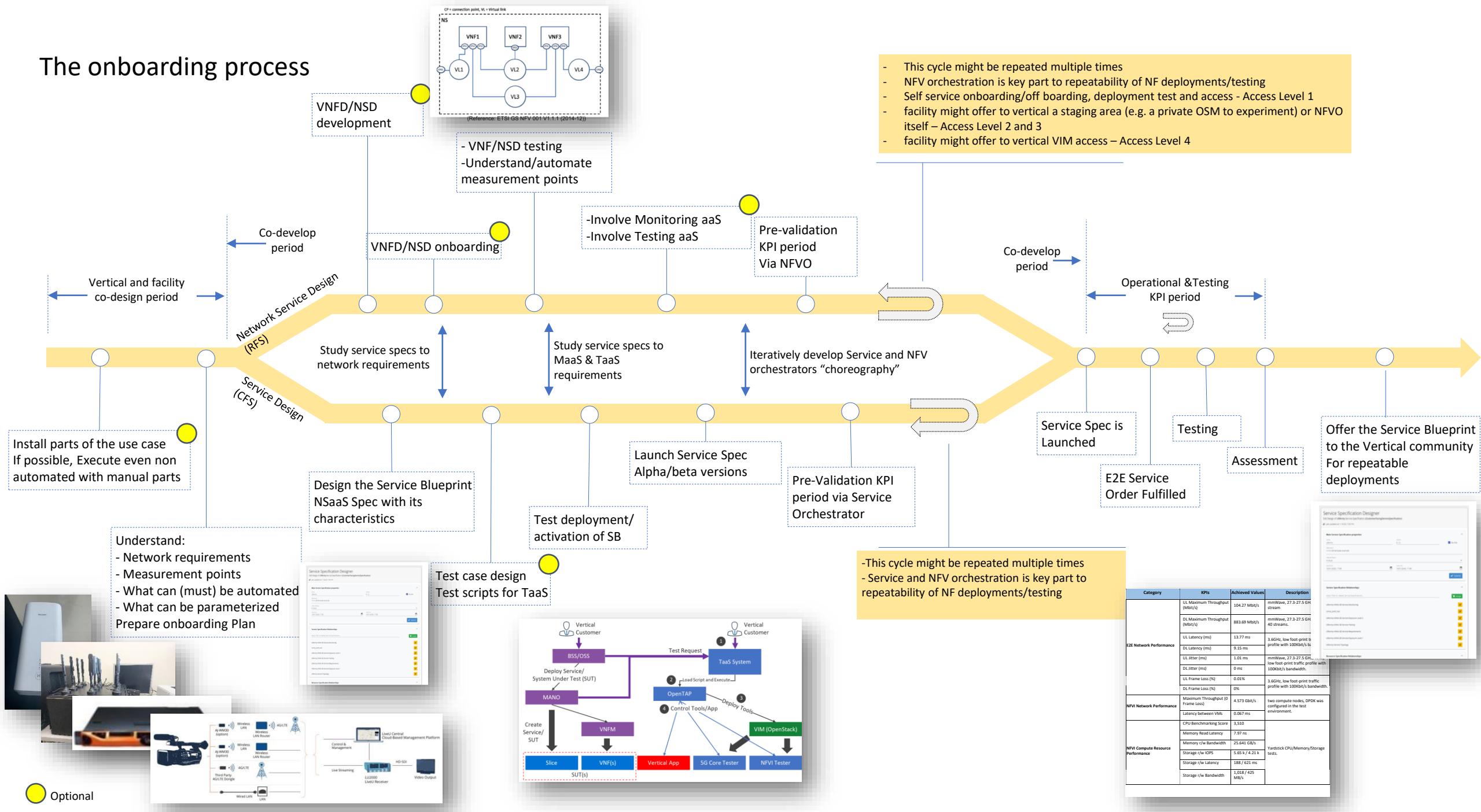


Onboarding a vertical in a 5G experimentation infrastructure involves various **iterative and parallel steps**. **Different stakeholders** (customer, facility provider) must co-design and co-develop different parts for a successful operation and KPI testing on top of a 5G facility.

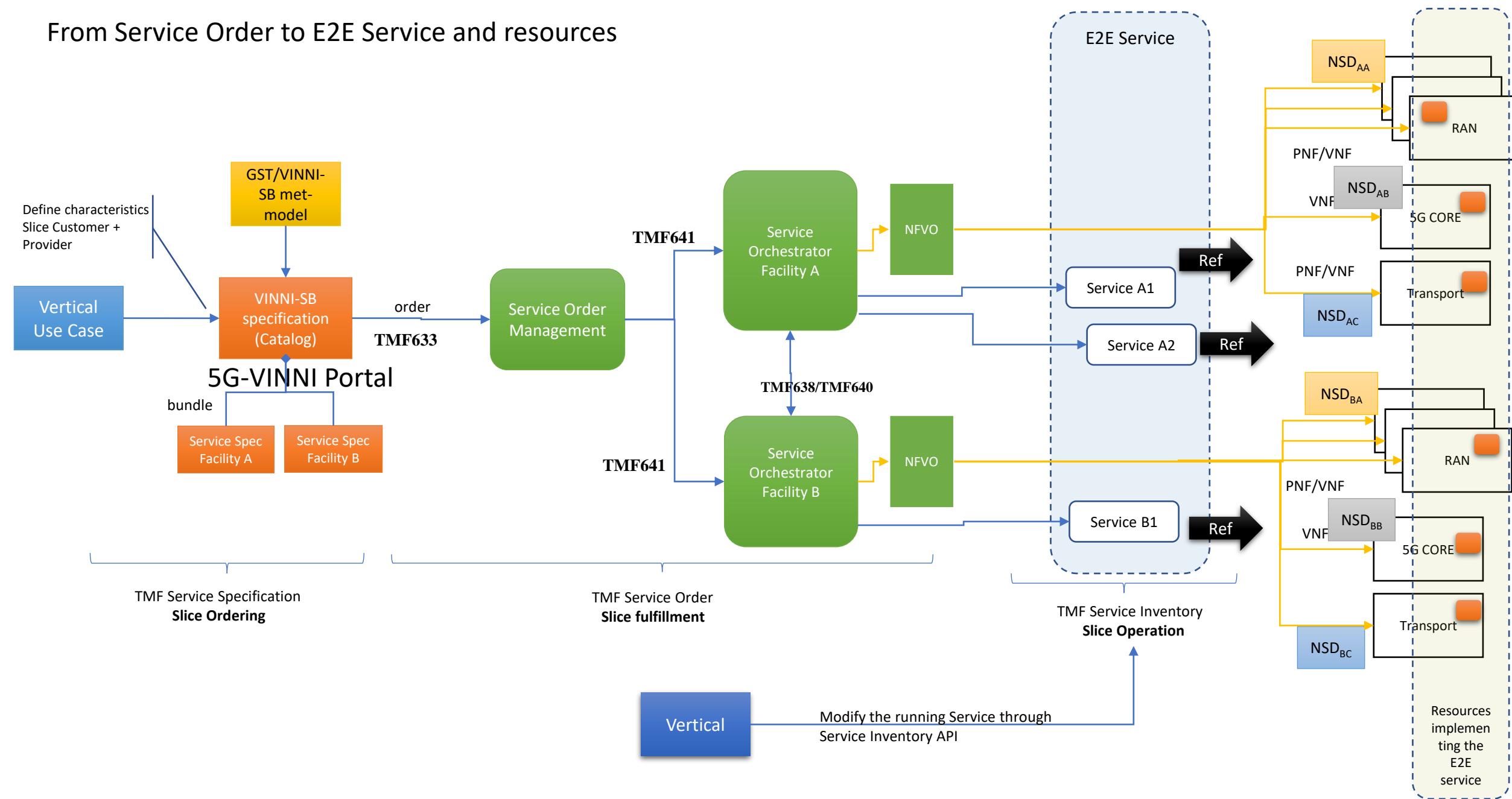
We defined three periods of the onboarding process:

- i) a **co-design** period,
- ii) an iterative **co-development** period and
- iii) the **Operation and Testing KPI** iterative period.

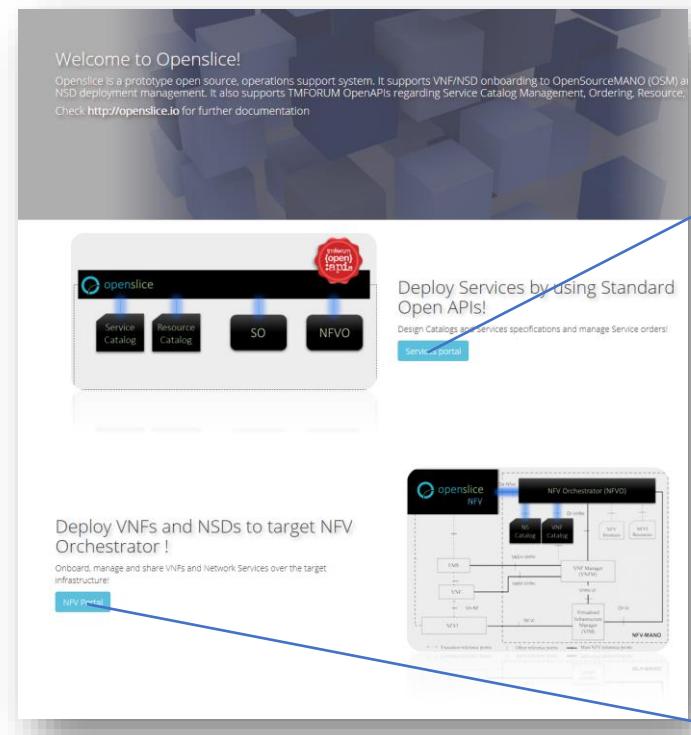
# The onboarding process



# From Service Order to E2E Service and resources



# Supporting the onboarding-process



Welcome to Openslice demo!  
Browse available services and sign in to order.

Service Catalog Explorer

Service Specifications of External category

Filter services...

SG-ACIA-Local Control-to-control  
Version: 0.4.0  
Generic Services External  
SG-ACIA-Local Control-to-control - GST external example Loc...  
Preview  
Last updated at May 7, 2020, 2:58:03 PM

SG-ACIA-Mobile Robots (indoor)  
Version: 0.4.0  
Generic Services External  
SG-ACIA-Mobile Robots - GST external example Mobile robots ...  
Preview  
Last updated at Jan 20, 2020, 9:55:48 PM

enhanced Mobile Broadband with IMS support  
Version: 0.4.0  
eMBB External  
minimum set of attributes needed for NEST for enhanced Mobi...  
Preview  
Last updated at May 22, 2020, 2:29:33 PM

ExampleDemo  
Version: 0.1.0  
External  
VNNI-SB template  
Preview  
Last updated at Jan 15, 2020, 11:32:17 AM

URArmy  
Version: 0.1.0  
External  
VNNI-SB template example  
Preview  
Last updated at Jan 16, 2020, 7:00:09 PM

Services

Welcome to Patras5G!  
Browse available NSDs and sign in as an NSD creator to deploy your NSDs!

All  
Networking  
None  
Service

hackfest\_epa-ns  
by admin  
Version: 1.0  
Networking  
hackfest\_epa-ns  
View details

patras5g\_multivdu\_nsду\_example  
by admin  
Version: 1.0  
Networking  
patras5g\_multivdu\_nsду\_example  
View details

NFV artifacts



# Service Catalog/Service Specification Design

The screenshot shows the openslice Services Marketplace interface. The top navigation bar includes the openslice logo, 'Services Marketplace', and 'Manage Services'. The main content area is titled 'Service Catalog Explorer' and contains a section titled 'Example Facility Services' with a 'eMBB' tab selected. Below this, there are sections for 'Generic Services' and 'External'. A detailed table view is overlaid on the right side, showing 'Location Characteristics' with tabs for 'Functional', 'KPI', 'Character Attribute', 'Scalability Attribute', and 'Performance'. A green button at the top right of the table says 'Create New Characteristic'. The table has columns for 'Characteristic', 'Value Type', 'Default Values', 'Configurable', and 'Actions'. The data rows include:

Characteristic	Type	Default Values	Configurable	Actions
Region specification	SET	5 (Local_Indoor) N/A	false	
Delay tolerance	BINARY	0 (Not supported)	false	
Deterministic communication: Availability	BINARY	1 (Supported)	false	
Deterministic communication: Periodicity	ARRAY	0 (1-10) ms	false	
Downlink throughput per UE: Guaranteed downlink throughput	INTEGER	500 Mbps	false	
Downlink throughput per UE: Maximum downlink throughput	INTEGER		false	
Downlink throughput per network slice: Guaranteed downlink throughput	FLOAT	5 Gbps	false	
Downlink throughput per network slice: Maximum downlink throughput	INTEGER		false	
Group communication support	ENUM	0 (not available)	false	

## TMF633 - Service Catalog Management

## TMF634 - Resource Catalog Management (no UI currently)

# Service Order and SOM

Service Catalog Explorer

Example Facility Services

General Services

External

enhanced Mobile Broadband with IMS support

5G

Version 0.4.0

Bundle TRUE

Description: minimum set of attributes needed for NEST for enhanced Mobile Broadband (eMBB) SST, where IMS services (MME) and (PC) are supported with example value for HPLMN Germany. To provide the seamless service continuity, N26 interface and SCC mode 1 must be used.

Place In Order List

Service Characteristics

User Defined Service Characteristics

Characteristics Name Default Values

Area of Service: Region specification 0 (Full Country)

Downlink throughput per UE: Guaranteed downlink throughput 192.0 Mbps

IMSIS 00000

Number of terminals 10000 (terminals)

Open5G Core-2emb\_ns:inst-nsid 401:0004:00000001:0000000000000000

Cancel

Open5G Core-2emb\_ns:inst-nsid A portal that allows 5G experimenters to display experiment descriptors

Service Order Overview

Preview and Manage Service Order of *My order*  
with id #1901cf7-6fb7-445e-9f60-45ed2130e395

Main Service Order properties

Orderer By	Order Date	Priority	State
meilisha	21 May 2020, 11:17 AM		COMPLETED
Description			
Requested Starting Date 1 Jan 1970, 2:00 AM			
Starting Date 21 May 2020, 11:17 AM			
Notes SG Solutions use case written by CDSO @ 21 May 2020, 11:17 AM			

Order item #8dd7c761-da8c-4f8b-87e9-e762807c2b82

Main Service properties

ID	Name	State
0a73dc99-3798-4c26-071b-e5d9a90531e3	My order	active
Service Type Category		

Service Specification Characteristics allocated with Service

Characteristic	Value (- Alias)
cirros_2vnf_nsid:NSID	5 - id
cirros_2vnf_nsid:OMANProvider_Name	uop
cirros_2vnf_nsid:OnBoardingStatus	ONBOARDED
cirros_2vnf_nsid:PackageLocation	/osapi/packages/ed3692a2-33ef-4a68-9a53-b9c5117cb8fe/cirros_2vnf
cirros_2vnf_nsid:PackagingFormat	OSMFIVE - PackagingFormat
cirros_2vnf_nsid:Vendor	OSM - Vendor
Director return channel to cameras	0 - Audio
Image of Network Assistance Server (NASS)	tno-naas:latest - tno-naas:latest
Location of Mobile Cameras	2610
Location of NASS	2310
Maximum Number of cameras	3
Number of reserved hours	2

Supporting Services allocated with Service

Open5GCore-2emb_ns:inst-nsid	Open5GCore-2emb_ns:inst-nsid:VIM	Video quality of the mobile cameras	Video response time of the mobile cameras
Open5GCore-2emb_ns:inst-nsid:5	691c8956-0369-4b91-b914-b61dccba74db	0	1

Supporting Service Information

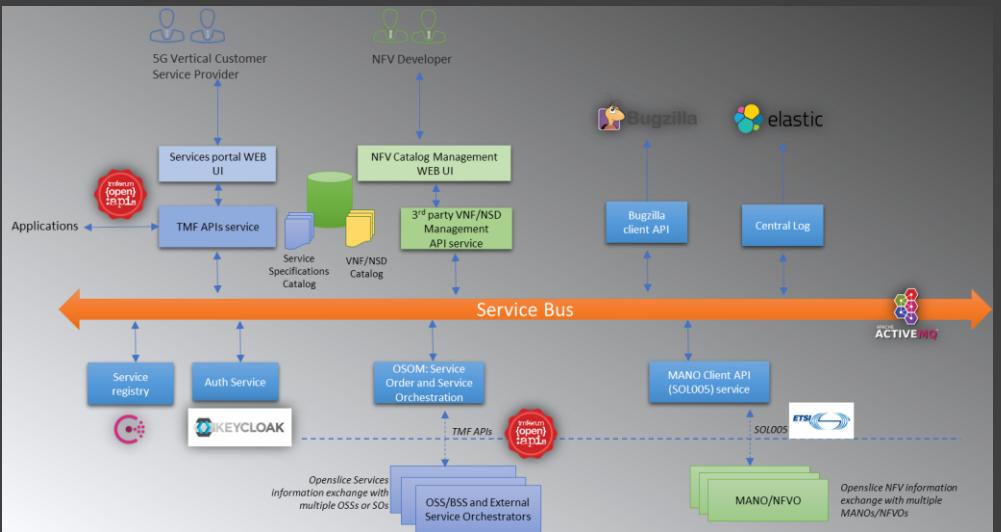
ID	Name	Desc
982cbf5f-101f-425a-a70e-cabfcc126f68	Upstream journalist case	A Service for Upstream journalist case
Service Type Category		
Start Date 21 May 2020, 11:18 AM		
Start Mode AUTOMATICALLY_MANAGED		
Supporting Resources		
There are not supporting resources allocated		
Supporting Services		
There are not supporting services allocated		
Service Characteristics		
cirros_2vnf_nsid:NSID:5		
cirros_2vnf_nsid:OnBoardingStatus: ONBOARDED		
cirros_2vnf_nsid:nsName: Open5GCore-2emb_ns		
cirros_2vnf_nsid:Vendor: OSM		
cirros_2vnf_nsid:PackageLocation: /osapi/packages/ed3692a2-33ef-4a68-9a53-b9c5117cb8fe/cirros_2vnf_ns.tar.gz		
Location of Mobile Cameras: 2610		
Image of Network Assistance Server (NASS): tno-naas:latest		
Number of reserved hours: 2		
cirros_2vnf_nsid:OMANProvider_Name: uop		
Maximum Number of cameras: 3		
Location of NASS: 2310		
Open5GCore-2emb_ns:inst-nsid:VIM: 691c8956-0369-4b91-b914-b61dccba74db		
cirros_2vnf_nsid:PackagingFormat: OSMFIVE		
Video response time of the mobile cameras: 7		
Director return channel to cameras: 0		
Video quality of the mobile cameras: 0		
Notes		
Update Service Order State to: active.		
written by OSOM @ 21 May 2020, 11:18 AM		
Local Service Orchestration Initialized for spec:Upstream journalist case done!		

TMF 638 - Service Inventory Management  
TMF 640 - Service Activation and Configuration

TMF 641 - Service Ordering Management

# Openslice Open API access

- **Supported TMF OpenAPIs for programmatic access by Vertical Application**
- For a quick access check our swagger links:
- TMF APIs: <http://portal.openslice.io/tmf-api/swagger-ui.html>
- API for VNF/NSD management: <http://portal.openslice.io/osapi/swagger-ui.html>



**Service Catalog Management** TMF API Reference : TMF633 - Service Catalog Management ## Release : 18.5 - December 2018 Service Catalog API is one of Catalog Management API Family. Service Catalog API goal is to provide a catalog of services. ## Resource - serviceCatalog ## Operations Service Catalog API performs the following operations on the resource : - Retrieve an entity or a collection of entities depending on filter criteria - Partial update of an entity (including updating rules) - Create an entity (including default values and creation rules) - Delete an entity (for administration purposes) - Manage notification of events

License

export-job-api-controller-633 the exportJob API  
hub-api-controller the hub API  
import-job-api-controller the importJob API  
listener-api-controller the listener API  
service-candidate-api-controller the serviceCandidate API  
service-catalog-api-controller the serviceCatalog API  
service-category-api-controller the serviceCategory API  
service-specification-api-controller the serviceSpecification API  
exportJob  
events subscription  
portJob  
listeners (client side)

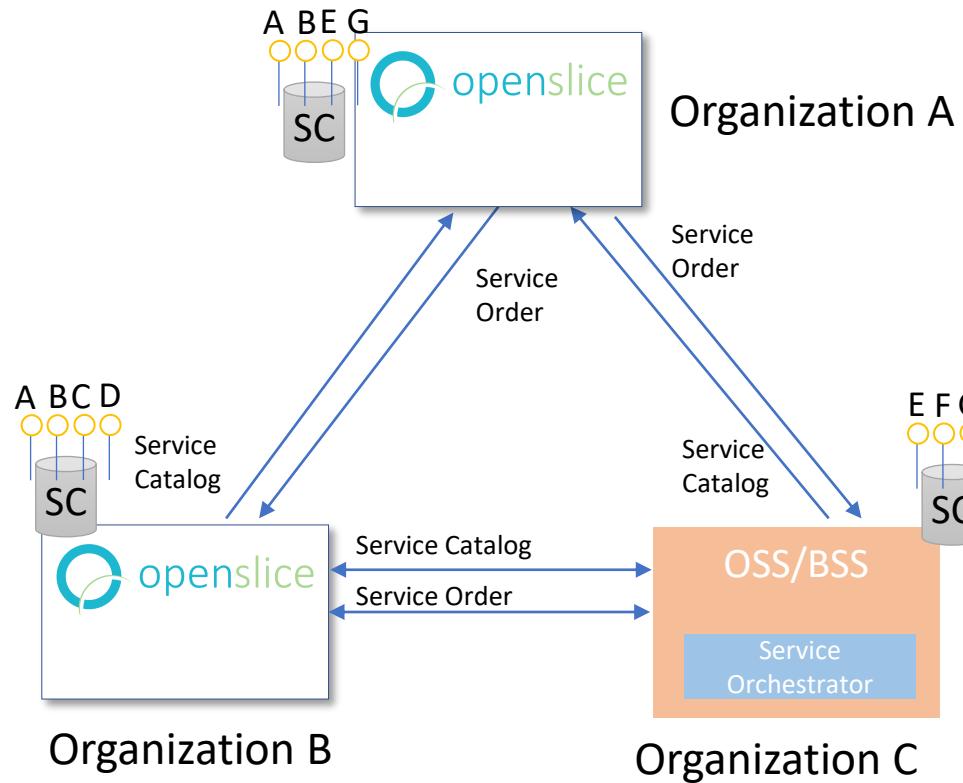
**Service Ordering Management** TMF API Reference : TMF 641 - Service Ordering Management ## Release : 18.5 - Dec 2018 The Service Order API is a standardized mechanism for managing Service Order, a type of order which can be used to place an order between a customer and a service provider or between a service provider and a partner and vice versa. ## Resource - serviceOrder ## Operations Service Order API performs the following operations on service order : - Retrieval of a service order - Partial update of a service order (including updating rules) - Creation of a service order (including default values and creation rules) - Deletion of service order (for administration purposes) - Notification of events on Service order Copyright © TM Forum 2018. All Rights Reserved

License

hub-api-controller the hub API  
listener-api-controller the listener API  
service-order-api-controller the serviceOrder API  
events subscription  
notification listeners (client side)  
serviceOrder  
GET /serviceOrder/{id} or /serviceOrder  
POST /serviceOrder/{id} or /serviceOrder Create a ServiceOrder  
GET /serviceOrder/{id} or /serviceOrder/{id}/status  
PUT /serviceOrder/{id} or /serviceOrder/{id}/status  
DELETE /serviceOrder/{id} or /serviceOrder/{id}/status  
PUT /serviceOrder/{id} or /serviceOrder/{id}/status  
Models

## Multidomain scenarios and federation

Openslice can be used to exchange service specifications/catalogs and make service orders between Organizations



## Service Specification Designer

Edit Design of *URArmy* Service Specification (*CustomerFacingServiceSpecification*)

Last updated at 1/16/20, 7:00 PM

### Main Service Specification properties

Name	URArmy	Version	0.1.0
<input checked="" type="checkbox"/> Bundle			
Description	VINNI-SB template example		
LifeCycle Status	In study		
Valid From	16/01/2020, 17:39	Valid Until	16/01/2040, 17:39
<input type="button" value="Submit"/>			

### Service Specification Relationships

Apply Filter to related Service Specifications...

URArmy-VINNI-SB Service Monitoring



cirros\_2vnf\_nsd



URArmy-VINNI-SB Service Exposure Level 2



URArmy-VINNI-SB Service Testing



URArmy-VINNI-SB Service Requirements



URArmy-VINNI-SB Service Exposure Level 1



URArmy-Service Topology



### Resource Specification Relationships

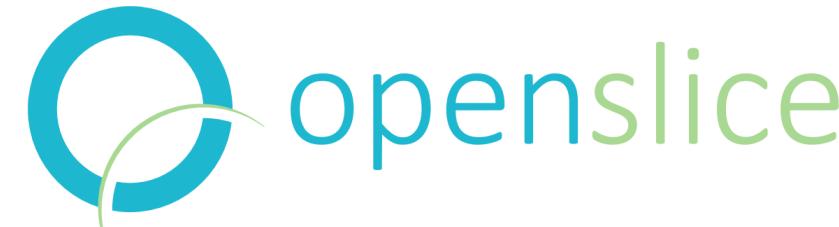
There are no resource specification relationships assigned

### Service Specification Characteristics

Apply Filter...

All  Performance  Functionality  Network Optimisation  Exposure Level

Name	Type	Default Values	Configurable	Actions
5G-VINNI Service Type	SET	1 (MBB) NA	false	
URArmy-VINNI-SB Service Exposure Level 1::Exposure Level	SET	1 (Level 1) NA	false	
URArmy-VINNI-SB Service Exposure Level 2::Exposure Level	SET	2 (Level 2) NA	false	
URArmy-VINNI-SB Service Monitoring::On-demand monitoring support	BINARY	1 (Yes)	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::DL Packet loss rate	FLOAT	10 %	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::DL Packet size	INTEGER	8 Bytes	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::E2E latency	INTEGER	10 ms	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::Jitter	INTEGER	10 ms	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::One-way latency	INTEGER	10 ms	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::UL Packet loss rate	FLOAT	10 %	false	
URArmy-VINNI-SB Service Requirements::5G Quality of Service (QoS)::UL Packet size	INTEGER	8 Bytes	false	
URArmy-VINNI-SB Service Requirements::Access technology	ENUM	1 (NR)	false	



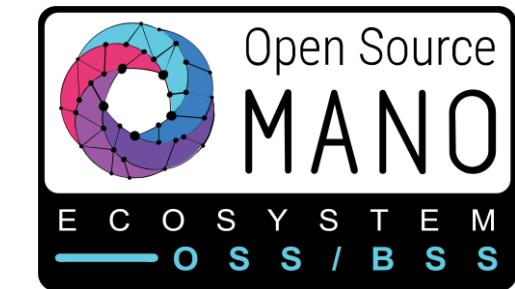
Openslice is a prototype open source, operations support system. It supports VNF/NSD onboarding to OpenSourceMANO (OSM) and NSD deployment management. It also supports TMFORUM OpenAPIs regarding Service Catalog Management, Ordering, Resource, etc.

Microservices based architecture

<http://openslice.io>

## Demo

- Openslice demo: <http://portal.openslice.io/>
- Openslice Service Catalogs and ordering:  
<http://portal.openslice.io/services/>





Use case examples  
Test case training sessions

5G VINNI

35 subscribers

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5G VINNI demo day for US visitors Service Orchestration 1:07:36

5G VINNI demo day for US visitors Defence use case 22:07

5G VINNI demo day for US visitors NSA and SA slices 23:42

Norway NSA and SA slices 21:23

Test Case 40:32

5G end-to-end experimentation: From Service Order to Network Monitoring Service Patras5G.eu 3 views • 21 hours ago

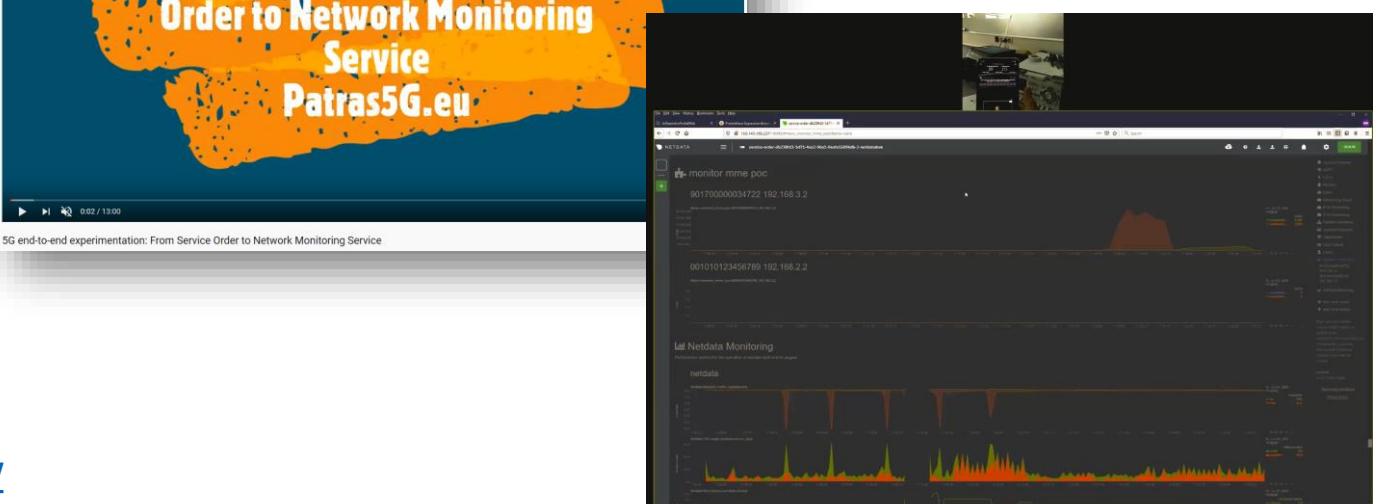
5G VINNI demo day for US visitors Service Orchestration 34 views • 1 week ago

5G VINNI demo day for US visitors Defence use case 31 views • 1 month ago

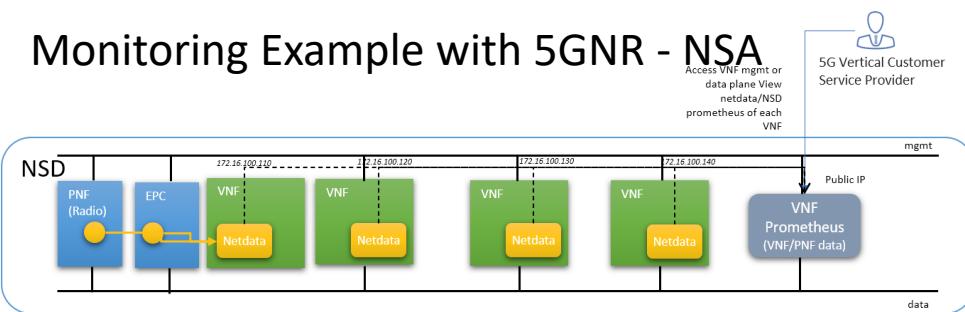
5G VINNI demo day for US visitors NSA and SA slices 25 views • 1 month ago

5G VINNI demo day for US visitors Topology and... 11 views • 1 month ago

5G-VINNI training for testing – Session 3 – Test as a... 11 views • 1 month ago



## Monitoring Example with 5GNR - NSA



<https://www.youtube.com/watch?v=X662lml0p8w>

# Challenges

- Understand the facility and offered services
  - Training sessions
- Automation of Services
  - NFV artifacts/ Service Templates
  - Orchestration
- Interconnection with APIs and Services (Commercial/Open source)
  - Standards
- Integration with new locations (NPNs)
- Definition of Service Parameters and KPIs
- 5G SA available in next months (orchestrated/shared slice support)
- Verticals expectations vs 5G System maturity (RAN, Core, UEs)
  - Orchestration and multiple slices ( research )
  - Only eMBB is available (URLLC or mMTC in future)



This project has received funding from  
the EU's Horizon 2020 research and  
innovation programme under grant  
agreement No 815279.



End-to-end  
service  
specification and  
deployment in  
5G-VINNI

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o-end exper-  
ticipal in EU

Thank you!



**Dr. Christos Tranoris** is a Senior Researcher at the Electrical and Computer Engineering department of University of Patras, Greece. He currently participates in several Horizon 2020 European projects related to 5G.