Deliverable D5.2

Business requirements and fundamentals of the 5G-VINNI Business Layer

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Abstract

This document provides a consolidation of the 5G-VINNI business layer requirements and the identification of the associated capabilities leading to the design of a conceptual system supporting business enablement. By following a comprehensive methodology for the definition of the business layer requirements based on the design-thinking approach, the following capabilities were identified as key for any such system to support meaningful system interactions: (i) User Login; (ii) Service Order Management and (iii) Knowledge Repository Management. Each of these capabilities includes a number of sub-capabilities, which are necessary for automated service ordering, provisioning and monitoring, as well as, trust build up.

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Executive summary

Mobile operators and communication service providers realize that new 5G use cases from vertical industries, such as automotive, industry 4.0, media and utilities, constitute promising opportunities for them to increase demand, capture additional value and bring extra profits. But in order to capitalize on the 5G opportunity, existing Business Support Systems/Operational Support Systems (BSS/OSS) need to be upgraded in order to support:

- massive scaling of devices, customers and end-users;
- new services, bundling products, and services with different requirements for quality of service, coverage or security;
- services customized to the customers' requirements
- zero-touch self-service models that are cost-efficient and ideally suited for short-lived services either due to their uncertain market potential or on-demand nature;
- a broad range of business models that involve a wide set of partners and variety of pricing strategies and Service Level Agreements (SLAs) for attracting any customer;
- interoperability with other business systems, either own ones or belonging to their partners.

In this report we identify the requirements and key features for this new breed of 5G backend systems, which we call "5G-VINNI business layer", and make a first attempt to provide an architecture design.

The 5G-VINNI business layer should support users from a) vertical organisations in planning, designing, executing and evaluating experiments with pre-commercial 5G infrastructures, b) third-parties willing to advertise, offer and probably bill their software and services via the platform of a facility site/communication service provider, and c) members of facility sites that are managing the platform and assist the a) and b) users in their journeys. We refer to business layer users in a) and b) as external; while users in category c) are internal.

Following a design thinking approach, where users' needs and pains are carefully examined in an interactive and iterative process, we identified an initial set of business layer requirements and then run an online survey for validating the ones focusing on external users and discovering additional ones.

In order to carefully examine the needs and pains of both internal and external users and at the same time cover all types of business processes, we decided to work with "representative users", called personae. In particular, a set of 12 internal and external personae has been selected that cover all business processes, namely plan/design, build/development, run, manage and support/process improvement. Consequently, members of the External Stakeholder Board (ESB) and representatives from ICT-19 projects were invited to provide their preferences on how they would like to interact with 5G-VINNI. Some interesting findings are the following:

- Not all respondents prefer an online, self-service mode when interacting with 5G-VINNI; less tech-savvy users consider off-line communication or face-to-face meetings as more efficient;
- Several users foresee to use more than one facility site, while some of them prefer to have a single business relationship (i.e., prefer a one-stop-shop model);
- A significant proportion of respondents think that standard slices will not be sufficient;
- Most users are positive towards and would use certified 3rd party solutions and guidance (I.e., consultancy services);
- Documentation is necessary for interacting efficiently with 5G facilities.

By performing a statistical analysis of all responses, we were able to come up with the following set of 20 business layer requirements: 1) Secure universal login, 2) Assisted customer access, 3) Global Service Catalogue, 4) Open to external suppliers, 5) Pick and choose, 6) Experiment, 7) Global coverage, 8) Homogeneous service end-to-end, 9) Automated replicability, 10) Flexible cost/revenue

sharing agreements, 11) Flexible way of SLA definition and billing, 12) Real-time resource monitoring, 13) Reporting, 14) Community, 15) License management, 16) Experiment scheduling, 17) User Device access control, 18) Open documentation, 19) Feedback mechanism and 20) Slice Control.

The comprehensive and extensive set of business layer requirements was then mapped into a set of business layer capabilities for both external and internal users. Users interact via the User Login layer and access Service Order Management and Knowledge Repository Management capabilities as required. The business layer will then interact with the Service Orchestration capabilities of the facility in order to fulfil and manage the requirements of the vertical.

The main/tier-1 capabilities can be further decomposed into secondary features as follows:

- **User Login** is supported by Role management, Profile management and Notification management;
- **Service Order management** is complemented by Service Catalogue management, License management, Service Inventory management, SLA management, Quote management, Billing management, Payment management, Experiment scheduling and User device management;
- **Knowledge repository management** is facilitated by Documentation management, Performance Monitoring, Ticket management, Reporting and Feedback management.

Finally, a high-level blueprint of the Business layer has been proposed that describes how the proposed Business Layer capabilities are organised into modules and how these interact with other 5G-VINNI facility sites and vertical customers, via east/west and northbound interfaces. While the proposed business layer is generic enough and can support any business model for Communication Service Providers and facility sites, the latter can choose the capabilities to be adopted and for which ones they will be relying on partners. Thus, two extreme cases can be distinguished:

- Each CSP/facility site has its own full stack of Business Layer and it supports both E/W interfaces (for interacting with peers) and N/S interfaces towards their customers.
- CSPs/facility sites decide to have a core stack of Business Layer and rely on other CSPs who have the full stack, or Brokers who host the rest complementary capabilities.

Selected 5G-VINNI Business Layer capabilities will be further analysed and candidate business logic will be proposed in D5.3. Furthermore, the business logic of these capabilities may be adjusted based on the needs of the different maturity levels of the 5G-VINNI facility. The sustainability of those mechanisms will be evaluated both analytically (e.g., using simulations and/or economic models) as well as quantitatively (by computing key Business and Economic Key Performance Indicators).

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Abbreviations

A list of abbreviations is strongly recommended

Abbreviation	Complete name
3GPP	3rd Generation Partnership Project
5G	Fifth Generation (mobile/cellular networks)
5GT	5G-TRANSFORMER
AAA	Authentication, Authorization and Accounting
AI	Artificial Intelligence
API	Application Programming Interface
B2B	Business-to-Business
B2C	Business-to-Customer
BA	Business Analyst
BSS	Business Support System
CAPEX	Capital Expenditures
CSP	Communication Service Provider
DC	Digital Consultant
DCF	Discounted Cash Flow
DevOps	Development and Operations
E2E	End-to-End
EBI	EastBound Interface
eMBB	enhanced Mobile BroadBand
ESB	External Stakeholder Board
eSIM	embedded Subscriber Identification Module
ICT	Information and Communication Technologies
IoT	Internet of Things
IPS	Interface Profile Specification
KAM	Key Account Manager
KPI	Key Performance Indicator
LSO	Lifecycle Service Orchestration
M2M	Machine-to-Machine
MANO	Management and Orchestration
MEF	Metro Ethernet Forum
MIoT	Massive Internet-of-Things
ML	Maturity Level
MNO	Mobile Network Operator
NF	Network Function
NFV	Network Function Virtualization
NSD	Network Service Descriptor
NSI	Network Slice Instance
NSSI	Network Slice Subnet Instance
OLA	Operational Level Agreement

OPEX	Operating Expenditures
OSM	Open Source MANO
OSS	Operational Support System
QAM	Quality Assurance Manager
QoE	Quality of Experience
QoS	Quality of Service
R&D	Research & Development
R&D	Research and Development
RAN	Radio Access Network
SA	System Architect
SC	Service Component
SD	Solution Designer
SDK	Software Development Kit
SDN	Software Defined Networking
SEL	Service Exposure Level
SLA	Service Level Agreement
SM	Service Manager
SO	Service Orchestration
SVP	Service Virtualization Platform
UC	Use Case
UCD	User-Centred Design
URLLC	Ultra-Reliable Low-Latency Communications
VAF	Virtual Application Function
VIM	Virtual Infrastructure Manager
VNF	Virtual Network Function
VNFD	Virtual Network Function Descriptor
VS	Vertical Slicer
VSB	Vertical Service Blueprint
VSD	Vertical Service Descriptor
VSI	Vertical Service Instance
WBI	WestBound Interface
xMEC	extended Mobile Edge Computing

1 Introduction and Motivation

Increased competition and limited ability to offer differentiated services has put significant pressure on Mobile Network Operators' (MNOs') and Communication Service Providers' (CSPs) profit margins during the last decade [1]. The latter realize that new 5G use cases from vertical industries such as automotive, industry 4.0, media, utilities, constitute promising opportunities for them to increase demand, capture additional value and bring extra profits. According to a recent report, 5G is expected to enable $12.3 trillion of global economic output by 2035 [2]. But in order to capitalize on the 5G opportunity, advanced 5G network infrastructures are not enough. Half of the service provider representatives that participated in a third-party survey identified legacy Business Support Systems as the highest barrier [3]. Similarly,

Traditionally, providers have had separate backend systems for different services, or even different market segments. For example, a major European operator was found to run more than 4,000 operational and business support systems [4]. Obviously, following this approach is neither cost-effective nor scalable. Providers have to make sure that their Business Support Systems/Operational Support Systems (BSS/OSS) ecosystem can support ([5], [6]):

- massive scaling of devices, customers and end-users;
- new services and bundled products customized to the different customers' requirements for quality of service, coverage or security;
- zero-touch self-service models that are cost-efficient and ideally suited for short-lived services either due to their uncertain market potential or on-demand nature;
- a broad range of business models that involve a wide set of partners and variety of pricing strategies and Service Level Agreements (SLAs) for attracting any customer;
- advanced and integrated analytics that take advantage of the vast amount of data generated (e.g., based on Artificial Intelligence - AI)
- interoperability with other business systems, either own ones (i.e., legacy) or belonging to their partners.

The new ecosystem requires radical changes to the service providers' "business layer", which in this report it is assumed to cover:

- features from traditional Business Support Systems, such as order, revenue and customer management and
- a subset of features from traditional Operational Support Systems environments that focus on the interactions with peers and partners, such as product catalogue management, inventory management and reporting.

In this report we will identify the requirements, the features and the initial design for a 5G-VINNI business layer that will support users from:

a) vertical organisations in planning, designing, executing and evaluating experiments with pre-commercial 5G infrastructures,
b) third-parties willing to advertise, offer and probably bill their software and services via the platform of a facility site/communication service provider, and
c) members of facility sites that are managing the platform and assist the a) and b) users in their journeys.

In the following, we refer to business layer users in a) and b) as "external", while users in category c) are the "internal" ones.

Low-level services, such as those performed by Management and Orchestration systems (MANO) when translating orders to network elements, while key ingredients of 5G systems are out of this report's scope.

While the focus is on pre-commercial facility sites, we believe that user requirements will be similar for the actual delivery of services in a commercial 5G setting. For this reason, we have identified several Maturity Levels (ML) of the 5G-VINNI facility capturing its evolution over the lifetime of the project. We foresee that the operation of the facility during the project will significantly differ from the one after the project's completion, considering also the long-term vision of 5G-VINNI facility experimentation as a service. These MLs are described below and in Figure 1:

- ML1 focuses on running conformance tests for validating technical Key Performance Indicators (KPIs).
- ML2 refers to a mature facility that will allow a restricted set of vertical "customers" to integrate their applications and run stress tests in order to assess the technical merits and feasibility of innovative use-cases.
- ML3 refers to the same facility as in ML2 but for a 1-year period after the contracted duration of 5G-VINNI. In order to guarantee its sustainability, vertical organisations will have to compensate 5G-VINNI members for any additional capital or operational expenses incurred. Accordingly, we expect that some business-level experiments will be performed during this phase.
- ML4 captures the long-term vision for 5G-VINNI experimentation as a service toward vertical customers. This could involve individual 5G-VINNI facility sites, multiple 5G-VINNI facility sites or even interworking with other external facilities. This will imply broadening the European footprint and governance structure. Experimenters, such as vertical customers and vertical application providers, are asked to pay competitive prices for using the infrastructure to get valuable feedback, considering various levels of public funding and support.

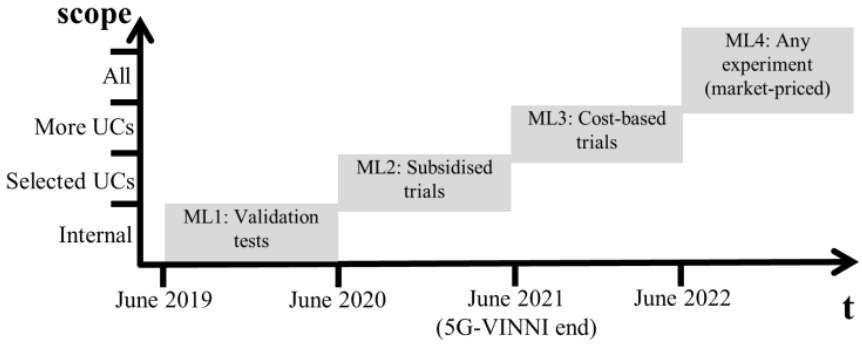

Figure 1: The 5G-VINNI maturity levels and expected use-case (UC) scope (from [9])

1.1 Objectives of this document

The objectives of the document are as follows:

- Identify the 5G-VINNI Business Layer requirements from ICT-19 projects[1] and vertical industries point of view (external users), as well as, from communication service providers and network operators (internal users)
- Explore which Business Layer requirements spanning across multiple administrative domains can be addressed by current business support systems;

[1] The projects funded under H2020-ICT-2018-20 call for proposals titled "Advanced 5G validation trials across multiple vertical industries" which can be found online at https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/ict-19-2019.

- Specify 5G-VINNI Business Layer capabilities and business mechanisms to enable cross-administrative domain interworking and automated E2E management of the deployed vertical services;
- Provide an initial design of the 5G-VINNI Business Layer for the different maturity levels of 5G-VINNI, starting from its early basic version for supporting the ICT-19 projects all way through the ultimate maturity level of the 5G-VINNI facility offering commercial experimentation services.

1.2 Methodological approach

This section aims at describing the followed methodology for the definition of the 5G-VINNI business layer requirements, the identification of the associated capabilities and eventually to the design of the relevant conceptual system.

Products or services should be developed by starting from a challenge, captured as a perceived need. Transforming this need into a solution that can successfully satisfy the real need requires an appropriate design process. This is called “inclusive design process”. As defined in [7], it can include the follow steps:

1. **Discover**: The systematic exploration of the perceived needs to ensure the right design is addressed, with due consideration of all stakeholders and with the understanding of their real needs;
2. **Translate**: The conversion of this understanding into a categorised, complete and well-defined description of the design intent, represents the requirements specification.
3. **Create:** The creation of prototypes that are evaluated against the requirements brings to the concepts.
4. **Develop**: The detailed design of the final product or service, ready to be manufactured or implemented implements the solutions.

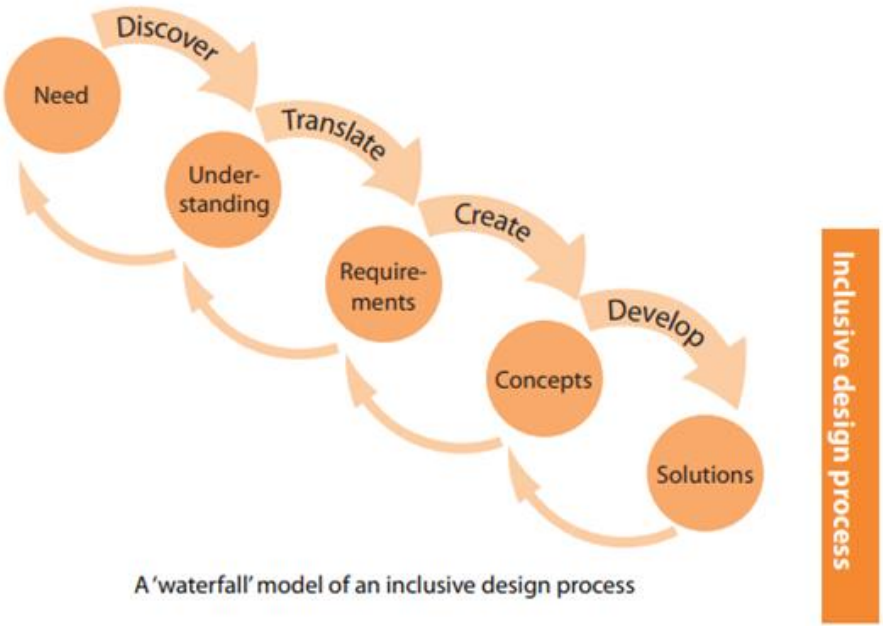

Figure 2: The system lifecycle representation following the inclusive design process

In the inclusive design process the interaction with stakeholders and the continuous refinements according to their feedback are the foundation. These continuous interactions and refinements are the cornerstone of the “design thinking” approach as well, that appears in the figure below. What is important is that while qualitative and quantitative research can result in identifying a broad set of customers’ pain points during the “discover” phase, a refinement takes place in the “define” phase

that reduces the space of candidate user requirements. As soon as the team of analysts converge on the main needs, they start brainstorming on a wide spectrum of solutions that could be employed for addressing the core pain points. Eventually a subset of those ideas is turned into prototypes where users are asked to evaluate. Their feedback can trigger a new "double diamond" design process, which can be repeated several times.

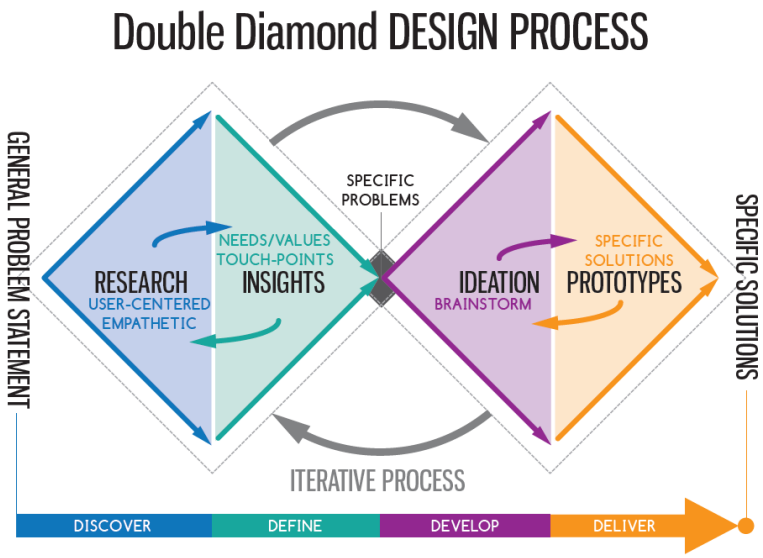

Figure 3: The system lifecycle representation following a design-thinking approach (from [8])

The main objective of this deliverable is to discover and define the requirements and conceptual architecture of the 5G-VINNI "business layer". Thus, it focuses on the first diamond of the "design thinking" approach, or equivalently to the top three steps of the "inclusive design process". Exploring different candidate implementation options for each business layer capability and delivering the most appropriate solution is out of the scope of this report. For example, we identify the need for verticals users to form communities where knowledge can be exchanged, such as online forums, but we neither compile a full list of candidate options, nor propose or will develop the most compelling solution. Nevertheless, D5.3 will propose novel approaches for a subset of those business layer capabilities, while WP3 will implement a 5G-VINNI service portal that can be seen as a "lightweight" business layer.

1.2.1 User needs discovery and definition

Following a design thinking approach for the requirement identification requires to put the users and his needs and pains at the centre. At the same time, it requires to manage interactive improvement cycles and engage an interdisciplinary teamwork.

In order to consider as many user groups as possible we decided to work with "representative users", called personae, for both vertical customers ("external" users) and facility site representatives ("internal" users). These personae were selected based on a taxonomy of Information and Communication Technology (ICT) role profiles, covering all types of business processes. The selection process followed for external and internal users is documented in Annex B.

After identifying all key "internal" (5G-VINNI members) and "external" personae (complementors and vertical enterprises), we interviewed instances of these personae and provided a description (together with pain points) following the template that is detailed in the next subsection. In particular, instances of internal personae were selected from the facility site owners, while consortium members with experiences in other 5G projects targeting specific vertical domains, interviewed vertical industry representatives. These interactions, together with the pain points of

vertical customers that were identified in D5.1 [9], resulted in a set of initial business layer requirements.

In order to expand the set of vertical domains covered and involve more individuals by following an interactive process, as suggested by the design thinking approach, we run an online survey. Members of the External Stakeholder Board (ESB) and representatives from ICT-19 projects were invited to participate in this survey and provide their preferences on how they would like to interact with 5G-VINNI during the planning, setup, run and analysis phases of their experiments. Details about the online survey targeting external users can be found in Annex A. By performing a statistical analysis of these responses, we were able to assess the importance of the initial set of business layer requirements, as well as, to identify new ones.

1.2.2 Business Layer capabilities and design

The business layer requirements that were identified were then mapped into business layer capabilities for external and internal users. These capabilities were grouped into 3 tier-1 features, while several secondary features were identified, as well.

Finally, a high-level blueprint of the Business layer has been proposed that describes how the proposed Business Layer capabilities are organised into modules and how these interact with other 5G-VINNI facility sites and vertical customers, via east/west and northbound interfaces.

1.3 Relationships with other Deliverables

Selected 5G-VINNI Business Layer capabilities will be further analysed and candidate business logic will be proposed in D5.3. Furthermore, the business logic of these capabilities may be adjusted based on the needs of the different maturity levels of the 5G-VINNI E2E facility. The sustainability of those mechanisms will be evaluated both analytically (e.g., using simulations and/or economic models) as well as quantitatively (by computing key Business and Economic Key Performance Indicators).

The design of the business layer outlined in section 5.2 of this document is related to similar work on end-to-end service catalogues and how they are addressed by portal solutions described in D3.3 (Publication of Service Catalogues for End-to-end Services) [10]. This in turn builds upon work currently being addressed in 5G-VINNI Research Item R01 (End-to-end LSO, Open APIs and Exposure).

The design of the 5G-VINNI Business Layer will also affect the overall design of 5G-VINNI architecture (to be documented in D1.4).

1.4 Document outline

Section 2 provides a State-of-the-Art and gap analysis of existing Business Layers. Section 3 provides detailed descriptions of the key internal and external personae, while Section 4 lists the 5G-VINNI Business Layer requirements identified. Section 5 documents the proposed 5G-VINNI Business Layer capabilities and high-level design and conclude this report with our findings and recommendation in Section 6.

2 Business Layer State of the Art and gap analysis

2.1 Overview of existing Business Layer systems

In this section existing Business Layer systems, proposed either by researchers or industry fora, are analysed focusing on the capabilities offered.

2.1.1 TMForum Open APIs

The TMForum Application Programming Interfaces (APIs)[2] can be grouped into a set of eight (business) domains, as shown in the figure below:

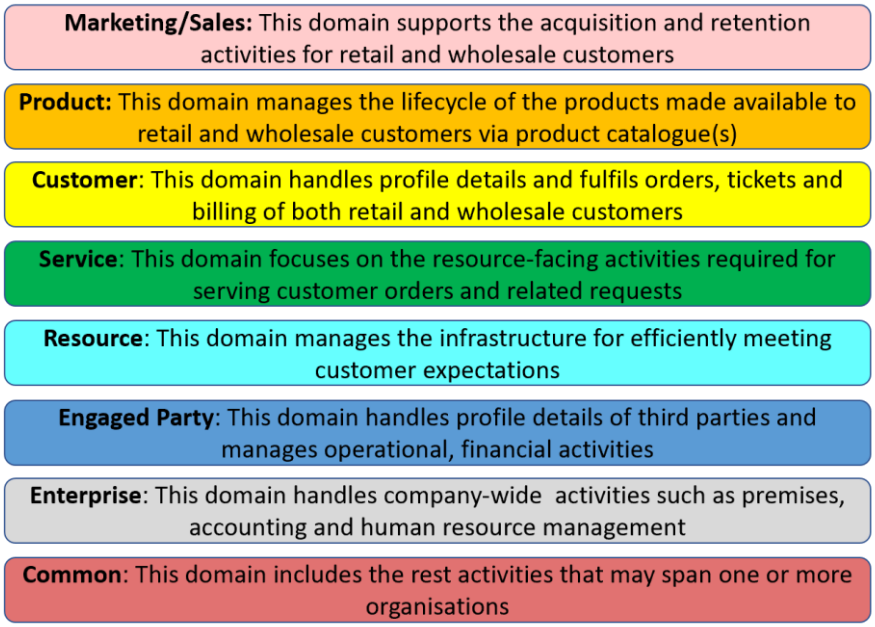

Figure 4: The eight business domains of TM Forum Open APIs (elaborated by 5G-VINNI members based on [11])

The existing and very diverse set of APIs, including the deprecated ones, in each domain appear in the following figure. Note that a certain API may be relevant for several business processes and thus appear more than once. A detailed description of the APIs can be found in Annex C.

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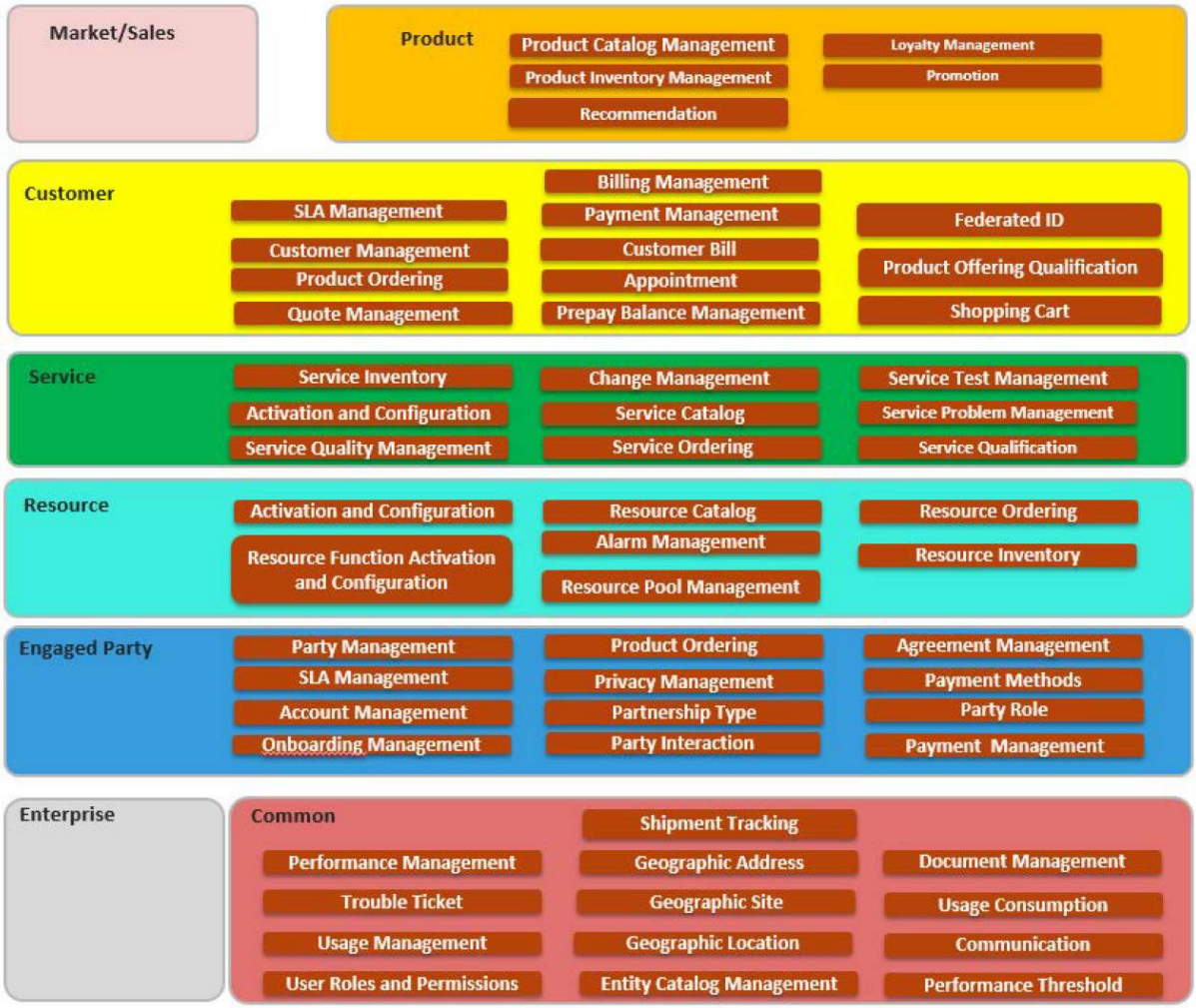

Figure 5: The TM Forum Open APIs per business domain

2.1.2 MEF LSO

Figure 6 demonstrates the reference architecture of Metro Ethernet Forum (MEF) Lifecycle Service Orchestration (LSO). The MEF LSO Reference architecture (MEF55) [12] defines the functional management and control elements required for enabling the LSO capabilities. In addition, the interactions of these elements located on the same or different administrative domain is enabled by well-defined Management Interface Reference Points implemented by certain APIs.

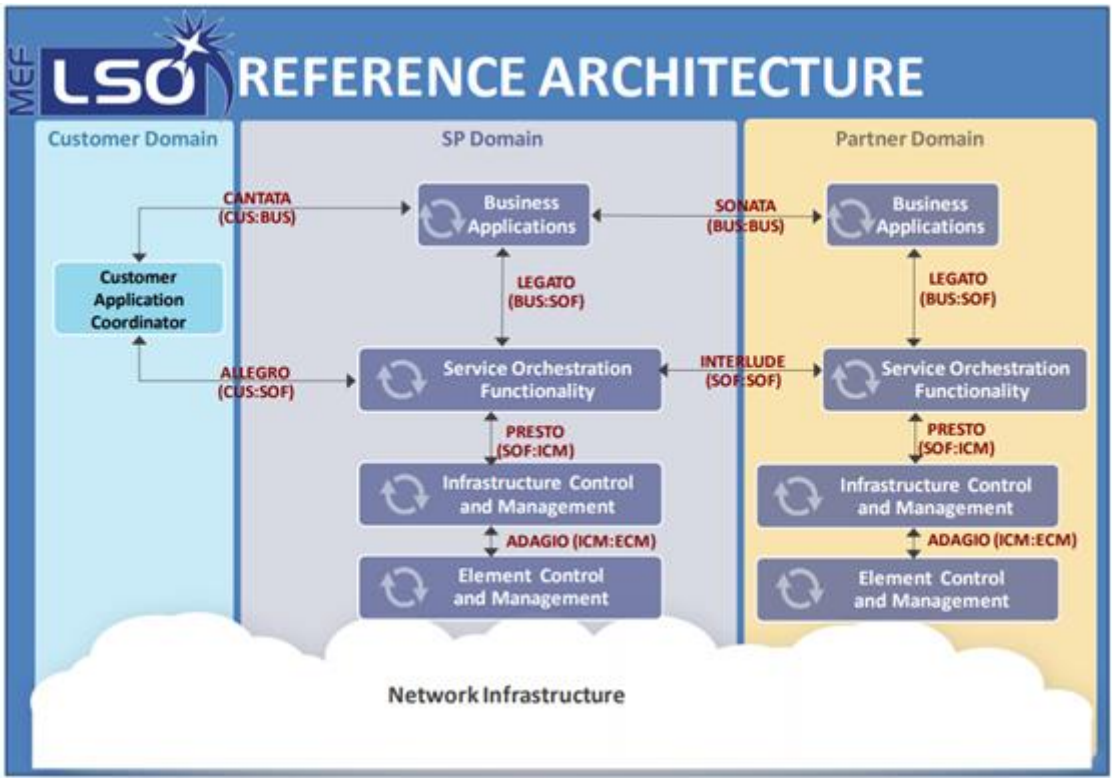

Figure 6: MEF LSO Reference architecture (MEF55) [12]

In this section, we only focus on the description of the Functional Management Entities and Management Interface Reference Points that are related to what we envision as a 5G-VINNI business layer.

- The **Customer Application Coordinator** is a functional management entity in the Customer's domain that is responsible for the management of the service needs of the offered applications with respect to computation, storage, network, etc. Usually, the Customer Application Coordinator is responsible for managing of services related to multiple applications. This entity is responsible for the communication with Service Provider in order to request, modify, manage, control, and terminate Products or Services.
- The **Business Applications** entity gives Service Provider the capability to support Business Management Layer functionality such as product catalogue, order, billing, customer relationship management, etc. The Business Application element communicates with the Customer Application Coordinator element of different customers and the Business Applications element of Partner Service Providers. Finally, internally to a Service Provider, the Business Application element exchanges information with the Service Orchestration Functionality in order to translate the business-level logic/product view into service-level logic/service view.

The Management Interface Reference Points that are utilized to facilitate the communication of the aforementioned entities are CANTANTA (CUS:BUS) and SONATA (BUS:BUS). These are described below.

2.1.2.1 SONATA

SONATA supports the management and operations interactions such as serviceability, ordering, billing, trouble ticketing, etc., between two network providers (e.g., Service Provider Domain and Partner Domain). In other words, LSO SONATA supports non-control cross domain interactions between the Service Provider's *Business Applications* and the Partner's *Business Applications.* SONATA connects between the BSS functions of the Service Provider domain and the Partner domain respectively and connects 'East-West' in parallel to INTERLUDE. Some high-level interaction example of the SONATA Management Interface Reference Point are:

- Service Provider browses the Partner's Product Catalogue (e.g. wholesale catalogue) for Product Offerings that are available for the Service Provider to select. This may include some geographical and service information to support availability queries of a Product Offering in a specific geographical area.
- Service Provider develops (based on Product Offerings), places, tracks, and changes Product Orders with the Partner.
- Service Provider requests modification of Product Instances.
- Service Provider receives Product Instance performance and fault information provided by the Partner.
- Service Provider receives information from the Partner about the scheduled maintenance that may impact their Product Instances.
- Service Provider places and tracks trouble reports.
- Service Provider exchanges usage and billing information.

MEF has released the LSO SONATA Software Development Kit (SDK), which so far includes API definitions for the following functional areas:

- **Serviceability -** API definitions that allow the Buyer (Service Provider or Customer) to:
    - Retrieve address information, such as street, postcode, county, etc and validate that an address description corresponds to a geographical address know to the seller;
    - Retrieve service site information for a certain location, such as identifier, description, name, contact person, etc., from the seller;
    - Determine whether it is feasible for the Seller to deliver a particular Product with a given configuration to a particular geographic location;
- **Product Quote** - API definitions for inter-carrier service quotation capability;
- **Product Order** - API definitions for inter-carrier service ordering capability;
- **Product Inventory** - API definitions necessary for inter-carrier retrieval of Product Inventory Management.

Some additional APIs that are currently under development and will be included in SONATA SDK are the following:

- Trouble-ticketing for managing customer relationships
- Billing
- Contract
- SLA Reporting
- Invoicing

2.1.2.2 CANTATA

CANTATA provides a *Customer Application Coordinator* (including enterprise Customers) with the capability to support interactions such as serviceability, ordering, billing, trouble ticketing, etc., with the Service Provider's *Business Applications* for a portion of the Service Provider service capabilities related to the Customer's products and services. This Management Interface Reference Point

consists of multiple Interface Profile Specifications (IPSs) that are currently under active collaborative development by MEF members. Each IPS will define the use cases and business requirements that will lead to the definition, modelling and development of one or more APIs. Some high-level interaction example of the CANTATA Management Interface Reference Point are:

- *Customer Application Coordinator* browses the Product Catalogue for Product Offerings that are available for the Customer to select.
- Based on Product Offerings, *Customer Application Coordinator* develops, places, tracks, and changes Product Orders.
- *Customer Application Coordinator* requests modification of Product Instances.
- *Customer Application Coordinator* receives information about the scheduled maintenance that may impact their Product Instances.
- *Customer Application Coordinator* places and tracks trouble reports.
- *Customer Application Coordinator* queries and views usage and billing information.

CANTATA APIs definition has not been kicked off yet, however the functional areas that will be covered are the same as the one described in the previous paragraph (i.e., Serviceability, Product Quote, Product Order and Product Inventory).

2.1.3 5GEx Business Layer

The 5GEx project has introduced the notion of business layer in its architecture, which is anticipated as the set of components and interfaces that enables the BSS-like functionality of the 5GEx architecture [13]. This business layer captures the business interactions both towards vertical customers but also among all the interconnected operators/members of a 5GEx community. In particular, 5GEx defines the set of interfaces I1 (Business-to-Customer/B2C) and I2 (Business-to-Business/B2B) for the interactions with vertical customers and other operators respectively as shown in Figure 7. These initially technical-oriented interfaces have been augmented to support the business layer capabilities.

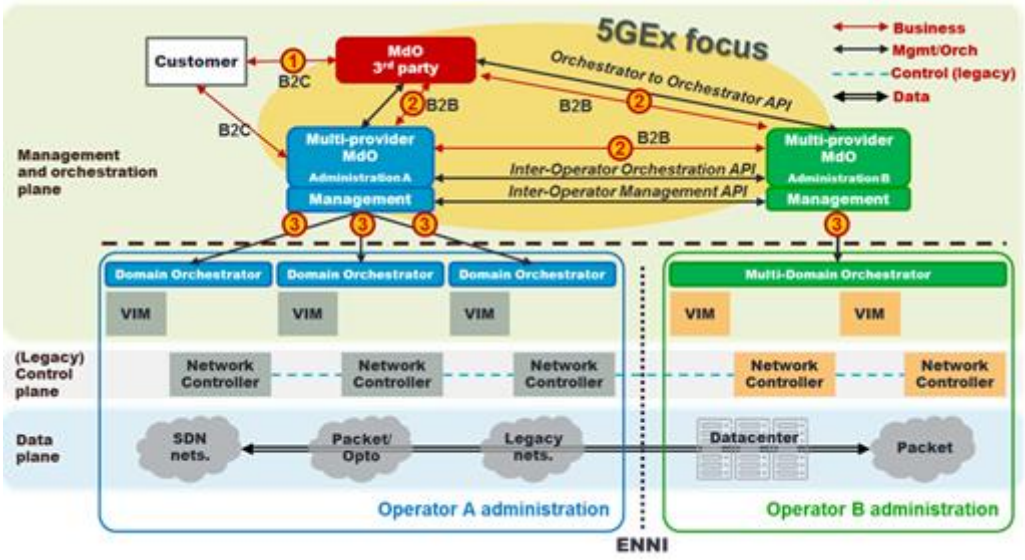

Figure 7: 5GEx Reference architecture ([14])

The identified functional blocks of the 5GEx business layer consist the “business logic capabilities” required for the 5GEx multi-provider setup:

- *Service Catalogue.* This component maintains the multi-domain service offerings that a Provider makes available to the vertical customers.

- *Order Manager*. This component is responsible for managing the orders for multi-provider 5GEx services coming from the customer.
- *Service SLA Manager.* The Service SLA manager will be in charge of storing all the SLAs for each of the services (SLA aggregation for multi-provider cases) and based on SLA evaluation will be able to reward customers (e.g. offer discounts) in case of SLA breaches.
- *Billing and Charging.* This component is responsible for performing the pricing and keep tracks of usage of 5GEx (bundles of) services for billing purposes.
- *Offers and Requests Manager.* This component is responsible for managing quotes for multi-provider 5GEx services. This component is vital for the creation on multi-domain services, since it enables the business coordination among multiple Providers. In particular, it is responsible for the dissemination of offers and requests, by following the coordination model determined by the *Business Policy Manager.* This component aims at generating meaningful multi-domain service offering that will be pushed to the *Service Catalogue*.
- *Business Policy Manager.* This component is responsible for determining / enforcing the coordination model for information dissemination by the *Offers and Requests Manager*. Furthermore, it is responsible for maintaining and enforcing 5GEx community policies such as revenue sharing mechanisms. 5GEx-wide policies are stored and enforced here, also in line with individual provider BSS policies e.g. for resource/service contribution.
- *Multi-*Customer Relationship Manager.* This component is the extended CRM functionality needed for multi-provider services due to the increased complexity and ambiguity in terms of customer ownership, service ticketing, management, fulfilment, and recovery.
- *Negotiations and Auctions Manager (not mandatory).* This is where novel economic mechanisms and frameworks, such as auctions and negotiations are managed.

Apart from the business logic capabilities mentioned above, additional capabilities are also required for the proper operation of the business layer:

- “Network slice management capabilities”, to allow management and control of slices by the vertical customer.
- “Service logic capabilities”, to complete the service configuration as complement to the multi-domain orchestration.

Regarding “business logic capabilities” and the attributes required for ordering and billing, 5GEx considers as basis for further investigation the approach of MEF LSO SONATA interface ([15]). On the other hand, the “network slice management capabilities” are enabled by adopting the network slice management functions defined by 3rd Generation Partnership Project (3GPP) ([16]).

2.1.4 5G-TRANSFORMER

The EU-funded project 5G-TRANSFORMER has defined an architecture for allowing vertical services to be onboarded. The 5G-TRANSFORMER (5GT) system to be developed will be interacting with vertical representatives via the Vertical Slicer (5GT-VS) component. The following figure provides a high-level overview of the northbound interfaces exposed; the "Ve-Vs" (an external interface between a vertical and the 5GT-VS) and the "Mgt-Vs" (an internal interface between the OSS/BSS of the provider and the 5GT-VS).

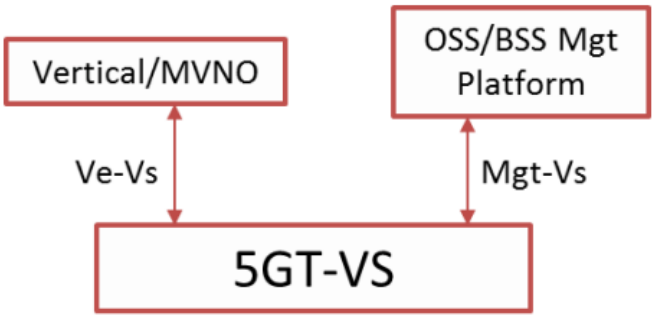

Figure 8: A high-level overview of the northbound interfaces exposed by 5G TRANSFORMER

In particular:

- "Ve-Vs" provides the mechanisms to allow the verticals to:
  - define vertical services by selecting a Vertical Service Blueprint (VSB) from a catalogue and fill in all the necessary details of the vertical service in order to generate a Vertical Service Descriptor (VSD);
  - manage own VSDs (e.g., retrieve own or public VSDs, update and delete own ones);
  - instantiate a VSD into one or more Vertical Service Instances (VSIs) by hiding the complexity and details of service orchestration;
  - manage VSIs, like terminate and modify their resources or budget;
  - monitor performance in terms of KPIs and subscribe/unsubscribe from notification to important events of VSIs (such as failures, automated scale-ups, etc.).
- "Mgt-Vs" provides primitives to administrators to:
  - Create, query and delete tenants.
  - Create, query, modify and delete SLAs.
  - Create, query and delete VSBs.

Note that third-party suppliers (complementors) are not considered as users of the 5G-TRANSFORMER system (i.e., the Ve-Vs interface). Furthermore, management of tenants and SLAs is done by system administrators.

The 5G-TRANSFORMER Service Orchestrator (5GT-SO), that is part of 5GT-VS, provides the interface to another external 5G-TRANSFORMER system. Therefore, the eastbound/westbound interface (EBI/WBI) of the 5GT-SO is as well the EBI/WBI of the 5G-TRANSFORMER system.

The 5G-TRANSFORMER system supports interactions with other external systems via the following six interfaces:

- So-So(-Life Cycle Management),
- So-So(-MONitoring),
- So-So(-Catalogue),

- So-So(-Resource Management),
- So-So(-Resource Monitoring Management), and
- So-So(-Resource Advertising Management)

Note that 5G-TRANSFORMER assumes already established business level between different administrative domains. In other words, the 5GT-SO is the only component providing East-West interfaces (EBI/WBI) to another external 5G-TRANSFORMER system; the related interfaces of 5GT-VS and OSS/BSS are out of scope.

2.1.5 5G-MEDIA

5G-MEDIA aims at innovating media-related applications by investigating how these applications and the underlying 5G network should be coupled and interwork to the benefit of both. In this perspective, 5G-MEDIA project is building an integrated programmable service platform to facilitate the design, development and deployment of media services over 5G infrastructures. The logical architecture description of the 5G-MEDIA platform is shown in Figure 9 below, giving a high view of the main parts of the system.

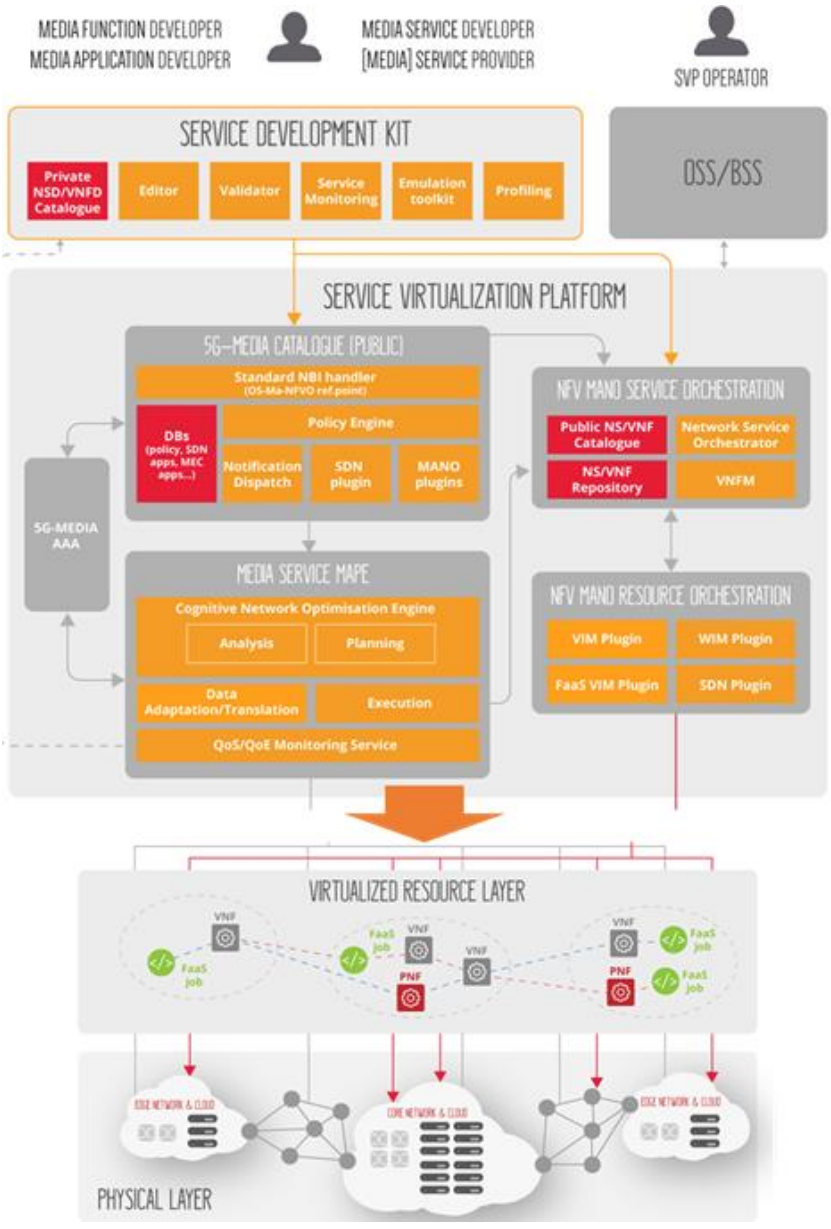

Figure 9: The logical architecture description of the 5G-MEDIA platform

In a top-down perspective, the architecture defines three layers of operations: the DevOps layer, the Service Virtualization Platform (SVP) layer and the physical layer.

For the scope of 5G-VINNI business layer definition, the 5G-MEDIA layer of interest is the first one, but also some components like 5G MEDIA Authentication, Authorization and Accounting (AAA) and 5G MEDIA catalogue part of the SVP layer lay the foundation for business functionalities.

Consequently, some common business layer capabilities have been identified, even though these are seen as outside of OSS/BSS (not developed in 5G-MEDIA project) and they represent in any case the foundation for providing services like User authentication, authorization, catalogue access and management, billing and payment management.

2.1.6 NRG5

Within NRG-5, the 5G communication networks has been considered as a fundamental communication infrastructure for meeting the huge emerging challenges in the smart energy domain, both in functional directions (i.e. stability, resiliency and highly availability) and in non-functional directions (i.e. sustainability, security, privacy and Capital/ Operating Expenditures or CAPEX/OPEX). From a financial point of view, an important requirement to forge technology adoption is to allow seamless reuse of the already existing hardware and network infrastructure. Virtualization concepts for IT and energy equipment has been adopted, allowing software & functional upgrades with developments and features to be deployed, saving time and operating costs. NRG-5 pursues a modular architecture orchestrated by a Software Defined Networking/Network Function Virtualization SDN/NFV framework according to the 5GPPP architectural model. Figure 10 shows the high-level architecture of NRG-5.

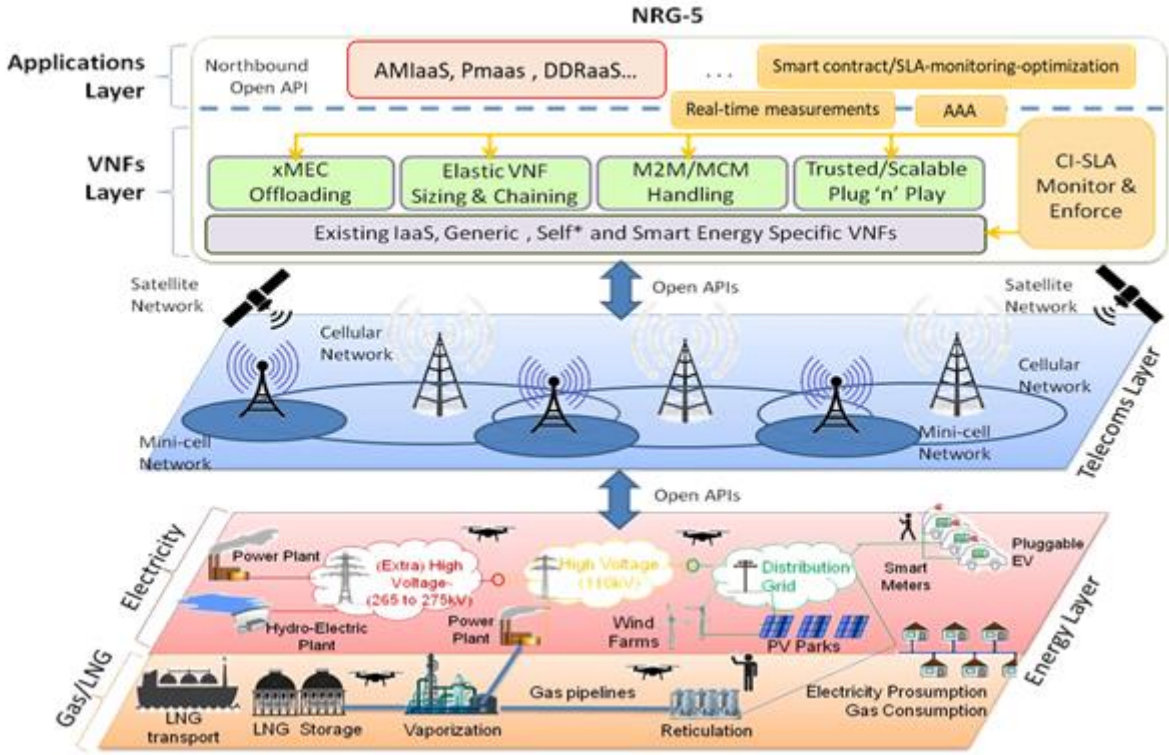

Figure 10: NRG-5 high-level architecture

According this architecture, at the lower level there is the smart energy (electricity & gas) layer, composed of varying energy infrastructure assets. Then there is the telecommunications network layer, compiled of cellular and mini-cells, Internet-of-Things (IoT) and satellite communications. The NRG-5 framework is positioned over the energy and telecommunications layers. The higher layer,

NRG-5 introduces mechanisms for extended Mobile Edge Computing (xMEC) offloading, elastic Virtual Network Function (VNF) sizing and chaining, Machine-to-Machine (M2M) communications and trusted/scalable Plug 'n' Play. These activities are coordinated and supervised by a Critical Infrastructures Service Level Agreement mechanism, which is a monitoring and enforcement entity, such as Open Source MANO (OSM). As proof of concept, NRG-5 considers many novel utility functions offered following the "X as a Service" approach, separated by an Open Northbound API (NBI).

For the scope of 5G-VINNI business layer definition, the NRG5 layer of interest for identify requirements is the highest one. Some of the more relevant functionalities considered are the Real-time measurements, Authorization & Authentication and Smart contracting and SLA-monitoring and optimization loop.

2.1.7 SLICENET

SliceNet works on End-to-End Cognitive Network Slicing and Slice Management in Virtualised Multi-Domain, Multi-Tenant 5G Networks. One of the main innovations is the introduction of the so called "One-Stop API" which is illustrated at the top of Figure 11.

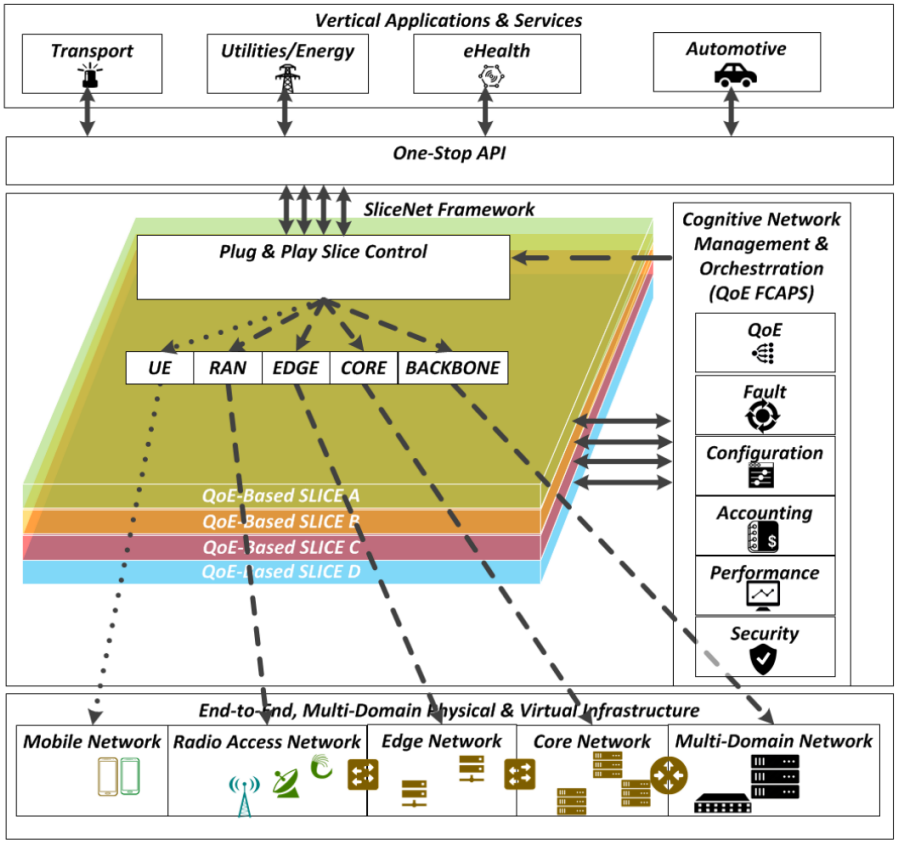

Figure 11: Conceptual view of SliceNet

The concept is considering the needs of the different roles that are identified in the 5G Architecture white paper [17] and that is aligned with the 3GPP role model described in TR28.801 [18].

2.1.7.1 One Stop API

The One-Stop API is conceived as the main entry point of the slicing framework. It is the enabler for the engagement of verticals into slice design and provisioning, and it reflects the overall outcome of the multi-domain slicing concept as this is tailored to the requirements for the support of "Verticals-in-the-loop" concept.

The diversity of functional, performance and security requirements that may relate with a vertical, necessitates the support of a level of abstraction offered through the One-Stop API. The abstraction aims at enabling verticals express accurately the particular communication/service/application requests that are considered important for the delivery of the end-to-end functionality. The abstraction builds on top of a layered view of the architecture in terms of services utilising Network Slice Instances (NSIs), the contained Network Slice Subnet Instances (NSSIs) and subsequently of the Network Functions (NFs) that are required for the provision of each NSSI, with this layering spanning across domains. The overall view exposed via the One-Stop API aggregates the NSI/NSSI/NF offerings as a pool of selectable features that can be identified into a service creation request. These selectable features are expected to be offered in a way that allows verticals easily identify those aspects that are dictated by the expected requirements from the slice-based service.

As there might be interdependencies and even conflicts among features, aggregation concepts should apply on the basis of identified slice templates/blueprints. For example, a vertical may define a specific service/application characteristic as a quite high-level requirement. In case the vertical does not require to deal with the fine grained details about how this service requirement is decomposed in terms of interconnections and fine tuning among underlying components (e.g., among NSI/NSSI/NF, or the programmable data path), the One-Stop API should allow the selection of the service/application characteristic without requiring from the vertical to intervene - if not requested - with the underlying details. On the other hand, if there is need for fine tuning of the underlying interdependencies, this should be also possible in the context of the authorisation and the privileges with which a One-Stop API user is related.

Depending on the vertical role and apart from the fine tuning of a template/blueprint instantiation details, the option for building a new template from scratch should be also enabled through the One-Stop API. Optionally, new templates might be shareable so that these can be requested by other stakeholders. Having the service requirements identified by verticals, either from a high-level perspective or via a more fine-grained approach, the One-Stop API should decompose those requirements in the form of a set of service provisioning workflows as defined by the involved slice provisioning templates.

Embracing inter-domain plug and play options and the fact the SliceNet platform requires multiple entries - at least one per administrative domain - the One Stop API should cater for both vertical and horizontal management. The vertical management is mainly intended for the use by application and use case verticals for the selection of offered services, whereas the horizontal management space is intended for administrative roles that should be offered the possibility to provide service definitions based on the clearly defined inter-domain ecosystem as this is projected in terms of available intra and inter domain slice offerings.

2.1.7.2 Requirements on the One-Stop API

The transactions between a Network Service Provider (NSP) a Digital Service Provider (DSP) and a vertical company serve a single purpose: the provision of end to end communication services leveraging all the aspects of emerging technologies. Considering this fact, SliceNet proposes a common approach for the support of all the interactions via different projections of the information accessible at each point based on the role of the entity that consumes or influences the information. This translates into the definition of the concept of the One Stop API (OSA) as an approach that allows the creation of an ecosystem with easy participation of various players in the context of the business objective of the related role. For a thorough understanding of the concept, the study of further SliceNet deliverables is advised. In particular vertical sector requirements are captured in [19], architecture and interfaces are defined in [20], system definitions and interfaces for control plane [21] and management plane [22] are provided in the related documents.

Starting from bottom to top the following OSA transactions/projections are foreseen per role:

- Network Service Provider (NSP)
  - actuation descriptors onboarding
  - monitoring descriptors onboarding
  - resource types registration associated with actuation and monitoring descriptors
  - identification of resource types availabilities
  - onboarding of policy-based rules with dependencies on actuation and monitoring descriptors
  - coverage (location) support
  - resources are listed based on type and capabilities
- Digital Service Provider (DSP)
  - observes technology agnostic information of descriptors
  - identifies monitoring and actuation capabilities offered by NSPs
  - is able to select service Level Agreement related automation rules
  - is able to indicate which of the monitoring and actuation options should be activated per slice type
  - enhances management of underlying NSP supported monitoring and actuation options by crafting and registration of Quality of Experience, Cognition, and Plug & Play service aspects
  - registration of slice templates with dependencies on Quality of Experience, Cognition, and Plug and Play service aspects
  - slice templates are listed based on service tailored aspects and underlying dependencies including location support per aspect
  - slice templates are annotated with service features
- Vertical
  - observes slice templates through service features
  - selects service features to be activated
  - gets access to slice specific actuations and slice monitoring as exposed via Plug & Play functions

Vertical requests trigger the provision of the slice through a multi-level orchestration process. Along the instantiation of the artifacts at each level to support the deployment and operation of the slice, the descriptors are instantiated on the basis of the resolution of the provisioning details to form an inventory distributed across the involved domains. Inventory entries created shall be sufficient to allow management modules per domain to align with the required support for monitoring, actuation, cognition and Quality of Experience processing as well as enable verticals to plug their own control logics and specialize their slices according to their needs via the Plug & Play approach.

2.2 Gap analysis of existing Business Layer solutions

The following figure gives an overview of the most popular business-layer features proposed/ supported by the seven industry fora and research project consortia. We observe that customer relationship management (e.g., user login and ticket management) together with SLA management are identified as key by all initiatives surveyed.

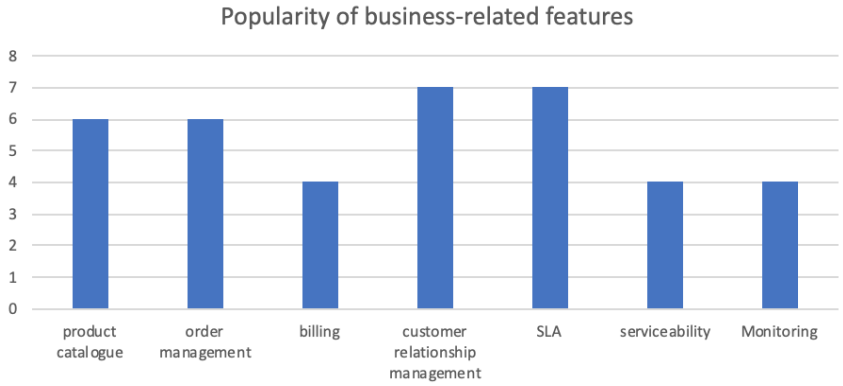

Figure 12: Most popular business-layer features

Interestingly, one of the major threats that have been identified during the SWOT analysis of 5G-VINNI, was the lack of trust and collaboration between an operator and vertical customers, third-party software suppliers or other complementors [9].

When it comes to the relationship between a vertical customer and its provider(s), we believe that innovative SLAs tailored to the requirements and "5G literacy" of customers need to be defined for commercial 5G services to be widely adopted (i.e., for 5G-VINNI ML4 and beyond). For example, most vertical customers, or their consultants, cannot safely estimate the performance requirements of the digital services they are interested in. Thus, these vertical customers are less likely to ask for an SLA that specifies maximum throughput of an enhanced Mobile BroadBand (eMBB) slice, or the nominal minimum delay of an Ultra-Reliable Low-Latency Communications (URLLC) slice. And even if they attempt this, chances are that they will miss-choose SLA terms and receive a pricey quote that renders the 5G service unattractive business-wise. Less tech-savvy vertical customers would prefer to specify SLA terms based on the minimum number of customers that can be successfully served, or the minimum number of concurrent events completed. This, of course, places the risk on the communication service providers to correctly determine the requirements of different types of services. Nevertheless, CSPs have the advantage of more experience and better information compared to their customers due to the information collected and advanced systems that can predict requirements using Artificial Intelligence techniques and/or scale resources on demand to meet SLAs. Facility sites such as 5G-VINNI can help both providers/facility sites and customers in this process. In particular, SLAs in the first 5G-VINNI maturity levels, where 5G services are not commercially priced (i.e., ML2 and ML3), can be used for both providers and customers to get familiar with 5G service performance under different SLA terms (along with different configurations, different underlying network conditions, etc). Then, customer-friendly SLAs can be offered in ML4, e.g., those proposed by 5G-VINNI, so that all customers feel comfortable enough with the performance levels promised by communication service providers and facility site providers.

Apart from SLAs, vertical customers need to be able to monitor service performance and compare the values of the KPIs for the service obtained with the relevant performance promised. This is important for establishing trust that SLA breaches are taken into account in the billing process, as well as, for allowing vertical customers to act in case network performance deteriorates (e.g., inform users, perform load balancing, etc).

Due to the multi-provider 5G service provisioning SLAs and monitoring capabilities will be needed between communication service providers, as well as, between a CSP and its network operator(s). While new forms of inter-provider SLAs are not mandatory, monitoring and accounting will still be important. Furthermore, even though the consortium agreement and the management plan can ensure collaboration among the 5G-VINNI members in the short term (i.e. during the project lifetime or Maturity Level 2), things can become more complicated as facility sites charge vertical customers for doing experiments. This is especially true for experiments spanning across several facility sites, where involved entities need to agree on a viable and fair way to share costs in case of Maturity Level 3, or revenues in Maturity Level 4 (as described in Figure 1). For this reason, we expect that the business models to be proposed, together with federation mechanisms defined, will result in "all-win" scenarios and thus contribute to smooth collaboration amongst the involved actors in 5G-VINNI. On the technical side of this wholesale collaboration, integrated product catalogues and online order management will be key. These features were found to be very popular ones in the desk research we performed, as can be seen in the figure above.

3 Personae Profiles

This section documents the description of each relevant internal and external persona according to a well-defined template, together with their needs and pains collected.

3.1 Personae profiles and scenarios

The aim of this section is to give an overview about the methodologies used for identifying and describing the 5G-VINNI business layer requirements.

The activities executed in this phase by project partners were carried out by elaborating the needs gathered from the users, following the design thinking and agile approaches.

The main users taken into account were (as described before) project internal partners and the vertical sector represented by users from:

- External Stakeholder Board (ESB) of 5G-VINNI;
- ICT19 projects;
- Other research projects focusing on specific vertical industries (e.g.: 5G-MEDIA, NRG5).

The Discover methodology of the Inclusive Design provides the definition of problems through the understanding of the five classic dimensions of investigation: “The discovery process needs to uncover knowledge in response to the following simple questions

- **Who** are the users and other stakeholders?
- **What** tasks will the product be used to achieve?
- **Why** does the business / user want this product?
- **When** will the product be delivered?
- **Where** will the product be used” [7]

The needs emerged from the mentioned users were collected and managed to achieve personae[3] strongly characterized in the normal course of everyone's daily work.

The elaboration of personae[4] based on a deep modelling of their profile and described in narrative form, with a detailed research on their normal work life and, above all, work needs and pains.

The personae elaborated not only allow to answer the questions "**Who** are the users and other stakeholders?" And "**Why** does the user want this product?” but force the designer into a creation methodology based on *putting oneself in someone's shoes*. In this way, we create an empathic relationship with the users, whose connotations lose their generality to assume more and more realistic specific features, soon transforming them into “ordinary people".

The work that was carried out was therefore to imagine the personae as strongly familiar figures, as if they were colleagues, friends or close people with whom themselves were to spend those normal moments of the workday.

The elaborated personae, once defined and verified with the project partner, were then used as protagonists in the preparation of scenarios, representations in which specific users pursue a certain objective in a specific context of use.

[3] **Persona** is an archetype or character that represents a potential user of the system that will be developed. In a narrative way, personae express and focus on the major needs and expectations of the user groups.

[4] **Personae** aid inclusive design because: Users’ goals and needs become a common point of focus for the team; The team can design for a manageable set of personae, knowing that they represent the needs of many users; Design efforts can be prioritised based on the personae; Disagreements over design decisions can be resolved by referring back to the personae; Designs can be evaluated against the personae and their capabilities.

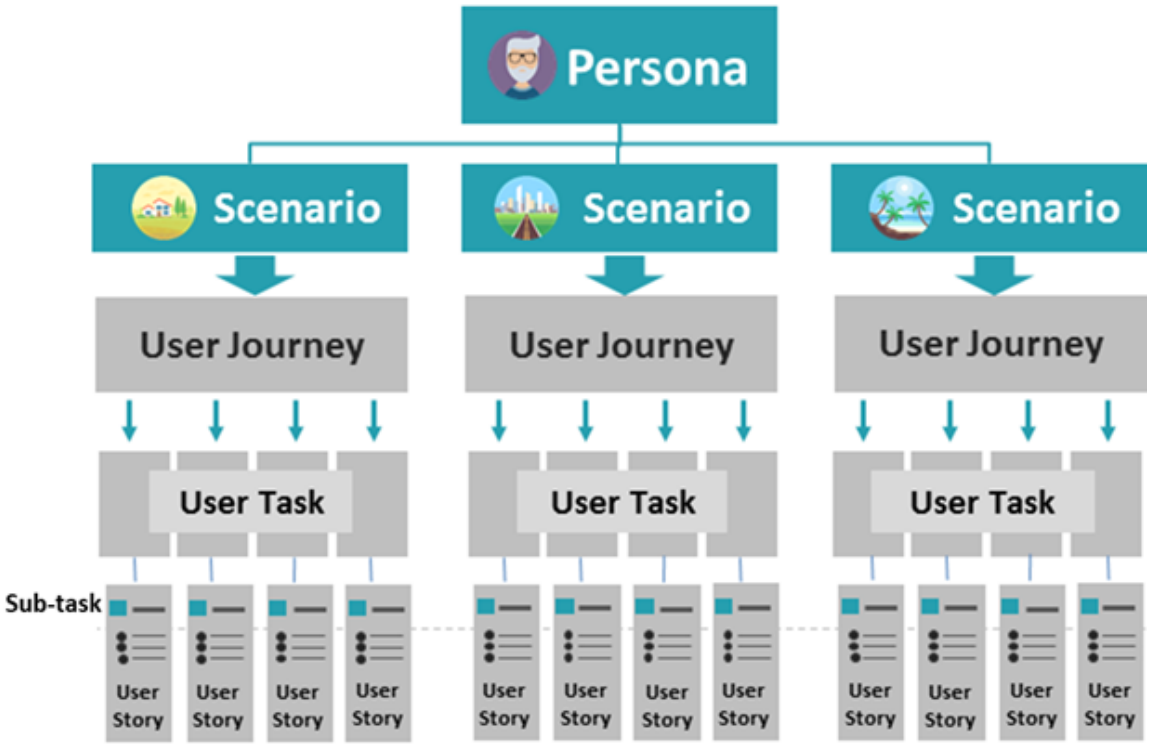

Figure 13: Requirements design process based on personae

The **scenarios**[5] have been identified and elaborated starting from their normal work activities and main needs and pains faced for the implementation of 5G solutions, as it is experienced by that specific user. The scenarios provide contextualization of different moments in different environments, to engage as many touchpoints as possible each time. The design activity has been carried out with an elevated level of attention on the realism of the situations and personal experiences that have been described.

The narrative component of the scenarios is the most suitable form of description in this design phase, because this envisioning activity requiring the maximum freedom of expression from designers. This could not have been achieved with forms of representation based on more rigid and structured models. The scenarios are particularly effective because:

- offer concretion and at the same time evocative representations, able to be immediately interpreted by anyone, even outside the User-Centred Design (UCD) methodologies;
- they can be easily handle allowing rapid intervention and to evolve them with extreme flexibility even in the subsequent phases of the project;
- place emphasis on people and their experiences, allowing them to identify the most useful and appropriate solutions for end users;
- the narrative form creates empathy both in the author and in the readers, facilitating the identification with the user;
- allow to define broad scenarios with a wide range of solutions.

The role that scenarios will play in the development of the whole project is well described by the methodological framework suggested by Rosson and Carroll in their *Scenario-Based Design*[2]: "The framework incorporates scenario-based analysis and design into all phases of system development, from requirements analysis through usability evaluation and iterative development. The overall

[5] **Scenario** describes a basic story of an action or goal that a user wants to accomplish in a specified context of use.

process is one of usability engineering, where the scenarios support continual assessment and elaboration of the system's usefulness, ease of use, and user satisfaction. The aim is to develop a rich understanding of current activities and work practices, and to use this understanding as a basis for activity transformation".

As for the personae, the scenarios have also been analysed with the project partner to verify the realism of the situations described and the correspondence of the proposed solutions with respect to the needs of the user profiles considered. This result was achieved through progressive analysis and processing of the steps in each scenario with the aim of obtaining an increasingly fine granularity of the design elements.

First of all, the **User journey**[6] of each scenario were elaborated in order to visualize in a schematic form the description of the scenario. This is a synoptic model whose purpose is to map the main dimensions on which every single scenario operates (daily job routine, context of use, devices used), articulating them for each set of expected tasks. In this way, a holistic representation of the user's experience is obtained, which is particularly useful to highlight the steps that take place between the devices and the technologies involved in the scenario.

The subsequent activity concerned the generation, on the basis of the agreed scenarios, of the **User tasks**[7] related to each analysed persona. This analysis allows to define the objectives that the user is trying to achieve through 5G-VINNI business layers, the ways in which it can reach them, but also how it is influenced by the environment in which it is located and by the available technologies. Imagining this context, the user experience was deconstructed into single actions (tasks), which were then described with simple one-sentence phrases, to make them immediately perceptible.

Each of these user tasks, were then analysed and decomposed into the so called "sub-tasks". Each single defined task represents a high-level transition of the user experience. This level of definition has been further analysed and decomposed into a series of sub-tasks, to specify in more detail all the micro-objectives of the user that will have to be satisfied through one or more functional features of the system.

A further step in defining the needs of the user to be satisfied was the elaboration of the **User stories**[8], continuing to work on the analysis of the results from previous analysis activities.

The description of each sub-task (as user stories) was then elaborated with the perspective of the end user, using one of the most established models of formalization of user stories, the so-called "Connextra template" (named after the company that first used it).

This format is organized on a construct articulated as follows:

As a [type of user] I want to [do something] So that I can [get some benefit]

This form of exposure of each sub-task has the advantage of not using a technical language, in order to be understandable for technical and not technical staff.

[6] **User journey** describes the journey of a user by representing the different touchpoints that characterize his interaction with the service.

[7] **User Tasks** are steps that users currently take in order to achieve their goals.

[8] **User Stories** are a short, specific and goal-oriented descriptions of what a user will do with a part of a system. User Stories have the following structure: "As a , I want so that ".

3.2 Service scenario

The activities described so far, related to user research, analysis and design, have led to the definition of different **Service scenarios**.

The Service scenario is a framework that has allowed to identify and define users' potential requirement collecting the different types of design tools described previously:

- Persona
- Scenario
- User Journey
- User Task and User stories

Consequently, a set of structured documents have been developed starting from figures of users that should interact with the 5G-VINNI business layer, derived from the vertical sectors (defined as external stakeholders) but also from 5G-VINNI facility sites (defined as internal stakeholders).

Each document is presented through a template designed to explain, in the clearest way possible, the process and the elements described in the illustrated section above.

In the next part, is thus presented an overview that displays the template's structure of each document.

It is important to clarify that names, situations and job contexts described are completely fictitious and fictional. Though they are based on the analysis of the needs emerged by users in the surveys and interviews, they are the result of a process of storytelling and envisioning realized for the 5G-VINNI project.

The personae Map

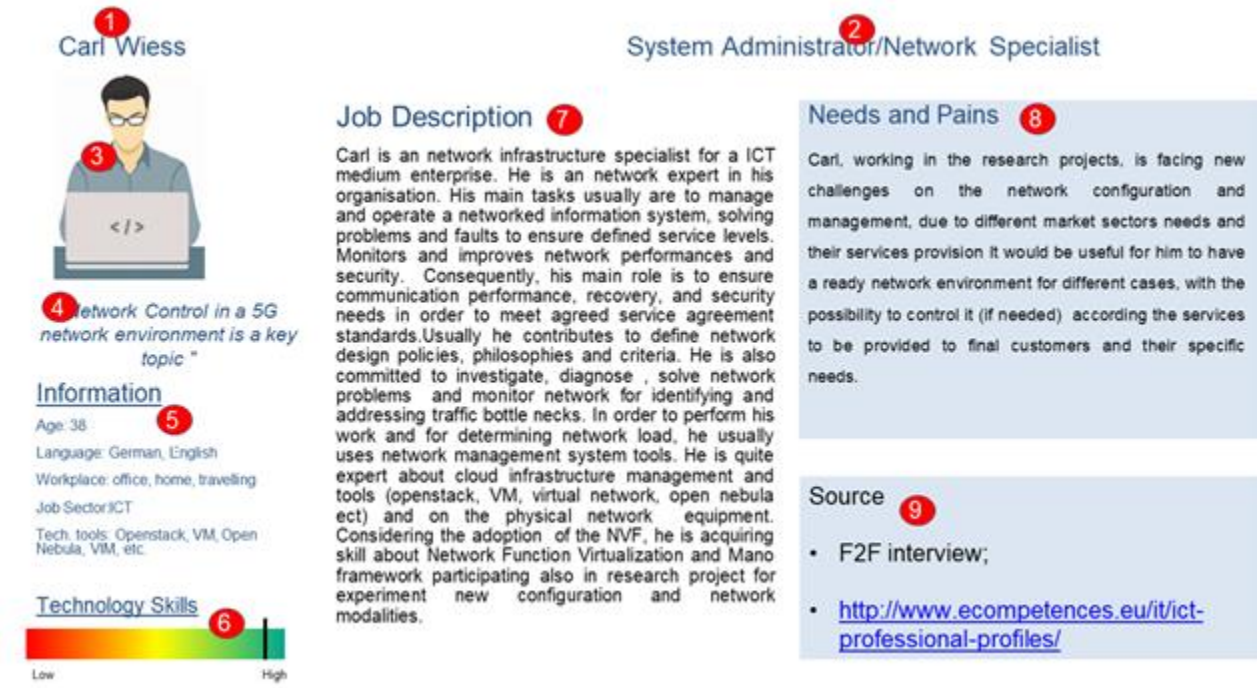

Figure 14: The "Personae Map" part of template

1. Persona's Name.
2. Persona's job position.
3. Persona's visual representation.

4. Main quote: a quote that express and summarise the Persona's main needs.
5. Personal information: socio-demographic information useful to better understand the profile of each Persona.
6. Familiarity with technologies: parameter defined on a scale from *low* to *high.*
7. Narrative description of Persona's job: main activities, habits and routines followed in the job activities.
8. Needs and pains when performing the main activities of his/her job.
9. Related sources of context that has been analysed to define the profile of each Persona.

The Scenario Map

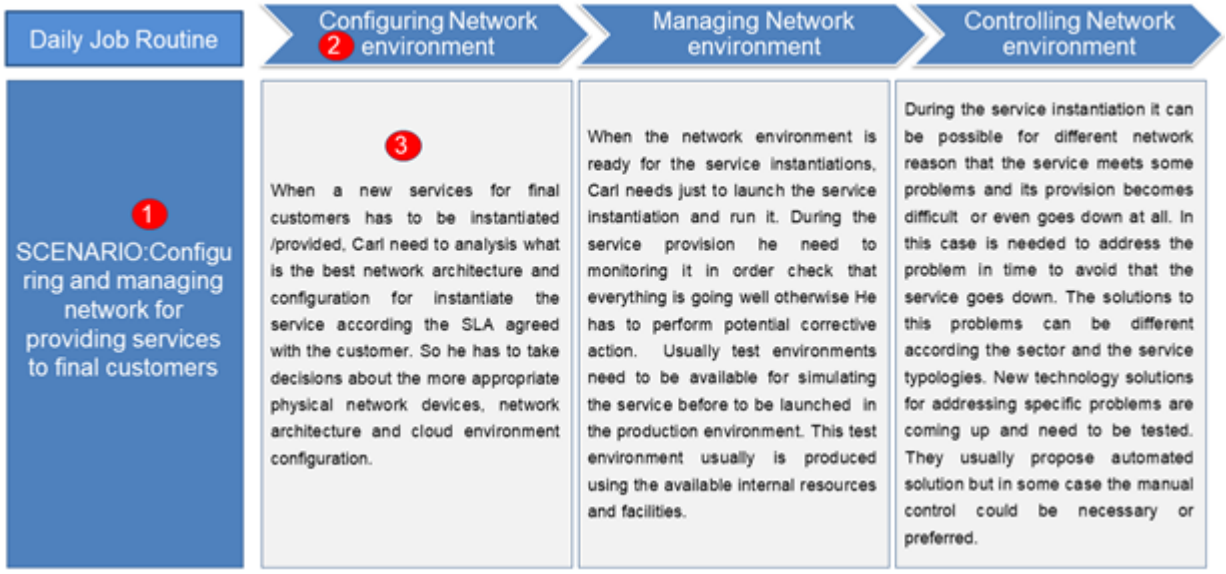

Figure 15: The "Scenario Map" part of template

1. Scenario's title: it defines Persona's main area of interest and needs.
2. Daily job routine: the different steps of the day of a Persona in which his needs must be satisfied.
3. Storytelling of the scenario that takes place in a context defined by the specific step of the daily job routine: conditions of use, tools adopted, available time and user attitudes are some of the parameters defined that will allow to identify the requirements of the Persona's activities.

The User Journey

The User Journey includes the following details:

1. Daily job routine: the different steps of the day of a Persona in which his needs must be satisfied (as identified before)
2. Context: the specific context of use in which Persona's needs must be satisfied.
3. Device: devices used by user to access to the functionalities able to satisfy his needs.
4. Technology tools layers: all the technology tools layers according technology solutions used (that generate touchpoint) expected from the Scenario.

5. Flow of the user experience between the different touchpoints foreseen, during the workday of the user.

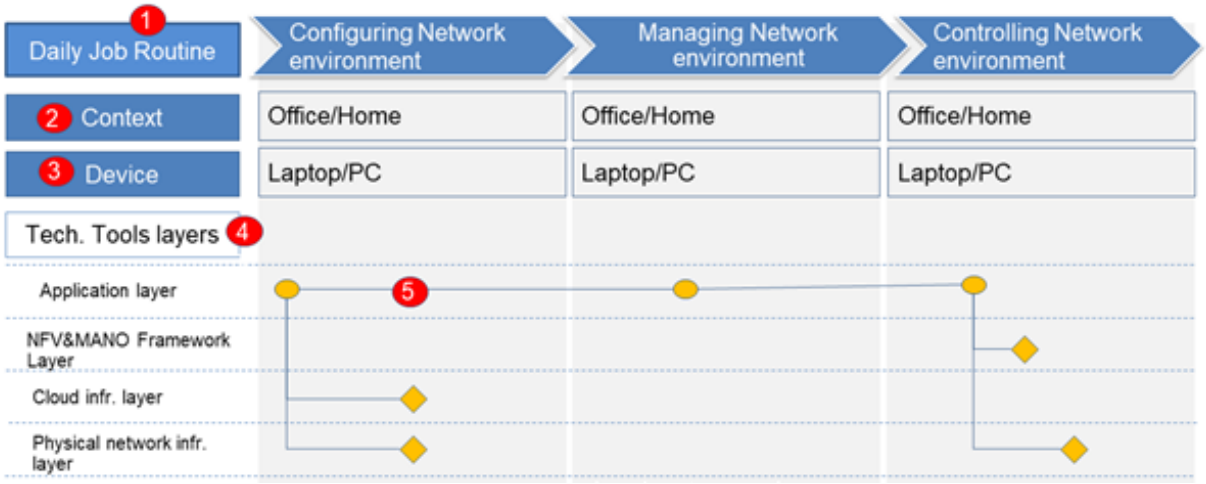

Figure 16: The "User journey" part of persona template

The User Story

The results of the previously illustrated documents were used to proceed with the analysis of the tasks of each Scenario. This additional design activity has generated for each User task a detailed list of sub-tasks with which have been defined micro-activities that the user can/must perform to satisfy their needs. Those sub tasks are described using the agile user story methodology.

ID	User Task 1	Sub-task 2	User Stories 3
A.1	Analyse how to move service components to VNF	understanding requirements for provide a VNF	As a SW developer, I need to know how to make available the developed service as a VNF. I need to know standards, methodologies, processes and rules to be followed.
A.2	Analyse how to move service components to VNF	Accessing for upload service as a VNF	As a SW developer, I need to have an access point for uploading my services. In case of problem or needs for more clarifications, it would be nice to have the possibility to contact someone for having support or to access to the experiences of other people.
B.1	Upload the solution as a VNF	Move services as a VNF	As a SW developer, I have to implement the VNF and I have to upload it according specified and shared guidelines. A common shared space should be available for upload the VNF. Share my feedback or access to the ones of others about that common space and it services, could be useful for improving it and made more easy it usage over the time.
C.1	Validate the deployed service against requirements	Obtain integrated test report	As a SW developer, I need to have a detailed report about the test results in order to validate that the functional requirements are met and that also service code works well. If not I have to address the bugs and problems.

Figure 17: The "User stories" part of persona template

The final panel aims therefore, to provide more details passing from the epic task to sub-task to user stories.

This template shows an example of the detail developed, for each sub-task described using a user story:

1. *User Task* performed by the user during his daily job routine;
2. *Sub-task* of the epic task aims to give some detailed tasks for each epic task;

3. User Story: for each sub-task a functional description is provided according to the end user's perspective following the "Connextra template"(which follows this template: “As a <who>, I want <what> so that <why>.”[9]);

3.3 Descriptions of identified key external personae

The main “external personae” identified as main potential users of the 5G-VINNI business layer, coming from the vertical stakeholders, are listed below. For each of them we present the “persona map” and their related “User stories” while the whole version of the user description, as has been introduced in Section 3.1, are available in Annex D.

Each user/persona is identified with a name and a role/job in his/her organisation. These users/ personae are:

- Lara - Digital transformation leader;
- Bill - Business Analyst & Digital Consultant
- Samuel – SW developer
- Carl - System Administrator/Network Specialist
- Sandra - Service Manager & Quality Assurance Manager
- Steve - Solution Designer & System Architect

3.3.1 Lara - Digital transformation leader

Figure 18: The “Persona map” for Lara

[9] Who- This is typically a job role, customer or type of user, also known as the user persona.

What- This is the goal that the user wants the product to accomplish or implement.

Why- This is the reason why the user needs the feature or functionality.

Table 1: The "user stories" for Lara

ID	User Tasks	Sub-task	User Stories
A.1	Looking to technology outcomes	Access to the solution experimentation process	As a digital transformation leader, I need to have visibility of the process, software and hardware configuration and everything that can support me to understand its impact on my organisation and customers.
A.2	Looking to technology outcomes	Contact relevant people involved in the experimentation process	As a digital transformation leader, I need to have the possibility to access to a central point and to contact and interview all the different people involved in the experimentation development and deployment of the solution.
B.1	Identifying solution benefits for company/ customers	Gather information on ICT solution and its potential experimentation deployment.	As a digital transformation leader, I need to have clear reports on the solution design and experimentation deployment, which should include information about software/hardware used, software licenses, infrastructure resources involved and their configuration, test order status and faults etc..
B.2	Identifying solution benefits for company/ customers	Assess and clarifying reports	As a digital transformation leader, I need to improve my understanding of the available reports, it is important for me to be able to know who can provide clarification on them and contact them
B.3	Identifying solution benefits for company/ customers	Access to information not available in the reports	As a digital transformation leader, If I have doubts or I can't find information for me relevant, It would be useful to be able to identify the reference people and contact them.
B.4	Identifying solution benefits for company/ customers	Access to already available cost/benefits models	As a digital transformation leader, it would be nice to have the possibility to access to already available cost/benefits models or at least cost models of part of the system for deploy the experiment.
C.1	Assessing solution feasibility	Assess ICT solution feasibility in terms of digital transformation	As a digital transformation leader, it is very important to access to business report in order to assess the tested solution in business terms. it would be also nice to have tools for assessing new technology solution/s feasibility and their impact on the internal organisation or/and customers/market,

3.3.2 Bill - Business Analyst & Digital Consultant

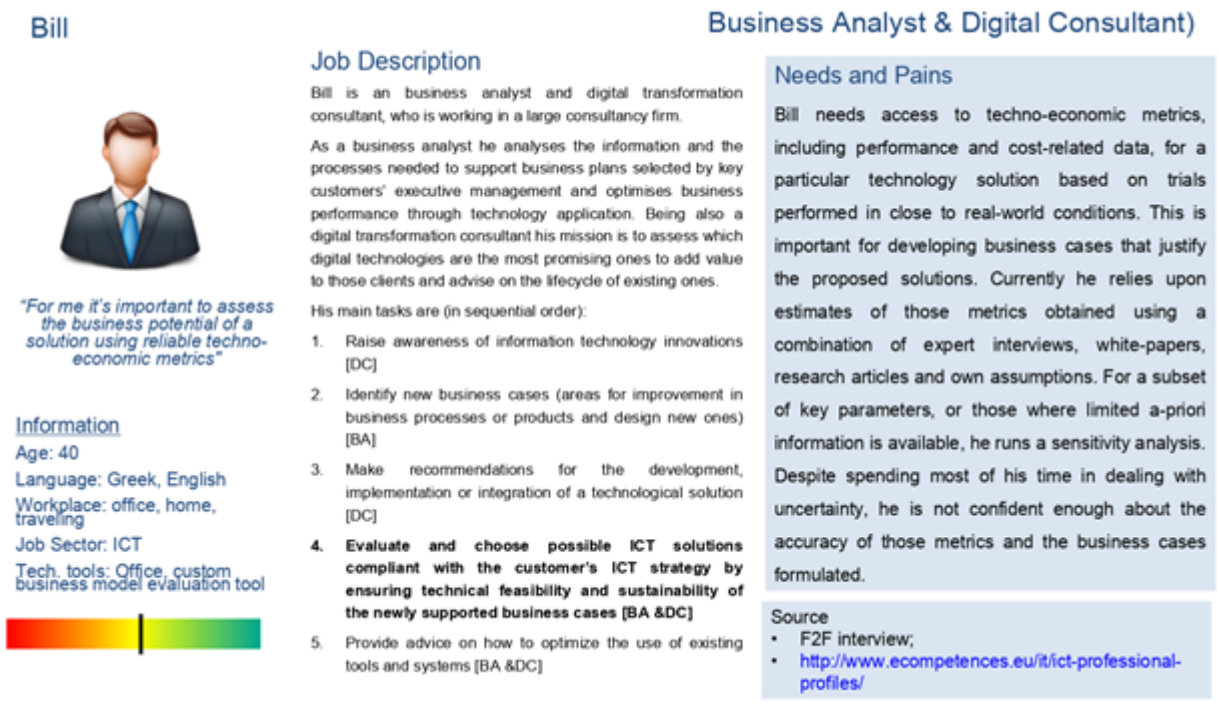

Figure 19 The "Persona map" for Bill

Table 2: The "user stories" for Bill

ID	User Task	Sub-task	User Stories
A1	Obtain valuable techno-economic KPIs	Log in to service catalogue	As a Business Analyst I want to be able to log in to the service catalogue, in order to specify details for the experiments to be performed on behalf of my customer and retrieve results.
A2	Obtain valuable techno-economic KPIs	check documentation	As a Business Analyst I want to be able to consult the system documentation, in order to reduce the risk of misconfiguration and increase efficiency.
A3	Obtain valuable techno-economic KPIs	choose attributes to be included in the KPI report for each trial executed (under a certain system configuration)	As a Business Analyst I want to be able to choose what metrics should be monitored and reported, so that I can focus on the aspects of the solution's configuration that are being tested/validated
A4	Obtain valuable techno-economic KPIs	retrieve KPI report during and after a trial execution (under a certain system configuration)	As a Business Analyst I want to be able to have access to a technical report at various stages of trial execution, so that I can continuously validate my hypotheses and decide (jointly with colleagues) if additional trials and/or configurations are needed
A5	Obtain valuable techno-economic KPIs	Obtain valid cost information	As a Business Analyst I want to be able to have detailed information about the costs associated with the experiment and be able to ask my colleagues and other experts, so that I can estimate future operating expenditures (OPEX) and wherever possible capital expenses (CAPEX)
B1	Assess business	Perform Discounted Cash Flow (DCF) analysis for the	As a Business Analyst I want to be able to repeat a trial so that I can perform sensitivity analysis of the DCF

	cases	baseline scenario and its sensitivity to key parameters	results obtained.

3.3.3 Samuel – SW developer

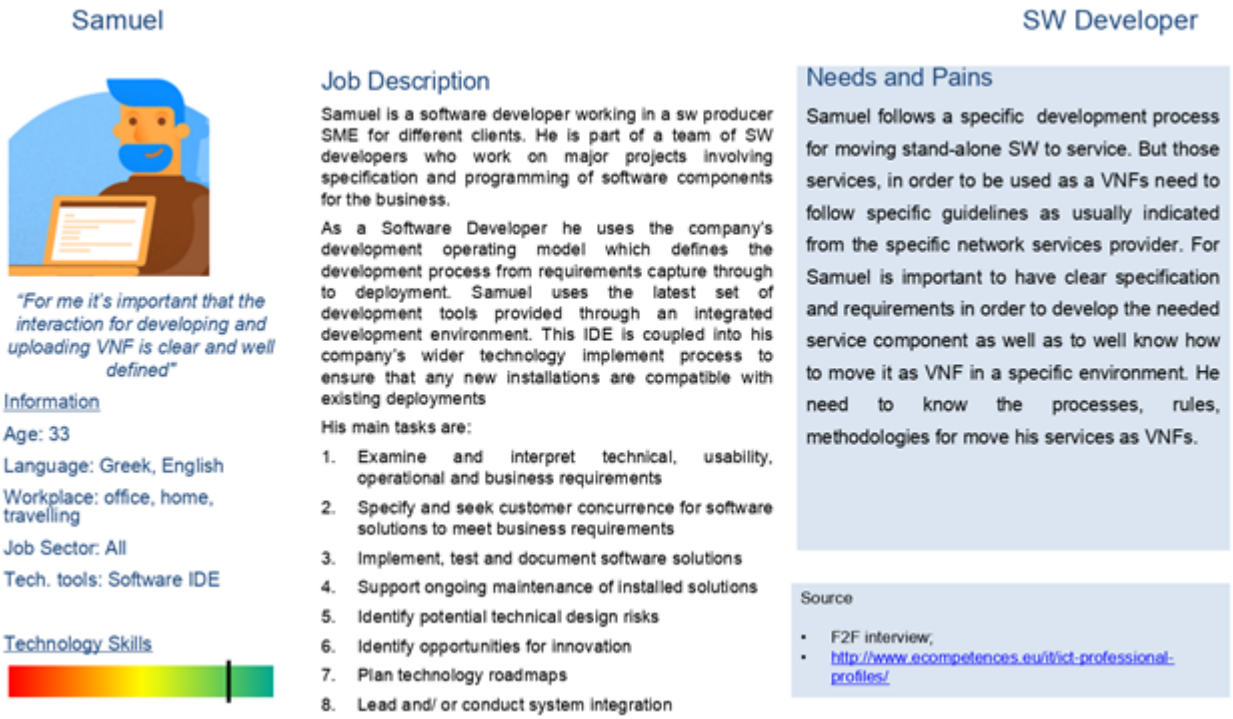

Figure 20: The "Persona map" for Samuel

Table 3: The "user stories" for Samuel

ID	User Task	Sub-task	User Stories
A.1	Analyse how to move service components to VNF	understanding requirements for provide a VNF	As a SW developer, I need to know how to make available the developed service as a VNF (Virtual Network Function). I need to know standards, methodologies, processes and rules to be followed.
A.2	Analyse how to move service components to VNF	Accessing for upload service as a VNF	As a SW developer, I need to have an access point for uploading my services. In case of problem or needs for more clarifications, it would be nice to have the possibility to contact someone for having support or to access to the experiences of other people.
B.1	Upload the solution as a VNF	Move services as a VNF	As a SW developer, I have to implement the VNF and I have to upload it according specified and shared guidelines. A common shared space should be available for uploading the VNF. Sharing my feedback or access to the ones of others about that common space, could be useful for improving it and making its usage easier over the time.
C.1	Validate the deployed service against requirements	Obtain integrated test report	As a SW developer, I need to have a detailed report about the test results in order to validate that the functional requirements are met and that also service code works well. If not, I have to address the bugs and problems.

3.3.4 Carl - System Administrator/Network Specialist

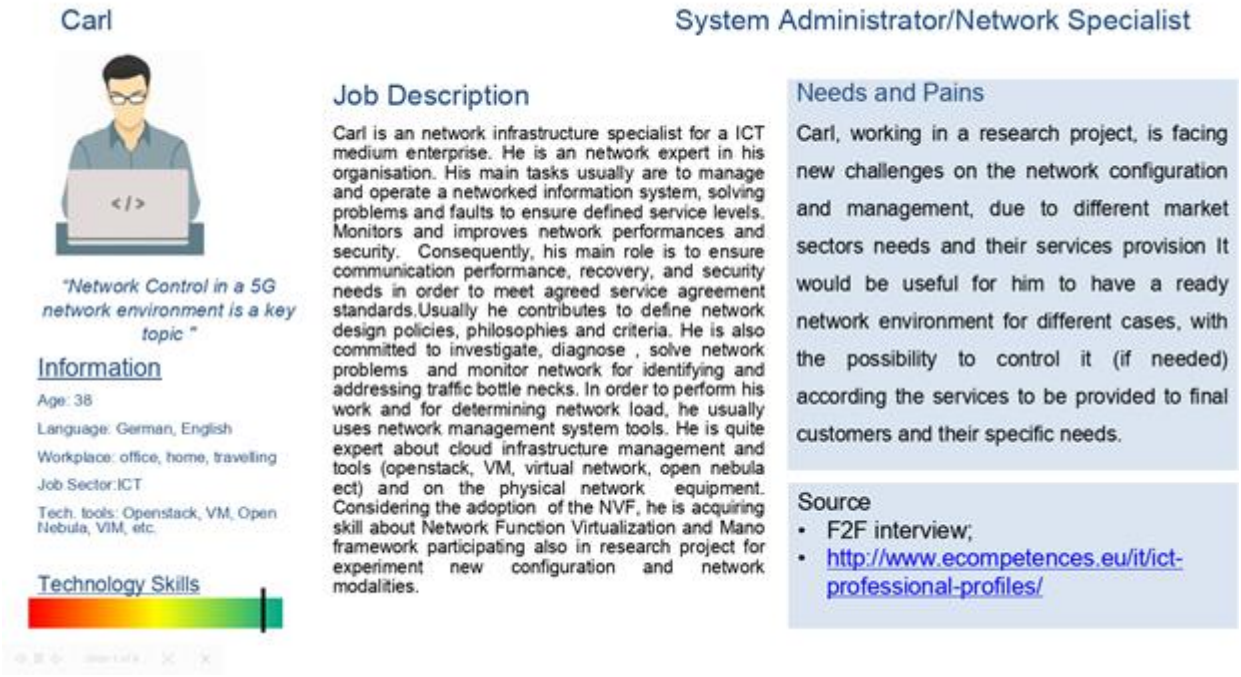

Figure 21: The "Persona map" for Carl

Table 4: The "user stories" for Carl

ID	User Task	Sub-task	User Stories
A.1	Configuring Network environment	Identify and choose network infrastructure architecture	As a network administrator, I need to access and understand all the possible available options in terms of network architecture in order to identify the one more appropriate for the instantiation/ provision of the final customers service according their needs in terms of latency, bandwidth etc. In the case it is not or partially available to decide if to include new network infrastructure facilities or use external network facilities. In this last case, the interoperability among network infrastructure is very important.
A.2	Configuring Network environment	Identify and choose network cloud configuration	As a network administrator, I need to know all the possible available options in terms of network cloud configuration (Openstack, VM, open nebula Virtual Infrastructure Manager (VIM), use of proprietary solution and their features, etc.) in order to identify the one more appropriate for the instantiation/ provision of the final customers service.
B.1	Managing Network environment	Launch service instantiation in test and production environment	As a network administrator, I have to launch the service at the right time as it is required, following the specific requirement agreed at SLA level in order to assure the service as it has to be. This service launch can be automatized once defined all the service features for its provision. Usually before to launch the real service it is required to launch it in an environment test. Consequently, it is required to create an environment test which simulate the overall production environment. This test environment usually is produced using the available internal resources and facilities.
B.2	Managing Network environment	Monitoring of the running service	As a network administrator, I need to monitor during the service running if everything is going as expected. For this reason, can be useful to use run-time monitoring tools. They

			can support me to detect system faults or limitation to be addressed.
C.1	Controlling Network environment	Adopting problem mitigation solution	As a network administrator, I could need to follow different network problem mitigation approaches, some of those could propose technology solutions. So, it would be needed to integrate those solutions. It would be also nice to have already some automated solutions in place in the test and production environment. Share and discuss on those issues and solution with who already faced or have to face they, should be useful.
C.2	Controlling Network environment	Using manual network control	As a network administrator, in some case could be useful and needed to have the possibility to control the network environment in terms for instance to decide where to instantiate the VNFs and services, to modify variables during the runtime service if a problem rises, etc. Share and discuss on those issues and solution with who already faced or have to face they, should be useful.

3.3.5 Sandra - Service Manager & Quality Assurance Manager

Figure 22: The "Persona map" for Sandra

Table 5: The "user stories" for Sandra

ID	User Task	Sub-task	User Stories
A.1	Order business experiments	Log in to service catalogue	As a Service Manager, I need to be able to log in to the service catalogue, in order to have personalised view of my company's interactions with the testbed
A.2	Order business experiments	check documentation	As a Service Manager, I want to be able to consult the system documentation, in order to reduce the risk of misconfiguration and increase efficiency.
A.3	Order business experiments	Configure experiment	As a Service Manager, I need to be able to define the details of the experiment, such as geographical scope, using an intuitive GUI so that I can test the business hypotheses in a close to real life environment by placing a new order from scratch, continue configuring pending ones or resubmitting an old one.

A.4	Order business experiments	Agree on SLA and cost	As a Service Manager, I need to be able to define the SLA terms by choosing a target value for each KPI in a certain analysis period that is important to her customers, so that we and testbed provider can have a shared understanding on the expectations and costs.
B.1	Invite test users	Define the set of test users	As a Service Manager, I need to be able to define any number of users (i.e., devices) that will be granted access to the testbed, so that I can run a close-to-real-life experiment.
C.1	Analyse business experiment results	Analyse results	As a Service Manager, I need to be able to get a detailed report of testbed events and system behaviour, so that I can assess the readiness and performance level of the system under test.
C.2	Analyse business experiment results	Analyse feedback	As a Service Manager, I need to be able to retrieve the feedback that end-users have provided, so that I can assess the readiness and performance level of the system under test from the point-of-view of end-users.

3.3.6 Steve - Solution Designer & System Architect

Figure 23: The "Persona map" for Steve

Table 6: The "user stories" for Steve

ID	User Task	Sub-task	User Stories
A.1	Identifying and picking up VNF/ image and analysing their interdependencies	Identify VNFs and their Images, searching VNFs and Images	As a solution design and system architect I needs to know if VNFs and Images are available, what they do, where they are available and at what conditions. It would be nice to have a unique access point and catalogue for searching those components with information for understanding them and how it is possible to use them.

A.2	Identifying and picking up VNF/ image and analysing their interdependencies	Browse through the service catalogue for complementary Service Components (SCs)/ VNFs	As a a solution designer and system architect, I need to be able to log-in and query the VNF catalogue, in order to find details about the Service components/VNFs which have to interact with for delivering the final service. For me is useful to have the possibility to contact the responsible person of those services/VNF or who already used them for have further information on them.
A.3	Identifying and picking up VNF/ image and analysing their interdependencies	Retrieve APIs for each external VNF Package	As a solution designer and system architect, I need to have access to the metadata of the external VNFs in order to understand how the service could be modified according the needs (if needed) and how it will be interacting with.
B.1	Realising and uploading solution descriptor	Understanding standards and models to be used	As a solution designer and system architect before to start to develop my service descriptor, I need to know what standards and data modelling I have to follow for producing it. It could be nice to have available information, description, about them as well as to know about experiences of other users.
B.2	Realising and uploading solution descriptor	Developing and Uploading Service Descriptor	As a solution designer and system architect it could be nice for me, to have available information, description, handbook, tutorial, feedback on already done experiences, that can be able to drive me in the descriptor development to be instantiated in a specific environment.
C.1	Set up experiment and Identify potential technical design risks	Monitoring results of the instantiated services	As a solution designer and system architect, it would be useful to have the possibility to have a list of the results of all the instantiated services. In same case the real time resource monitoring could be necessary.
C.2	Set up experiment and Identify potential technical design risks	Accessing and checking reports for bugs/risk check	As a solution designer and system architect, it is very important to access to technical reports on the instantiated services. Those reports have to support me to understand if the service works as expected, to identify bugs or risks about its deployment.
C.3	Set up experiment and Identify potential technical design risks	Set up experiment	As a solution designer and system architect I need to have an access point where is possible to set up an experiment for validate my designed solution. I would like to have the possibility to pick up: more appropriate facilities, time schedule, duration, the possibility to control the network environment or to have an automated management of it based on requirements like bandwidth and latency, automated replicability. I need to define SLA and according them to know the potential bill.

3.4 Descriptions of key internal personae

The main “internal personae” identified as main potential users of the 5G-VINNI business layer , coming from the 5G-VINNI facilities stakeholders, are here below listed and for each of them are presented the “persona map” and their related “User stories” while the whole version of the user description appears in the Annex D.

Each user/persona is identified with a name and a role/job in his/her organisation. These users/ personae are:

- David - DevOps Expert

- Siren - Service manager
- Nadia - Network Specialist
- Sonny - Solution designer
- Ted - Test specialist
- Anton - Account manager

3.4.1 David - DevOps (Development and Operations) Expert

Figure 24: The "Persona map" for David

Table 7: The "user stories" for David

ID	User Task	Sub-task	User Stories
A.1	Assess the extent of the problem	Find the faulty component	As a DevOps Expert, I need to have access to a detailed report of past transactions and KPIs in order to find the root of the problem.
A.2	Assess the extent of the problem	Find what needs to be fixed	As a DevOps Expert, I need to be able to monitor the status of certain subcomponents that appear to misbehave in order to understand what needs to be fixed.
B.1	Develop and test the DevOps solution	Develop patch	As a DevOps Expert, I need to prepare a patch in order to deal with the malfunction.
B.2	Develop and test the DevOps solution	Test patch	As a DevOps Expert, I need to specify a set of automated tests in order to verify the effectiveness of the patch.
C.1	Deploy solution	Deploy solution	As a DevOps Expert, I need to be able to replace the faulty component with the new one (or update service topology if additional components need to be introduced) in order to deploy new solution.

3.4.2 Siren - Service manager

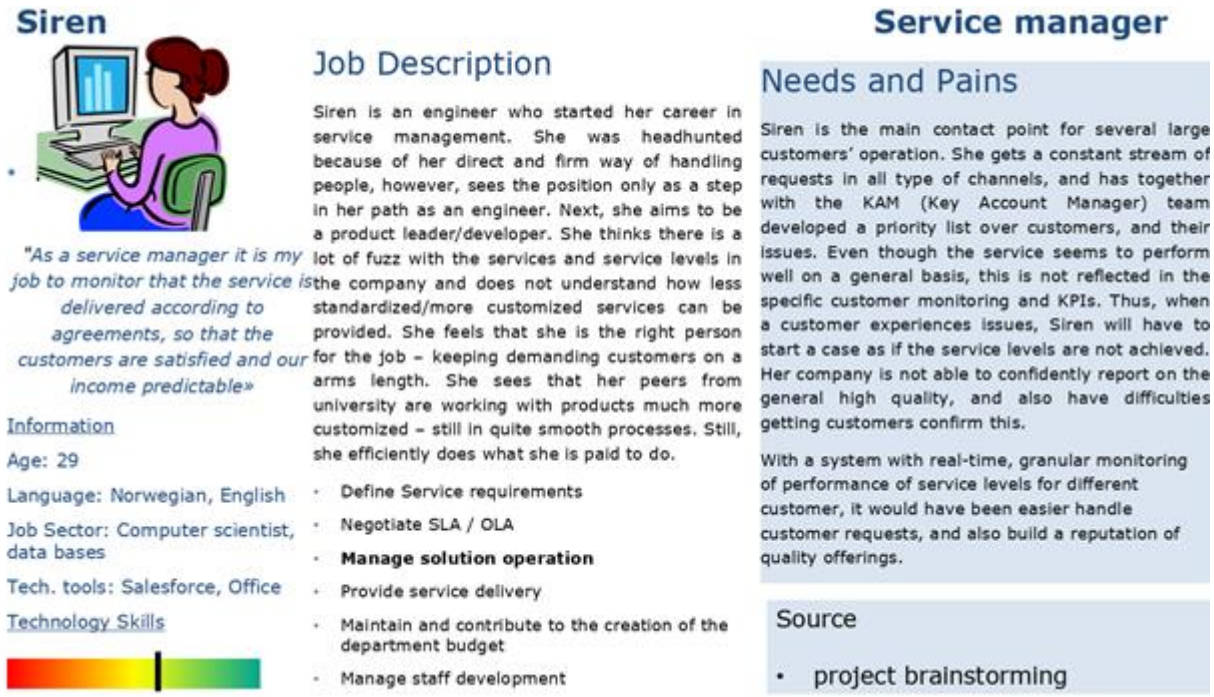

Figure 25: The "Persona map" for Siren

Table 8: The "user stories" for Siren

ID	User Task	Sub-task	User Stories
A1	Receive request from customer	Receive ticket	As a Service manager I need to see all new and pending tickets so that we can take care of them as soon as possible
A2	Receive request from customer	Prioritise requests	As a Service manager I need to be able to prioritise tickets so that important and old ones are treated first
A3	Receive request from customer	Delegate responsibility	As a Service manager I need to be able to delegate responsibility to colleagues so that we can take advantage of each member' expertise
B1	Response on request	Check historical data and KPIs	As a Service manager I need to be able to check historical data and KPIs, even for a particular customer, service or area, so that we can narrow down candidate options
B2	Response on request	Consult "best practices" playbook	As a Service manager I need to be able to check "best practices" playbook or ideally to see an automatically-generated list of measures, so that we reduce resolution time
B3	Assess customer satisfaction	obtain feedback from customers	As a Service manager I need to be able to collect customer feedback, so that we get more insight about customer requirements and expectations
C1	Assess customer satisfaction	Analyse customer satisfaction	As a Service manager I need to be able to analyse customer feedback, so that we can improve conversion rate (for tentative customers) and retention rate (for existing ones)
C2	Assess customer satisfaction	Update "best practices" playbook	As a Service manager I need to be able to continuously evaluate best practices, so that we can include new proposed actions and revise/replace/delete older ones

3.4.3 Nadia - Network Specialist

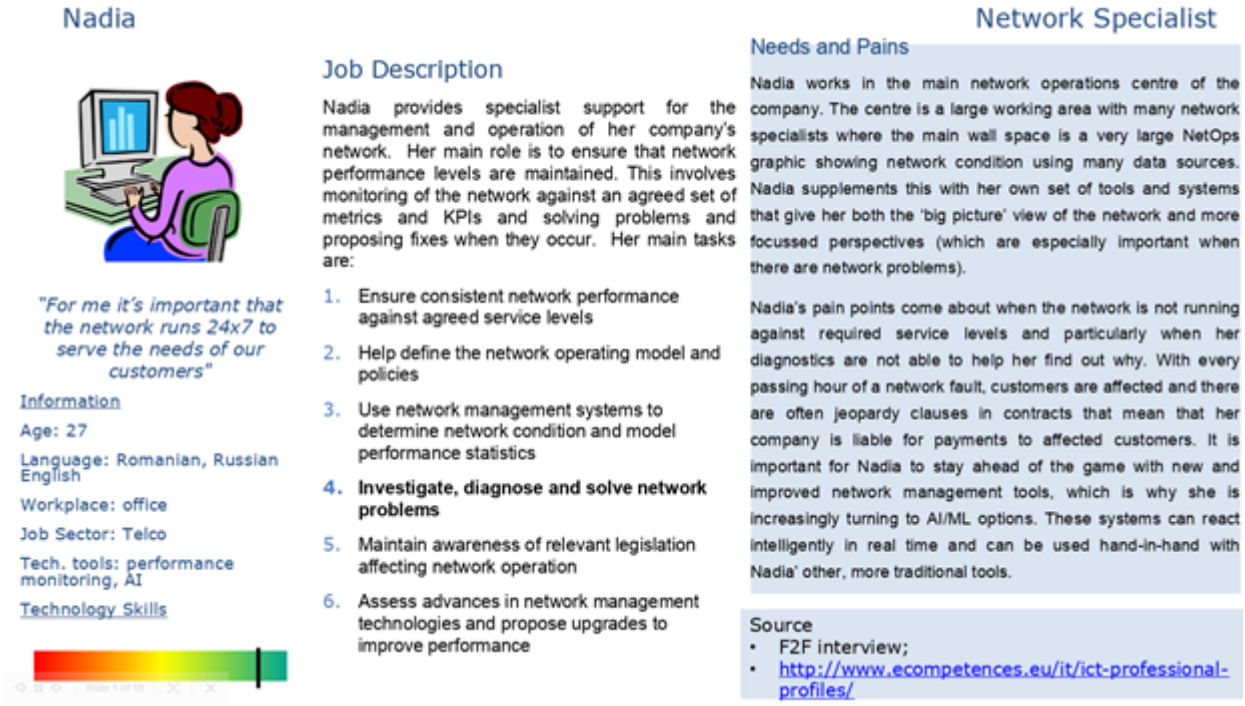

Figure 26: The "Persona map" for Nadia

Table 9: The "user stories" for Nadia

ID	User Task	Sub-task	User Stories
A1	Install new management tool	Log in to service catalogue	As a Network Specialist I want to be able to log in to the service catalogue, in order to have personalised view of the testbed
A2	Install new management tool	Define network digital twin	As a Network Specialist, I need to be able to create/select the network digital twin (i.e., a network slice) in order to test the effectiveness of a new tool.
A3	Install new management tool	Assess tool compatibility	As a Network Specialist, I need to be able to have access to a detailed compatibility report in order to identify any incompatibilities well in advance.
A4	Install new management tool	Install new tool	As a Network Specialist, I need to be able to update service topology of the network digital twin in order to deploy the new tool.
B1	Monitor tool compatibility	Define integration tests	As a Network Specialist, I need to specify and schedule a set of automated tests in order to ensure network integrity.
B2	Monitor tool compatibility	Monitor tool compatibility	As a Network Specialist, I need to have access to a detailed report of KPIs in order to assess tool compatibility.
C1	Assess tool effectiveness	Define run-time tests	As a Network Specialist, I need to be able to specify and schedule a set of automated tests in order to trigger the required events.
C2	Assess tool effectiveness	Assess tool effectiveness	As a Network Specialist, I need to have access to real-time resource monitoring and a detailed report of KPIs as soon a test has concluded, in order to assess tool effectiveness.
D1	Assess Customer Requirements	Log in to service catalogue	As a Network Specialist I want to be able to log in to the service catalogue, in order to have a personalised view of the network and assignments to me
D2	Assess Customer Requirements	Get a notification about a new customer	As a Network Specialist, I want to receive a notification as soon as a new assignment emerges together with context information, so that I can work on it as soon as possible.

		requirement	
D3	Assess Customer Requirements	Find what needs to be updated	As a Network Specialist, I need to be able to have access to the service inventory in order to understand what needs to be updated.
E1	Develop MANO and SO Solutions	Manage service blueprints	As a Network Specialist, I need to be able to create new service blueprints by reusing existing ones in order to increase efficiency.
E2	Develop MANO and Service Orchestration (SO) Solutions	Manage service inventory	As a Network Specialist, I need to be able to create a new, pre-commercial service based on existing blueprints (as well as retrieve, update and delete existing pre-commercial services) in order to reduce the likelihood of missing elements. Furthermore, I need to be able to consider services from other providers in order to offer homogeneous service to customers.
F1	Test and Deploy	Define network digital twin	As a Network Specialist, I need to be able to create/select the network digital twin (i.e., a network slice instance from the inventory) in order to avoid the risk of misconfigurations affecting the production network.
F2	Test and Deploy	Define run-time tests	As a Network Specialist, I need to be able to specify and schedule a set of automated tests in order to trigger the required events.
F3	Test and Deploy	Assess service correctness	As a Network Specialist, I need to have access to real-time resource monitoring and a detailed report of KPIs as soon a test has concluded, in order to assess service correctness.
F4	Test and Deploy	Send a notification when new service is ready to be made publicly available	As a Network Specialist, I want to send a notification to account manager, so that resolution time includes the actual time I have spent with each customer ticket.

3.4.4 Sonny - Solution designer

Figure 27: The "Persona map" for Sonny

Table 10: The "user stories" for Sonny

ID	User Task	Sub-task	User Stories
A.1	Develop business case	Review requirements	As a Solution Designer, I want to specify the available budget framework and retrieve suggestions for components so that we quickly can proceed in solution dialogue and negotiate co-financing with customer
A.2	Develop business case	Prepare solution	As a Solution Designer, I want to have a set of direct interactions that allow me to rapidly develop solutions and share with my customer
B.1	Develop, deploy and test solution	Develop solution	As a Solution Designer, I want access to documentation on deployed solutions so I can re-use previous designs
B.2	Develop, deploy and test solution	Simulate in the digital twin	As a Solution Designer, I want to receive a test report that specifically highlights where the network is compromised by the addition of a new solution so that I'm confident that the solution satisfies network integrity
B.3	Develop, deploy and test solution	Test solution in the real network	As a Solution Designer, I need access to a set of detailed test reports
C.1	Confirm customer compliance	Agree solution with customer	As a Solution Designer, I want strong and meaningful interaction (by sharing test reports) with the customer to ensure the customer is satisfied with the deployed solution

3.4.5 Ted - Test specialist

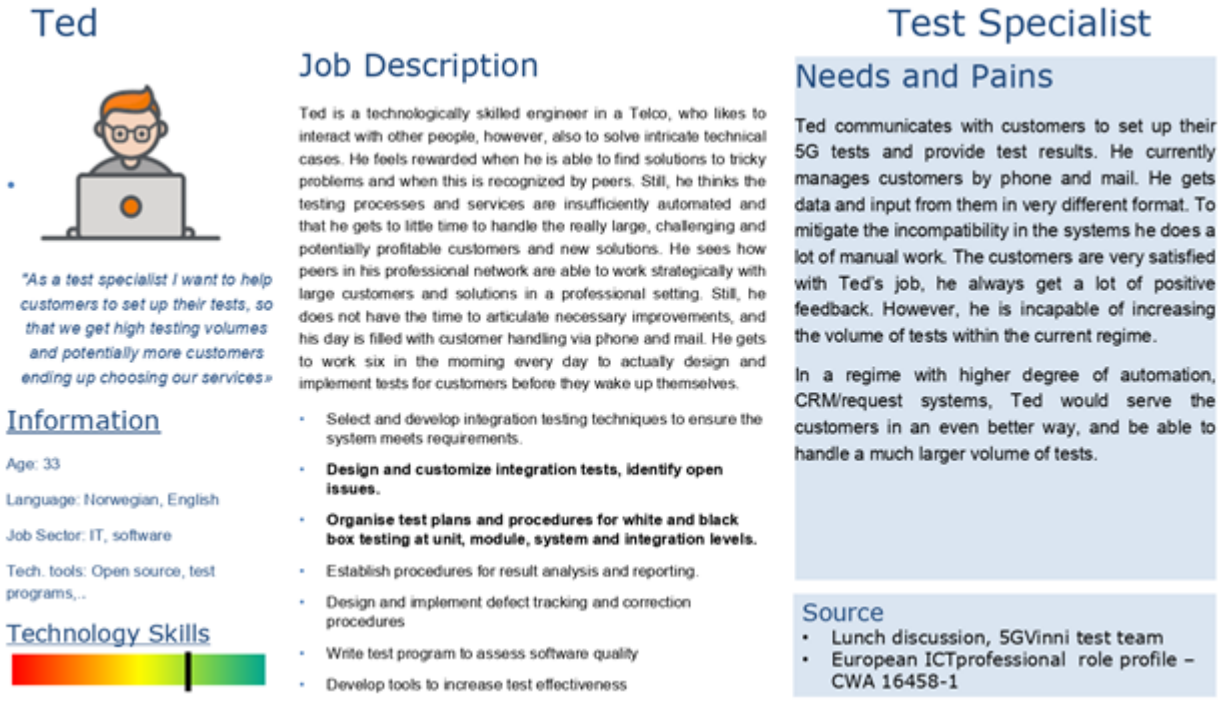

Figure 28: The "Persona map" for Ted

Table 11: The "user stories" for Ted

ID	User Task	Sub-task	User Stories
A1	Receive request from customer	Obtain user profile information	As a test specialist assisting customers to design, deploy and execute their experiments, I want each user to have its own account, including profile details, so that they can collaborate during the different experiment phases and I know the

			background of the person I'm interacting with.
A2	Receive request from customer	Gather experiment details via a design tool	As a test specialist assessing how intuitive and user-friendly our solution is, I want the digital solution to guide customers in the process of designing, deploying, executing, analysing each experiment iteration, with support for "copy and paste" when testing a slightly different configuration or even replication of their experiments to another site, so that they perform more tests (rather than spending time with me).
A3	Receive request from customer	Get a notification about a new test request	As a test specialist assisting customers to design, deploy and execute their experiments, I want to receive a notification as soon as I have resolved the last ticket, so that resolution time includes the actual time I have spent with each customer seeking support.
A4	Receive request from customer	Get acquaint with the customer	As a test specialist assisting customers to design, deploy and execute their experiments, I want to retrieve the customer profile and details about previous interactions (if these exist), so that I efficiently can ask for the right kind of input.
A5	Receive request from customer	Understand test scope and objectives	As a test specialist assisting customers to design, deploy and execute their experiments, I want to initiate an online discussion with the customer in order to find out if/how our solution meets their needs and solve their challenges.
B1	Design and set-up test	Discover third-party components	As a test specialist assisting customers to design and deploy their experiments, I want third-party solutions to be easily accessible, so that innovative components can be used in the experiments.
B2	Design and set-up test	Change topology	As a test specialist assisting customers to design and deploy their experiments, I want the topology to support the on-boarding and commission/decommission of third-party solutions, so that innovative experiments can be executed.
C1	Reporting test results	The customer chooses what/when/how should be monitored	As a test specialist, I want to let the customers be able to select what components and events should be monitored, the granularity and the metrics to be used, so that they have sufficient and timely information on their experiments.
C2	Reporting test results	The customer get links to encrypted results and notifications when they are ready	As a test specialist, I want to let the customers have secure access to test results without my interference, so that they are not afraid of revealing sensitive information to me or other third parties

3.4.6 Anton - Account manager

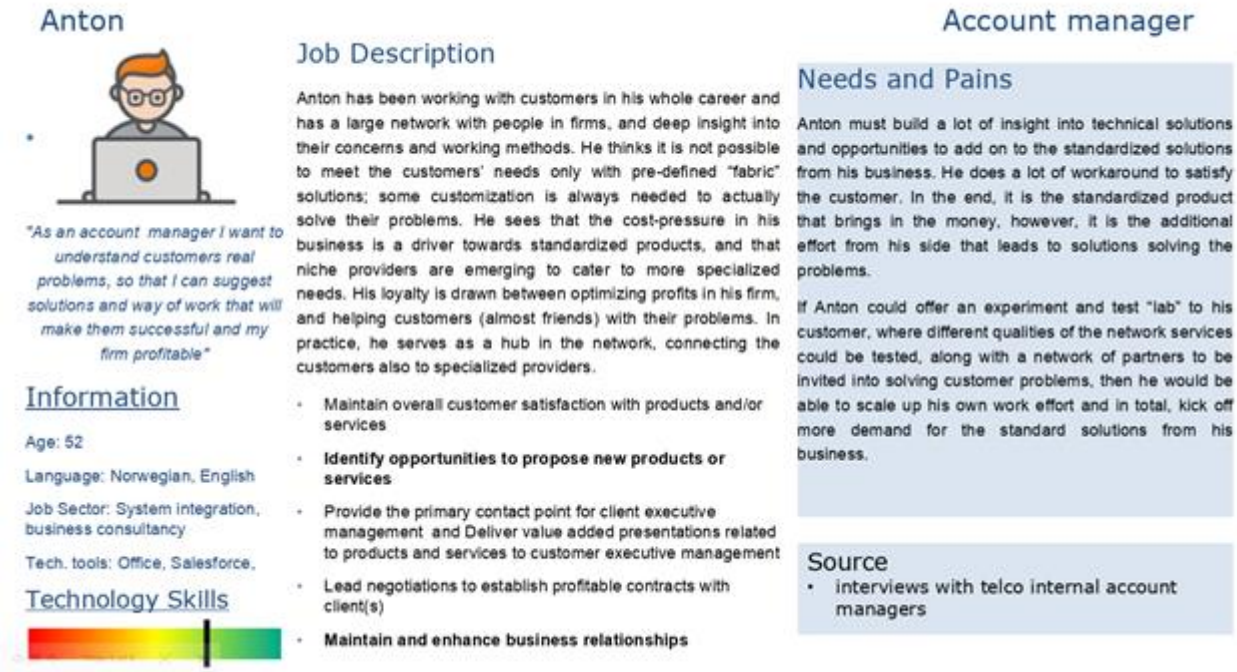

Figure 29: The "Persona map" for Anton

Table 12: The "user stories" for Anton

ID	User Task	Sub-task	User Stories
A1	Interconnect with peers	Adopt standards for interconnecting with peers	As an account manager of the 5G testbed, I want it to be based on standard interfaces and support standard network slice types, so that we can offer full national (and even global) coverage to our customers and third-party solution providers.
A2	Interconnect with peers	Agree on governance model	As an account manager of the 5G testbed, I want it to support centralised and distributed governance models, so that we can accommodate requests both on-the-fly and proactively and act as a "one-stop shop" for our customers.
B1	Attract third-party solutions	Attract third-party solutions	As an account manager of the 5G testbed, I want it to be based on standard interfaces and support standard VNF descriptors, so that third-party developers and professionals will make their services available to my customers rather than offer only a limited set of in-house solutions.
B2	Attract third-party solutions	Agree on revenue sharing agreements	As an account manager of the 5G testbed, I want to be able to negotiate revenue sharing agreements with third-party solution providers so that we can reach an "all-win" situation
C1	Attract vertical customers to run experiments	Attract vertical customers to run experiments	As an account manager, I want to encourage my customers experiment with our solutions, so that they can get more assured that our solutions are actually solving their problems.
C2	Attract vertical customers to run experiments	Offer cost estimation for experiment order	As an account manager, I want to offer a cost estimation tool to my customers so that they get a better idea on the cost of different experiment configurations (in terms of performance, customisation, number of users, duration etc.) and plan their experiments based on their available budget.
C3	Attract vertical customers to run	Offer a wide range of cost sharing options	As an account manager, I want to allow my customers forming a consortium to share the costs in a clear and

	experiments		detailed way, so that trust levels within the consortium is increased
C4	Attract vertical customers to run experiments	Offer customers the ability to extend the network	As an account manager, I want to allow customers co-finance and operate the network infrastructure, so that I can realize an extension of the network and enable serving further customers.

4 Business Layer requirements

This section documents the requirements for the 5G-VINNI business layer based on the persona profile descriptions of Section 3. The following table provides a short summary of these requirements.

Table 13: A summary of the identified requirements for the 5G-VINNI business layer

Requirement Title	Short description
Secure universal login	A unique customer access to the platform should be available.
Assisted customer access	Customers should be capable of monitoring order status (including faults)
Global Service Catalogue	A service catalogue should include all the 5G-VINNI facility offerings that are available and accessible to vertical customers (e.g. enterprises)
Open to external suppliers	A service catalogue should include capabilities and other services (e.g., VNFs) by other facility sites and complementors
Pick and choose	Capabilities and services should be available so that vertical customers and aggregators/brokers can compose new ones
Experiment	Capabilities and services should be available so that customers can experiment and consider if system meets their requirements
Global coverage	A service should not be restricted to the subscribers and resources of a single communications service provider/network operator
Homogeneous service e2e	Operators participating in service delivery should have a common view of the attributes to be met
Automated replicability	A product/service/experiment should be automatically replicated in other regions or instantiated over time
Flexible cost/revenue sharing agreements	Billing systems should support a wide range of revenue sharing and cost splitting agreements
Flexible way of SLA definition and billing	Customer to define SLA terms and get a quote
Real-time resource monitoring	Resource and capability monitoring mechanism should be in place
Reporting	At the end of the experimentation and for each experiment a detailed report should be available of the results and used resources and capabilities.
Community	5G knowledge building by allowing experiment results to be shared

License management	Experimenters that want to onboard VNFs from third parties should be able to supply license details or where these can be retrieved from
Experiment scheduling	Customers should be able to define when an experiment will take place and see an overview of other planned experiments
User Device access control	Customers may want to restrict the set of participants in the experiments
Open documentation	The experiment results and other reports can be made available and shared with registered and unregistered users.
Feedback mechanism	Customer feedback on the experience perceived and trouble-shooting tickets can support facility owners to improve their offers and other users to have justifiable levels of trust to the system.
Slice Control	In some case the Customer (vertical or complementor) could need to manage and control dynamically parameters for the service instantiation (for instance the location to instantiate a specific VNF, modify the latency and bandwidth at run time, etc.)

4.1 Secure universal login

A customer access to the platform should be available to know who can log-in and allow new accounts to be created. This access should be authorised in order for each member to have a personalised view of past transactions and pending items. Furthermore, actions performed should be based on the privileges associated to the role(s) taken by this account. Monitoring of those actions is also needed in order to be able to trace back who and when issued a command. Last, but not least, the accounts should be valid across all the members of a federation in order to simplify the user journey, which requires special east-west interfaces to be in place for offline account synchronisation.

From the following two tables we see that all personae, both internal and external, would need the universal login feature.

Table 14: The external personae that need the universal login feature and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
A2, C1	A1	A2	A1	A1	A2, A3

Table 15: The internal personae that need the universal login feature and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
A1, C2	A1	A1, D1	A1, A2, C1	A1, A5	A2

The following figures provide a statistical analysis of the responses to an online survey on how verticals would like to interact with 5G-VINNI and in particular questions related to universal login.

According to Figure 30, some 40% of respondents would prefer to interact with 5G-VINNI in an online fashion (either via a 5G-VINNI portal or by integrating their existing backend systems with 5G-VINNI systems through APIs). On the other hand, half of participants would prefer to plan their experiments during face-to-face meetings with 5G-VINNI representatives and via offline communication (e.g., email exchange).

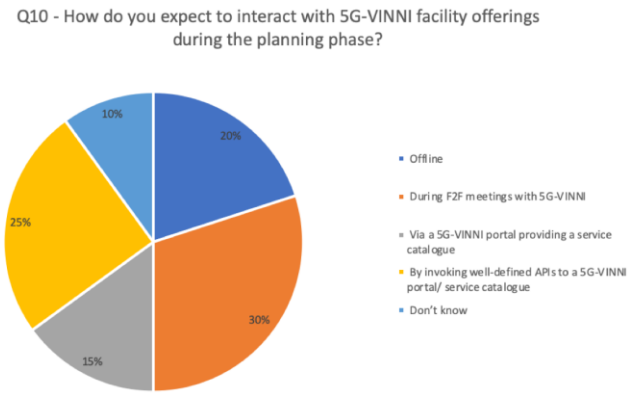

Figure 30: Preferred way of interacting with 5G-VINNI during the planning phase

This is an interesting finding that could be attributed to lack of familiarity with 5G-related technologies, and consequently, the need for training sessions. Nevertheless, it seems that participants would still need to use their own accounts when experimenting with 5G-enabled solutions. This is evident from Table 16, below, where only 5% of participants (a single one in

absolute terms) would prefer to plan and track the status of the experiments in an off-line manner (the cell marked with grey background colour).

Table 16: Contingency table for way of interaction during planning phase and way of monitoring experiment status

		Way of interaction during planning phase					
		Offline	During F2F meetings with 5G-VINNI	By invoking well-defined APIs to a 5G-VINNI portal/ service catalogue	Via a 5G-VINNI portal providing a service catalogue	Don't know	**Grand Total**
Way of monitoring experiment status	Automatically	0%	15%	10%	10%	0%	**35%**
	Don't know	5%	0%	5%	0%	10%	**20%**
	Manually	10%	15%	10%	5%	0%	**40%**
	Offline	**5%**	0%	0%	0%	0%	**5%**
	Grand Total	**20%**	**30%**	**25%**	**15%**	**10%**	**100%**

The need for universal login across 5G-VINNI facility sites/domains as a way to improve user experience is also analysed in the figure on the right (Figure 31). We observe that:

- some 40% respondents plan to run experiments on multiple (2-3) 5G-VINNI facility sites;
- 45% of participants shall use a single facility site only (e.g., the closest one);
- 15% of the sample haven't decided yet;
- no respondents plan to use all four facility sites.

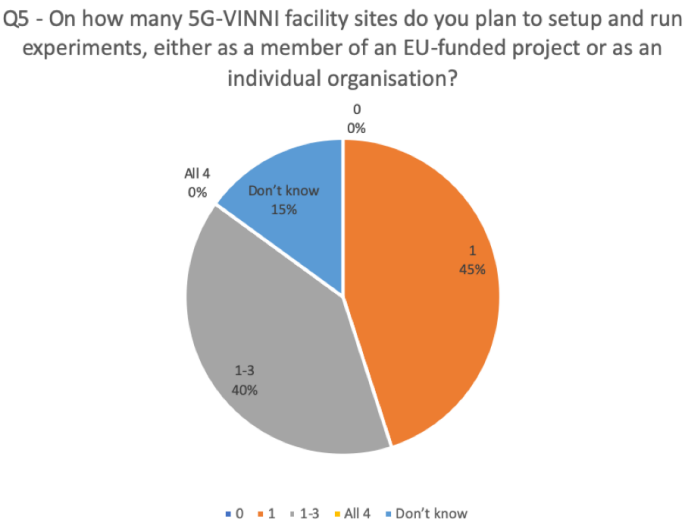

Figure 31: Number of 5G-VINNI facility sites to run experiments on

As depicted in Figure 32, the majority of experimenters (namely 65%) plan to have business agreements with a single facility site, while 10% haven't decided yet. The rest of respondents, which account of about 25% of sample size, plan to have business relationships with more than one facility sites. It is expected that universal login will improve the user experience of this latter group, as they don't need to have separate accounts for each individual facility site.

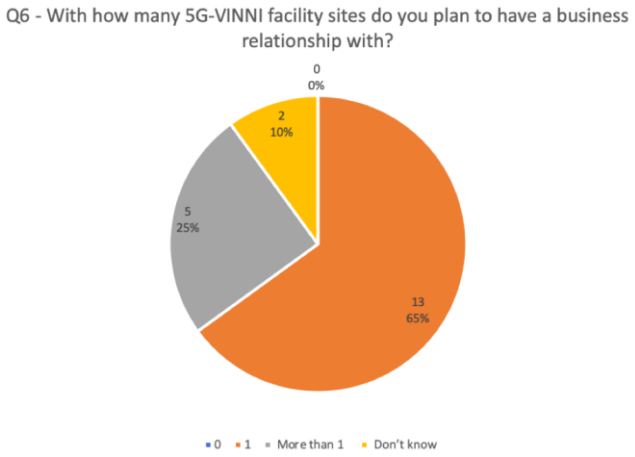

Figure 32: Number of 5G-VINNI facility sites to have a business relationship with

Figure 33 takes a broader perspective, where the interest to run experiments in other pre-commercial 5G facilities (either exclusively or at the same time with 5G-VINNI ones). We observe that:

- Some 45% respondents will be experimenting on one or more ICT17 projects (e.g., 5G-EVE and/or 5GENESIS);
- 35% of participants will run experiments on 5G-VINNI only;
- 20% of respondents haven't decided yet.

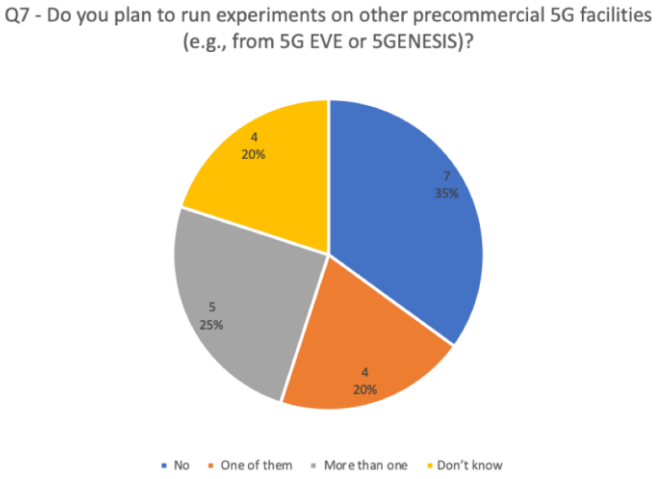

Figure 33: Number of other pre-commercial 5G facilities (e.g., from 5G EVE or 5GENESIS) to run experiments on (apart from 5G-VINNI)

Thus, having standardised interfaces for exchanging credentials or authenticating and authorising user access, such as Federated ID Management API of TMForum OPEN API initiative, could be useful.

Apart from universal login, the need to support multiple roles is analysed in Figure 34 on the right. Assuming that each experiment consists of four individual phases (plan, setup, execution and analysis), we observe that:

- no respondent expects that a single person from her organisation will be responsible for all aspects of the experiments;
- most of respondents (60% of sample) stated that 2-4 individuals will be involved;
- some 35% of respondents expect that more than 4 persons shall be involved;
- 5% haven't decided yet.

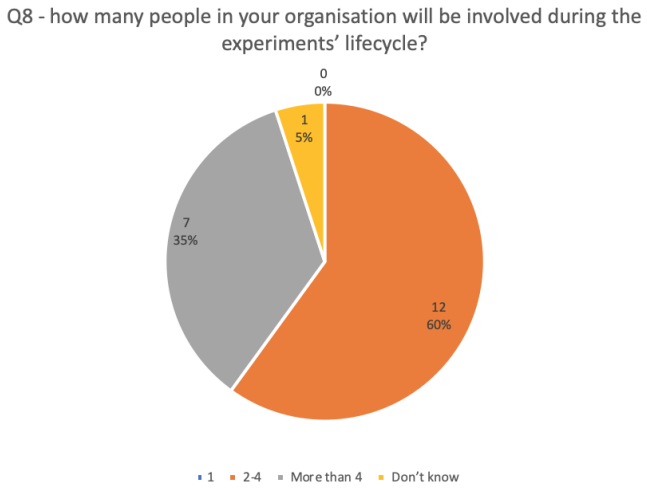

Figure 34: Number of people in your organisation that will be involved during the experiments' lifecycle

Thus, the great majority (95%) of experimenters will need multiple accounts, which indicates that different persons will have different roles. These preferences are further broken down as follows with respect to collaboration with 3rd parties:

i. 55% of them will probably be relying on 3rd parties
ii. 35% of the experimenters will definitely be relying on 3rd parties
iii. 5% don't know if they will be relying on 3rd parties and the rest 5% don't know if multiple accounts will be necessary

Table 17: Contingency table for number of envisaged accounts and number of 3rd parties involved (% of grand total)

		NUMBER OF ACCOUNTS			GRAND TOTAL
		Don't know	More than 4	2-4	
NUMBER OF 3rd PARTIES	Don't know	5%	0%	5%	**10%**
	Probably yes	0%	25%	30%	**55%**
	Yes	0%	10%	25%	**35%**
Grand Total		**5%**	**35%**	**60%**	**100%**

When table above is recalculated so that columns add to 100%, we get the following table.

We observe that, 100% of respondents who need >4 accounts are positive in collaborating with 3rd parties, while 92% of those who need up to 4 accounts find collaboration with 3rd parties as useful.

Table 18: Contingency table for number of envisaged accounts and number of 3rd parties involved (% of each column)

		NUMBER OF ACCOUNTS			GRAND TOTAL
		Don't know	More than 4	2-4	
NUMBER OF 3rd PARTIES	Don't know	100%	0%	8%	**10%**
	Probably yes	0%	71%	50%	**55%**
	Yes	0%	29%	42%	**35%**
Grand Total		**100%**	**100%**	**100%**	**100%**

4.2 Global Service Catalogue

A service catalogue should include all the 5G-VINNI facility offerings that are available and accessible to vertical customers (e.g. enterprises). These offerings can originate from the customer-facing provider, her peers (e.g., those providers that participate in the federation) and 3rd-party providers. Furthermore, these services can refer to communication services, Software (as a Service) and consultancy among others.

The following two tables gives an overview of the external and internal personae that would need access to a global service catalogue.

Table 19: The external personae that need access to a global service catalogue and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
		B1			A1, A2, A3

Table 20: The internal personae that need access to a global service catalogue and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
		D3		C1	A2

Table 21 below shows the contingency table for the responses of individuals on the number of facility sites to be used (columns) and number of business agreements (rows). We observe that 15% of respondents to the small-scale online survey would use more than one facility sites but would prefer to have a single business relationship (corresponding cell is emphasized and highlighted with grey colour). This is an interesting finding and driver for a facility site/MNO (or a third party) to act as intermediary (or a customer-facing provider) and maintain a global service catalogue. Furthermore, we notice that one participant (representing 5% of sample) will perform experiment on a single facility site but plans to have business relationships with more than one provider. As will be analysed later on, a candidate explanation is that this participant plans to recruit actual users during (some of) her experiments and these will come from multiple MNOs.

Table 21: Contingency table for the responses of individuals on the number of facility sites to be used (columns) and number of business agreements (rows)

		NUMBER OF FACILITY SITES			
		1	1-3	Don't know	**Grand Total**
NUMBER OF BUSINESS AGREEMENTS	1	40%	**15%**	10%	**65%**
	Don't know	0%	5%	5%	**10%**
	More than 1	5%	20%	0%	**25%**
	Grand Total	**45%**	**40%**	**15%**	**100%**

As evidenced from the following table, all types of vertical customers plan to have more than one business agreement regardless of the number of their employees, while medium -sized organisations seem to be less interested in doing so.

Table 22: Correlating responses based on size of organisation and number of business agreements

		SIZE OF ORGANISATION (BY NUMBER OF EMPLOYEES)			
		small (<=200)	medium (201-1000)	large (>1001)	**Grand Total**
NUMBER OF BUSINESS AGREEMENTS	1	30%	5%	30%	65%
	Don't know	5%	0%	5%	10%
	More than 1	5%	5%	15%	25%
	Grand Total	**40%**	**10%**	**50%**	**100%**

According to Figure 30 above, some 40% of respondents would prefer to interact via a portal. By drilling down those responses according to their role we found that a) 100% of administration & product management prefer offline, b) Only 40% of tech-savvy users (R&D, IT, technology analysis) prefer interacting online and c) 100% of non-business entities prefer interacting online (marked with grey, light green and orange background colour respectively).

Table 23: Contingency table of role and preferred interaction type

		PREFERRED INTERACTION TYPE					
		Don't know	Offline	During F2F meetings	By invoking APIs	Via a 5G-VINNI portal	**Grand Total**
ROLE	Member of Administration	0%	5%	5%	0%	0%	**10%**
	Member of Information Technology Department	0%	0%	5%	0%	0%	**5%**
	Member of Product management or development	0%	0%	5%	0%	0%	**5%**
	Member of Research and Development Department	10%	10%	10%	15%	10%	**55%**
	Member of Technology analysis or development	0%	0%	5%	0%	5%	**10%**
	Not part of a business entity	0%	0%	0%	10%	0%	**10%**
	Other role	0%	5%	0%	0%	0%	**5%**
	Grand Total	**10%**	**20%**	**30%**	**25%**	**15%**	**100%**

4.3 Assisted customer access

Users should be assisted when interacting with a facility site during each phase of experiment or service lifecycle by receiving notifications when certain events take place. For example, Sandra the Service Manager, needs to know when the technical feasibility of a newly defined experiment has been concluded and a quote for the SLA terms asked is available.

The following two tables gives an overview of the external and internal personae that would need assisted customer access.

Table 24: The external personae that need assisted customer access and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
B1, B2, B3				A3, A4	

Table 25: The internal personae that need assisted customer access and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
	B3	D2, F4		A3, A5, C2	

Figure 35 on the right shows that some 40% of respondents would like to manually ask for status updates (e.g., by visiting a special-purpose experiments' status webpage) and an additional 35% to get updates automatically (e.g., by receiving system-generated alerts/ notifications about selected experiment status changes). Furthermore, 20% of participants were uncertain, while 5% would prefer offline communication (e.g., to receive an email/ call by a 5G-VINNI facility manager).

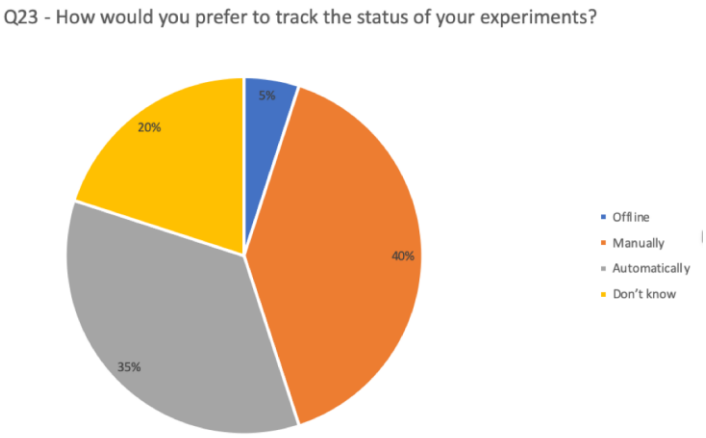

Figure 35: Preferences regarding how experiments' status should be tracked

Respondents were then asked to elaborate on their preferences for what experiment status events should be tracked. Figure 36 reveals that confirmation events for successful events are the most popular amongst all notification types (chosen by 75% of participants), closely followed by error notifications and other informative messages (selected by 65% and 60% respectively). Finally, 3 respondents did not indicate preferences for any of the notification types.

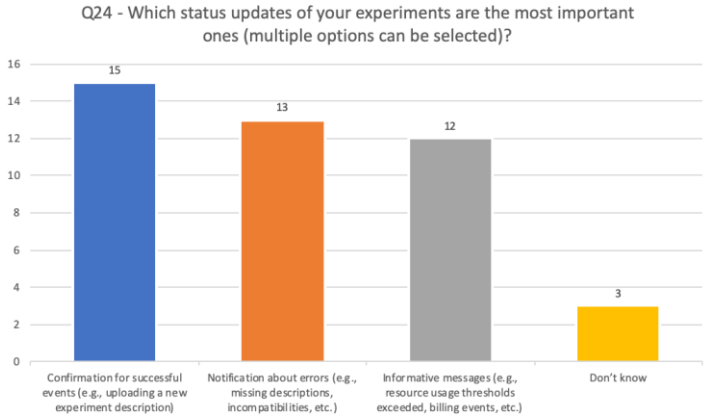

Figure 36: Preferences for what experiment status events should be tracked

In our effort to get insights about how different groups of individuals prefer to be informed about changes to their orders in 5G-VINNI, we found that a) the only group that would prefer to be informed offline is under the "rest roles", b) 79% of tech-savvy users (Research & Development/R&D, IT, technology analysis) and 66% of non-business entities prefer interacting online, either manually or automatically (marked with light green, grey and orange background colour respectively).

Table 26: Contingency table of role and preferred way of tracking order status

		PREFERRED WAY OF ORDER STATUS TRACKING				
		Don't know	**Offline**	**Manual**	**Automatic**	**Grand Total**
ROLE IN ORGANISATION	Member of Administration	5%	0%	0%	5%	**10%**
	Member of Information Technology Department	0%	0%	0%	5%	**5%**
	Member of Product management or development	0%	0%	5%	0%	**5%**
	Member of Research and Development Department	15%	0%	25%	15%	**55%**
	Member of Technology analysis or development	0%	0%	5%	5%	**10%**
	Not part of a business entity	0%	0%	5%	5%	**10%**
	Other role	0%	5%	0%	0%	**5%**
	Grand Total	**20%**	**5%**	**40%**	**35%**	**100%**

4.4 Global coverage

In many services the value perceived by consumers/end-users depends on the number of end-users reached (positive network externalities) or ability to roam. For this reason, a service should not be restricted to the subscribers and resources of a single communications service provider/network operator.

The following two tables gives an overview of the external and internal personae that would need global coverage.

Table 27: The external personae that need assisted global coverage and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
				B1	

Table 28: The internal personae that need assisted global coverage and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
					A1

Figure 37 on the right investigates to what extent participants intend to run experiments with real users (e.g., selected customers or employees). We found that:

a) some 45% of respondents will probably recruit actual users;
b) 35% of participants see great value in getting feedback from real users;
c) 10% most likely will not involve users;
d) 5% will not recruit users, and
e) 5% of respondents haven't decided yet.

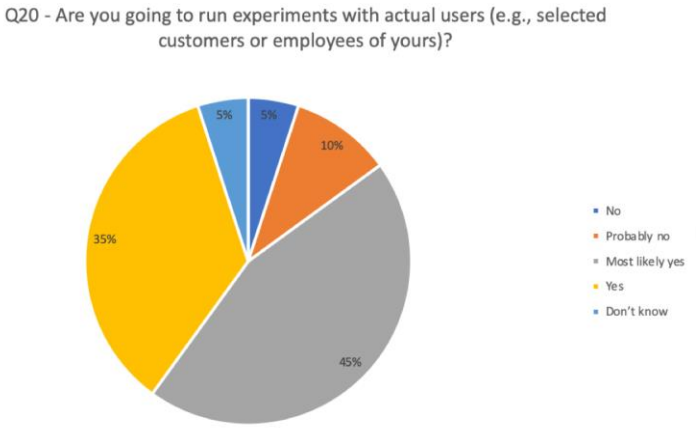

Figure 37: Intention to run experiments with actual users

Then, we asked the participants whether the users recruited will originate from one or more operators. Figure 38 shows that some 30% of respondents will either involve, or most likely do so. On the other hand, 60% of participants to the online survey will either recruit users from a single operator, or most probably follow this approach. Finally, 10% of respondents haven't decided yet.

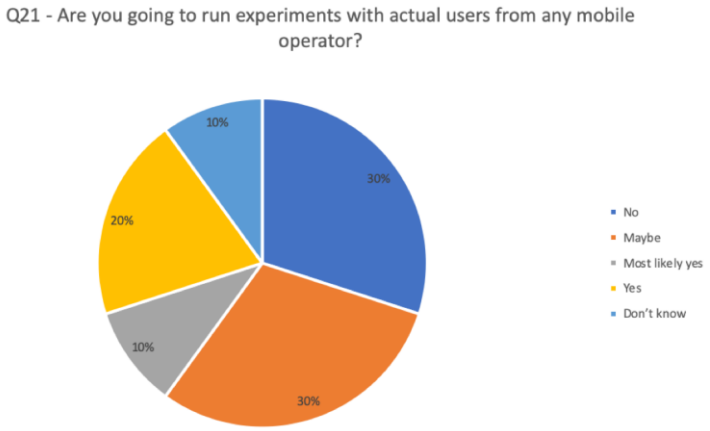

Figure 38: Intention to run experiments with actual users from several mobile communication service providers

The following contingency table combines the responses regarding the presence (or not) of actual users and the number of MNOs serving those users. We observe that those who tend to involve users from multiple MNOs indeed see value in getting feedback from actual users (these respondents are placed on the bottom-right quadrant and marked with grey background colour).

Table 29: Contingency table regarding the presence (or not) of actual users and the number of MNOs serving those users

		EXPERIMENTS WITH ACTUAL USERS					
		Don't know	No	Probably no	Most likely yes	Yes	**Grand Total**
ACTUAL USERS FROM MULTIPLE MNOs	Don't know	5%	0%	0%	0%	5%	**10%**
	No	0%	5%	10%	5%	10%	**30%**
	Maybe	0%	0%	0%	20%	10%	**30%**
	Most likely yes	0%	0%	0%	10%	0%	**10%**
	Yes	0%	0%	0%	10%	10%	**20%**
	Grand Total	**5%**	**5%**	**10%**	**45%**	**35%**	**100%**

4.5 Flexible cost/revenue sharing agreements

A vertical organisation should be allowed to sponsor services and equipment, such as unlimited voice plans or compatible 5G picocells, to its customer base as part of a promotion or a bundle. In such cases, the service recipient differs from service payer. Similarly, federated/collaborative service provisioning require flexible cost and revenue sharing (e.g., for deploying a common 5G infrastructure and supporting roaming users).

The following two tables gives an overview of the external and internal personae that would welcome support for flexible revenue sharing arrangements.

Table 30: The external personae that need flexible revenue sharing arrangements and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
				B1	

Table 31: The internal personae that need flexible revenue sharing arrangements and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
					B2, C3, C4

As the online survey targeted vertical organisations, who are expected to be paid by their customers, in the following we will focus on cost sharing only. Figure 39, below, depicts the need for flexible cost sharing schemes.

Based on the responses obtained, we observe that:

a) almost half of participants (55%) haven't decided yet;
b) some 30% of respondents have recognised this need. In particular 20% of the sample would prefer 5G-VINNI to perform cost allocation in a fair manner, while the rest 10% would split the bill internally.
c) 15% of the participants don't plan to share the experiment costs.

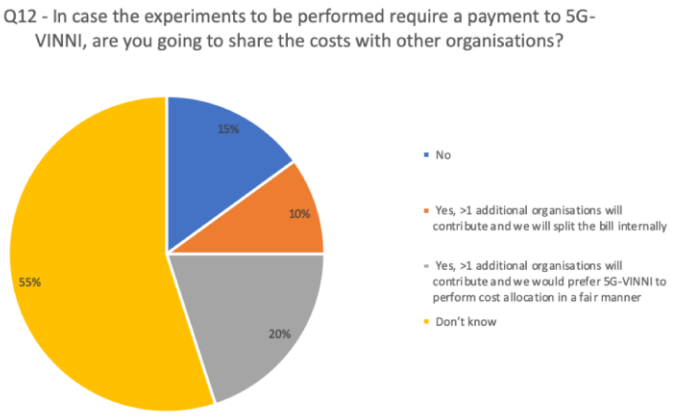

Figure 39: The need for sharing experiments' cost with other organisations

From the contingency table below, we observe that those participants 100% of those that don't know if they will be relying on 3rd parties, don't know if cost sharing will be needed as well. Vice versa, 100% of those that believe will need to share the costs, plan to collaborate with 3rd parties. These results validate the consistency of the responses we got and the belief that viable business relationships are not fully explored, yet.

Table 32: Contingency table for presence of 3rd parties and cost sharing preferences (% of grand total)

		PRESENCE OF 3RD PARTIES			
		Don't know	Probably yes	Yes	**Grand Total**
COST SHARING PREFERENCES	Don't know	10%	20%	25%	**55%**
	No	0%	10%	5%	**15%**
	Yes, >1 additional organisation will contribute, and we will split the bill internally	0%	5%	5%	**10%**
	Yes, >1 additional organisation will contribute, and we would prefer 5G-VINNI to perform cost allocation in a fair manner	0%	20%	0%	**20%**
	Grand Total	**10%**	**55%**	**35%**	**100%**

4.6 Homogeneous service end-to-end

Vertical organisations should obtain consistent experience, even in the case of federated/collaborative service provisioning. Thus, operators participating in service delivery should have a common view of the attributes to be met. The following tables give an overview of the external and internal personae that would welcome support for homogeneous service across administrative domains and regions.

Table 33: The external personae that need homogeneous service end-to-end and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
				A3	

Table 34: The internal personae that need homogeneous service end-to-end and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
		E2		B2	A1, C4

Figure 40 presents the interest for different types of network slice types supported by 5G-VINNI. We observe that:

a) in total 50% of participants would need custom (10%) or non-standard network slices (40%)
b) some 35% would need standard network slices
c) 15% of respondents did not know at the time of survey.

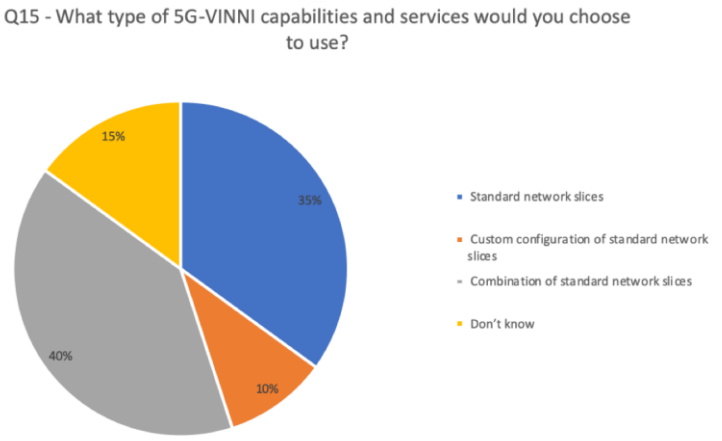

Figure 40: Interest in 5G-VINNI communication services

The following contingency table shows that 20% of the sample size expect that standard network slice types will not be enough, and at the same time, they will need to run experiments on more than one facility sites (marked with grey background colour). This means that homogeneous end-to-end service is needed.

Table 35: Contingency table for preferred slice types and number of additional facility sites apart from 5G-VINNI (% of grand total)

		SLICE TYPES				
		Don't know	Standard network slices	Combination of standard network slices	Custom configuration of standard network slices	**Grand Total**
NUMBER OF FACILITY SITES	Don't know	5%	5%	5%	0%	**15%**
	1	5%	15%	15%	10%	**45%**
	More than 1	5%	15%	20%	0%	**40%**
	Grand Total	**15%**	**35%**	**40%**	**10%**	**100%**

In our effort to get insights about how different groups of individuals prefer to be informed about changes to their orders in 5G-VINNI, we found that 66% of non-business entities believe that standard network slices will not be enough, while 44% of tech-savvy users (R&D, IT, technology analysis) share this opinion (marked with grey and light green background colour respectively). Furthermore, 100% of the rest participants (shown with orange colour) expect that customisations will be necessary.

Table 36: Contingency table of role and preferred network slice types

		PREFERRED NETWORK SLICE TYPES				
		Don't know	Standard network slices	Combination of standard network slices	Custom configuration of standard network slices	Grand Total
ROLE	Member of Administration	0%	5%	5%	0%	10%
	Member of Information Technology Department	0%	5%	0%	0%	**5%**
	Member of Product management or development	0%	0%	0%	5%	**5%**
	Member of Research and Development Department	15%	20%	15%	5%	**55%**
	Member of Technology analysis or development	0%	5%	5%	0%	**10%**
	Not part of a business entity	0%	0%	10%	0%	**10%**
	Other role	0%	0%	5%	0%	**5%**
	Grand Total	**15%**	**35%**	**40%**	**10%**	**100%**

4.7 Open to external suppliers

A platform ecosystem where new, trustworthy capabilities are added by third parties increases the value of consumers (due to variety, time-to-market etc.), creates new revenue streams for platform operator, as well as, a new channel for suppliers. Thus, a service catalogue should include capabilities and other services (e.g. VNFs) by other facility sites and complementors.

The following tables give an overview of the external and internal personae that would welcome support for third-party solutions and services to be ordered, deployed, managed and decommissioned.

Table 37: The external personae that need a 5G platform to be open to external suppliers and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
		B1			A2, A3

Table 38: The internal personae that need a 5G platform to be open to external suppliers and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
				B1	B1

Figure 41 on the right suggests that:

a) no respondent excludes the possibility of collaborating with third parties;
b) 55% of experimenters most probably will collaborate with 3rd parties;
a) 35% of experimenters will seek assistance from 3rd parties; and
c) 10% haven't decided yet.

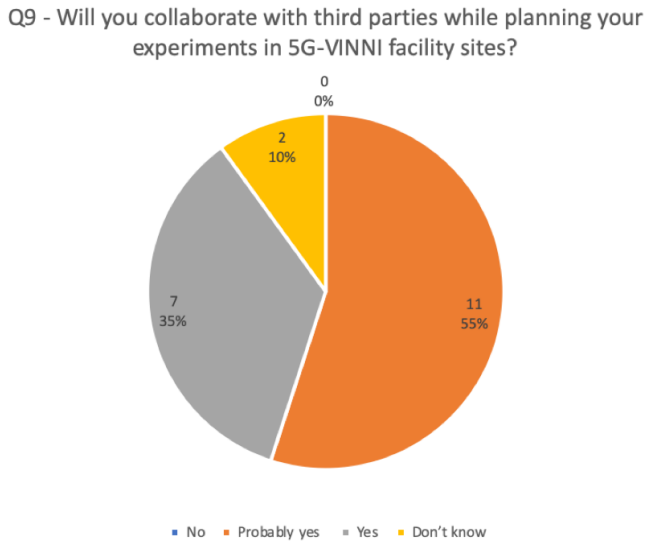

Figure 41: Collaboration with third parties during the experiments' lifecycle

The following table shows that all (100% of) respondents from Digital retail, eHealth, Manufacturing, Media/Entertainment, Public safety, Smart cities and transportation and Utilities would use 3rd parties. For the rest industries, a subset of participants has not decided yet, but in any case, no one excludes this possibility.

Table 39: Contingency table for intention to rely on 3rd parties and main vertical industry (% of grand total)

		INTENTION TO RELY ON 3RD PARTIES			
		Don't know	Probably yes	Yes	**Grand Total**
MAIN VERTICAL INDUSTRY (by revenues)	Digital retail	0%	0%	5%	5%
	eHealth	0%	5%	5%	10%
	Manufacturing	0%	0%	5%	5%
	Media/Entertainment	0%	10%	0%	10%
	Not part of a business entity	0%	10%	0%	10%
	Other industry	5%	5%	10%	20%
	Public safety	0%	5%	0%	5%
	Smart agriculture/aquaculture	5%	10%	5%	20%
	Smart cities and transportation	0%	5%	0%	5%
	Utilities	0%	5%	5%	10%
	Grand Total	**10%**	**55%**	**35%**	**100%**

Figure 42 on the right examines the interest in using 3rd-party features, such as VNFs and VAFs. We observe that:

a) some 10% of respondents will rely upon capabilities offered either by facility sites or own ones;
b) almost 1/3 of the sample would use 3rd-party features, but only if certified by 5G-VINNI;
c) the rest 55% of participants are not sure yet.

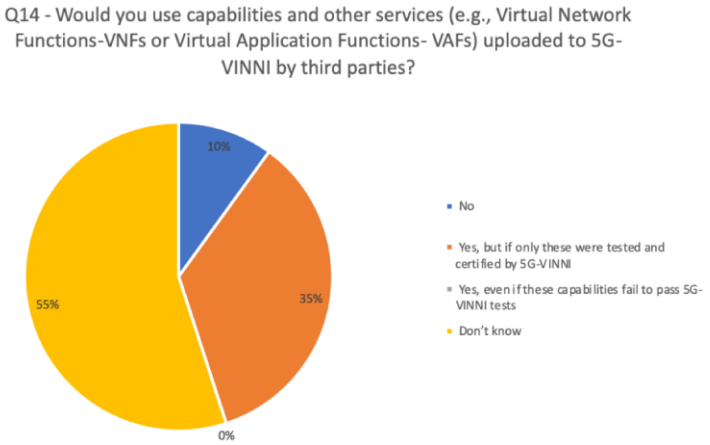

Figure 42: Interest in using 3rd-party features

4.8 Pick and choose

Capabilities and services should be available so that vertical customers and aggregators/brokers can compose new, chained services to cater to their needs and business model. This is similar to the cloud market where verticals can compose services and pay only for what the get.

The following table gives an overview of the external personae that would welcome the ability of selecting the services to be combined for meeting their expectations.

Table 40: The external personae that need to choose the services to be consumed and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
	B1			A3	A1, A2, A3

Similarly, the following table gives an overview of the internal personae that would need freedom to choose the solutions and services to be used:

Table 41: The internal personae that need to choose the services to be consumed and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
B2		F1		A2	

According to Figure 30 above (pp.59), some 40% of respondents would prefer to interact via a portal, while Figure 42 above (pp.74) suggests that 35% of participants would use 3rd-party features, but only if were certified. The following table gives the percentage of all participants for each pair of options. We observe that 100% (10%/10%) of those that don't plan to use third parties would prefer to interact with 5G-VINNI facility sites in an offline manner (e.g., by email or during face-to-face meetings). These pairs are marked with grey colour. On the other hand, 57% (20%/35%) of participants who would use 3rd-party features and services plan to use self-service schemes (these options are marked with orange colour). Finally, 36% (20%/55%) of the respondents that hadn't decided whether 3rd party services will be useful, would prefer to use a 5G-VINNI portal or relevant APIs (marked with light blue colour).

Table 42: Contingency table for preferred interaction type and intention to use 3rd party features (% of grand total)

		PREFERRED INTERACTION TYPE					
	Row Labels	Don't know	Offline	F2F meetings	5G-VINNI portal	APIs	**Grand Total**
INTENTION TO USE 3rd PARTY FEATURES	Don't know	5%	10%	20%	5%	15%	**55%**
	No	0%	5%	5%	0%	0%	**10%**
	Yes, but if only these were tested and certified by 5G-VINNI	5%	5%	5%	10%	10%	**35%**
	Grand Total	**10%**	**20%**	**30%**	**15%**	**25%**	**100%**

4.9 Experiment

Vertical organisations are often technology agnostic (and have such advisers) and will need experimentation to consider if 5G is the right solution for them. Thus, capabilities and services should be available so that customers can easily experiment and consider if it meets their requirements

The following two tables give an overview of the external and internal personae that would welcome the ability to define and run experiments.

Table 43: The external personae that need to experiment with 5G technologies and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
	B1			A3	C1, C2, C3

Table 44: The internal personae that need to experiment with 5G technologies and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
B2		F2	A2	A1	C1

Figure 43 on the right sheds some light on the way vertical organisations will be experimenting. We observe that:

a) no participant expects that a single iteration will be enough;
b) 45% of participants plan to run about three iterations of each experiment;
c) 35% of respondents believe that many iterations will be necessary, and
d) 20% of the sample size haven't decided yet.

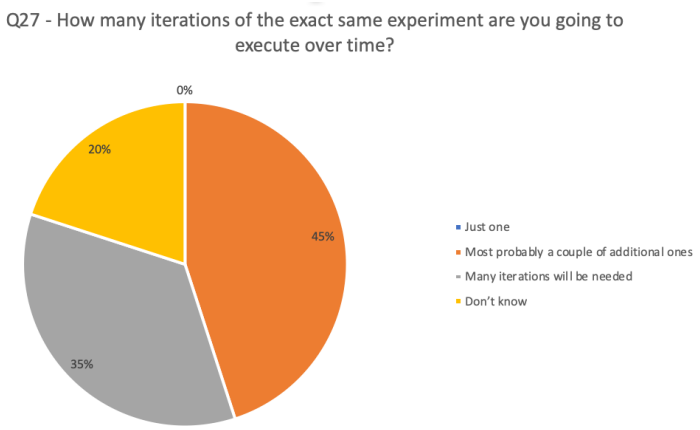

Figure 43: Intended number of iterations per experiment

4.10 Automated replicability

After performing one or more iterations of an experiment and gaining insights on the performance, usability, efficiency etc. of the solution under study, a set of further iterations may be required in order to understand the sensitivity of key performance indicators to different geographical regions (where a different mix of users is present) or periods in time. For this reason, and in order to reduce complexity and time to market, a product/service/experiment should be automatically replicated in other regions or instantiated over time.

The following two tables give an overview of the external and internal personae that would welcome support for automated replicability.

Table 45: The external personae that need to automatically replicate experiments and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
	B1			A3	C3

Table 46: The internal personae that need to automatically replicate experiments and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
B2		F1, F2		A2	

Figure 44 on the right suggests that:

a) some 25% of respondents will not replicate their experiments to other sites;
b) another 30% of the sample don't plan to verify the results on other facility sites;
c) 25% of participants expect to replicate the exact same experiment on several facility sites
d) 5% of participants will replicate the experiments, while
e) 15% haven't decided yet.

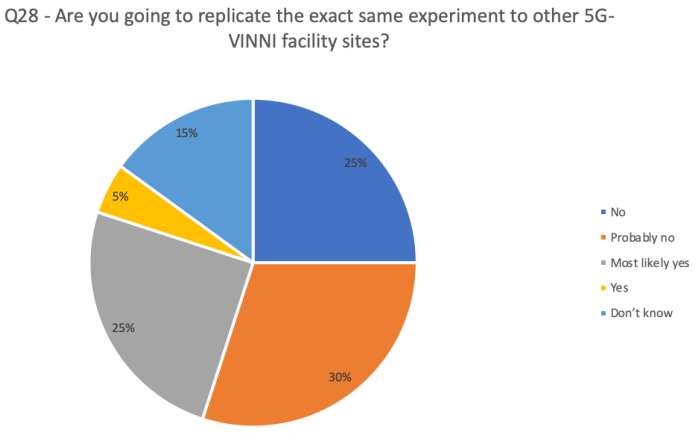

Figure 44: Intention to replicate an experiment to other 5G-VINNI facility sites

4.11 Community

Exchange of knowledge, such as best practices obtained from previous experiments, troubleshooting, etc. could be useful for new potential customers, who have limited experience with 5G onboarding processes.

The following table gives an overview of the external personae that would welcome the ability to share with others the knowledge obtained and seek assistance from their peers and other experts.

Table 47: The external personae that need to interact with other community members and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
A2, B2, B3, B4	A5	A2	C1, C2		A2

Similarly, the following table gives an overview of the internal personae that would value the ability to form a community with other members:

Table 48: The internal personae that need to interact with other community members and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
A1, B2, C1	B2, C2	A3	B1, B3	A1, A5	

Figure 45 on the right investigates whether participants intend to share experiment results with other organisations. We observe that:

a) 15% of respondents would not publish best practices or insights gained from experiments (e.g., fearing that this would threaten their "first mover" advantage);
b) 5% of users consider that the knowledge obtained will not be useful to other vertical organisations;
c) 65% of participants would share the knowledge obtained with other organisations, and
d) 15% of participants haven't decided yet.

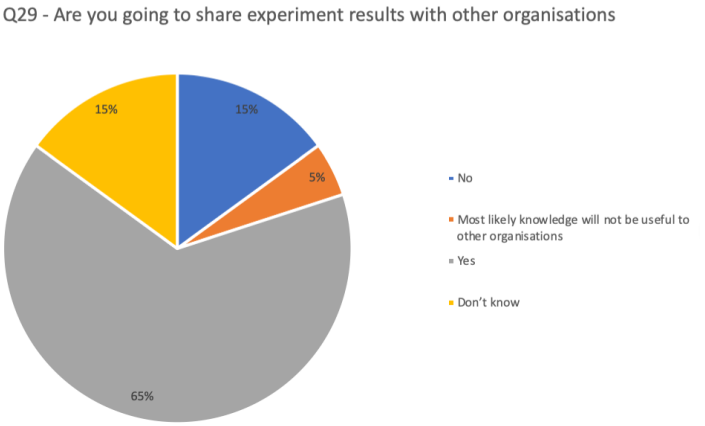

Figure 45: Intention to share experiment results with other organisations

4.12 Real-time performance monitoring

The following two tables give an overview of the external and internal personae that would welcome the ability to have granular and up-to real-time monitoring capabilities.

Table 49: The external personae that need advanced monitoring capabilities and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
			B2		C1

Table 50: The internal personae that need advanced monitoring capabilities and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
	A2, A3, B2, C2	C2, F3	B2	C1	

According to Figure 46 on the right:

a) 20% of respondents would prefer to see aggregate results after the experiment has concluded;
b) 10% of sample size would be happy to track the status of the experiments at the end of each day;
c) 10% of respondents would like to see hourly status updates;
d) 35% of participants would like real-time info about experiment status, and
e) 25% haven't decided at the time of completing the online questionnaire.

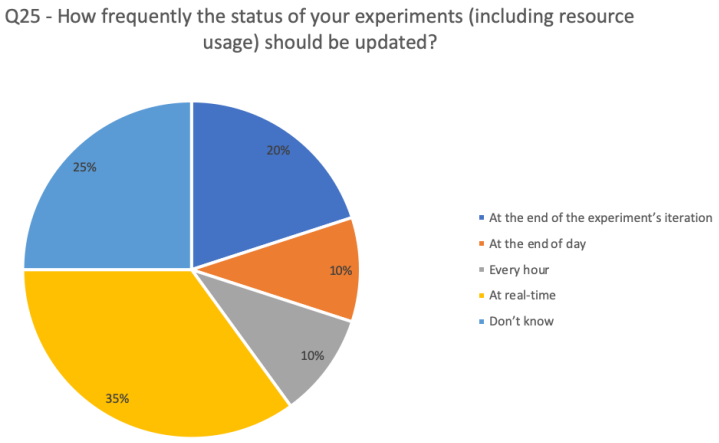

Figure 46: Preferences regarding frequency of experiment and resource status update

4.13 Reporting

At the end of the experimentation and for each experiment a detailed report should be available of the results and used resources and capabilities. These reports can support vertical organisations to take better decisions for the replication in the real world and to understand if they are meeting the required needs.

The following two tables give an overview of the external and internal personae that would welcome the ability to have detailed reporting capabilities.

Table 51: The external personae that need advanced reporting capabilities and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
A1, B1, B4, C1	A3, A4	C1		C1	C2

Table 52: The internal personae that need advanced reporting capabilities and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
A1, C1	A1, C1, C2	A3, B2, C2, F3	B1, B2, B3	A3, A4, C1, C2	C3

Figure 47 on the right presents a pie chart about the way experiment results will be analysed by vertical organisations. We observe that:

a) 30% of respondents expect their own applications to collect relevant data and generate custom reports;
b) 30% of sample size would like to have access to standard reports generated by 5G-VINNI;
c) 25% of participants would expect to see custom 5G-VINNI reports for analysing experiment results, while
d) 15% of experimenters haven't decided yet.

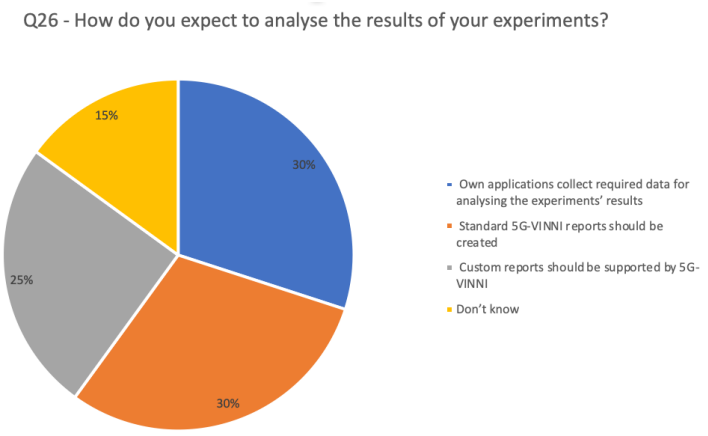

Figure 47: Expectations on how experiment analysis should be facilitated

4.14 Platform documentation

Users should have access to information, description, tutorials etc. on how they can use the 5G-VINNI platform. For example, it should include details about standards to be followed and examples to be considered when a SW developer uploads a new VNF or the Service manager orders a new experiment for testing a new service. Remember that according to Figure 30, half of participants would prefer to interact with 5G-VINNI facility sites during face-to-face meetings with 5G-VINNI representatives and via offline communication, which could be attributed to lack of training and experience.

The following table gives an overview of the external personae that would value the existence of documentation for interacting with the platform.

Table 53: The external personae that need platform documentation and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
B4	A2	A2	A1, C1, C2	A2	B1

Likewise, the following table gives an overview of the internal personae that would rely on an up-to-date system documentation:

Table 54: The internal personae that need platform documentation and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
A1, A2, C1	B1, B2, B3, C1, C2	A2, C1, E1, E3, F1	B1, B2, B3	A2	A2, B2, C3, C4

We observe that all personae, both internal and external, would consult system documentation while performing their tasks.

4.15 Feedback mechanism

Vertical customers should be able to provide their feedback on the experience they perceived and justify their view wherever needed. Special care is needed for the case of multi-provider services. This should help other users to choose the appropriate configuration and at the same time provide incentives to providers, especially those that do not support SLAs, for higher-quality services. Furthermore, they should be able to create tickets for trouble-shooting issues they face.

The following table gives an overview of the external personae that would welcome the ability to consult the reputation score of different providers during the service order phase, as well as provide their feedback after service provisioning.

Table 55: The external personae that need support for customer feedback and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
		B1		C2	B2

Similarly, the following table gives an overview of the internal personae that would value the ability of vertical customers to check and provide feedback:

Table 56: The internal personae that need support for customer feedback and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
	A1, B3, B4			A5	B1, C1

This requirement is related to the intention of a fair share of participants (65%) to share the knowledge obtained with other organisations. The next table analyses the percentage of participants choosing a certain pair of options regarding intention to use 3rd party services (columns) and share results (rows). We observe that 30% (20%/65%) of the respondents willing to share results would also use 3rd party features (relevant cell marked with grey colour). This means that the rest vertical organisations could draw conclusions on the performance that their peers have experienced.

Table 57: Contingency table for intention to use 3rd party features and intention to share results (% of grand total)

		INTENTION TO USE 3RD PARTY FEATURES			
		Don't know	No	Yes, but if only these were tested and certified	**Grand Total**
INTENTION TO SHARE RESULTS	Don't know	5%	5%	5%	**15%**
	No	5%	0%	10%	**15%**
	Most likely knowledge will not be useful to other organisations	5%	0%	0%	**5%**
	Yes	40%	5%	20%	**65%**
	Grand Total	**55%**	**10%**	**35%**	**100%**

4.16 Flexible way of SLA definition and billing

Figure 48 on the right examines to what extent vertical organisations would need an SLA with 5G-VINNI facility sites. Interestingly no participant eliminated the possibility of signing an SLA. Furthermore, 40% of participants would enter into an agreement but prefer 5G-VINNI to make a first offer. On the other hand, 25% would prefer to specify the terms to be included in the SLA. Finally, 35% of the sample size were unsure at that time.

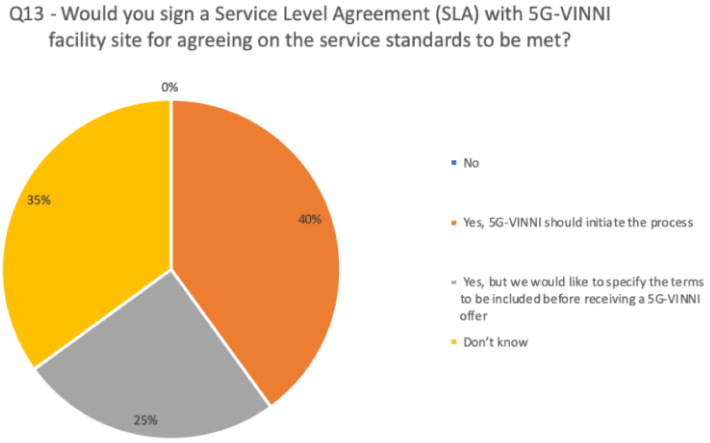

Figure 48: The need for SLAs

Table 58: Contingency table for preferences regarding SLAs and role in organisation (% of grand total)

		PREFERENCES REGARDING SLAS			
		Don't know	**Yes, 5G-VINNI should initiate the process**	**Yes, but we would like to specify the metrics**	**Grand Total**
ROLE	Member of Administration	10%	0%	0%	10%
	Member of Information Technology Department	0%	5%	0%	5%
	Member of Product management or development	0%	0%	5%	5%
	Member of Research and Development Department	20%	20%	15%	55%
	Member of Technology analysis or development	0%	5%	5%	10%
	Not part of a business entity	5%	5%	0%	10%
	Other role	0%	5%	0%	5%
	Grand Total	**35%**	**40%**	**25%**	**100%**

We observe that about 33% (5%/15%) of business experts (marked with grey colour) would sign an SLA, while 70% (50%/70%) of more technical roles (R&D, IT, technology analysis) would do so. This could be attributed to the rather technical nature of key performance indicators traditionally used in the telecommunications industry.

The following two tables give an overview of the external and internal personae that would welcome the ability to define the SLA terms that will govern service provision.

Table 59: The external personae that need support for SLA and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
	A5			A4	C3

Table 60: The internal personae that need support for SLA and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
	A1, B1, C2				C2

4.17 Slice Control

In some cases, the Customer (vertical organisation or third-party/complementor) needs to manage and control dynamically parameters for the service instantiation, for instance scale-up or down at run time, etc.). The following table gives an overview of the external personae that would welcome the ability of controlling slice instances.

Table 61: The external personae that need control of network slices and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
			A1, A2, B1, C1, C2		

Similarly, the following table summarizes the internal personae that see value in offering the ability to their customers to control slice instances:

Table 62: The internal personae that need control of network slices and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
		E1, E2			

Figure 49 on the right analyses the expectations of vertical representatives regarding control of underlying network conditions. We observe that:

a) 30% of participants would not want to determine themselves background traffic during their experiments;
b) 55% of respondents want to affect underlying network conditions by defining what/ when/ where events (e.g., physical infrastructure failures, virtual machine congestion) will be taking place
c) 15% of sample size haven't decided yet

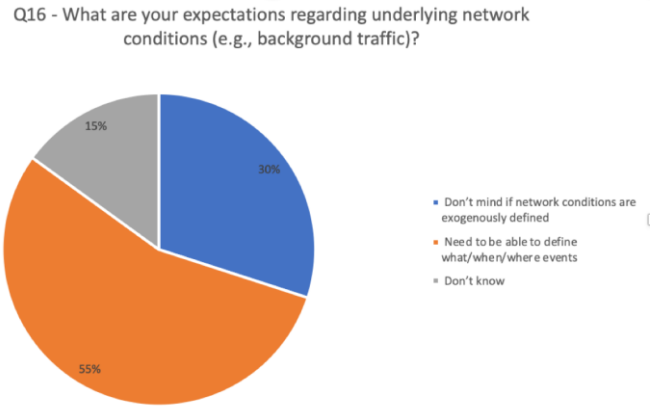

Figure 49: Expectations regarding underlying network conditions

The following table analyses together the preferences for affecting underlying network conditions and the way interacting with 5G-VINNI. We observe that:

- Those that haven't decided how they would prefer to interact with 5G-VINNI are uncertain also if they would like to be able to affect underlying network conditions (marked with grey colour).
- On the contrary, all of those that prefer to use a 5G-VINNI portal need to be able to define the network conditions (marked with orange colour);

- 75% of the participants who prefer offline interactions, don't mind if network conditions are exogenously defined, while the rest would like to be able to affect network conditions (marked with light blue colour);
- On the contrary, most (83%) of those that prefer to interact with 5G-VINNI during F2F meetings need to be able to define what/when/where events, while the rest don't mind if these are exogenously set (marked with pink colour).
- The participants that would like to invoke well-defined APIs (exposed by 5G-VINNI portal/ service catalogue) are ambivalent as 20% of them don't know, while the rest of them form two equally-sized groups of 40% (marked with violet colour)

Table 63: Contingency table for preferences on affecting underlying conditions and preferences on how to interact with 5G-VINNI (% of grand total)

		PREFERENCES ON AFFECTING UNDERLYING CONDITIONS			
		Don't know	Exogenously defined	Need to be able to define what/ when/ where events	**Grand Total**
PREFERENCES ON HOW TO INTERACT WITH 5G-VINNI	Don't know	10%	0%	0%	**10%**
	Offline	0%	15%	5%	**20%**
	During F2F meetings with 5G-VINNI	0%	5%	25%	**30%**
	Via a 5G-VINNI portal providing a service catalogue	0%	0%	15%	**15%**
	By invoking APIs to a 5G-VINNI portal	5%	10%	10%	**25%**
	Grand Total	**15%**	**30%**	**55%**	**100%**

The next two figures analyse vertical customers' expectations regarding network slices' dimensioning either during set-up or run-time phases.

From Figure 50 on the right, we observe that:

a) 40% of respondents would prefer network slice dimensioning to be performed by 5G-VINNI experts;
b) 40% of participants would like to get advanced 5G-VINNI Service Exposure Levels/SEL (2 and beyond) at setup phase, while
c) 20% of sample size haven't decided yet.

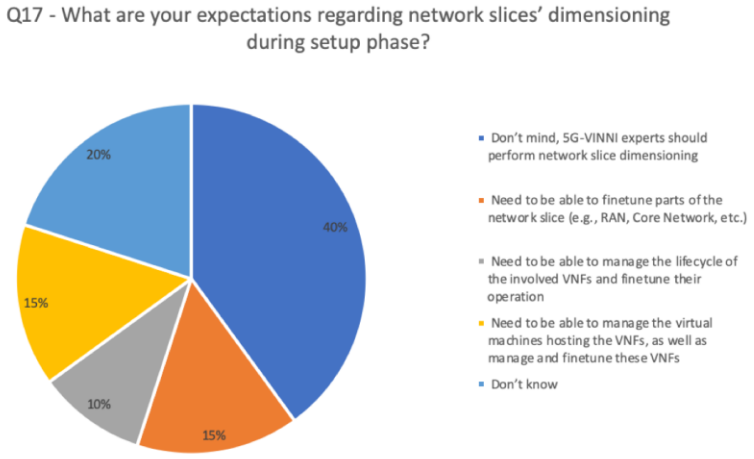

Figure 50: Expectations regarding network slices' dimensioning during setup phase

Similar results are obtained for run-time dimensioning of network slices (Figure 51). The main difference is that 10% of respondents who would like advanced SEL at set-up phase, were unsure about the need to do so at run-time. This could be attribute to the presence of SLAs, which ensure that after having dimensioned the facility site the agreed performance level will be maintained.

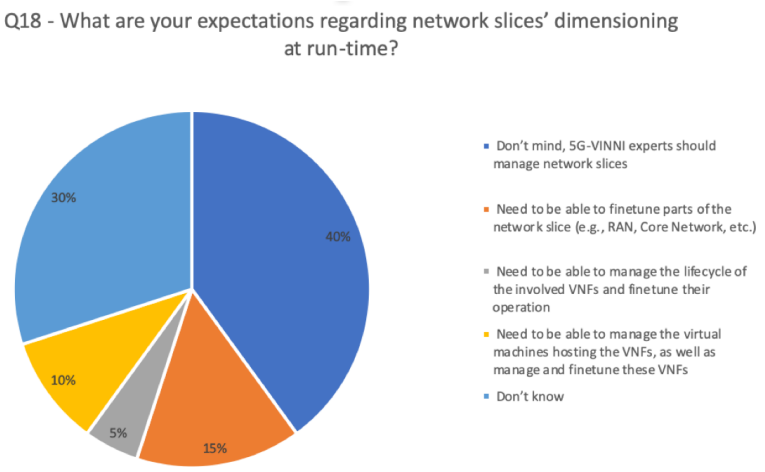

Figure 51: Expectations for network slices' management at runtime

4.18 License management

Experimenters that want to on-board VNFs from third parties should be able to supply license details or where these can be retrieved from.

The following two tables give an overview of the external and internal personae that would welcome the ability to simplify the process of managing licences for 3rd-party VNFs.

Table 64: The external personae that need support for VNF license management and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
B1					

Table 65: The internal personae that need support for VNF license management and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
	B2				B2

Figure 52 below, examines the preferences of the experimenters regarding the handling of license management.

Based on the responses obtained we observe that:

a) 50% of respondents would like 5G-VINNI either to act as a one-stop shop regarding licenses of 3rd party services (40%) or provide assistance only (10%).
b) some 40% haven't decided yet
c) 10% of participants believe that 5G-VINNI should not be involved at all

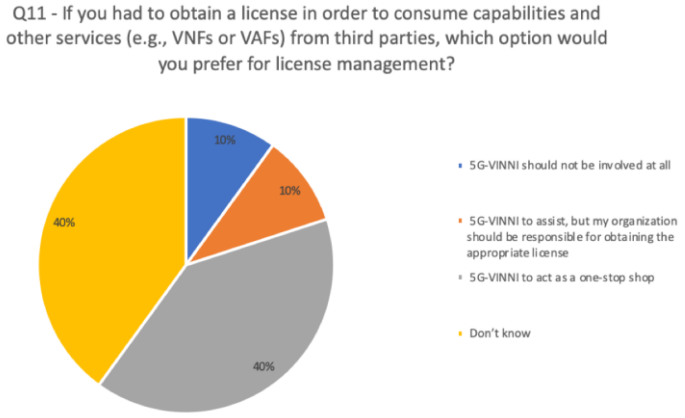

Figure 52: License management of external capabilities

4.19 Experiment scheduling

Figure 53, below, investigates to what extent vertical organisations would run concurrent experiments.

We observe that:

a) 5% of participants would need a dedicated facility site for the whole duration of their experiments (e.g., for performance, security etc.);
b) 10% of sample size would need dedicated network slice;
c) 25% of respondents expect to be able to choose when dedicated network slice is used (e.g., during the first experiments) and when not;
d) 40% of participants stated that they would need to run all experiments on a close-to-reality environment (thus prefer to share the resources of a network slice), and
e) 20% of sample size haven't concluded yet.

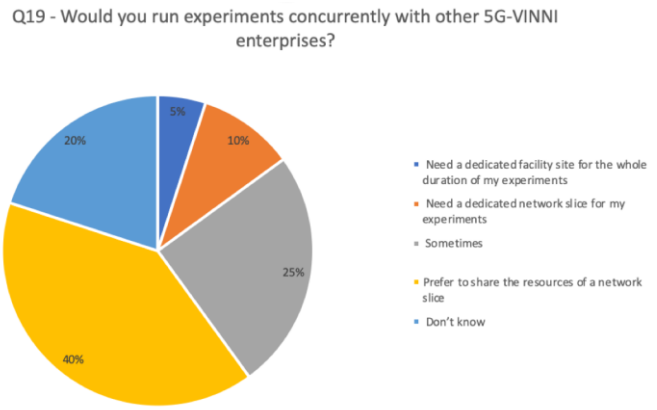

Figure 53: Concurrent vs isolated experiments

Thus, some customers expect to be able to run concurrent experiments while others prefer isolation (either virtual or not). In both extreme cases, customers should be able to define when an experiment will take place and see an overview of other planned experiments.

By combining responses related to the involvements of actual users and the interest in running concurrent experiments, we observe the following:

i. All users apart from undecided respondents are interested in involving actual users
ii. Participants that don't know or will not engage with actual users don't know whether they will be running concurrent experiments

The following two tables give an overview of the external and internal personae that would welcome the ability to schedule their experiments.

Table 66: The external personae that need support for scheduling experiments and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
				A2	C3

Table 67: The internal personae that need support for scheduling experiments and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
		B1, C1	A2	A2	

4.20 User Device access control

Figure 54, below, examines to what extent vertical organisations want to restrict the users participating in the experiments. We observe that:

a) 10% of participants don't plan to restrict users. Note that according to Table 68, these users (marked with grey colour) don't expect to involve actual users at all;
b) 40% of respondents most likely will restrict the set of participants in the experiments. The great majority of them plan to involve actual users (as marked with orange colour in Table 68);
c) 40% of respondents will restrict the set of participants in the experiments, who will be actual users (as evidenced by the light blue cells of Table 68), and
d) 5% of sample size haven't decided yet not only whether they will be restricting users but also if actual users will be involved at all (cells marked with light green).

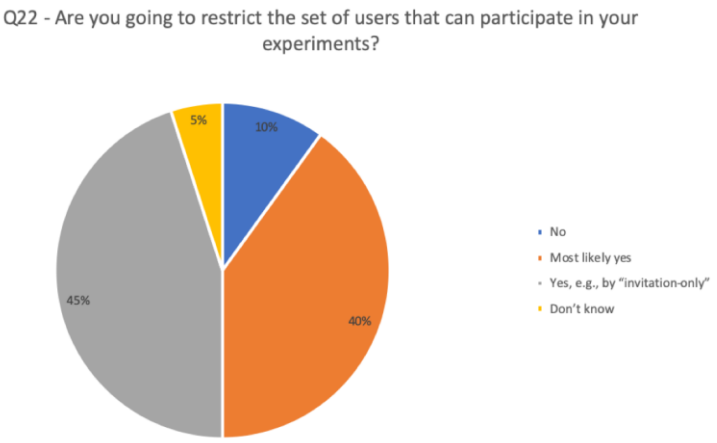

Figure 54: Intention to restrict the set of users that can participate in your experiments

Table 68: Contingency table for intention to recruit actual users and preferences to restrict which users should participate (% of grand total)

		PREFERENCES ABOUT RECRUITING ACTUAL USERS					
		Don't know	No	Probably no	Most likely yes	Yes	**Grand Total**
PREFERENCES ABOUT RESTRICTING PARTICIPATING USERS	Don't know	5%	0%	0%	0%	0%	**5%**
	No	0%	5%	5%	0%	0%	**10%**
	Most likely yes	0%	0%	5%	30%	5%	**40%**
	Yes, e.g., by "invitation-only"	0%	0%	0%	15%	30%	**45%**
	Grand Total	**5%**	**5%**	**10%**	**45%**	**35%**	**100%**

The following table gives an overview of the external personae that would welcome the ability to control who can participate in an experiment (or during service provisioning).

Table 69: The external personae that need user-device access control and related user stories

Lara - Digital transformation leader	Bill-Business Analyst (BA) & Digital Consultant (DC)	Samuel – SW developer	Carl - System Administrator/Network Specialist	Sandra - Service Manager (SM) & Quality Assurance Manager (QAM)	Steve - Solution Designer (SD) & System Architect (SA)
				B1	

The following table gives an overview of the internal personae that see value in allowing vertical customers to control who/when can use a certain slice instance and for how long:

Table 70: The internal personae that need user-device access control and related user stories

David DevOps Expert	Siren the Service manager	Nadia - Network Specialist	Sonny the Solution designer	Ted the Test specialist	Anton the account manager
	B2	F2			

4.21 Summary

This section provides a summary of the insights we got by our analyses of future 5G facility users and which form the foundation for the capabilities and design we suggest for the 5G-VINNI Business layer in the next section.

From the internal personae descriptions, we could highlight the need of CSPs to serve their customers better and faster while operating more efficiently. To this end self-service portals and advanced technologies such as predictive analytics along with machine learning and artificial intelligence (AI), are expected to be key.

Most respondents to the small-scale online survey see off-line communication, or face-to-face meetings, as more efficient for learning about supported services and choosing the most suitable for their experiments. Thus, documentation seems to be necessary for interacting efficiently with 5G facilities. Nevertheless, it seems that almost all participants would still need to access an online portal when experimenting with 5G-enabled solutions, e.g., in order to monitor the status of their experiments. Furthermore, the great majority of the participants to the online survey expect that more than one of his colleagues will be involved in the experiment lifecycle, which suggests that individual accounts and a secure login process will be needed.

A significant share of users foresees to use more than one 5G-VINNI facility sites and even expect to replicate the exact same experiment on several facility sites. Some of them would prefer to have a (business) relationship with a single facility site/MNO, which will be acting as an intermediary, and use a global service catalogue. For the rest users, having universal accounts and standardised experiment descriptions would simplify their journeys.

Most respondents intend to run experiments with real users (e.g., selected customers or employees) and their vast majority wants to have tight access control of the users and device that are involved in their experiments. Furthermore, some vertical customers that will recruit actual users, expect these to originate from multiple operators.

Experimentation is imperative for stakeholders in the 5G-VINNI context; many expect that the experiments will require many iterations. Experimenters should be able to define when an experiment will take place and see an overview of other planned experiments. All have expectations to easy access to reports from experimentation; however, real-time reports are not critical for most. Also, there is a noteworthy willingness to share experience with others and be part of the 5G community.

Another Interesting finding is that the majority of respondents think that standard slices will not be sufficient. Thus, standardised slice descriptors should be used to guarantee homogeneous end-to-end service. Furthermore, most of them are also positive towards and would use 3rd parties. There is a preference for flexible cost and revenue sharing seem to be important. SLAs are seen as productive tools, but these must also be flexible.

5 Proposed 5G-VINNI Business Layer Capabilities and Design

5.1 Business layer capabilities

The purpose of this subsection is to describe a set of business mechanisms to enable the automated cross-administrative domain Business Layer capabilities that were identified as key for the emerging 5G ecosystems.

This subsection documents three Tier-1 features, namely user login, service order management and knowledge repository management, as well as, the related sub-features.

5.2 User Login

This feature supports user authentication, user authorisation and accounting for user logins (e.g., collecting timestamps, IP addresses, etc.). Users can be internal (e.g., members of the facility site and Communication Service Provider) or external ones. The latter category may include a wide gamut of user types, such as representatives from a) vertical industries, b) other facility sites and CSPs, c) third-party suppliers and other complementors, d) research community interested in implementation details, such as APIs, rather than using the services offered, or even end-users of services who can be informed about their status, top-up their accounts, etc.

Apart from the main feature described above, a set of secondary/supportive features are needed also:

- **Role management** for creating, updating, deleting roles (e.g., B2B customer, 3rd-party supplier, 3rd-party consultant, etc) retrieving their details. It is expected that service provider's partner ecosystem will constantly expand and will need to support diverse collaborative business models: a) selling bundles of own and third-party services to the vertical customer, b) providing wholesale services to other partners who have established high market share in niche market segments, c) network sharing arrangements with other network operators, etc. Furthermore, this can be used for implementing Role-based access control, i.e., retrieving, assigning, revoking and updating rights granted to different roles/accounts with regards to order management (e.g., to a 3rd-party consultant).
- **Profile management** for creating, updating, deleting accounts as well as retrieving their details. Managing the roles assigned to a profile is supported as well.
- **Notification management** for
    - creating, updating, deleting and listing the type of events that a user would like to receive notifications for the orders placed (e.g., that an order has been successfully validated and activated).
    - creating, updating, deleting and listing the type of monitoring events that a user would like to receive notifications for (e.g., when certain types of violations are encountered)
    - creating, updating, deleting and listing the type of events that a user would like to receive notifications for (e.g., when violations are encountered, daily, hourly, etc.)
    - informing interested parties when a service, API, etc. is added, updated or deprecated.

5.3 Service Order management

As already explained, 5G back-ends will have to support instantaneous delivery of complex, multi-component on-demand service offerings, taking into account a variety of network parameters including current network capacity and demand. On the one hand it will have to support extensive configuration capabilities for unlocking the creativity of CSPs and tech-savvy Over-the-top (OTT)

providers (e.g., via open APIs) and on the other hand it should utilize a user-friendly interface for non-technical users.

This feature allows a vertical customer to manage the lifecycle of service orders, e.g., network slice instances with and without 3rd party VNFs/VAFs, effortlessly with just a couple of clicks. The order lifecycle includes selection of service elements (based on what is available to the user), order temporary saving, retrieval, update, deletion, placement. We should highlight that vertical customers shall be able to chain one or more (external) digital services (VNFs/VAFs) with communication services already ordered in order to compile and eventually assess whether this complete solution can address its pain points[10]. Given the uncertainty regarding the business case of a certain 5G-enabled service, vertical customers, in particular those acting as Sandra (the Service Manager and Quality Assurance Manager persona), should be encouraged to explore several configurations, e.g., test different vertical-related services for a certain slice instance, test different slice instances for a certain vertical-related service or both. Thus, a vertical could have already ordered an URLLC slice instance and place complementary orders for an VAF1 from provider A and if not happy for VAF2 from provider B, etc. Similarly, order for VAF1 could be the baseline and place a short-lived order for URLLC slice instance 1, then URLLC slice instance 2 and so on. For this reason, we argue that a vertical's order should be decomposed into 2 parts/phases: a) communication services and b) vertical-related services. A user can specify from scratch both parts of a service order, one of them, or even choose to combine existing ones. In the latter case, a user could choose, for example, a different pricing plan or different SLA terms. This decomposition is very important for allowing vertical users to experiment with 5G features.

Fulfilling the orders of vertical customers will often involve several types of providers, as well as multiple instances of the same type, to collaborate. This collaboration will be realised via wholesale (or B2B2X) orders, where a provider procures services from other "upstream" providers. These orders can be on-demand, i.e., triggered by a vertical customer order, or asynchronous.

Apart from providing a customisable user interface, service providers will need to support the full service lifecycle. Given the multi-technology, multi-domain, multi-provider landscape, operators need to move away from siloed back-end systems, where each one dedicated to one or a handful of applications, to an integrated omni-channel ecosystem. In that way, after an order is placed or modified at run-time, it can be validated for verifying that resources will be available, instantiated and activated, and eventually deactivated.

Tier-2 features include the following:

- **Service Catalogue management** for the online management of the catalogue elements, e.g., network slice instances, which a service provider makes available to a customer or group of customers (e.g., members of the same vertical industry). Note that there can be several configurations of the same service and restrictions may apply on which ones are accessible by a certain user. This feature can also support interworking amongst service catalogues of different providers by using east/west interfaces, which is expected to be crucial for serving customers of vertical enterprises regardless of their communication service provider. Furthermore, it may be used by third-party providers to upload the SW image, SW descriptor and any additional information of their solution, such as pricing information, keywords, etc. Given the uncertainty on the actual business model to be used for monetising 5G-enabled services (e.g., direct relationship with customers, indirectly through a partner, etc.) and the requirement for instantaneous time-to-market, the need for exposing APIs that allow

[10] In particular, the user needs to specify where these 3rd party VNFs should be instantiated, so that deployment actions are issued.

catalogue items to be introduced, monitored, modified and retired in a fast and inexpensive way is high.

- **License management** for adding, deleting, updating and retrieving the licensing details for consuming capabilities and other services (e.g., VNFs or VAFs) from third parties. As the number of virtualized functions being part of a complete service increases, tracking license expirations and choosing the most cost-effective license scheme becomes increasingly important for avoiding disruptions and reducing costs. At the same time, SW providers need to know that their product is used according to the license terms. These challenges can have an adverse effect on the competitiveness of the VNF market and eventually on the innovation potential of 5G, as network operators may avoid the overhead of managing contracts with a large number of providers and enter into agreement with a few dominant players.
- **Service Inventory management** for creating, updating and retrieving instances of 5G-VINNI service blueprints (e.g., hybrid eMBB and URLLC slice instances) and eventually terminated/ deleted. These instances should be based on standardised Network Service Descriptors (NSDs) and VNF Descriptors (VNFDs) that provide a reusable template and machine-readable specification, so that their customisation to the needs of the envisaged target group, deployment and operation can be automated as much as possible.
- **SLA management** for creating new SLAs and retrieving, modifying or terminating existing ones. An SLA is a contract between a provider and a customer, which underlines each party's responsibilities while at the same time defining the performance standards that are to be met by the provider and any penalties/bonuses for missing/exceeding the targets. There are two main options for automatically agreeing SLAs in 5G; a) providers to prepare one or more SLA instances from which customers can choose from, and b) providers to announce the SLA attributes/metrics supported, customers to select the ones that are important together with the appropriate values and the time-window/number of events used when calculating values for chosen SLA attributes/metrics. SLAs can be defined for any type of products/services provisioned, e.g., physical infrastructures, virtual infrastructures, communication services, software, etc. and given their hierarchical/recursive nature of these relationships one SLA could depend on other lower-level ones. Thus, a broad set of SLA attributes/metrics should be supported, including traditional ones (e.g., "five 9s availability"), as well as, newer ones such as "1 minute to deploy a new Service Instance" and at least "1000 users enjoying an Augmented Reality service in a stadium". It is expected that SLAs involving vertical organisations will be less focused on technology and be more context-specific. Another important feature is closed-loop SLA adherence and heal, scale or modify the underlying services when deviation is detected.
- **Quote management** for preparing a new quote based on the details of the order placed, either by a vertical customer or another provider, and retrieving, modifying or withdrawing an existing one. Quote management needs to be flexible and automated in order to satisfy the requirements of a broad range of customers, whose pain points require integrated digital solutions and not advanced communication services alone. In most of the cases a quote will be in monetary terms and, given that CSPs are unsure what services will be the 5G "killer applications", it should be flexible enough to support any pricing strategy, such as:
    - Differentiated pricing according to connectivity needs, where each slice type (e.g., eMBB, URLLC, MIoT) is priced differently and based on an additional set of diverse parameters like SLA targets for meeting QoS requirements, number of users, etc.;
    - Differentiated pricing according to mobility needs, i.e., how much is a device allowed to roam in the network of the "home" operator and other operators;
    - The number of certain events expected to take place (e.g., how many connected cars will be entering a 5G-supported highway);
    - Promotions and other marketing techniques for boosting sales;

- Accessing advanced features, such as network QoS predictions, as part of network exposure

Furthermore, for those orders that involve VAFs/VNFs from third parties, support for several VNF licensing models, such as pay-per-instance, pay-per-GByte, pay-per-Gbit, pay-by-maximum-instances, pay-per-day, pay-per-month, pay-per-transaction, etc is required.

In case of on-demand orders, the service details selected by the vertical customer will determine the exact providers to be contacted/involved, while in the case of asynchronous wholesale orders the process is initiated by a provider. While in both cases the order issuer will choose whether to accept a certain quote, adjust order details or cancel it, it is expected that in the B2B2X case a) orders will last longer and b) remuneration of the serving provider could be a percentage of the revenues obtained by the downstream provider. For example, wholesale orders may include network slices of the same type for coverage extension, support for roaming users (by relying on other communication service providers) or even infrastructure sharing arrangements. Based on the analysis above, computing a single quote can be a challenging process as each of the service elements may be priced with different units and at irregular time intervals.

- **Billing management** for creating, retrieving, updating and deleting bills after taking into account promotions, penalties and discounts due to SLA violations. While quotes are computed when an order is placed, bills are issued only if an order is realised, and depending on the chosen plan, this can be done before or after service delivery. A customer should receive a single invoice for all the services obtained and at the same time bills receivable should be prepared for each upstream provider. In order to do this, billable events should be identified and assigned a price on the basis of a rating table. In case of real-time pricing, this table should include the actual price at any point in time.
- **Payment management** for handling payments from customers (either vertical organisations or downstream providers) to (upstream) providers. In order to simplify payments, it should be possible for wholesale bills payable and receivable to be cleared, so that only the balances have to be paid. Payments from vertical organisations should be immediately processed so that pre-paid contracts are supported, which is important for consumers' spending control and credit risk minimisation for providers.
- **Experiment scheduling** for managing when and where the complete solution will be accessible. Vertical organisations during the early stages of product/service development may prefer to test the performance/feasibility, usability and efficiency of the 5G-enabled service in an isolated environment. This isolation could be achieved by several means depending on the scope and budget; from dedicated parts of the network to single-tenant slices and multi-tenant slices with reservation capabilities. At the same time, those vertical organisations that are closer to service roll-out may seek running concurrent experiments in order to mimic realistic conditions and get better insights on the expected user experience. In both extreme cases, customers should be able to define when an experiment will take place and see an overview of other planned experiments.
- **User device management** for creating, updating, deleting user devices (e.g., embedded Subscriber Identification Module/eSIM) that can use a service instance as well as retrieving their details. This is important for vertical organisations who want to have control over the set of devices that can benefit from their services, e.g., allow access to subscribers only for economic reasons, limit access to authorised users for security purposes, etc. A major challenge is how verticals will be able to specify a potentially large number of devices that is already available on their back-end systems and keep this list up-to-date so that end-customers who have reached their credit limit are immediately excluded. Furthermore, having the ability to group devices (e.g., IoT sensors) would simplify operations.

5.4 Knowledge repository management

This feature allows the users of this ecosystem to form communities and interact, via offline (e.g., forums) and online (e.g., chat rooms) means. These interactions are important for members to exchange knowledge, troubleshoot problems in a peer-to-peer fashion, while reducing the cost of customer support groups for providers. Users having an account and the appropriate user roles should be able to manage forum threads, chat rooms etc., i.e., create communities with different participation and visibility constraints, retrieve communities and their members, update rules and delete inactive communities. Furthermore, members in each community should be able to participate in discussions.

Tier-2 features include the following:

- **Documentation management** for creating, updating, deleting documentation articles, best practices, tutorials, etc. Mastering 5G-related standards requires a steep learning curve and these articles can be of great help. As an example, tutorials and sample projects can guide third-party developers in preparing VNF images and associated descriptors according to well-accepted, standardised templates.
- **Performance Monitoring** for allowing a user to visually track the performance of the service obtained and be contrasted with SLA terms (if any). A user should be able to see real-time information, such as performance metrics and event streams, about the entities involved in service delivery or the level of information that she has subscribed/paid for/to. Having this information via dashboards and/or APIs, users and closed-loop systems will be able to detect service disruptions and trigger resolution actions (e.g. for healing or scaling)[11].
- **Reporting** for allowing the user to manage reporting preferences and retrieve, delete existing reports. The users should be able to define the reporting intervals and the exact contents, such as statistics, graphs to be included.
- **Ticket management** for creating a new request for troubleshooting an issue, updating its status including responsibilities, listing tickets according to several criteria (e.g., by user account, service affected, etc.) and deleting/cancelling existing ones.
- **Feedback management** for describing the experience obtained, as well as retrieving, updating and deleting existing ones. The feedback could be in the form of a scalar from 1 to 10 where higher numbers indicate better perceived experience. While this information is typical and helpful in e-commerce platforms, such as Amazon and eBay, the multi-provider nature of 5G ecosystem mandates that scores should not be necessarily uniform across all providers involved. For example, in case of service disruption the reputation of the underperforming providers should be affected only. This requires multi-facility wide accounting for the usage of the infrastructure and related KPIs.

5.5 Business layer design

This subsection aims to give a high-level overview of how the proposed Business Layer capabilities are organised into modules and how the latter interact with other 5G-VINNI architecture nodes.

The business layer architecture shown in Figure 55 provides a pictorial representation of the main capabilities in the business layer, how these are arranged, and how they interact. Verticals (customers) interact via the User Login layer and access Service Order Management and Knowledge Repository Management capabilities as required.

[11] This capability would heavily depend on Telemetry for retrieving data from remote resources. While this feature is invoked by performance monitoring management, it is NOT necessarily part of the business layer (e.g., it could be part of the Service Orchestrator).

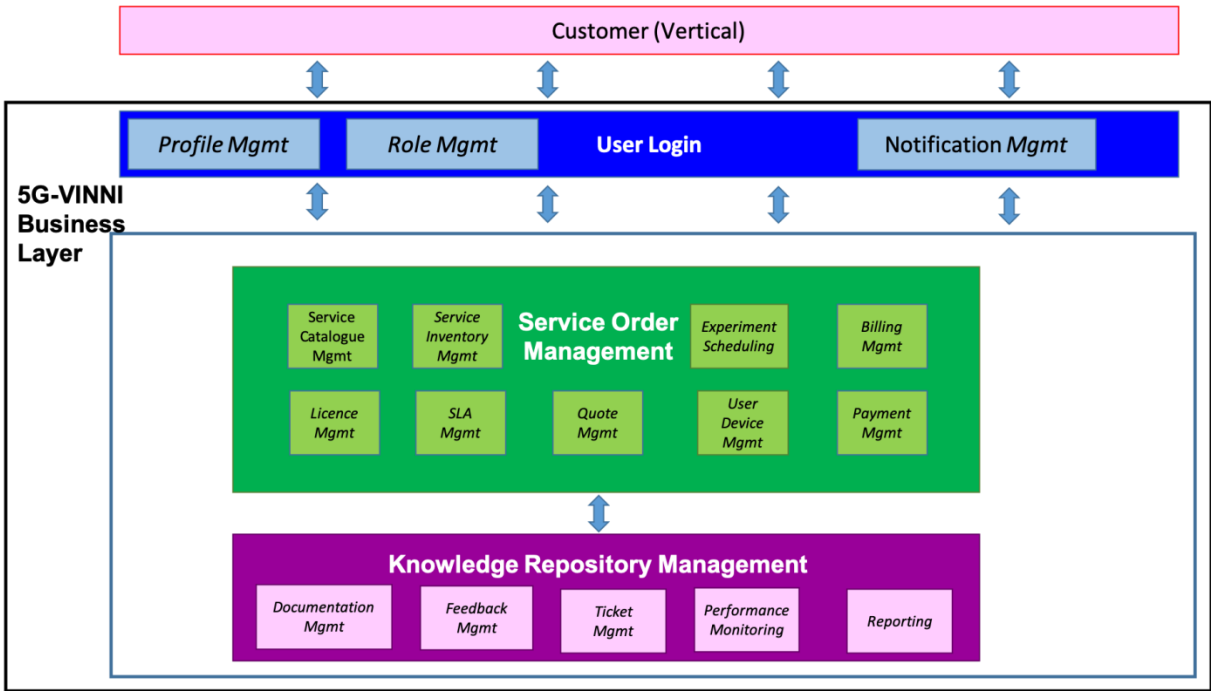

Figure 55: 5G-VINNI Business Layer Architecture

The business layer provides the first point of interaction for verticals as they seek to access the 5G-VINNI platform with a view to defining and running experiments. At each facility, the business layer will interact with the Service Orchestration capabilities of the facility in order to fulfil and manage the requirements of the vertical.

In general, Communication Service Providers (CSPs) operating 5G-VINNI facilities will make use of a range of business agreements that will determine how two or more business layers will interact. Although the business layer is generic enough to support any business model, two broad categories can be distinguished:

- Each CSP/facility site has its own stack of Business Layer and these can interact via E/W interfaces. Each one can act as a customer-facing provider when multi-provider services are needed. Furthermore, these providers can decide whether to run a full-blown Business Layer of choose a subset.
- Some CSPs/facility sites decide to have a core stack of Business Layer and rely on other CSPs who have the full stack (or Brokers who host the rest complementary capabilities).

The first case is shown in Figure 56 below, which supports the concept of a 'Service Portal' as introduced in [10], This Service Portal is an instantiation of the business layer architecture and therefore each facility will have a Service Portal of some kind. The customer interacts with the business layer of Facility A which then a) interacts via the N/S interface to its own Service Orchestration capability, and b) interacts with Facility B via the E/W interface between business layers in order to properly co-ordinate the implementation. Note, there is no direct interface between the business layer of Facility B and the customer – Facility A is seen to handle all customer relationships.

For example, a customer may wish to run a connected ambulance use case in which the ambulance paramedic wears a hololens which is able to capture content at an emergency/accident site. The content is streamed in real time back to a hospital where a surgeon is able to guide the paramedic through a procedure via a voice interface. The customer accesses the business layer of the Norway facility and provides the requirements of this experiment. The hospital is located in Norway and the ambulance/paramedic is located in the UK. The Norway business layer will interact with the UK

business layer via the East/West interfaces shown in Figure 56. The business layers in Norway and UK will interact with their respective Service Orchestration capabilities via the North/South interfaces shown.

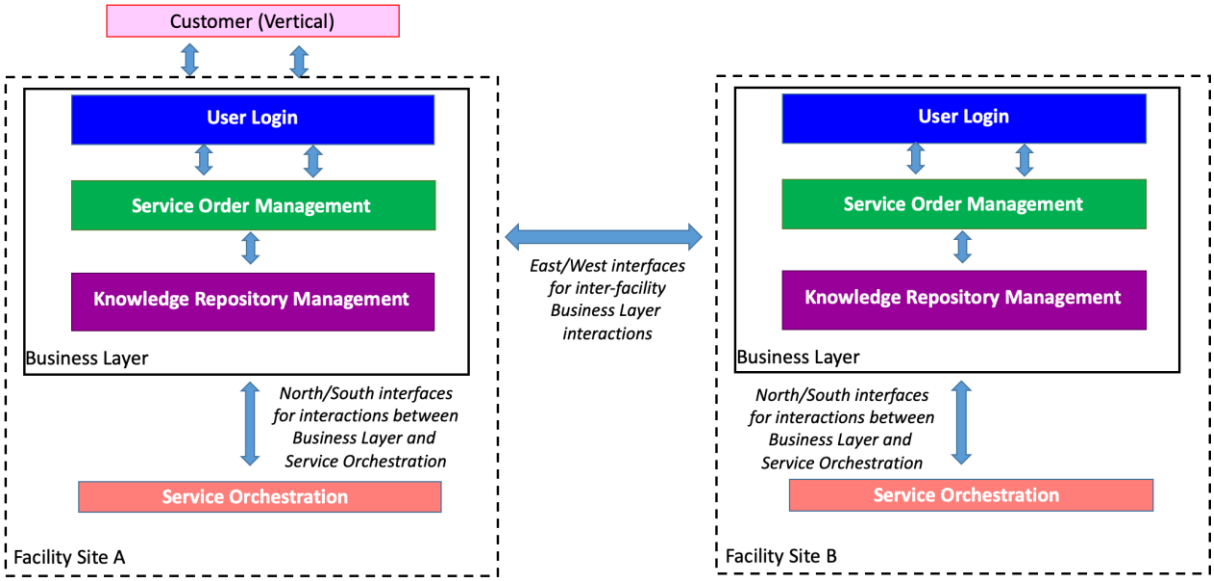

Figure 56: Business Layer Interactions with Service Orchestration and between Facilities

In addition to this, [10] describes the goal for 5G-VINNI to develop a 'global portal' that acts as a single customer facing service across the whole 5G-VINNI platform. One option to implement this global portal is via a '5G-VINNI Broker', as shown in Figure 57, below. The 5G-VINNI Broker maintains all customer relationships with vertical customers via Northbound interfaces, as well as, with two facility sites via east/west interfaces. The broker and the two facility sites are shown to implement complementary business layer features and thus this option is categorised under the second case of inter-facility coordination.

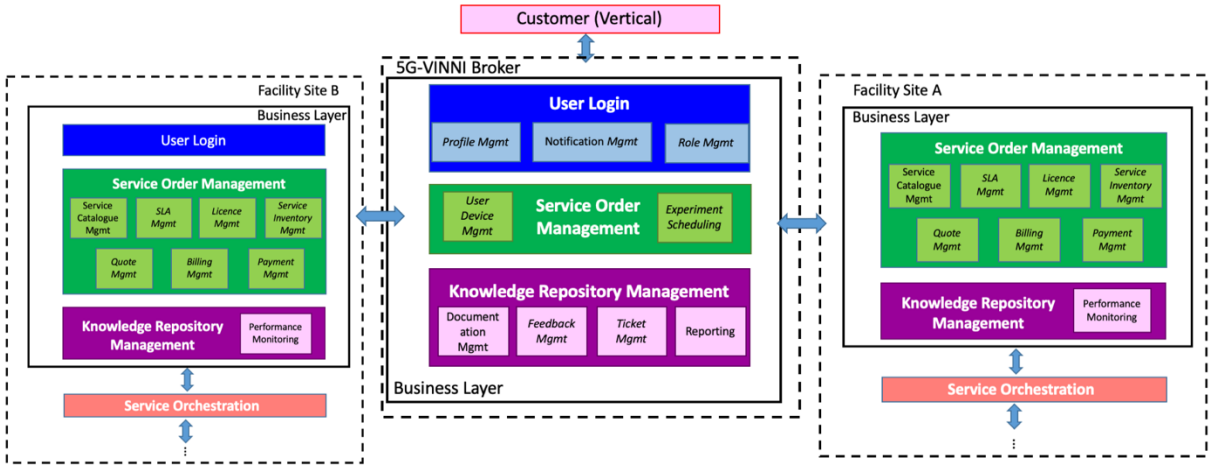

Figure 57: A candidate implementation option for 5G-VINNI Service Portal between a third-party entity and two facility sites

In particular, the business layer supporting the global portal consists of:

- User login capabilities
- Service order management capabilities
- A subset of knowledge repository management (e.g. documentation management, feedback management, reporting).

The business layer supporting the service portal for each facility site consists of:

- User login capabilities for Facility Site B only (Facility Site A relies on the Broker to perform authentication, authorisation and accounting for demonstrative purposes)
- Service order management capabilities
- A subset of knowledge repository management (e.g. performance monitoring).

Note that there are several alternative options of the second case. For example, the Broker could operate a service catalogue management module that interacts with the service catalogue in each facility so it is aware of what capabilities can be provided at each facility. In that way the Broker contains knowledge of the whole of the 5G-VINNI platform, contained within a single global service catalogue. Some customers may come with requirements to experiment with use cases where they have no particular preference for which facility is to be used. In this case, the global portal will assess which facilities can provide the service and will present the customer with the choice as appropriate. More likely, however, is that the customer will have a specific need to execute their experimentation at a given facility or facilities. This will be part of the customer requirement and as long as the facility can support that requirement, the global portal will support the interaction between the customer and the specified facility or facilities.

In the connected ambulance use case outlined above (where the customer does have a preference for the facilities to be used), the customer will interact with the 5G-VINNI global service portal, providing all the requirements including the desire to have the hospital based in Norway and the ambulance/paramedic based in the UK. The global service portal will interact with the service portals in Norway and UK which will in turn interact with their respective service orchestrators to implement the use case requirements.

6 Conclusions and recommendations

Conclusion 1: Apply systematic design thinking embracing customer stakeholders.

This document provided a consolidation of the 5G-VINNI business layer requirements and underlying fundamental concepts. It described a methodology for the definition of the business layer requirements and the identification of the associated capabilities leading to the design of a conceptual system supporting business enablement. In particular it includes in the design thinking the systematic identification of perceived needs by the user of the system; in this case the vertical companies that will access the 5G-VINNI infrastructure to perform experiments and test their vertical services and applications in a 5G environment.

Conclusion 2: Remove hurdles in the collaboration between communication/service providers and customers and increase trust.

Starting from a survey of achievements of past and current 5G PPP projects and ongoing standardisation in TMForum and Metro Ethernet Forum (MEF), a short gap analysis identifies the main customer relationship management functions that have to be in place to support the smooth interactions of the stakeholders in a 5G ecosystem. Based on the high level 3GPP role model that is extended by 5G PPP projects, it is identified that the interaction of 3 roles must be supported by a business layer; namely the Network Service Provider (NSP), the Digital Service Provider (DSP) and the vertical customer. The current lack of trust and collaboration between providers and customer is to some extend responsible for slow innovation in current networks. Future systems must overcome this hurdle to fully unfold the innovation potential of 5G.

Recommendation 1: Use a systematic approach to capture the needs of internal and external users of the system. 5G-VINNI used the persona approach, and does not claim that other methods are inferior.

To overcome this hurdle this document proposes the identification of the user requirements following a persona approach that tries to capture the needs of internal (i.e. experts in the communication and service provider companies) and external users (i.e. experts in the verticals and external software supplier companies) of the business layer.

Recommendation 2: A service provider must identify the business layer requirements for the system it plans to deploy starting from the requirements identified by 5G-VINNI.

An extensive list of business layer requirements has been identified using the persona approach. Even if this list does not claim completeness it is a solid starting point for all communication and service providers to design, implement and deploy a business layer supporting system to serve its customers.

Recommendation 3: Derive system capabilities that must be provided by the business layer system and prioritise the most important capabilities that shall be implemented.

5G-VINNI derived from the user requirements, a list of fundamental capabilities that are necessary for any such system to support meaningful system interactions. The business layer capabilities that are elaborated by 5G-VINNI are: (i) User Login; (ii) Service Order Management and (iii) Knowledge Repository Management. Each of these capabilities includes a number of sub-capabilities, which relate to the role (e.g. NSP, DSP, vertical) that each user accessing the system belongs to.

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Annex A Questionnaire

A.1 Approach

We followed a basic quantitative descriptive approach for better understanding how vertical organisations and other stakeholders would like to interact with 5G-VINNI or a commercial 5G platform at this point in time. As the population sample is largely unknown, we run a cross-sectional online survey in order to collect observations of a population's sample and draw conclusions for the population. In particular, the non-probability sampling procedure is selected, which does not provide any basis for estimating the probability of each individual in a population to be included in the final sample.

A core group of over 160 participants, from different European organizations and vertical industries, was invited to participate. The participants could invite other participants as they see fit, i.e., we used the snowball sampling technique. Eventually, the sample size reached 20 anonymous respondents.

A.2 Questionnaire

The questionnaire can be found in the following address:

https://www.5g-vinni.eu/business-layer-requirements-questionnaire/

For completeness, the questions are included below as well.

Please answer the following general questions about you and your organisation:

1. **Which is the main industry in which your company is doing business (e.g., in terms of revenue)?**
   - Smart cities and transportation
   - Automotive
   - Manufacturing
   - eHealth
   - Utilities
   - Media/Entertainment
   - Public safety
   - Financial
   - Digital retail
   - Smart agriculture/aquaculture
   - Other industry (please specify ……..)
   - Not part of a business entity

2. **What is your role in the organization?**
   - Member of Administration
   - Member of Product management or development
   - Member of Production & Manufacturing Department
   - Member of Operations Department
   - Member of Technology analysis or development
   - Member of Research and Development Department
   - Member of Information Technology Department
   - Member of Customer Relationships Department
   - Member of Inventory Department
   - Member of Human Resource Management Department
   - Member of Accounting and Finance Department
   - Member of Marketing and Advertising Department
   - Other role (please specify ……..)
   - Not part of a business entity

3. **What is the size of your organization in terms of employees?**
   - 1-10 employees
   - 11-50 employees
   - 51-200 employees
   - 201-500 employees
   - 501-1000 employees
   - 1001-5000 employees
   - 5001+ employees

4. **Have you ever participated in any of the following initiatives (multiple options can be selected)?:**
   - Public Private Partnerships (e.g., 5G-PPP)
   - EU-funded projects (e.g., under Horizon 2020)
   - National/regional research innovation projects
   - other

Please answer the following questions on how you (and your organisation) would like to interact with 5G-VINNI during the planning phase:

5. **The 5G-VINNI facility is composed of four (4) interoperable main facility sites in Norway, UK, Spain and Greece, which will facilitate the rapid experimentation by European organisations. On how many 5G-VINNI facility sites do you plan to setup and run experiments, either as a member of an EU-funded project or as an individual organisation?**
   a. 0 (e.g., not interested in running experiments in 5G-VINNI)
   b. 1 (e.g., the closest one)
   c. 1-3 (e.g., for replicating an experiment to additional regions, or experiments spanning across several 5G-VINNI facility sites)
   d. All 4
   e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

6. **With how many 5G-VINNI facility sites do you plan to have a business relationship with?**
   a. 0 (e.g., not interested in running experiments in 5G-VINNI)
   b. 1 (e.g., regardless of how many facility sites I will be running experiments on, I expect to be able to choose a single facility site as a contact point for all technical and financial matters)
   c. More than 1 (e.g., I prefer to contact each individual facility site for experiment details and financial arrangements)
   d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

7. **Do you plan to run experiments on other pre-commercial 5G facilities (e.g., from 5G EVE or 5GENESIS)?**
   a. No (e.g., not planning to run experiments in other 5G facilities)
   b. One of them
   c. More than one
   d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

8. **Assuming that each experiment iteration consists of 4 phases (plan, setup, execution and analysis), how many people in your organisation will be involved during the experiments' lifecycle?**
   a. 1 (e.g., a single person will be responsible during the experiments' lifecycle)
   b. 2-4 (e.g., some will be responsible for more than one phases of the experiment(s))
   c. More than 4 (e.g., a team of people will be involved in each experiment stage)
   d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

9. **Will you collaborate with third parties while planning your experiments in 5G-VINNI facility sites?**
   a. No (e.g., we will be interacting with 5G-VINNI systems and members only)

b. Probably yes (e.g., we may need some consultancy during the planning phase)
c. Yes
d. Don't know

Optionally, you can justify your response or include your comments on this question, below:

……..

10. **How do you expect to interact with 5G-VINNI facility offerings during the planning phase (e.g., learn about supported services, choose preferred ones, etc.)?**
    a. Offline (e.g., via phone or email based on information gathered at workshops and static webpages)
    b. During face-to-face meetings with 5G-VINNI representatives
    c. Via a 5G-VINNI portal providing a service catalogue
    d. By invoking well-defined APIs to a 5G-VINNI portal/ service catalogue
    e. Don't know

Optionally, you can justify your response or include your comments on this question, below:

……..

11. **If you had to obtain a license in order to consume capabilities and other services (e.g., VNFs or VAFs) from third parties, which option would you prefer for license management?**
    a. 5G-VINNI should not be involved at all
    b. 5G-VINNI to provide a link to the licensing server of each third party, but my organization should be responsible for obtaining the appropriate license
    c. 5G-VINNI to act as a one-stop shop
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:

……..

12. **In case the experiments to be performed require a payment to 5G-VINNI, are you going to share the costs with other organisations?**
    a. No (e.g., experiments will involve my organisation only)
    b. Yes, >1 additional organisations will contribute and we will split the bill internally
    c. Yes, >1 additional organisations will contribute and we would prefer 5G-VINNI to perform cost allocation in a fair manner
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:

……..

13. **Would you sign a Service Level Agreement (SLA) with 5G-VINNI facility site for agreeing on the service standards to be met?**
    a. No, (e.g., I don't need SLAs)
    b. Yes, agreeing on an SLA is very important and 5G-VINNI should initiate the process based on the details of my experiments
    c. Yes, agreeing on an SLA is key for building trust but we would like to specify the terms to be included before receiving a 5G-VINNI offer
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:

……..

14. **Would you use capabilities and other services (e.g., Virtual Network Functions-VNFs or Virtual Application Functions- VAFs) uploaded to 5G-VINNI by third parties?**
    a. No (e.g., we will use capabilities from 5G-VINNI only)
    b. Yes, but if only these were tested and certified by 5G-VINNI
    c. Yes, even if these capabilities fail to pass 5G-VINNI tests
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:

……..

15. **What type of 5G-VINNI capabilities and services would you choose to use?**
    a. Standard network slices (i.e., enhanced Mobile BroadBand-eMBB, ultra Reliable Low Latency Communications-uRLLC, massive Internet of Things-mIOT)
    b. Custom configuration of standard network slices (e.g., adding multiple VNF instances to eMBB slices for redundancy)

c. Combination of standard network slices (e.g., combining ultra Reliable Low Latency Communications with enhanced Mobile BroadBand for very high mobility support)
d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

Please answer the following questions on how you (and your organization) would like to interact with 5G-VINNI during the setup and run phases:

16. **What are your expectations regarding underlying network conditions (e.g., background traffic)?**
    a. Don't mind if network conditions are exogenously defined (e.g., by 5G-VINNI experts)
    b. Need to be able to define what/when/where events (e.g., physical infrastructure failures, virtual machine congestion) will be taking place
    c. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

17. **What are your expectations regarding network slices' dimensioning during <u>set-up phase</u> (e.g., regarding maximum uplink/downlink capacity)?**
    a. Don't mind, 5G-VINNI experts should perform network slice dimensioning
    b. Need to be able to finetune parts of the network slice (e.g., RAN, Core Network, etc.)
    c. Need to be able to manage the lifecycle of the involved VNFs and finetune their operation
    d. Need to be able to manage the virtual machines hosting the VNFs, as well as manage and finetune these VNFs
    e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

18. **What are your expectations regarding network slices' dimensioning at <u>run-time</u>?**
    a. Don't mind, 5G-VINNI experts should manage network slices
    b. Need to be able to finetune parts of the network slice (e.g., RAN, Core Network, etc.)
    c. Need to be able to manage the lifecycle of the involved VNFs and finetune their operation
    d. Need to be able to manage the virtual machines hosting the VNFs, as well as manage and finetune these VNFs
    e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

19. **Would you run experiments concurrently with other 5G-VINNI enterprises?**
    a. Need a dedicated facility site for the whole duration of my experiments (e.g., for performance and/or security reasons)
    b. Need a dedicated network slice for my experiments
    c. Sometimes (e.g., I would request a dedicated network slice during the first experiments and gradually move to a shared one or vice versa)
    d. Need to run all my experiment on a close-to-reality environment, thus prefer to share the resources of a network slice
    e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

20. **Are you going to run experiments with actual users (e.g., selected customers or employees of yours)?**
    a. No (e.g., interested in testing the technical feasibility of a service only)
    b. Probably no (e.g., most likely the services to be tested will involve simulated users only)
    c. Most likely yes (e.g., hopefully the services to be tested will be mature enough to reach actual users)
    d. Yes (e.g., getting feedback from actual users is key)
    e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

21. **Are you going to run experiments with actual users from any mobile operator?**
    a. No (e.g., recruiting users from a single operator is fine)
    b. Maybe (e.g., recruiting users from a single operator should be fine)

c. Most likely yes (e.g., I expect that it will be hard to reach the minimum number of actual users if these originate from a single mobile operator only)
d. Yes, (e.g., involving actual users from any mobile operator is key to verify interoperability)
e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

22. **Are you going to restrict the set of users that can participate in your experiments?**
    a. No (e.g., anyone will be able to participate)
    b. Most likely yes (e.g., eventually I will need to test access policies)
    c. Yes (e.g., I need to be able to check that access to services will be by "invitation-only")
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

Please answer the following questions on how you (and your organization) would like to interact with 5G-VINNI during the analysis phase:

23. **How would you prefer to track the status of your experiments?**
    a. Offline (e.g., receive an email/ call by a 5G-VINNI facility manager)
    b. Manually (e.g., by visiting a special-purpose experiments' status webpage)
    c. Automatically, (e.g., by receiving system-generated alerts/notifications about certain experiment status changes)
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

24. **Which status updates of your experiments are the most important ones (multiple options can be selected)?**
    a. Confirmation for successful events (e.g., uploading a new experiment description)
    b. Notification about errors (e.g., missing descriptions, incompatibilities, etc.)
    c. Informative messages (e.g., resource usage thresholds exceeded, billing events, etc.)
    d. Don't know

Optionally, you can justify your response or include additional types of status updates, below:
……..

25. **How frequently the status of your experiments (including resource usage) should be updated?**
    a. At the end of the experiment's iteration
    b. At the end of day
    c. Every hour
    d. At real-time
    e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

26. **How do you expect to analyse the results of your experiments?**
    a. Own applications collect required data for analysing the experiments' results
    b. Standard 5G-VINNI reports should be created
    c. Custom reports should be supported by 5G-VINNI
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

27. **How many iterations of the exact same experiment are you going to execute over time?**
    a. Just one
    b. Most probably a couple of additional ones
    c. Many iterations will be needed
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

28. **Are you going to replicate the exact same experiment to other 5G-VINNI facility sites?**
    a. No
    b. Probably no

c. Most likely yes
d. Yes
e. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

29. **Are you going to share experiment results with other organisations (e.g., for best practices, consultancy, etc.)?**
    a. No (e.g., sharing reports will threaten our "first mover" advantage)
    b. Most likely knowledge will not be useful to other organisations
    c. Yes, we plan to share the knowledge obtained with other organisations
    d. Don't know

Optionally, you can justify your response or include your comments on this question, below:
……..

A.3 Generic questions

Based on Figure 58 we observe that most vertical industries were represented by at least one respondent, apart from the automotive and financial ones. Furthermore, most participants identified smart agriculture/ aquaculture as the main focus of their organisation, while 4 chose “other industry”.

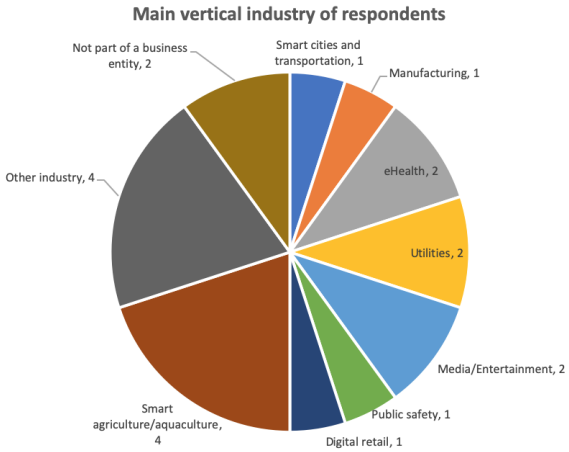


Figure 58: Main vertical industry of respondents

Figure 59 shows that more than 50% of respondents focus on Research and Development and about 10% are members of the administration.

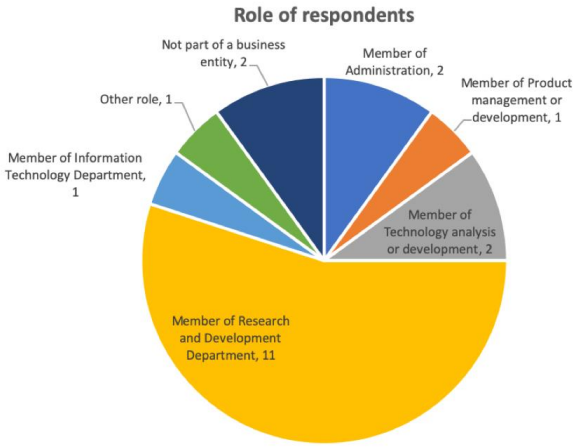


Figure 59: Role of respondents

According to Figure 60, half of respondents come from large organisations.

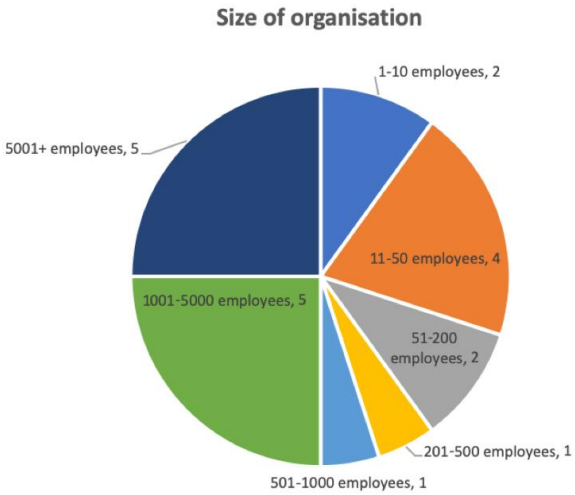


Figure 60: Size of organisation

According to Figure 61, 15% of respondents have never received R&D funding

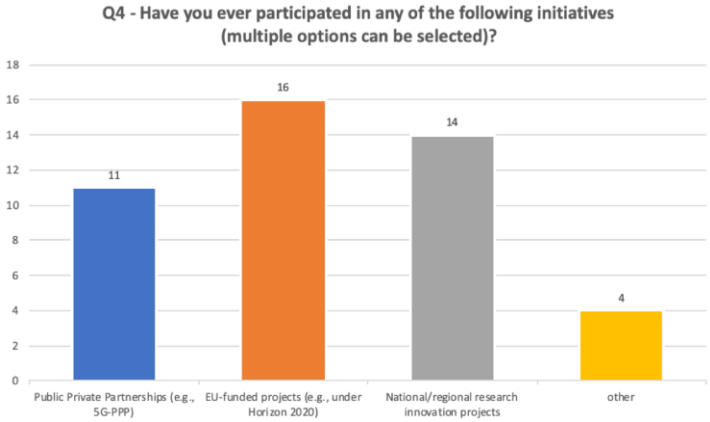


Figure 61: Participation in co-funded initiatives

Annex B Approach for choosing personae based on ICT Professional Role Profiles taxonomy

CEN has provided a taxonomy of ICT Professional Role Profiles which documents the typical roles performed by ICT Professionals in any organisation, covering the full ICT business processes[12]. This taxonomy includes 30 profile roles and Figure 62 groups those role profiles into seven families and relates those to the five main business processes.

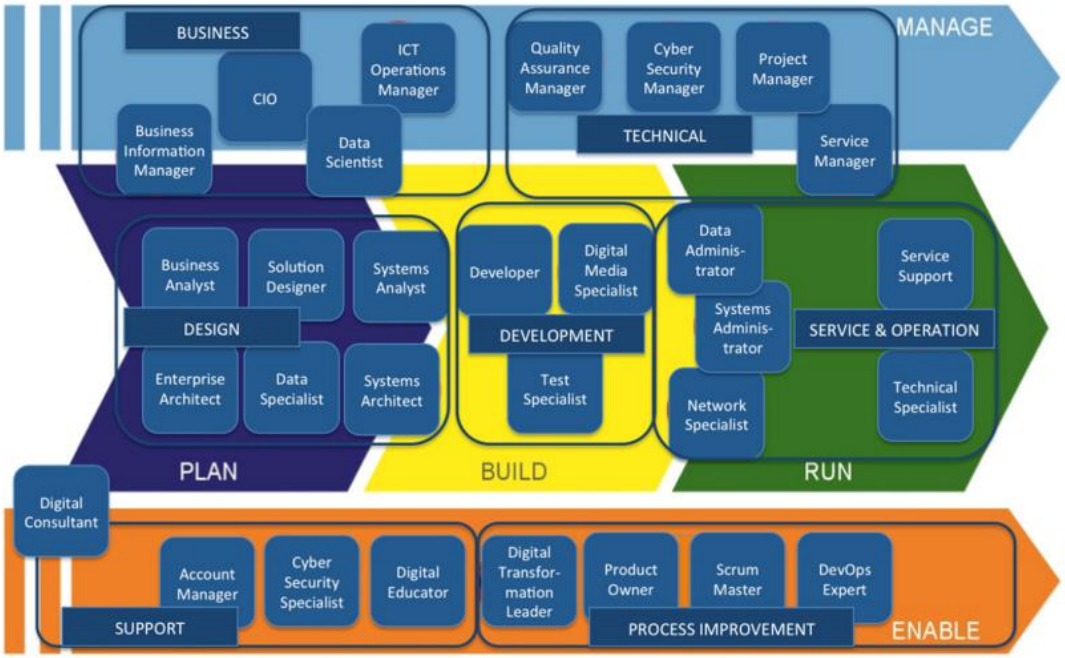


Figure 62: The 30 European ICT Professional Role Profiles grouped into seven families and positioned in the five main business processes

In particular, the following main archetype business processes (composing the first dimension of the European e-Competence Framework 3.0[13]) are defined in as follows[14]:

A. Plan: "Defines activities related to planning services or infrastructure, may include also elements of design and trends monitoring."
B. Build: "Includes activities related to applications development, deployment, engineering, and monitoring"
C. Run: "Includes activities to run/operate applications or infrastructure, including user support, change support, and problems management"
D. Enable: "Includes numerous activities related to support production and business processes' improvement in organisations that include sales support, channels management, knowledge management, personnel development and education and training."

[12] COMITÉ EUROPÉEN DE NORMALISATION, European ICT Professional Role Profiles CWA 16458. Available at http://www.ecompetences.eu/ict-professional-profiles/

[13] e-CF, the European e-Competence Framework, version 3.0 (2014), available online at: http://www.ecompetences.eu/wp-content/uploads/2014/02/European-e-Competence-Framework-3.0_CEN_CWA_16234-1_2014.pdf

[14] Edison CF-DS-Release 2, 2019. Data Science Competence Framework (CF-DS), available online at https://www.iabac.org/g-standards/IABAC-EDSF-CFDS-R2.pdf.

E. Manage: “Includes activities related to ICT/projects and business processes management including management of risk, customer relations, and information security.”

Each archetype business process is associated to one or more outputs/deliverables. The following table lists a preliminary set of outputs/deliverables that were found to be important for 5G-VINNI Business Layer.

Table 71: Selection of outputs/deliverables from e-CF, the European e-Competence Framework, version 3.0 that were found to be important for 5G-VINNI Business Layer

Deliverable	Deliverable Description	Related archetype business process(es)
Business Case (Lightweight Business Case)	An explanation of why the investment the business will see a return point in the future.	Plan
Data Analytics	A method of Data, Information use data aggregation and data past and answer: “What has reports, dashboards, etc.	Enable
Data Selection	The result of the process of determining the appropriate data type and source, as well as suitable instruments to collect data	Enable
ICT Audit Report	An examination and evaluation of an organization's information technology infrastructure, policies and operations. The evaluation of obtained evidence determines if the information systems are safeguarding assets, maintaining data integrity, and operating effectively to achieve the organization's goals or objectives.	Manage
New Solution and Critical Business Process Integration Proposal	A document which illustrates goals, benefits and strategy for introducing new ICT technology or re-engineering/ integrating business critical processes	Plan
Non Functional Requirements	A description of attributes such as security, reliability, maintainability, scalability, and usability which are not core to the specific function but necessary for effective software	Plan
Opportunity Memo	A Study that permits to assess the relevance of the project with regard to the users' demand aligned to the objectives of the organization, and to decide whether it is viable or not. This study specifies the issues, scope, context of the project and end users	Enable
Production Forecast	A projection of achievable/ likely production volumes, based on market needs, historical sales data and current production capacity	Manage

Quality Performance Indicators	A set of indicators measuring how quality policy is implemented on IS projects and ICT solutions in operation	Manage
Service Level Agreement	A service level agreement (SLA) is a contract between a service provider (either internal or external) and the end user that defines the level of service expected from the service provider.	Plan
Services Catalogue	A service catalogue information includes ordering and requesting processes/ prices/ deliverables /contract points.	Plan
Solution in Operation	A solution deployed and running in the actual operational environment	Run
Test Plan	A document describing the scope, approach, resources and schedule of intended test activities.	Build
Test Procedure	A set of tests which addresses homogeneous/ similar solution areas	Build
User Experience Design	A set of product specifications to enhance user satisfaction by improving the usability, accessibility, and pleasure provided in the interaction with the product. User experience design encompasses traditional human–computer interaction design, and extends it by addressing all aspects of a product or service as perceived by users	Build

The preliminary set of outputs in Table 71concerned both what we have denoted as internal and external profile roles. It has been necessary to make a distinction between internal and external roles as they requirements are different. Internal refers to 5G-VINNI members and 5G operators; external refers to vertical enterprise customers, third parties and complementors. We have used the same method to develop both the external and internal personae. In the following we describe the method by using the example of external personae. By filtering the profile roles based on the outputs/deliverables of interest to 5G-VINNI business layer that they are responsible and accountable for[15], a subset of the initial profile roles emerged. The preliminary set of 10 profile roles, which is considered as the most relevant for better understanding the (external) requirements of the 5G-VINNI business layer, appears in Figure 63.

Note that each archetype business process can include one or more families of business processes. In particular “Plan” includes those related to Design, “Build” includes “development”, while “Run” includes “Service and Operation”. Furthermore, business processes under “Manage” is further decomposed into “Business” and “Technical” ones. Finally, “Enable” business processes are broken down into “Support” and “Process Improvement”.

[15] We ignored the outputs where a singe role is contributing only, as these would be captured by other profile roles.

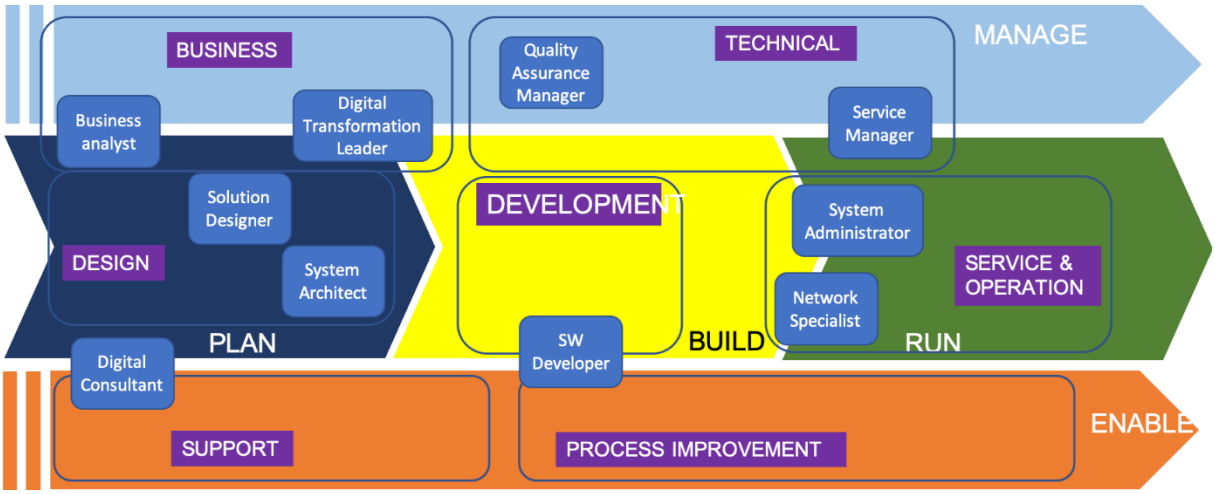


Figure 63: The subset of 10 profile roles selected as relevant for understanding the (external) requirements of the 5G-VINNI business layer (elaboration by 5G-VINNI members)

A similar figure to Figure 63, but following the agile methodology appears in Figure 64.

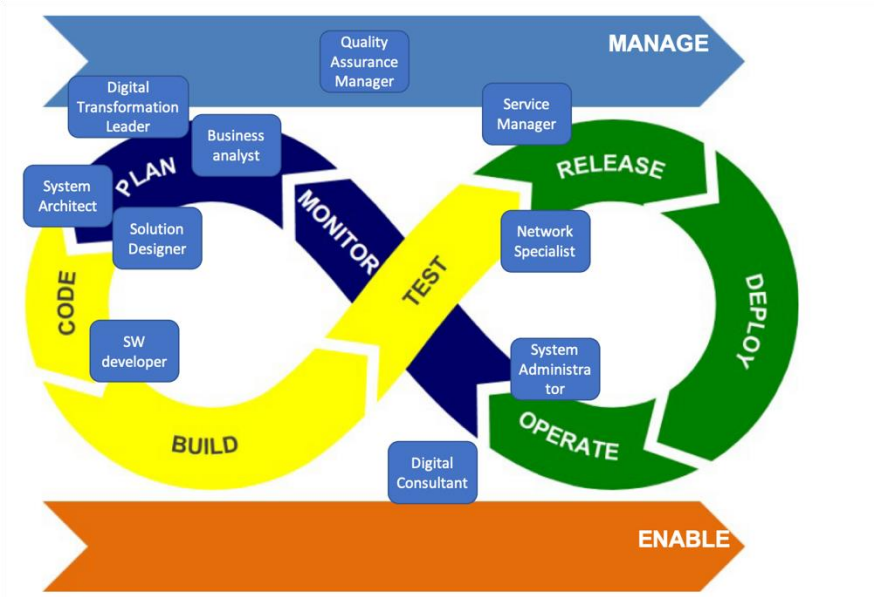


Figure 64: The subset of 10 profile roles participating in different phases of the agile methodology selected as relevant for understanding the (external) requirements of the 5G-VINNI business layer (elaboration by 5G-VINNI members).

These selected profile roles were used to identify key (external) personae for 5G VINNI Business layer as follows

- Digital Transformation Leader
- Business Analyst and Digital Consultant
- Solution Designer and System Architect
- SW Developer
- Quality Assurance Manager and Service Manager
- System Administrator and Network Specialist

The following figure presents how these role profiles are grouped into personae.

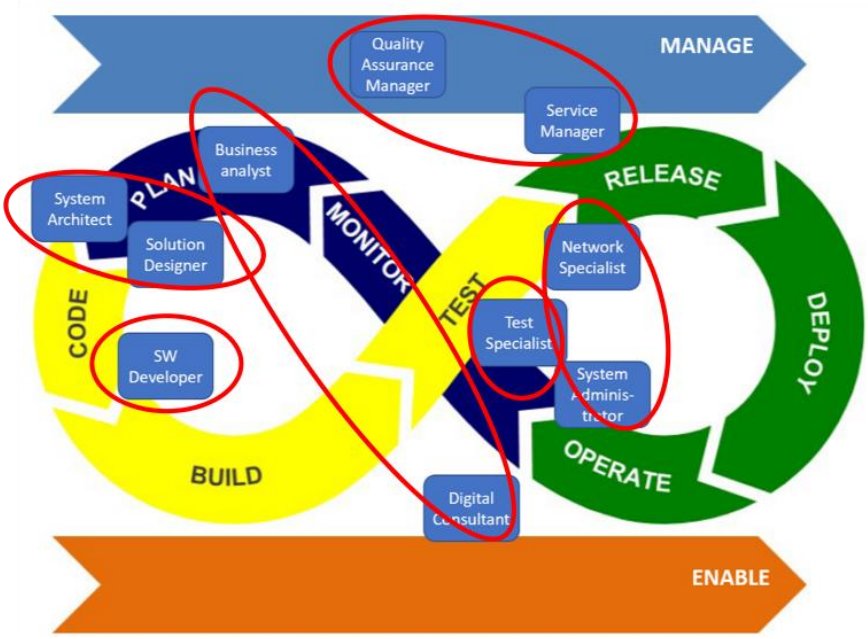


Figure 65: Grouping selected role profiles into personae

Note that some personae are assumed to take on several profile roles that share a lot of similarities in their responsibilities.

B.1 Detailed external profile roles

More details about the selected external profile roles appear in the following tables.

Profile Role name	**Business Analyst**
Deliverables	Accountable: Business Requirements, Responsible: Business Case
Main Tasks (related to D5.2)	Analyse business requirements and design related processes Support Digital Transformation, identifying areas for improvement in business processes Provide possible ICT solutions compliant with the ICT strategy Develop business cases related to the proposed solutions

Profile Role name	**Digital Consultant**
Deliverables	Accountable: New Solution & Critical Business Process Integration Proposal, Opportunity Memo
Main Tasks (related to D5.2)	Provide advice on how to optimize the use of existing tools and systems Raise awareness of information technology innovations and potential value to a business Make recommendations for the development and implementation of a business project or technological solution Participate in scoping the business case for potential projects Participate in the assessment and choice of digital solutions

Profile Role name	Solution Designer
Deliverables	Accountable: Solution in Operation, Responsible: User Experience Design
Main Tasks (related to D5.2)	Examine and interpret business requirements Establish solution intent Align solution with technical architecture Identify potential technical design risks Supervise the built-in quality Identify opportunities for innovation Plan technology roadmaps

Profile Role name	System Architect
Deliverables	Accountable: New Solution and Critical Business Process Integration Proposal
Main Tasks (related to D5.2)	Specify and implement the architecture of complex ICT solutions Lead and/ or conduct system integration Analyse technical and business requirements Develop and maintain a comprehensive record of usability requirements

Profile Role name	Data Scientist
Deliverables	Accountable: Data Selection, Responsible: Data analytics
Main Tasks (related to D5.2)	Represent business challenges through mathematical models Collect, understand, clean, analyse, integrate and investigate internal and external data to achieve the mission Create and test hypothesis Uncover data correlations/relationships in support of measurement and predication Select and optimise algorithms using data science tools

Profile Role name	Quality Assurance Manager
Deliverables	Responsible: Quality Performance Indicators
Main Tasks (related to D5.2)	Perform quality audits Organise customer satisfaction surveys Assist project team members to build and perform project quality plans

Profile Role name	Service Manager
Deliverables	Accountable: Solution in Operation, Responsible: Service Level Agreement, Service Catalogue
Main Tasks (related to D5.2)	Define Service requirements Negotiate SLA / OLA

Profile Role name	System Administrator
Deliverables	Accountable: Solution in Operation
Main Tasks (related to D5.2)	Investigate, diagnose and solve system related problems Install and upgrades software Test upgrades Schedule installation work, to minimize disruption

Profile Role name	Test Specialist
Deliverables	Responsible: Test plan, Test procedure
Main Tasks (related to D5.2)	Select and develop integration testing techniques to ensure the system meets requirements Design and customize integration tests, identify open issues. Organise test plans and procedures for white and black box testing at unit, module, system and integration levels. Establish procedures for result analysis and reporting. Design and implement defect tracking and correction procedures Write test program to assess software quality

B.2 Detailed internal profile roles

The above method and role description focuses on external roles, however, the same approach was used for the internal. The chosen profile roles picked from the 30 standard ones were:

- DevOps Expert
- Service manager
- Network Specialist
- Solution designer
- Test specialist
- Account manager

Figure 66 illustrates where they are situated in the business processes, and our main understanding of their responsibilities. Comparing the above list of roles and the figure, it is illustrated that we did not elaborate on the Developer role, that we emphasized the Network specialist, and downplayed the System administrator. The final list of roles developed into personae is considered to sufficiently cover the most important requirements for the business layer.

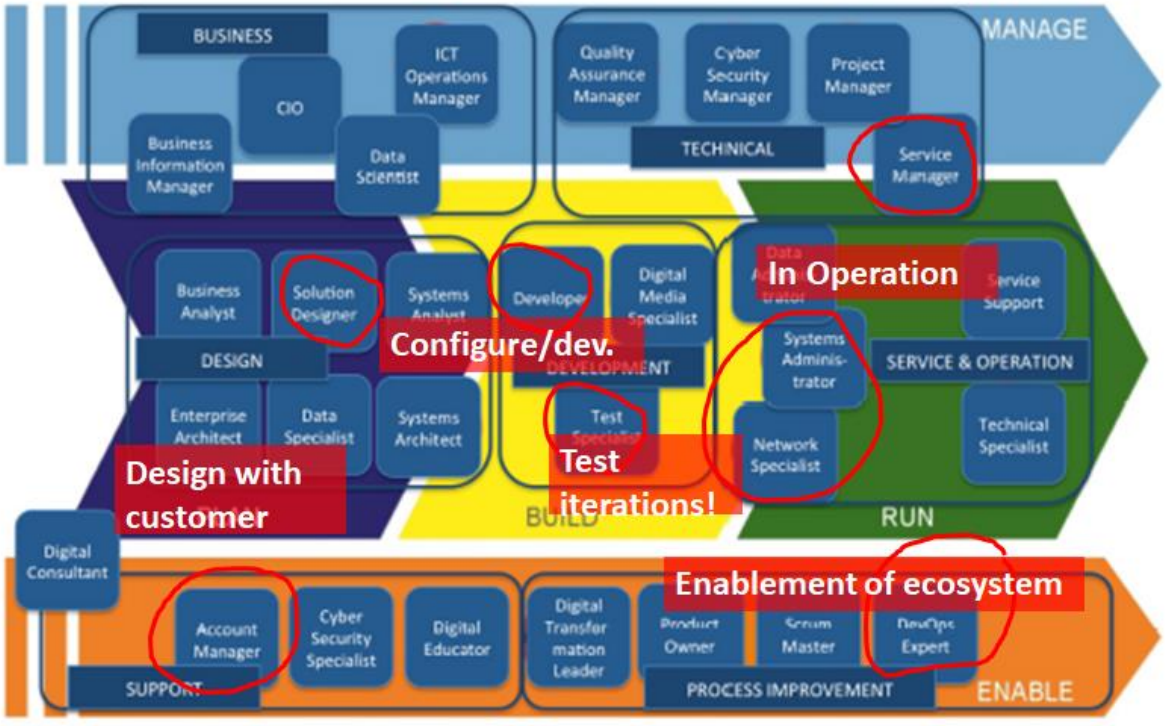


Figure 66: Illustration of internal profile roles identified as starting point for internal personae

In the previous section, more details are already given about CEN's general profile roles that are relevant as internal personae: the test specialist, network specialist, service manager, and solution designer. In addition, there are two profile roles relevant for internal personae: account manager and DevOps Expert. See details in tables below.

Profile Role name	**Account manager**
Deliverables	Responsible: Business Relationships
Main Tasks (related to D5.2)	Maintain overall customer satisfaction with products and/or services Identify opportunities to propose new products or services Provide the primary contact point for client executive management Deliver value added presentations related to products and services to customer executive management Lead negotiations to establish profitable contracts with client(s) Maintain and enhance business relationships

Profile Role name	**DevOps Expert**
Deliverables	Responsible: Development process
Main Tasks (related to D5.2)	Implement and manage continuous distribution methodologies Design systems with high levels of availability and scalability Manage testing across the release lifecycle Facilitate cross functional collaboration and engagement Design and manage process automation tools Adopt an agile software development methodology Manage continuous integration tool management

Annex C TM Forum Open APIs

The following table gives a high-level overview of the APIs, both customer-facing (north-bound) and provider-facing (east-west) interfaces.

Table 72: A high-level overview of the TMForum APIs

Business Domain	API name	API description	Users
Product	Product Catalog Management API	This API allows the management of the entire lifecycle of the catalog elements (product offerings or groups of products that are available to a customer including pricing information and product options such as SLA parameters, other parties involved in the provision, etc.). Furthermore, it is utilized during several processes, such as for looking up catalog elements (and their details) during order capture. It supports notification to entities subscribed for receiving relevant events (e.g., creation of a product catalog). Key operations include: • Retrieval of a catalog element or of a collection of catalog elements (and its details) depending on filter criteria and permissions • Full/partial update of catalog elements • Creation/Delete of catalog elements • Import/ Export of a catalog to another party • Notification of changes on catalog elements	Both internal and external (customer and provider)
Product	Product Inventory Management API	This API enables the creation, retrieval, update and deletion of the representation of a product in the inventory and managing the product details (e.g., specification, underlying services and resources, product offerings it is associated with, etc.). It also allows the notification of events related to product lifecycle. Key operations include: • Retrieval of the representation of a product inventory or of a collection of them depending on filter criteria and permissions • Full/partial update of the representation of a product • Creation/Deletion (for administration purposes) of a new product entry in the inventory • Notification of events	Internal
Product	Promotion API	This API allows the configuration and maintenance of promotions (an online incentive, like a discount, gift or an external benefit, to encourage more	Internal

		consumption) and the activation rules/criteria. Key operations include: • Retrieval of an existing promotion depending on filter criteria and permissions • Partial update of an existing promotion • Creation (configuration) of a new promotion • Deletion of an existing promotion • Notification of events	
Product	Recommendation API	Recommendation API is used to recommend offering quickly based on the history and real-time context of customer. While querying with Product Catalog API would return all the existing product offerings, the Recommendation API only fetches the offerings which possibly cause the interest of the customer.	Internal
Customer	Billing Management API	This API allows to manage bills (also called invoices) produced for a B2C, B2B or B2B2C customer. It supports three basic billing types: postpaid periodical bill, postpaid real-time bill and prepaid real-time bill. This API provides also operations to find and retrieve the details of applied customer billing rates presented on a customer bill. In addition, it allows notification of settlement note advice to partners who can, then, query it. Finally, this API allows to request in real-time a customer bill creation and to manage this request. Key operations include: • Retrieval of an existing bill depending on filter criteria and permissions • Partial update of an existing bill • Creation of a new bill • Deletion of an existing bill • Notification of events	Both internal and external (customer and provider)
Customer	SLA Management API	This API manages the SLA life cycle (SLA Negotiation, SLA configuration, SLA Activation/enforcement, SLA Operations, SLA violation / consequence handling, SLA reporting) between a Customer and a Service Provider. It is also useful in a multi-partner environment, while additional actors can be involved, such as those taking on the roles of SLA Auditor or SLA Integrator. Key operations include: • Retrieval of SLA and SLA violation • Creation of a SLA and SLA violation (planned) • Full/ Partial update of a SLA (planned)	Both internal and external (customer and provider)

		• Notification of SLA violation Creation	
Customer	Payment Management API	This API manages the payment performed by the customer. It contains both information about the payment and the payment method used. Key operations include: • Retrieve a list of performed payments and refunds (or a specific one) filtered by different criteria • Notify of a new performed payment or refund • Request a specific refund	Both internal and external (customer and provider)
Customer	Federated ID Management API	This API covers the activities required to grant an application access to information about the identity of an individual (e.g., name, username, phone number, birthdate, balance, location, etc.). In particular, the (only) operation supported is retrieval of information according to permissions.	Both internal users and external providers
Customer	Customer Management API	This API allows customer account management, i.e., management of identification and financial information. Note that customer can be a person, an organization or another service provider who buys products from an enterprise. Customer management API allows supports the creation, update, retrieval, deletion of accounts and notification about such events.	Both internal and external (customer and provider)
Customer	Product Offering Qualification API	This API allows to check the commercial eligibility of a certain Product Offering, i.e., validates that the items in the shopping cart (either selected by a customer or a recommendation service) can be realized. Furthermore, it can suggest alternatives from a product category or based on the products' specification description. Key operations include: • Retrieve a Product Offering Qualification • Partial update of a Product Offering Qualification • Store a Product Offering Qualification • Delete a Product Offering Qualification (for administration purposes) • Notify about events on Product Offering Qualification	Both internal users and external customers
Customer	Product Ordering API	This API is used to manage orders and their attributes (e.g., order status, effective dates, related billing account, order items, prices, service level agreements and geographical coverage) between a customer and a service provider, or between a service provider and a partner and vice	Both internal and external (customer and provider)

		versa. It also allows notifications of events on product orders to be created. Note that a product order is created based on a product offering that is defined in a product catalog. The product offering identifies the product or set of products that are available to a customer, and includes characteristics such as pricing, product options and market.	
Customer	Appointment API	This API offers a mechanism to manage appointments, i.e., create, update, retrieve appointments. This API includes all the necessary appointment characteristics, such as searching free slots based on parameters, as for example a party, dates, location, nature, etc.	Both internal users and external customers
Customer	Quote API	This API exposes a standardized mechanism for creating, updating (either by the provider: approving/cancelling or by the customer: accepting/rejecting), retrieving and deleting a customer quote for a set of product offers with all necessary quote parameters. A quote can be used to negotiate and agree on the product options and pricing (eventually special pricing for the customer described in the quote) between a customer and a service provider (Supplier Quote is out of scope).	Both internal and external (customer and provider)
Customer	Prepay Balance Management API	Prepay Balance Management API manages the balance, recharge (top-up), consumption/adjustment, transfer, reserve, and unreserve balance for those users that pay before using services. A user may be using multiple services, so balance needs to be managed for each service. This is done by using the concept of buckets and users may be allowed to transfer balance from one bucket to another (even between buckets belonging to different users).	Both internal and external (customer and provider)
Customer	Shopping Cart API	This API allows the creation, update, retrieval and deletion of a shopping cart, which is used for the temporarily selection and reservation of offerings in e-commerce and retail purchase by an existing or prospect customer. Furthermore, it supports notifications to be sent when a cart-related event takes place.	Both internal and external (customer and provider)
Service	Service Test Management API	This API provides test procedure for checking the quality, performance, or reliability of a service, e.g., periodically (as a proactive measure) or reactively (when customer experience has deteriorated). It allows a) describing a “service test specification” in	Internal

		terms of configuration parameters to be configured and measures to be taken and b) specifying when and how many tests will be executed. Furthermore, it allows notifications to be sent when service test specifications or test instances are managed. Key operations include: • Retrieve a Service Test Specification and/or Instance • Partial update of a Test Specification and/or Instance • Execute a Test Instance • Delete a Test Specification and/or Instance • Notify about related events	
Service	Service Problem Management API	This API is used for the service providers to manage any service problems in their area when upstream Network and Cloud Providers notify about on-going troubles they have identified. A Service Problem event may be generated a) by Service Providers based on own information or b) from infrastructure providers who provide the infrastructure of cloud or network. The event information includes alarm information, performance anomaly information, trouble ticket information, SLA violation, maintenance information and prediction information. This information is then used by Service Providers to identify and act on the service problems quickly and accurately.	Both internal users and external providers
Resource	(Service and Resource) Activation and Configuration API	This API allows the user to retrieve, create, update, delete services and monitor the execution of asynchronous requests on specific service or resource instance. Furthermore, notifications are supported during the lifecycle of both services and resources. Note that the same API can be used to Activate and Configure Services and Resources. Service creation can be performed either with a characteristic specification or YAML/JSON schemas.	Both internal users and external providers
Resource	Resource Catalog API	This API allows the management of the entire lifecycle of the Resource Catalog elements, the consultation of resource catalog elements during several processes such as ordering process, campaign management, and sales management. Furthermore, notifications for creation and deletion of Resource Catalogs. Resource Category, Resource Candidate, Resource Specification are supported. A resource catalog is a group of resource specifications that an organization provides to the consumers (internal consumers like its employees	Both internal users and external providers

		or B2B customers or B2C customers) either directly or indirectly (via a third-party). A Resource Specification defines the common attributes and relationships of a set of related Resources. A Resource is a physical or non-physical component (or some combination of these) within an enterprise's infrastructure or inventory. They are typically consumed or used by services (for example a physical port assigned to a service) or contribute to the realization of a Product (for example, a SIM card). They can be drawn from the Application, Computing and Network domains, and include, for example, Network Elements, software, IT systems, content and information, and technology components.	
Resource	Resource ordering API	This API allows to create, update and retrieving Resource Orders with all necessary order parameters. A Resource Order is created based on a partner that makes a Resource Specification available to a resource catalog. Key operations include: • Retrieval of a Resource Order or a collection of Resource Orders depending on filter criteria • Partial update of a Resource order • Creation of a Resource order • Deletion of a resource order (for admin purposes) • Notifications of events on resource order	Both internal users and external providers
Resource	Resource Function Activation & Configuration API	This API is used for provisioning and lifecycle management of Resource Functions (Network Service, VNF and PNF), including requests to heal a resource function and be notified for new events. A Resource Function is equivalent to a Network Service, VNF or PNF and can be atomic or composite i.e. composed from one or many Resource Functions. In case of composite Resource Functions details about topollogy need to be specified.	Both internal users and external providers
Resource	Alarm Management API	This API provides the standardized client interface to Alarm Management systems for creating, tracking and managing alarms among partners. The interface supports alarm management on both resources and services. The alarmed objects are not restricted to any particular technology or a vendor, so the API can be used in a wide variety of fault management cases (e.g., simple alarm forwarding/notification or tight integration of peer	Both internal users and external providers

		alarm management systems).	
Resource	Resource Inventory API	This API provides a standardized mechanism to query and manipulate the Resource inventory. For example, a customer (or the Call Centre operator on behalf of the customer) can query the resource instances in case of a complaint.	Both internal and external (customers and providers)
Engaged party	Party Management API	This API provides standardized mechanism for party management such as creation, update, retrieval, deletion and notification of events. Party can be an individual or an organization that has any kind of relation with the enterprise. Party is created to record individual or organization information before the assignment of any role. For example, within the context of a split billing mechanism, Party management API allows creation of the individual or organization that will play the role of 3rd party payer for a given offer and, then, allows retrieval or update of their information. This API performs the following operations on individuals and organizations: • Retrieval of certain party • List a collection of parties depending on filter criteria • Partial update of a party • Creation of a party • Deletion of a party • Notification of events related to a certain party	Both internal users and external providers
Engaged party	Agreement Management API	This API provides standardized mechanism for managing agreements and associated templates, especially in the context on partnerships between partners. An agreement represents a contract or arrangement, either written or verbal and sometimes enforceable by law, such as a service level agreement or a customer price agreement. An agreement involves a number of other business entities, such as products, services, and resources and/or their specifications. Notifications related to Agreement include those for: • Creation • Attribute value change • State change • Remove notification	Both internal and external (customers and providers)
Engaged party	Privacy Management API	The Privacy Management API provides the management for the customer privacy information and preference, such as creation, update, retrieval,	Both internal and external

		deletion and notification of events for the following concepts: • Privacy Profile Type that represents a description for privacy profiles. • Privacy profile that represents the set of Privacy settings defined for a Party • Privacy agreement that represents the approval made by the Party about a Party Privacy Profile	providers
Engaged party	Payment Methods API	This API supports the management of payment methods for the customer to choose and pay the usage, including voucher card, coupon and money transfer. This API allows the following operations • Retrieve a specific (or a list of) payment methods filtered by a given criteria • Create a specific payment method • Delete a specific payment method	Both internal and external providers
Engaged party	(Party) Account Management API	This API supports the management of billing (bill structure, frequency, payment method, etc.) and settlement accounts for third parties, as well as for financial accounting (account receivable of one, or more, third-party accounts). Operations supported are: • List party/billing/settlement accounts • Retrieve party/billing/settlement account • Create party/billing/settlement account • Update party/billing/settlement account • Delete party/billing/settlement account • List billing cycle specifications • Retrieve billing cycle specification • Create billing cycle specification • Update billing cycle specification • Delete billing cycle specification • List bill formats • Retrieve bill format • Create bill format • Update bill format • Delete bill format	Both internal and external providers
Engaged party	Partnership Type API	This API supports the management of partnership structure and partnership instances. It defines the type of partnership between parties, including the list of role types that are permitted (i.e Buyer, Seller, Developer). During the agreement setup, the party accounts (for billing, settlement and financial) are created, if not exist.	Both internal and external providers

		The API allows the retrieval, creation, update, and deletion of partnership type.	
Engaged party	Party Role API	This API can be seen as a generalization of Customer management API where Party Roles may be any – not only a Customer. Thus, this API manages the coupling of a party with a given role. This API supports the creation, update, retrieval, deletion of party accounts and notification about such events.	Both internal and external providers
Engaged party	Party Interaction Management API	This API provides a mechanism to manage party interactions. A User Interaction captures information about past interactions in order to re-use it in future ones. This allows agents to serve users better by knowing the steps they went through. It also allows customers to see better the actions they have performed and how they interacted with the provider. Creation, update and retrieval of interactions are supported.	Both internal and external providers

Annex D Personae descriptions

D.1 Lara - Digital transformation leader

Lara

"For me it's important to access to data and information for assessing new solutions benefits "

Information

Age: 37

Language: Italian, English, Spanish

Workplace: office, home, traveling

Job Sector: ICT

Tech. tools: Office, web application, analytics tools for data analysis,... .

Technology Skills

Digital transformation leader

Job Description

Lara is a digital transformation leader working in the innovation department inside a big Media company. She is usually involved in research projects in order to follow the implementation of new, or improved technology solution and identify their benefits for the market as well as their technological and economic impact. She usually has to drives cultural change and builds digital capability to deliver innovative business models and processes. So, her main tasks are:

- Shape and deliver a digital strategy
- Develop awareness and education to improve digital capability
- **Demonstrate the benefits of digital transformation implementation**
- Advise and support on a 'digital by design' approach
- Lead cultural change required to facilitate digital strategy
- Lead and mobilise key organisation influencers to implement digital transformation

Needs and Pains

What is very important for Lara in order to do well its job, is to access to relevant information and data on the developed/tested technology outcomes during the research projects. She needs to know information like: used software, licences, infrastructure configuration, people involved, used staff ect. The main problem now is the difficulty to collect those information because in some projects the test facilities are limited and with different constraints. Consequently she can only hypothesize the complete technical configuration of the final solution and their impact on the organisation and customers.

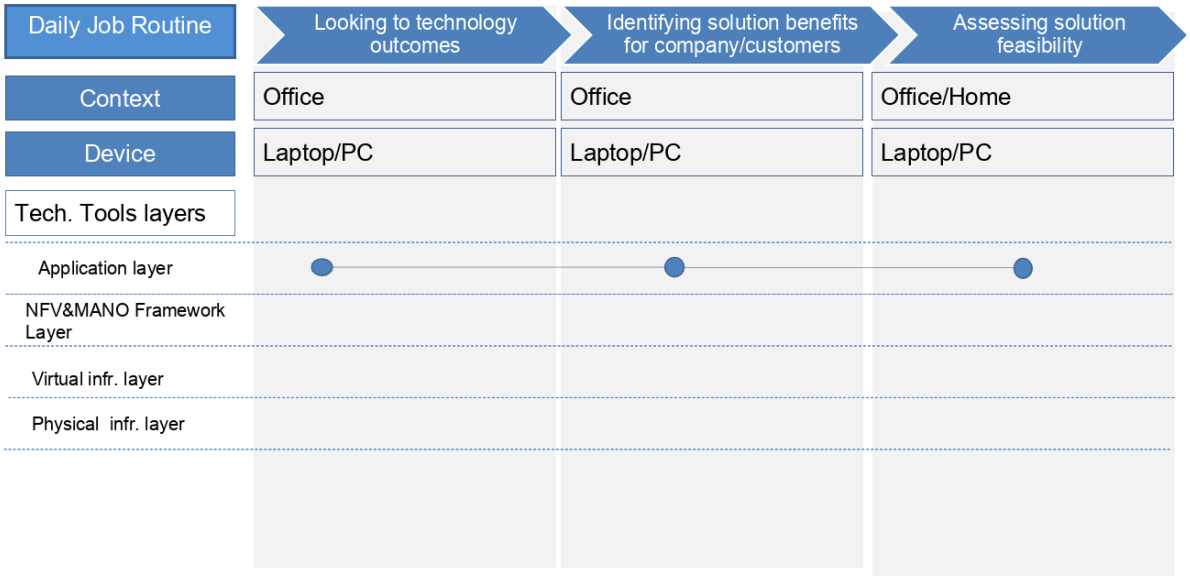
Source

- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

Daily Job Routine	Looking to technology outcomes	Identifying solution benefits for company/customers	Assessing solution feasibility
SCENARIO: **Demonstrate the benefits of digital transformation implementation**	Lara is always involved to follow the development of research projects. She is interested to the main technology outcomes in order to understand how they can be exploited in the marked and in her company and how they impact in terms of digital transformation. She usually analyses each activities inside those project following their development cycle in order to be able to identify the potential solution/s that can come up. In order to do it, she studies project documents and arranges calls or interviews with specific people involved in the project in order to understand the potential outcomes benefits for the potential market/users and his company.	The main goal, for Lara when analyses a potential new technology solution is to identify the cost/benefits model in order to estimate the cost for providing or deploying those solutions as well as the benefits for his company or their customers . For that reason she need to have a clear view of the solution architecture, software used and their licenses, hardware used/needed , people/staff involved or needed for manage the solution, process work-flow and each assets potentially necessary for deploying a technology solution. Moreover it is useful for her to access to the tested solution results.	It is very useful for Lara to access and understand the tested solution results. They are a relevant input for assessing the technology feasibility of a solution as well as how they can impact in terms of digital transformation. They are also a starting point for understand the solution marketability and how the solution can fit with the end user customer needs.It would be nice also to access to reports and results of experiments done in similar condition from other organisations.

User Journey



ID	User Tasks	Sub-task	User Stories
A.1	Looking to technology outcomes	Access to the solution experimentation process	As a digital transformation leader, I need to have visibility of the process, software and hardware configuration and every things that can support me to understand its impact on my organisation and customers.
A.2	Looking to technology outcomes	Contact relevant people involved in the experimentation process	As a digital transformation leader, I need to have the possibility to access to an central point and to contact and interview all the different people involved in the experimentation development and deployment of the solution
B.1	Identifying solution benefits for company/customers	Gather information on ICT solution and its potential experimentation deployment.	As a digital transformation leader, I need to have clear reports on the solution design and experimentation deployment, which should include information about software/hardware used, software licenses, infrastructure resources involved and their configuration, test order status and faults etc..
B.2	Identifying solution benefits for company/customers	Assess and clarifying reports	As a digital transformation leader, I need to improve my understanding of the available reports, it is important for me to be able to know who can provide clarification on them and contact them
B.3	Identifying solution benefits for company/customers	Access to information not available in the reports	As a digital transformation leader, If I have doubts or I can't find information for me relevant, It would be useful to be able to identify the reference people and contact them.
B.4	Identifying solution benefits for company/customers	Access to already available cost/benefits models	As a digital transformation leader, It would be nice to have the possibility to access to already available cost/benefits models or at least cost models of part of the system for deploy the experiment.
C.1	Assessing solution feasibility	Assess ICT solution feasibility in terms of digital transformation	As a digital transformation leader, It is very important to access to business report in order to assess the tested solution in business terms. it would be also nice to have tools for assessing new technology solution/s feasibility and their impact on the internal organisation or/and customers/market,

D.2 Bill - Business Analyst & Digital Consultant

Bill

Business Analyst & Digital Consultant)

"For me it's important to assess the business potential of a solution using reliable techno-economic metrics"

Information

Age: 40

Language: Greek, English

Workplace: office, home, traveling

Job Sector: ICT

Tech. tools: Office, custom business model evaluation tool

Job Description

Bill is an business analyst and digital transformation consultant, who is working in a large consultancy firm.

As a business analyst he analyses the information and the processes needed to support business plans selected by key customers' executive management and optimises business performance through technology application. Being also a digital transformation consultant his mission is to assess which digital technologies are the most promising ones to add value to those clients and advise on the lifecycle of existing ones.

His main tasks are (in sequential order):

1. Raise awareness of information technology innovations [DC]
2. Identify new business cases (areas for improvement in business processes or products and design new ones) [BA]
3. Make recommendations for the development, implementation or integration of a technological solution [DC]
4. **Evaluate and choose possible ICT solutions compliant with the customer's ICT strategy by ensuring technical feasibility and sustainability of the newly supported business cases [BA &DC]**
5. Provide advice on how to optimize the use of existing tools and systems [BA &DC]

Needs and Pains

Bill needs access to techno-economic metrics, including performance and cost-related data, for a particular technology solution based on trials performed in close to real-world conditions. This is important for developing business cases that justify the proposed solutions. Currently he relies upon estimates of those metrics obtained using a combination of expert interviews, white-papers, research articles and own assumptions. For a subset of key parameters, or those where limited a-priori information is available, he runs a sensitivity analysis. Despite spending most of his time in dealing with uncertainty, he is not confident enough about the accuracy of those metrics and the business cases formulated.

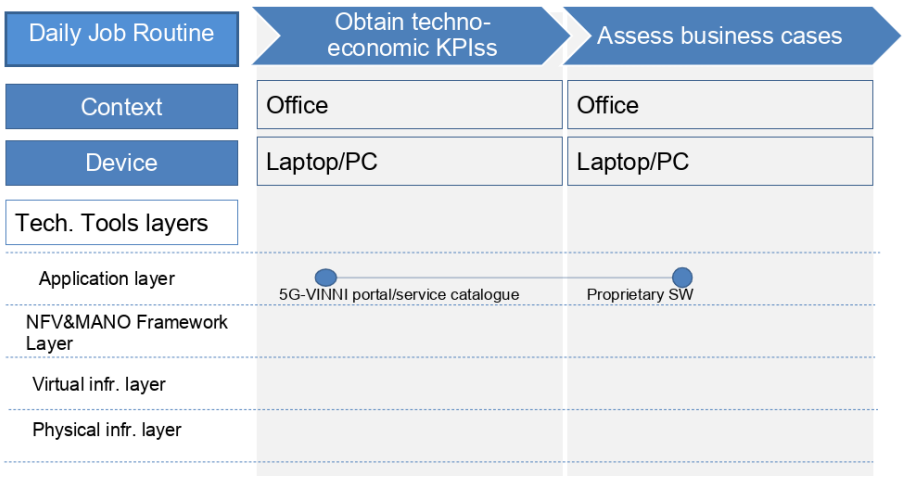
Source

- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

Daily Job Routine	Obtain techno-economic KPIs	Assess business cases
SCENARIO: Evaluate and choose possible ICT solutions compliant with the customer's ICT strategy by ensuring technical feasibility and sustainability of the newly supported business cases (see main task #5)	Each candidate ICT solution is usually composed of several sub-components that were never integrated before, or were not tested in close to real-world conditions. Thus, it is hard to have a good estimate on the performance of each solution in terms of key technical KPIs, such as maximum number of transactions supported. Furthermore, he needs info about economic KPIs, such as expected number of transactions, prices, CAPEX, OPEX, etc. In order to deal with this issue, he combines information gathered from expert interviews, white-papers, research articles, own assumptions or even special purpose simulators.	Each ICT solution can support one or more business cases. For assessing the sustainability and replicability of each business case he performs Discounted Cash Flow (DCF) analysis over a period, usually 5-10 years. Given that the accuracy of the techno-economic KPIs is not high enough today, he performs sensitivity analysis in order to study the effect of key uncertain factors on the profitability of each business case. These key uncertain metrics are commonly agreed with other colleagues and customer representatives. This is performed for each business case.

User Journey



ID	User Task	Sub-task	User Stories
A1	Obtain valuable techno-economic KPIs	Log in to service catalogue	As a Business Analyst I want to be able to log in to the service catalogue, in order to specify details for the experiments to be performed on behalf of my customer and retrieve results.
A2	Obtain valuable techno-economic KPIs	check documentation	As a Business Analyst I want to be able to consult the system documentation, in order to reduce the risk of misconfiguration and increase efficiency.
A3	Obtain valuable techno-economic KPIs	choose attributes to be included in the KPI report for each trial executed (under a certain system configuration)	As a Business Analyst I want to be able to choose what metrics should be monitored and reported, so that I can focus on the aspects of the solution's configuration that are being tested/validated
A4	Obtain valuable techno-economic KPIs	retrieve KPI report during and after a trial execution (under a certain system configuration)	As a Business Analyst I want to be able to have access to a technical report at various stages of trial execution, so that I can continuously validate my hypotheses and decide (jointly with colleagues) if additional trials and/or configurations are needed
A5	Obtain valuable techno-economic KPIs	Obtain valid cost information	As a Business Analyst I want to be able to have detailed information about the costs associated with the experiment and be able to ask my colleagues and other experts, so that I can estimate future operating expenditures (OPEX) and wherever possible capital expenses (CAPEX)
B1	Assess business cases	Perform Discounted Cash Flow (DCF) analysis for the baseline scenario and its sensitivity to key parameters	As a Business Analyst I want to be able to repeat a trial so that I can perform sensitivity analysis of the DCF results obtained.

D.3 Samuel – SW developer

Samuel

SW Developer

"For me it's important that the interaction for developing and uploading VNF is clear and well defined"

Information

Age: 33

Language: Greek, English

Workplace: office, home, travelling

Job Sector: All

Tech. tools: Software IDE

Technology Skills

Job Description

Samuel is a software developer working in a sw producer SME for different clients. He is part of a team of SW developers who work on major projects involving specification and programming of software components for the business.

As a Software Developer he uses the company's development operating model which defines the development process from requirements capture through to deployment. Samuel uses the latest set of development tools provided through an integrated development environment. This IDE is coupled into his company's wider technology implement process to ensure that any new installations are compatible with existing deployments

His main tasks are:

1. Examine and interpret technical, usability, operational and business requirements
2. Specify and seek customer concurrence for software solutions to meet business requirements
3. Implement, test and document software solutions
4. Support ongoing maintenance of installed solutions
5. Identify potential technical design risks
6. Identify opportunities for innovation
7. Plan technology roadmaps
8. Lead and/ or conduct system integration

Needs and Pains

Samuel follows a specific development process for moving stand-alone SW to service. But those services, in order to be used as a VNFs need to follow specific guidelines as usually indicated from the specific network services provider. For Samuel is important to have clear specification and requirements in order to develop the needed service component as well as to well know how to move it as VNF in a specific environment. He need to know the processes, rules, methodologies for move his services as VNFs.

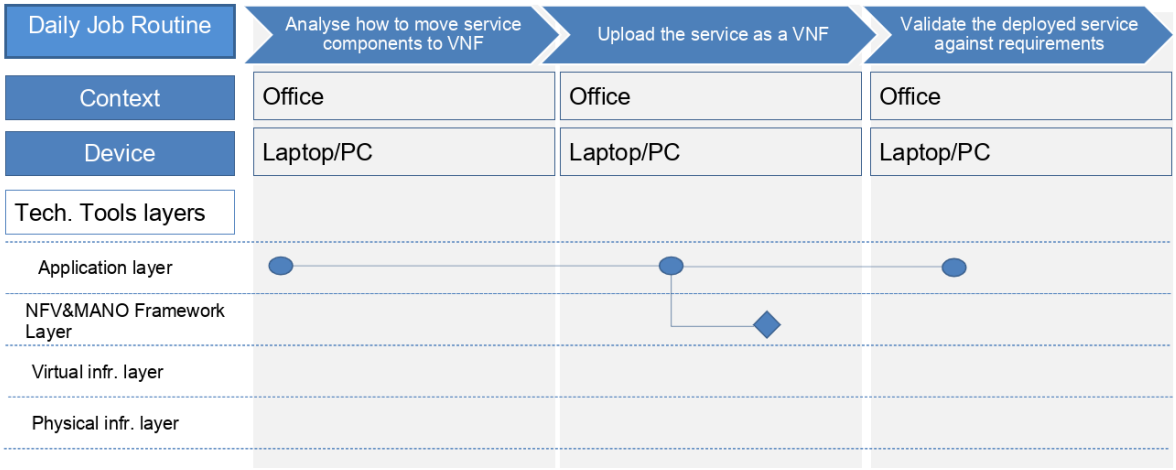
Source

- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

Daily Job Routine	Analyse how to move service components to VNF	Upload the service as a VNF	Validate the deployed service against requirements
SCENARIO Ensuring that the solution can be delivered in a manner and timeframe that support the overall business objectives	Samuel receives the functional requirements from his colleagues (especially Steve who is the Solution Designer and System Architect) together with an architecture diagram. According them he develop the needed services.In order to make it available as VNF, he need to know the standards, methodology and any rules for packaging the service and move it as a VNF.	Samuels enacts the development routine through the company software IDE. Samuel will use the IDE to produce the required code and will validate its execution through a set of unit tests. Sometimes, he has to contact the support team of external systems for help during debugging. He will check that the deployed service will be technically consistent with the current existing available VNFs following the required methodologies and processes. Samuel following the available guidelines makes the developed service available as a VNF and uploads it to the repository updating the service/VNF documentation.	Samuel and his colleagues will deploy the new service and test against the functional requirements. In order to do so he needs access to a testbed where developed services are deployed. After each experiment he can access to reports and understand if something need to be further addressed at functional or software level.

User Journey



ID	User Task	Sub-task	User Stories
A.1	Analyse how to move service components to VNF	understanding requirements for provide a VNF	As a SW developer, I need to know how to make available the developed service as a VNF. I need to know standards, methodologies, processes and rules to be followed.
A.2	Analyse how to move service components to VNF	Accessing for upload service as a VNF	As a SW developer, I need to have an access point for uploading my services. In case of problem or needs for more clarifications, it would be nice to have the possibility to contact someone for having support or to access to the experiences of other people.
B.1	Upload the solution as a VNF	Move services as a VNF	As a SW developer, I have to implement the VNF and I have to upload it according specified and shared guidelines. A common shared space should be available for upload the VNF. Share my feedback or access to the ones of others about that common space and it services, could be useful for improving it and made more easy it usage over the time.
C.1	Validate the deployed service against requirements	Obtain integrated test report	As a SW developer, I need to have a detailed report about the test results in order to validate that the functional requirements are met and that also service code works well. If not I have to address the bugs and problems.

D.4 Carl - System Administrator/Network Specialist

Carl

System Administrator/Network Specialist

"Network Control in a 5G network environment is a key topic "

Information

Age: 38

Language: German, English

Workplace: office, home, travelling

Job Sector:ICT

Tech. tools: Openstack, VM, Open Nebula, VIM, etc.

Technology Skills

Job Description

Carl is an network infrastructure specialist for a ICT medium enterprise. He is an network expert in his organisation. His main tasks usually are to manage and operate a networked information system, solving problems and faults to ensure defined service levels. Monitors and improves network performances and security. Consequently, his main role is to ensure communication performance, recovery, and security needs in order to meet agreed service agreement standards.Usually he contributes to define network design policies, philosophies and criteria. He is also committed to investigate, diagnose , solve network problems and monitor network for identifying and addressing traffic bottle necks. In order to perform his work and for determining network load, he usually uses network management system tools. He is quite expert about cloud infrastructure management and tools (openstack, VM, virtual network, open nebula ect) and on the physical network equipment. Considering the adoption of the NVF, he is acquiring skill about Network Function Virtualization and Mano framework participating also in research project for experiment new configuration and network modalities.

Needs and Pains

Carl, working in a research project, is facing new challenges on the network configuration and management, due to different market sectors needs and their services provision It would be useful for him to have a ready network environment for different cases, with the possibility to control it (if needed) according the services to be provided to final customers and their specific needs.

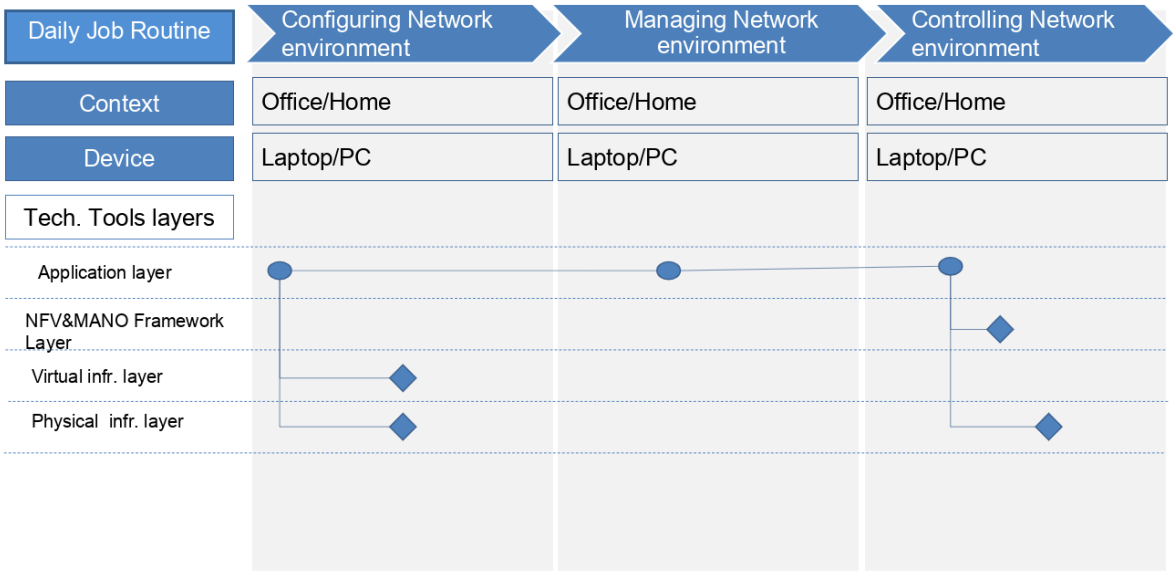
Source

- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

Daily Job Routine	Configuring Network environment	Managing Network environment	Controlling Network environment
SCENARIO:Configuring and managing network for providing services to final customers	When a new services for final customers has to be instantiated /provided, Carl need to analysis what is the best network architecture and configuration for instantiate the service according the SLA agreed with the customer. So he has to take decisions about the more appropriate physical network devices, network architecture and cloud environment configuration.	When the network environment is ready for the service instantiations, Carl needs just to launch the service instantiation and run it. During the service provision he need to monitoring it in order check that everything is going well otherwise He has to perform potential corrective action. Usually test environments need to be available for simulating the service before to be launched in the production environment. This test environment usually is produced using the available internal resources and facilities.	During the service instantiation it can be possible for different network reason that the service meets some problems and its provision becomes difficult or even goes down at all. In this case is needed to address the problem in time to avoid that the service goes down. The solutions to this problems can be different according the sector and the service typologies. New technology solutions for addressing specific problems are coming up and need to be tested. They usually propose automated solution but in some case the manual control could be necessary or preferred.

User Journey



ID	User Task	Sub-task	User Stories
A.1	Configuring Network environment	Identify and choose network infrastructure architecture	As a network administrator, I need to access and understand all the possible available options in terms of network architecture in order to identify the one more appropriate for the instantiation/ provision of the final customers service according their needs in terms of latency, bandwidth ect. In the case it is not or partially available to decide if to include new network infrastructure facilities or use external network facilities. In this last case, the interoperability among network infrastructure is very important.
A.2	Configuring Network environment	Identify and choose network cloud configuration	As a network administrator,I need to know all the possible available options in terms of network cloud configuration (openstack, VM, VIM open nebula, use of proprietary solution and their features, ect) in order to identify the one more appropriate for the instantiation/ provision of the final customers service.
B.1	Managing Network environment	Launch service instantiation in test and production environment	As a network administrator, I have to launch the service at the right time as it is required, following the specific requirement agreed at SLA level in order to assure the service as it has to be. This service launch can be automatized once defined all the service features for its provision. Usually before to launch the real service it is required to launch it in an environment test. Consequently, it is required to create an environment test which simulate the overall production environment. This test environment usually is produced using the available internal resources and facilities.
B.2	Managing Network environment	Monitoring of the running service	As a network administrator, I need to monitoring during the service running if everything is going as expected. For this reason can be useful to use run-time monitoring tools. They can support me to detect system faults or limitation to be addressed.
C.1	Controlling Network environment	Adopting problem mitigation solution	As a network administrator, I could need to follow different network problem mitigation approaches , some of those could propose technology solutions. So it would needed to integrate those solutions. It would be also nice to have already some automated solutions in place in the test and production environment. Share and discuss on those issues and solution with who already faced or have to face they, should be useful.
C.2	Controlling	Using manual	As a network administrator,in some case could be useful and needed to

	Network environment	network control	have the possibility to control the network environment in terms for instance to decide where to instantiate the VNFs and services, to modify variables during the runtime service if a problem rises, ect. Share and discuss on those issues and solution with who already faced or have to face they, should be useful

D.5 Sandra - Service Manager & Quality Assurance Manager

Sandra

Service Manager & Quality Assurance Manager

"For me 5G is a technology whose business benefits are still uncertain"

Information

Age: 49
Language: French, English
Workplace: workplace, travelling
Job Sector: smart grid
Tech. tools: SCADA

Technology Skills

Job Description

Sandra is a Service/Product Manager and Quality Assurance Manager product owner in a large software company and responsible for the commercial success of the Smart Grid product line.

As a Service/Product Manager she is responsible for the product portfolio to be published on the service catalogue, define Service Level Agreements (SLAs), Operational Level Agreements (OLAs) contracts and Key Performance Indicators (KPIs). As a Quality Assurance Manager she commits the organisation to the achievement of quality goals and encourages an environment of continuous improvement.

Her main tasks are:

1. Define Service requirements [SM]
2. **Negotiate SLA / OLA [SM]**
3. **Define KPIs [SM]**
4. Perform quality audits [QAM]
5. Organise customer satisfaction surveys [QAM]
6. **Assist project team members to build and perform project quality plans [QAM]**

Needs and Pains

The success of her products rely on meeting user requirements on an efficient manner. Helen needs to get feedback from representative users that the product can handle required tasks in real-world scenarios, according to their requirements. While beta testing is being extensively used, reproducing "real-world" conditions is not possible, or very costly, when the required infrastructure is not yet in place. This represents a major roadblock for rolling-out innovative features due to the high risk of failing to identify and address shortcomings early enough. Furthermore, she wants to be able to negotiate SLAs with upstream providers (e.g., network providers or system integrators) in an efficient/automated way and be able to monitor the status of KPIs for ongoing contracts in order to react accordingly. As composite services from several providers become the norm, the more important is to be able to identify the source for an SLA term violation.

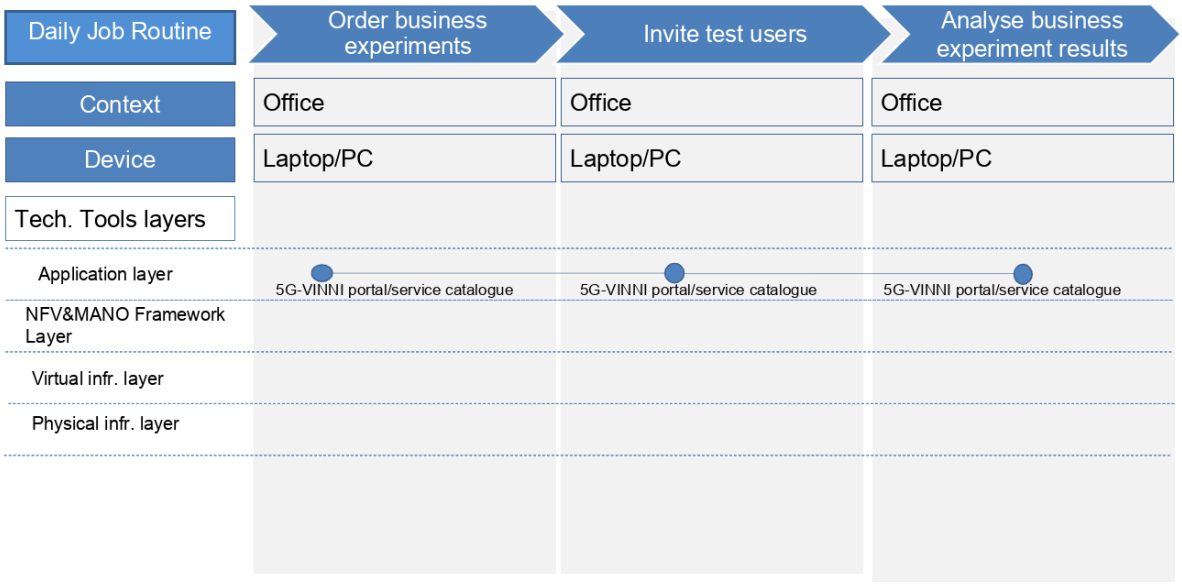
Source

- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

Daily Job Routine	Order business experiments	Invite test users	Analyse business experiment results
SCENARIO: Negotiate SLA / OLA, define KPIs and ensure quality (see main tasks: #2,3 6)	In order to test her product/service in close to real-world conditions and determine which system variant is more effective, she runs a series of "A/B tests". For this purpose, she places an order for a set of experiments. She browses the service catalogue like a system integrator would do and chooses the components that make up each variant/complete solution. For each KPI that is important to her customers she needs to choose a target value as part of the SLA(s) with the upstream providers.	Each test user needs to interact with a single system variant. Thus, she needs to schedule when each user will be invited to participate and supply them with the appropriate credentials.	At the end of each A/B test, users are asked to provide their opinions via questionnaires and interviews in order to perform the statistical analysis. Furthermore, she needs to get a detailed report with major system events and KPIs in order to get insights on the product's readiness and desired performance level.

User Journey



ID	User Task	Sub-task	User Stories
A.1	Order business experiments	Log in to service catalogue	As a Service Manager, I need to be able to log in to the service catalogue, in order to have personalised view of my company's interactions with the testbed
A.2	Order business experiments	check documentation	As a Service Manager, I want to be able to consult the system documentation, in order to reduce the risk of misconfiguration and increase efficiency.
A.3	Order business experiments	Configure experiment	As a Service Manager, I need to be able to define the details of the experiment using an intuitive GUI so that I can test the business hypotheses in a close to real life environment by placing a new order from scratch, continue configuring pending ones or resubmitting an old one.
A.4	Order business experiments	Agree on SLA and cost	As a Service Manager, I need to be able to define the SLA terms by choosing a target value for each KPI in a certain analysis period that is important to her customers, so that we and testbed provider can have a shared understanding on the expectations and costs.
B.1	Invite test users	Define the set of test users	As a Service Manager, I need to be able to define any number of users (i.e., devices) that will be granted access to the testbed, so that I can run a close-to-real-life experiment.
C.1	Analyse business experiment results	Analyse results	As a Service Manager, I need to be able to get a detailed report of testbed events and system behaviour, so that I can assess the readiness and performance level of the system under test.
C.2	Analyse business experiment results	Analyse feedback	As a Service Manager, I need to be able to retrieve the feedback that end-users have provided, so that I can assess the readiness and performance level of the system under test from the point-of-view of end-users.

D.6 Steve - Solution Designer & System Architect

Steve

Solution Designer & System Architect

"To have an interface for simplified the solution design process is a must"

Information

Age: 33
Language: English
Workplace: office, home, traveling
Job Sector: ICT in media sector
Tech. tools: IDE, Java, web/cloud services ect

Technology Skills

Job Description

Steve is a Solution Designer & System Architect, who is working in a SME developing and integrating new ICT solutions for its clients in the media sector. He has a long experience in this sector and a good awareness about its trends and needs.

As a Solution Designer he provides the translation of business requirements into a set of product specifications for the end-to-end ICT solutions that enhance user satisfaction. Furthermore, as a system architect he plans, designs and integrates ICT system components including hardware, software and services.

His main tasks are:

1. Examine and interpret technical, usability and business requirements [SD & SA]
2. **Specify and implement the architecture of complex ICT solutions [SD & SA]**
3. **Identify potential technical design risks [SD]**
4. Supervise the built-in quality [SD]
5. Identify opportunities for innovation [SD]
6. Plan technology roadmaps [SD]
7. Lead and/ or conduct system integration [SA]

Needs and Pains

The new solutions require to follow more and more a cloud native approach consequently the solution design process is changed, where well managed it can become more simplified. He need to have access to information about individual system components as a services (VNFs and their images) in a single "app store" to be instantiated according the main solution logic designed in his descriptor. He needs to know the methods/standards for realising the descriptor as well as to have a GUI able to address him in the creation and uploading of the descriptor. He can avoid to waste time if the VNFs available are well documented. Once the solution experiment has been instantiated, Steve needs to know the results of the experiment in order to address issues in the solution design. O course, on the other hand he needs his customers to be part of the development journey – specifying the business requirements, following the development process, and signing off the new component/VNFs as part of the final solution.

Source
- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

Daily Job Routine	Identifying and picking up VNF/image analysing interdependencies	Realising and uploading solution descriptor	Set up experiment and Identify potential technical design risks
SCENARIO: Specify and implement the architecture of complex ICT solutions and identify potential technical design risks (see main tasks #2,3)	Once Steve has a concrete idea about how the solution has to be, according requirements received, he start to identify on the network/cloud environment, available and useful (for his scope) VNFs. They needs to be available in the environment where they will be instantiated. He has to validate that any available needed VNFs are compatible with their own designed service solution and well-documented. If they are non available, he will ask to developers (like Samuel) to provide and upload them on the network/cloud environment.	When Steve has available all the needed VNFs and images, he can start to compose its service (the ICT solution). Composing his services mean that he has to define the logical relationship/combination of the VNFs, how and when they have to be instantiated , in which conditions ect. This logical representation of the services is represented in a "software document" called "descriptor". He needs to know the standard required and to be addressed for the production and uploading of the descriptor inside the specific environment for the service instantiation .	Once he his ready with the defined solution he can set up a specific experiment where test it. It could be nice to have the possibility to pick up: more appropriate facilities, time schedule, duration, the possibility to control the network environment or to have an automated management of it based on requirements like bandwidth and latency. He also has to agree on the test that need to be performed (both at the services and solution level). After the service instantiation, Steve needs to know the results of the experiment done in order to be able to identify bugs and risks to be addressed before to ask for a new experiment.

User Journey

ID	User Task	Sub-task	User Stories
A.1	Identifying and picking up VNF/image analysing interdependencies analysing	Identify VNFs and their Images, searching VNFs and Images	As a solution design and system architect I needs to know if VNFs and Images are available, what they do, where they are available and at what conditions. It would be nice to have a unique access point and catalogue for searching those components with information for understanding them and how it is possible to use them.
A.2	Identifying and picking up VNF/image analysing interdependencies	Browse through the service catalogue for complementary Service Components (SCs)/ VNFs	As a a solution designer and system architect, I need to be able to log-in and query the VNF catalogue , in order to find details about the Service components/VNFs which have to interact with for delivering the final service. For me is useful to have the possibility to contact the responsible person of those services/VNF or who already used them for have further information on them.
A.3	Identifying and picking up VNF/image analysing interdependencies	Retrieve APIs for each external VNF Package	As a solution designer and system architect, I need to have access to the metadata of the external VNFs in order to understand how the service could be modified according the needs (if needed) and how it will be interacting with.
B.1	Realising and uploading solution descriptor	Understanding standards and models to be used	As a solution designer and system architect before to start to develop my service descriptor, I need to know what standards and data modelling I have to follow for producing it. It could be nice to have available information, description, about them as well as to know about experiences of other users.
B.2	Realising and uploading solution descriptor	Developing and Uploading Service Descriptor	As a solution designer and system architect It could be nice for me, to have available information, description, handbook, tutorial, feedback on already done experiences that can be able to drive me in the descriptor development to be instantiated in a specific environment.

C.1	Set up experiment and Identify potential technical design risks	Monitoring results of the instantiated services	As a solution designer and system architect, It would be useful to have the possibility to have a list of the results of all the instantiated services. In same case the real time resource monitoring could be necessary.
C.2	Set up experiment and Identify potential technical design risks	Accessing and checking reports for bugs/risk check	As a solution designer and system architect, It is very important to access to technical reports on the instantiated services. Those reports have to support me to understand if the service works as expected, to identify bugs or risks about its deployment.
C.3	Set up experiment and Identify potential technical design risks	Set up experiment	As a solution designer and system architect I need to have an access point where is possible to set up an experiment for validate my designed solution. I would like to have the possibility to pick up: more appropriate facilities, time schedule, duration, the possibility to control the network environment or to have an automated management of it based on requirements like bandwidth and latency, automated replicability. I need to define SLA and according them to know the potential bill.

D.7 David - DevOps Expert

David

"For me it's important that the solution implementation process is as agile as possible"

Information

Age: 25

Language: Spanish, English

Workplace: office, home, traveling

Job Sector: Infrastructure

Tech. tools: DevOps Software

Technology Skills

Job Description

David is a DevOps Expert working in the operations department of a major infrastructure provider. He is part of a specialised team of devOps experts who support the day-to-day operational running of the infrastructure.

As a DevOps Expert he uses agile methods and processes to support the company's operational model. David uses a set of specialised DevOps tools dedicated to streamlining the company's operations. When the operations are running smoothly, David analyses operational performance with a view to executing improvements. When the operations are not running smoothly, David is part of an agile HIT team, whose aim is to resolve faults and bring the operations back to normal running as quickly as possible.

His main tasks are:

1. Assess the operational performance of the company's infrastructure
2. Analyse and specify improvements operational performance
3. **Implement, test and document devops solutions**
4. Support ongoing maintenance of installed solutions
5. Execute agile methods to resolve operational problems and faults
6. Identify opportunities for innovation
7. Plan technology roadmaps

DevOps Expert

Needs and Pains

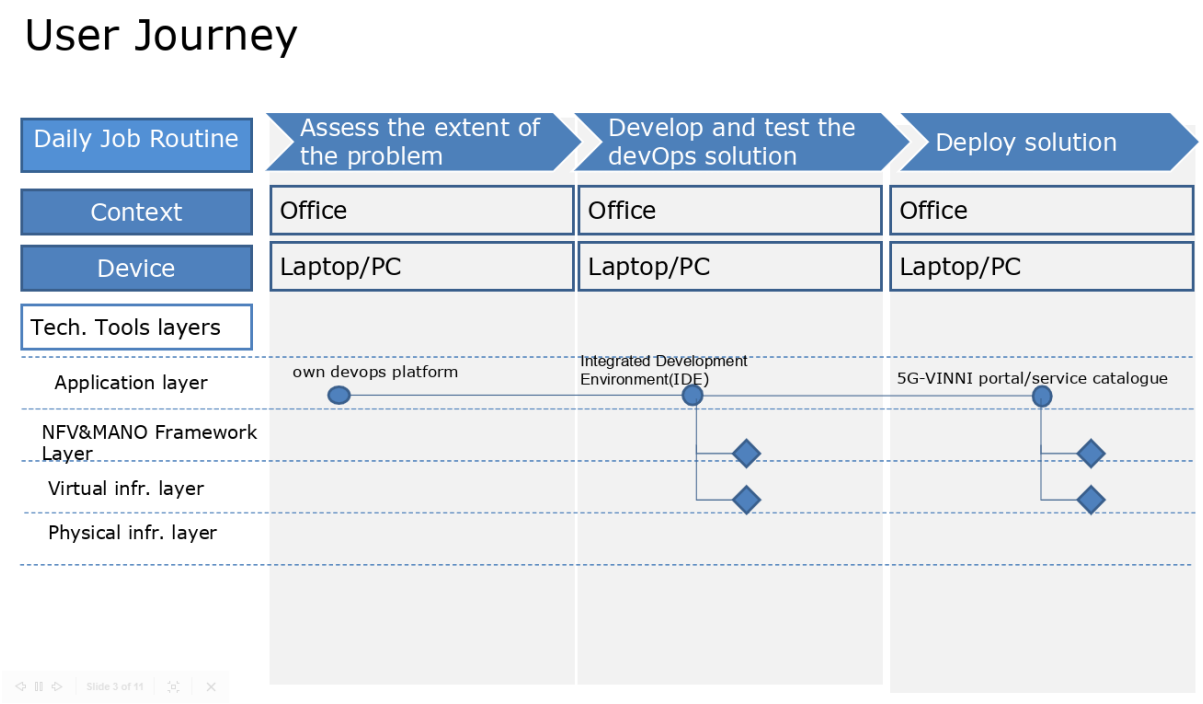
David's main modus operandum is speed of implementation. DevOps is the application of agile development methods to the day-to-day running of his company's infrastructure. It is vital to David's ability to deliver that the company's processes allow him free and immediate access to implement devOps solutions. This is especially true when David is required to quickly resolve operational problems.

David's pain points come about when automation in build, test, deploy, and operation phases is hard, especially when legacy systems are involved or limited data are available to identify the problem and plan a better road mapping. In addition, sometimes David sees that developers are reluctant to collaborate with administrators and vice versa. Furthermore, sometimes he needs to suspend operations while the solution is deployed and thus a lot of people need to be informed about the timeplan.

Source
- F2F interviews;

User Scenario

Daily Job Routine	Assess the extent of the problem	Develop and test the devOps solution	Deploy solution
SCENARIO Rapidly identify a devOps solution to a broken operational process	David receives a call from his product manager at home early one morning. A major business process in the company's operations has failed and the infrastructure is showing faults against service metrics. David is at work quickly and enacts together with the rest of his team a series of systems analytics in order to identify the source of the broken process.	David and his team develop a devops solution that can be deployed in the company's testing infrastructure. Then he triggers a set of automated tests for validating its robustness.	As soon as David and his team are satisfied with the results, they package up a new image and prepare a script for automated deploy. Then, he deploys the devops solution in order to fix the problem and bring the infrastructure back online. David documents his devops solution and the test results in the company's solution library.



ID	User Task	Sub-task	User Stories
A.1	Assess the extent of the problem	Find the faulty component	As a DevOps Expert, I need to have access to a detailed report of past transactions and KPIs in order to find the root of the problem.
A.2	Assess the extent of the problem	Find what needs to be fixed	As a DevOps Expert, I need to be able to monitor the status of certain subcomponents that appear to misbehave in order to understand what needs to be fixed.
B.1	Develop and test the devOps solution	Develop patch	As a DevOps Expert, I need to prepare a patch in order to deal with the malfunction.
B.2	Develop and test the devOps solution	Test patch	As a DevOps Expert, I need to specify a set of automated tests in order to verify the effectiveness of the patch.
C.1	Deploy solution	Deploy solution	As a DevOps Expert, I need to be able to replace the faulty component with the new one (or update service topology if additional components need to be introduced) in order to deploy new solution.

D.8 Siren - Service manager

Siren

"As a service manager it is my job to monitor that the service is delivered according to agreements, so that the customers are satisfied and our income predictable»

Information

Age: 29

Language: Norwegian, English

Job Sector: Computer scientist, data bases

Tech. tools: Salesforce, Office

Technology Skills

Service manager

Job Description

Siren is an engineer who started her career in service management. She was headhunted because of her direct and firm way of handling people, however, sees the position only as a step in her path as an engineer. Next, she aims to be a product leader/developer. She thinks there is a lot of fuzz with the services and service levels in the company and does not understand how less standardized/more customized services can be provided. She feels that she is the right person for the job – keeping demanding customers on a arms length. She sees that her peers from university are working with products much more customized – still in quite smooth processes. Still, she efficiently does what she is paid to do.

- Define Service requirements
- Negotiate SLA / OLA
- **Manage solution operation**
- Provide service delivery
- Maintain and contribute to the creation of the department budget
- Manage staff development

Needs and Pains

Siren is the main contact point for several large customers' operation. She gets a constant stream of requests in all type of channels, and has together with the KAM (Key Account Manager) team developed a priority list over customers, and their issues. Even though the service seems to perform well on a general basis, this is not reflected in the specific customer monitoring and KPIs. Thus, when a customer experiences issues, Siren will have to start a case as if the service levels are not achieved. Her company is not able to confidently report on the general high quality, and also have difficulties getting customers confirm this.

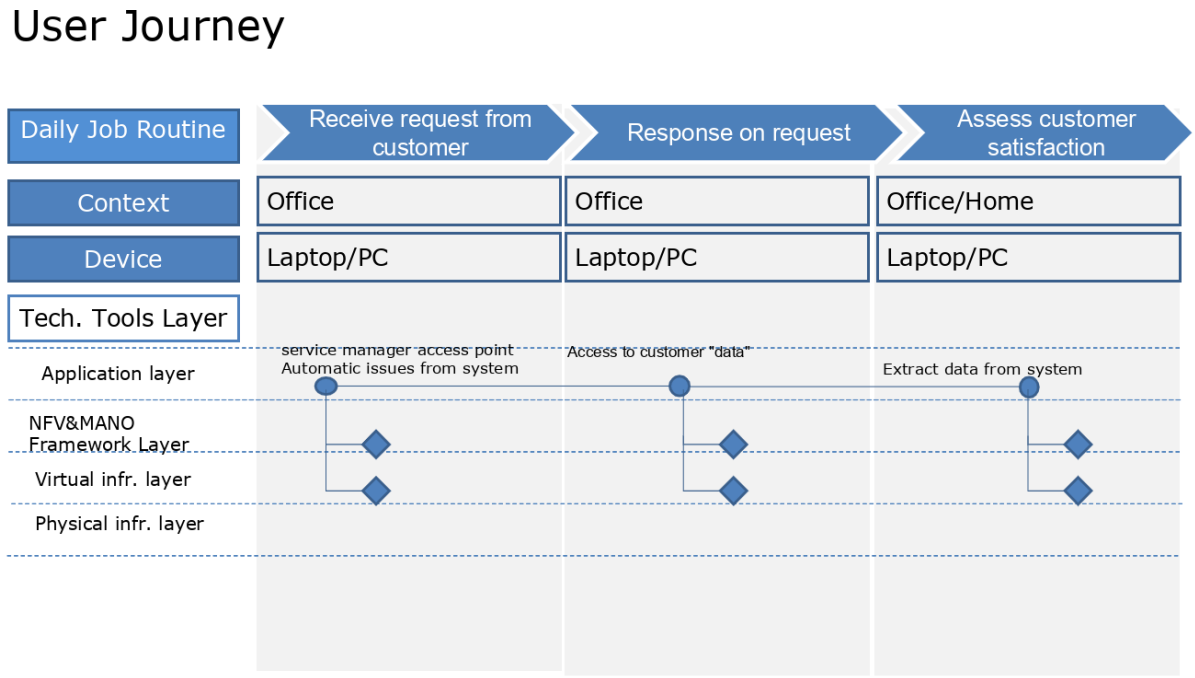
With a system with real-time, granular monitoring of performance of service levels for different customer, it would have been easier handle customer requests, and also build a reputation of quality offerings.

Source

- project brainstorming

User Scenario

Daily Job Routine	Receive request from customer	Response on request	Assess customer satisfaction
Manage solution operation	Siren gets a request from a customer in the form of a new ticket. A user has either placed a new order or reported some disturbance in parts of the network.	In case of a new order, Siren relies on some "rules of thumb" in order to decide whether additional resources need to be deployed. In case of complaint, she is not able to look into the customers network historical data, or real-time monitoring of performance, but relies on aggregate monitoring data. Thus "per customer" SLAs cannot be supported.	Customers are in general giving good feedback. However, the tickets are counted, and customers remember only that they were sent. In general, they do not have information on the SLA levels promised, so as to confirm the quality. Thus, it is difficult to quantify customer satisfaction and build a huge momentum behind the high service quality.



ID	User Task	Sub-task	User Stories
A1	Receive request from customer	Receive ticket	As a Service manager I need to see all new and pending tickets so that we can take care of them as soon as possible
A2	Receive request from customer	Prioritise requests	As a Service manager I need to be able to prioritise tickets so that important and old ones are treated first
A3	Receive request from customer	Delegate responsibility	As a Service manager I need to be able to delegate responsibility to colleagues so that we can take advantage of each members' expertise
B1	Response on request	Check historical data and KPIs	As a Service manager I need to be able to check historical data and KPIs, even for a particular customer, service or area, so that we can narrow down candidate options
B2	Response on request	Consult "best practices" playbook	As a Service manager I need to be able to check "best practices" playbook or ideally to see an automatically-generated list of measures, so that we reduce resolution time
B3	Assess customer satisfaction	obtain feedback from customers	As a Service manager I need to be able to collect customer feedback, so that we get more insight about customer requirements and expectations
C1	Assess customer satisfaction	Analyse customer satisfaction	As a Service manager I need to be able to analyse customer feedback, so that we can improve conversion rate (for tentative customers) and retention rate (for existing ones)
C2	Assess customer satisfaction	Update "best practices" playbook	As a Service manager I need to be able to continuously evaluate best practices, so that we can include new proposed actions and revice/replace/delete older ones

D.9 Nadia - Network Specialist

Nadia

Network Specialist

"For me it's important that the network runs 24x7 to serve the needs of our customers"

Information

Age: 27

Language: Romanian, Russian English

Workplace: office

Job Sector: Telco

Tech. tools: performance monitoring, AI

Technology Skills

Job Description

Nadia provides specialist support for the management and operation of her company's network. Her main role is to ensure that network performance levels are maintained. This involves monitoring of the network against an agreed set of metrics and KPIs and solving problems and proposing fixes when they occur. Her main tasks are:

1. Ensure consistent network performance against agreed service levels
2. Help define the network operating model and policies
3. Use network management systems to determine network condition and model performance statistics
4. **Investigate, diagnose and solve network problems**
5. Maintain awareness of relevant legislation affecting network operation
6. Assess advances in network management technologies and propose upgrades to improve performance

Needs and Pains

Nadia works in the main network operations centre of the company. The centre is a large working area with many network specialists where the main wall space is a very large NetOps graphic showing network condition using many data sources. Nadia supplements this with her own set of tools and systems that give her both the 'big picture' view of the network and more focussed perspectives (which are especially important when there are network problems).

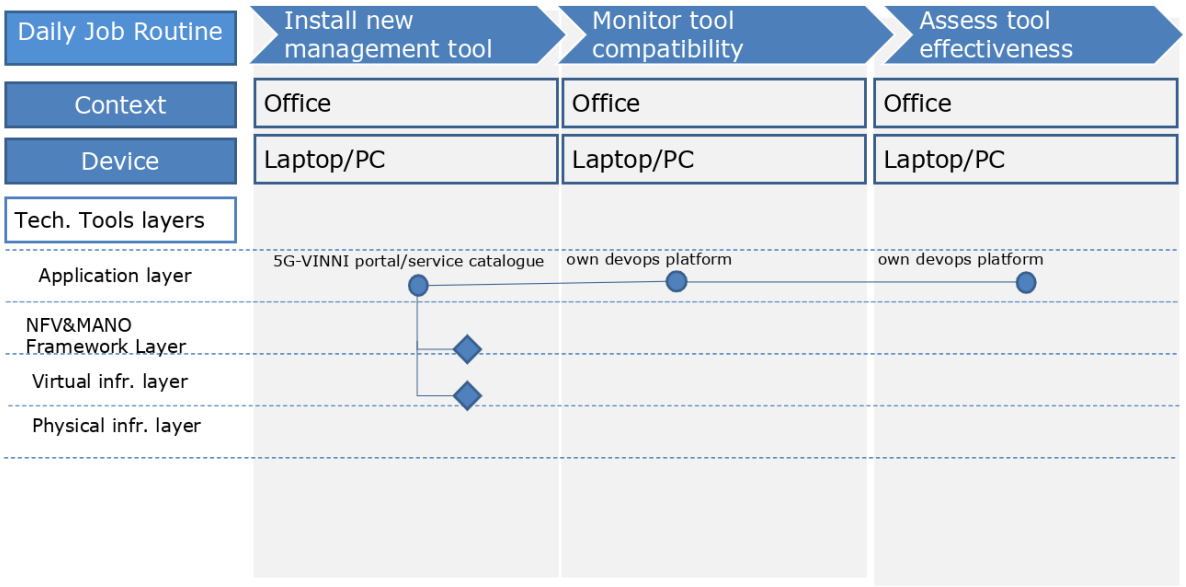
Nadia's pain points come about when the network is not running against required service levels and particularly when her diagnostics are not able to help her find out why. With every passing hour of a network fault, customers are affected and there are often jeopardy clauses in contracts that mean that her company is liable for payments to affected customers. It is important for Nadia to stay ahead of the game with new and improved network management tools, which is why she is increasingly turning to AI/ML options. These systems can react intelligently in real time and can be used hand-in-hand with Nadia' other, more traditional tools.

Source
- F2F interview;
- http://www.ecompetences.eu/it/ict-professional-profiles/

User Scenario

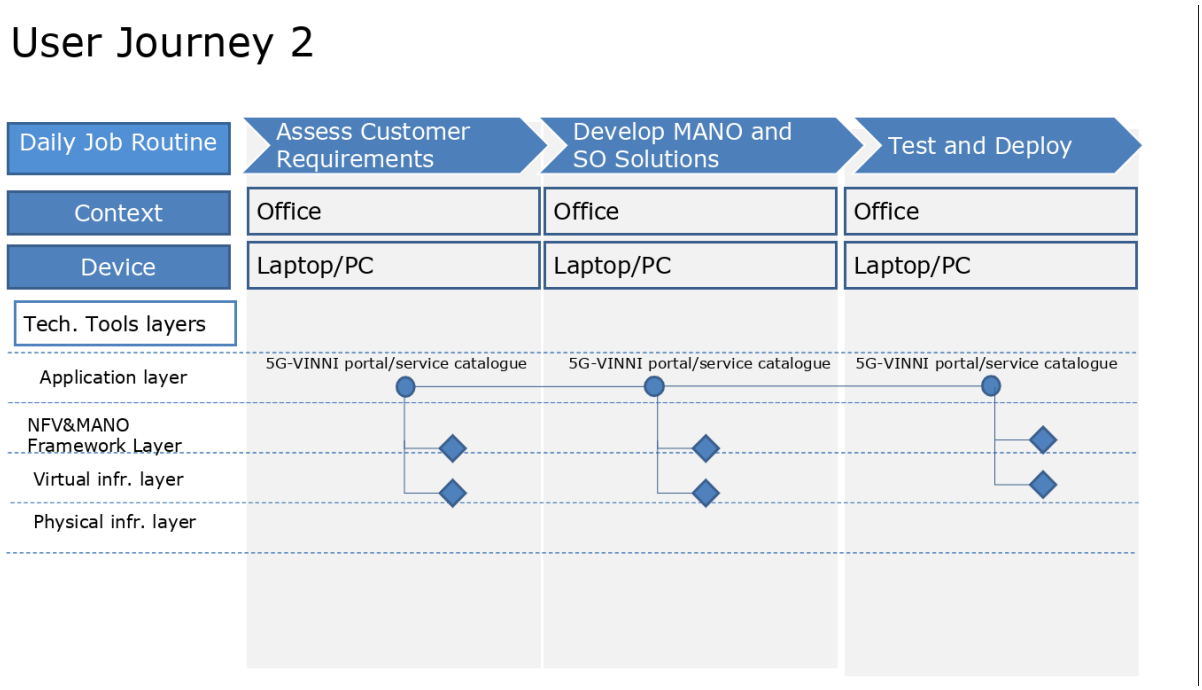
Daily Job Routine	Install new management tool	Monitor tool compatibility	Assess tool effectiveness
SCENARIO Develop an interworking relationship with a new AI/ML tool	Nadia installs a new breed of network management and operations tools in the network digital twin in order to test whether it can prevent, or quickly fix, a particular class of network outage issues. The new tool, which relies on AI and ML, is programmed to collect data from the many sources that might provide fault insight and is able to rapidly process these and propose, or even implement, a network fix.	Nadia runs a number of different scenarios to ensure the network integrity is not compromised by this new package.	After the training period of the tool is over, Nadia simulates network outages in the network digital twin by running dedicated tests. Nadia is notified when an event is detected. At the same time, she monitors the status of the network and related KPIs. After an extended period on the network digital twin she decides whether to implement in the live network.

User Journey



User Scenario 2

Daily Job Routine	Assess Customer Requirements	Develop MANO and SO Solutions	Test and Deploy
SCENARIO Configure Back-end Systems	Nadia receives a request from a customer (via the company's account manager) to support a new service that they wish to offer their users. This service requires additional functionality in Nadia's company network but also requires modification to the MANO and service orchestration systems that are required to undertake service management. Nadia makes an assessment of the requirements from the perspective of these management systems and decides the need for additional MANO scripts and a modification to the service catalogue.	Nadia develops the new MANO scripts and modifications to the service catalogue. She deploys the changes to a network digital twin which allows her to test the modifications and ensure they perform against the customer requirement. This process also ensures that any potentially negative effects on her company's live network from the changes are identified before the live deployment.	Nadia assesses the test results on the network digital twin and spots some small errors. After a few modifications, the changes are now ready and Nadia deploys these into the company's live network. Nadia informs the company's account manager that the changes have been successfully made and that the customer can be notified.



ID	User Task	Sub-task	User Stories
A1	Install new management tool	Log in to service catalogue	As a Network Specialist I want to be able to log in to the service catalogue, in order to have personalised view of the testbed
A2	Install new management tool	Define network digital twin	As a Network Specialist, I need to be able to create/select the network digital twin (i.e., a network slice) in order to test the effectiveness of a new tool.
A3	Install new management tool	Assess tool compatibility	As a Network Specialist, I need to be able to have access to a detailed compatibility report in order to identify any incompatibilities well in advance.
A4	Install new management tool	Install new tool	As a Network Specialist, I need to be able to update service topology of the network digital twin in order to deploy the new tool.
B1	Monitor tool compatibility	Define integration tests	As a Network Specialist, I need to specify and schedule a set of automated tests in order to ensure network integrity.
B2	Monitor tool compatibility	Monitor tool compatibility	As a Network Specialist, I need to have access to a detailed report of KPIs in order to assess tool compatibility.
C1	Assess tool effectiveness	Define run-time tests	As a Network Specialist, I need to be able to specify and schedule a set of automated tests in order to trigger the required events.
C2	Assess tool effectiveness	Assess tool effectiveness	As a Network Specialist, I need to have access to real-time resource monitoring and a detailed report of KPIs as soon a test has concluded, in order to assess tool effectiveness.
D1	Assess Customer Requirements	Log in to service catalogue	As a Network Specialist I want to be able to log in to the service catalogue, in order to have a personalised view of the network and assignments to me
D2	Assess Customer Requirements	Get a notification about a new customer requirement	As a Network Specialist, I want to receive a notification as soon as a new assignment emerges together with context information, so that I can work on it as soon as possible.
D3	Assess Customer Requirements	Find what needs to be updated	As a Network Specialist, I need to be able to have access to the service inventory in order to understand what needs to be updated.
E1	Develop MANO and SO Solutions	Manage service blueprints	As a Network Specialist, I need to be able to create new service blueprints by reusing existing ones in order to

			increase efficiency.
E2	Develop MANO and SO Solutions	Manage service inventory	As a Network Specialist, I need to be able to create a new, pre-commercial service based on existing blueprints (as well as retrieve, update and delete existing pre-commercial services) in order to reduce the likelihood of missing elements. Furthermore, I need to be able to consider services from other providers in order to offer homogeneous service to customers.
F1	Test and Deploy	Define network digital twin	As a Network Specialist, I need to be able to create/select the network digital twin (i.e., a network slice instance from the inventory) in order to avoid the risk of misconfigurations affecting the production network.
F2	Test and Deploy	Define run-time tests	As a Network Specialist, I need to be able to specify and schedule a set of automated tests in order to trigger the required events.
F3	Test and Deploy	Assess service correctness	As a Network Specialist, I need to have access to real-time resource monitoring and a detailed report of KPIs as soon a test has concluded, in order to assess service correctness.
F4	Test and Deploy	Send a notification when new service is ready to be made publicly available	As a Network Specialist, I want to send a notification to account manager, so that resolution time includes the actual time I have spent with each customer ticket.

D.10 Sonny - Solution designer

Sonny

Solution designer

"As a solution designer, I want us to facilitate that customers co-finance network infrastructure, so that customers get their problems solved, and we get a positive business case.

Information

Age: 41

Language: Norwegian, English

Job Sector: System integration, telco

Technology Skills

Job Description

Sonny sees a lot of cases where the customers' needs could be solved with the extension of the infrastructure, however, where the business case is negative for her business. She sees that smaller and agile firms instead are providing workarounds. In a setting where the 5G network shall be extended through customer cases, she thinks that the processes are far to centralized and defensive. She feels that her worries are not heard in a business tight cost/investment budgets, and that she is not trusted with the adequate responsibility. Still, she does provide customers with the necessary specifications that they will need to set up the solutions, even though she knows it might be used in negotiations with other, smaller and local providers.

- Examine and interpret business requirements
- Establish solution intent and develop new solutions against customer requirements
- **Align solution with technical architecture**
- Identify potential technical design risks
- Supervise the built in quality
- **Operate within the budgetary framework to validate the financial impact of design decisions**
- Identify opportunities for innovation
- Plan technology roadmaps

Needs and Pains

Sonny needs to quickly assess opportunities for inviting customers to co-finance network infrastructure. Currently, she designs the technical solution including a gap analysis between current and necessary network. This analysis is used for a business case for the customer solution in question, however, does not proceed into discussion on co-financing. Sonny knows that customers are using this gap analysis to discuss solution with other providers. Thus, Sonny goes a long way herself to suggest solutions that workaround the standardized solutions from her firm, however, where these are included.

If there was a strategy for, processes, and distributed decision responsibility Sonny could have captured more customers, extended the network infrastructure, and laid the ground for triggering off even more customers and new cases.

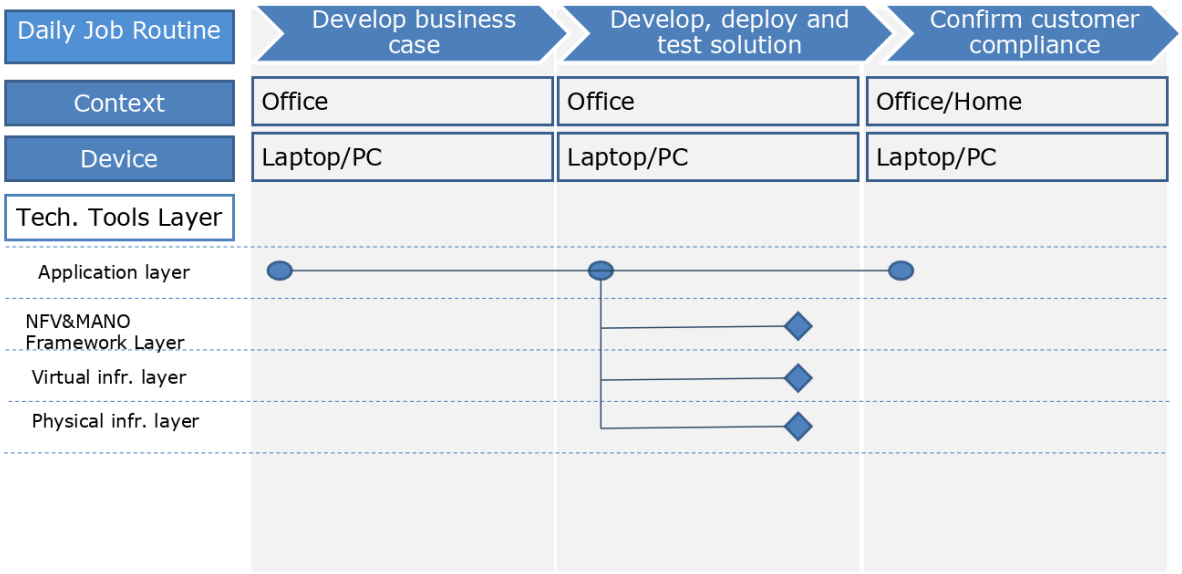
Source

- interviews with telco internal account managers

User Scenario

Daily Job Routine	Develop business case	Develop, deploy and test solution	Confirm customer compliance
SCENARIO Deliver solution to customer requirement	Sonny receives requirements for a new solution from a customer via the company account manager *that involves co-financing network extensions.* She interacts directly with the customer representative to refine and evolve the technical need. Sonny prepares an outline solution which can meet the customers needs and validates with the company's account manager that it returns a positive business case for her company. She agrees the solution with the customer.	Sonny develops, deploys and tests the solution against the customer requirements, within the bounds of the business case agreed. Furthermore, she uses existing APIs to other backend systems in order to guaranty backwards compatibility. Sonny interacts with the customer to refine the solution based on assessing the performance reports she receives from the customer.	Sonny agrees the final deployed solution with the customer, based upon the compliance report she prepares. Sonny prepares and submits a report for her company that describes the technical solution and contributes (along with the account manager) to the 3-year cost/benefit analysis that outlines the profit her company will make from this solution.

User Journey



ID	User Task	Sub-task	User Stories
A.1	Develop business case	Review requirements	As a Solution Designer, I want to specify the available budget framework and retrieve suggestions for components so that we quickly can proceed in solution dialogue and negotiate co-financing with customer
A.2	Develop business case	Prepare solution	As a Solution Designer, I want to have a set of direct interactions that allow me to rapidly develop solutions and share with my customer
B.1	Develop, deploy and test solution	Develop solution	As a Solution Designer, I want access to documentation on deployed solutions so I can re-use previous designs
B.2	Develop, deploy and test solution	Simulate in the digital twin	As a Solution Designer, I want to receive a test report that specifically highlights where the network is compromised by the addition of a new solution so that I'm confident that the solution satisfies network integrity
B.3	Develop, deploy and test solution	Test solution in the real network	As a Solution Designer, I need access to a set of detailed test reports
C.1	Confirm customer compliance	Agree solution with customer	As a Solution Designer, I want strong and meaningful interaction (by sharing test reports) with the customer to ensure the customer is satisfied with the deployed solution

D.11 Ted - Test specialist

Ted

"As a test specialist I want to help customers to set up their tests, so that we get high testing volumes and potentially more customers ending up choosing our services»

Information

Age: 33

Language: Norwegian, English

Job Sector: IT, software

Tech. tools: Open source, test programs,..

Technology Skills

Job Description

Ted is a technologically skilled engineer in a Telco, who likes to interact with other people, however, also to solve intricate technical cases. He feels rewarded when he is able to find solutions to tricky problems and when this is recognized by peers. Still, he thinks the testing processes and services are insufficiently automated and that he gets to little time to handle the really large, challenging and potentially profitable customers and new solutions. He sees how peers in his professional network are able to work strategically with large customers and solutions in a professional setting. Still, he does not have the time to articulate necessary improvements, and his day is filled with customer handling via phone and mail. He gets to work six in the morning every day to actually design and implement tests for customers before they wake up themselves.

- Select and develop integration testing techniques to ensure the system meets requirements.
- **Design and customize integration tests, identify open issues.**
- **Organise test plans and procedures for white and black box testing at unit, module, system and integration levels.**
- Establish procedures for result analysis and reporting.
- Design and implement defect tracking and correction procedures
- Write test program to assess software quality
- Develop tools to increase test effectiveness

Test Specialist

Needs and Pains

Ted communicates with customers to set up their 5G tests and provide test results. He currently manages customers by phone and mail. He gets data and input from them in very different format. To mitigate the incompatibility in the systems he does a lot of manual work. The customers are very satisfied with Ted's job, he always get a lot of positive feedback. However, he is incapable of increasing the volume of tests within the current regime.

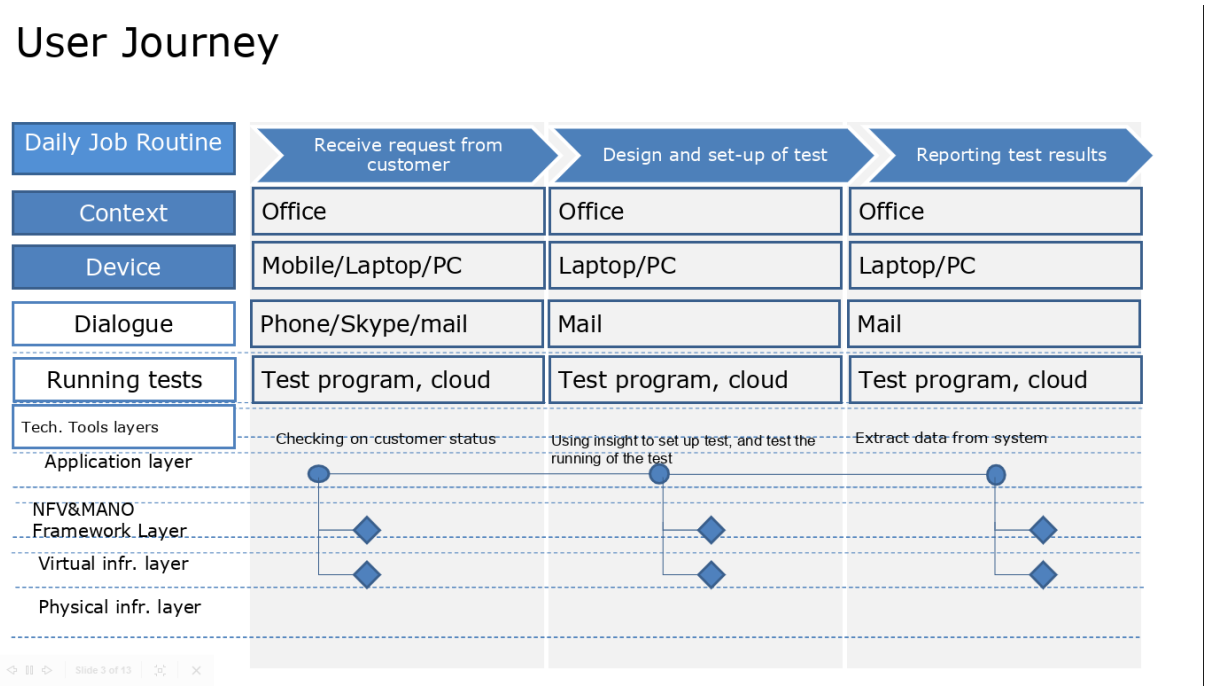
In a regime with higher degree of automation, CRM/request systems, Ted would serve the customers in an even better way, and be able to handle a much larger volume of tests.

Source

- Lunch discussion, 5GVinni test team
- European ICTprofessional role profile – CWA 16458-1

User Scenario

Daily Job Routine	Receive request from customer	Design and set-up of test	Reporting test results
SCENARIO **Design and customize integration tests, identify open issues.** **Organise test plans and procedures for white and black box testing at unit, module, system and integration levels.**	During the day, Ted gets a call or mail from a KAM or Service manager about a test a customer would want to do. Ted is requested to get in touch with customer to plan next steps. Ted uses the hours after lunch to interact with customer, understanding their needs, and suggesting the input he must have from them.	In the mornings, Ted starts designing and implementing the tests for which he has the necessary input from customers.	Ted is proud of being able to send a link to customers before lunch with access to the test, results, and suggestions for iterations.



ID	User Task	Sub-task	User Stories
A1	Receive request from customer	Obtain user profile information	As a test specialist assisting customers to design, deploy and execute their experiments, I want each user to have its own account, including profile details, so that they can collaborate during the different experiment phases and I know the background of the person I'm interacting with.
A2	Receive request from customer	Gather experiment details via a design tool	As a test specialist assessing how intuitive and user-friendly our solution is, I want the digital solution to guide customers in the process of designing, deploying, executing, analysing each experiment iteration, with support for "copy and paste" when testing a slightly different configuration or even replication of their experiments to another site, so that they perform more tests (rather than spending time with me).
A3	Receive request from customer	Get a notification about a new test request	As a test specialist assisting customers to design, deploy and execute their experiments, I want to receive a notification as soon as I have resolved the last ticket, so that resolution time includes the actual time I have spent with each customer seeking support.
A4	Receive request from customer	Get acquaint with the customer	As a test specialist assisting customers to design, deploy and execute their experiments, I want to retrieve the customer profile and details about previous interactions (if these exist), so that I efficiently can ask for the right kind of input.
A5	Receive request from customer	Understand test scope and objectives	As a test specialist assisting customers to design, deploy and execute their experiments, I want to initiate an online discussion with the customer in order to to find out if/how our solution meets their needs and solve their challenges.
B1	Design and set-up test	Discover third-party components	As a test specialist assisting customers to design and deploy their experiments, I want third-party solutions to be easily accessible, so that innovative components can be used in the experiments.
B2	Design and set-up test	Change topology	As a test specialist assisting customers to design and deploy their experiments, I want the topology to support the on-boarding and commission/decommission of third-party solutions, so that innovative experiments can be executed.
C1	Reporting test results	The customer chooses what/when/how	As a test specialist, I want to let the customers be able to select what components and events should be monitored, the granularity and the metrics to be used, so that they have sufficient and timely

		should be monitored	information on their experiments.
C2	Reporting test results	The customer get links to encrypted results and notifications when they are ready	As a test specialist, I want to let the customers have secure access to test results without my interference, so that they are not afraid of revealing sensitive information to me or other third parties

D.12 Anton - Account manager

Anton

"As an account manager I want to understand customers real problems, so that I can suggest solutions and way of work that will make them successful and my firm profitable"

Information

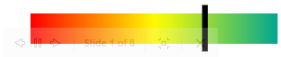
Age: 52

Language: Norwegian, English

Job Sector: System integration, business consultancy

Tech. tools: Office, Salesforce,

Technology Skills



Job Description

Anton has been working with customers in his whole career and has a large network with people in firms, and deep insight into their concerns and working methods. He thinks it is not possible to meet the customers' needs only with pre-defined "fabric" solutions; some customization is always needed to actually solve their problems. He sees that the cost-pressure in his business is a driver towards standardized products, and that niche providers are emerging to cater to more specialized needs. His loyalty is drawn between optimizing profits in his firm, and helping customers (almost friends) with their problems. In practice, he serves as a hub in the network, connecting the customers also to specialized providers.

- Maintain overall customer satisfaction with products and/or services
- **Identify opportunities to propose new products or services**
- Provide the primary contact point for client executive management and Deliver value added presentations related to products and services to customer executive management
- Lead negotiations to establish profitable contracts with client(s)
- **Maintain and enhance business relationships**

Account manager

Needs and Pains

Anton must build a lot of insight into technical solutions and opportunities to add on to the standardized solutions from his business. He does a lot of workaround to satisfy the customer. In the end, it is the standardized product that brings in the money, however, it is the additional effort from his side that leads to solutions solving the problems.

If Anton could offer an experiment and test "lab" to his customer, where different qualities of the network services could be tested, along with a network of partners to be invited into solving customer problems, then he would be able to scale up his own work effort and in total, kick off more demand for the standard solutions from his business.

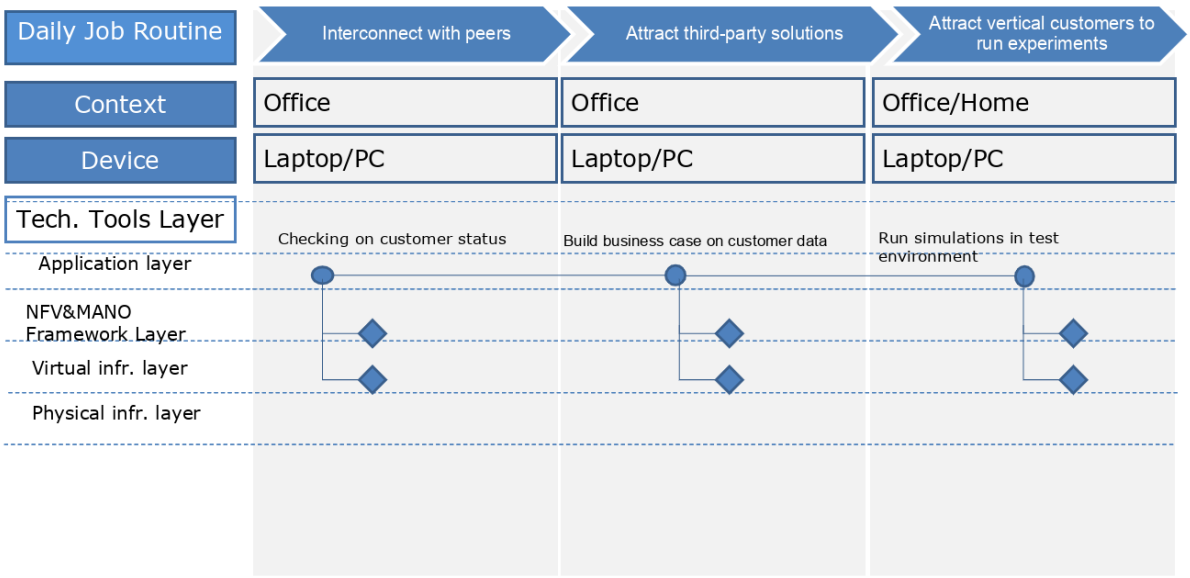
Source

- interviews with telco internal account managers

User Scenario

Daily Job Routine	Interconnect with peers	Attract third-party solutions	Attract vertical customers to run experiments
SCENARIO: Maintain and enhance business relationships	While Anton's company is a major network operator, there are some remote regions that are not serviced yet, but competitors do (and vice versa). Furthermore, there are many cases where the devices that need to communicate are provisioned by competing operators. Anton communicates frequently with his peers (especially national ones) about the benefits of interconnecting and the need for standard interfaces for automating this process.	While the vertical solution department of Anton's company steadily increases over the last 5 years, neither the resources suffice to develop innovative service components for each vertical domain (e.g., for firewall) nor the expertise. Anton presents the benefits of their platform ecosystem through which third-party developers can make available their solutions.	Anton presents his vision to representatives from a wide range of industries, such as Manufacturing, eHealth, Automotive and Utilities, of a 5G test-bed that will allow innovative services to be synthesised, validated and fine-tuned.

User Journey



ID	User Task	Sub-task	User Stories
A1	Interconnect with peers	Adopt standards for interconnecting with peers	As an account manager of the 5G testbed, I want it to be based on standard interfaces and support standard network slice types, so that we can offer full national (and even global) coverage to our customers and third-party solution providers.
A2	Interconnect with peers	Agree on governance model	As an account manager of the 5G testbed, I want it to support centralised and distributed governance models, so that we can accommodate requests both on-the-fly and proactively and act as a "one-stop shop" for our customers.
B1	Attract third-party solutions	Attract third-party solutions	As an account manager of the 5G testbed, I want it to be based on standard interfaces and support standard VNF descriptors, so that third-party developers and professionals will make their services available to my customers rather than offer only a limited set of in-house solutions.
B2	Attract third-party solutions	Agree on revenue sharing agreements	As an account manager of the 5G testbed, I want to be able to negotiate revenue sharing agreements with third-party solution providers so that we can reach an "all-win" situation
C1	Attract vertical customers to run experiments	Attract vertical customers to run experiments	As an account manager, I want to encourage my customers experiment with our solutions, so that they can get more assured that our solutions are actually solving their problems.
C2	Attract vertical customers to run experiments	Offer cost estimation for experiment order	As an account manager, I want to offer a cost estimation tool to my customers so that they get a better idea on the cost of different experiment configurations (in terms of performance, customisation, number of users, duration etc.) and plan their experiments based on their available budget.
C3	Attract vertical customers to run experiments	Offer a wide range of cost sharing options	As an account manager, I want to allow my customers forming a consortium to share the costs in a clear and detailed way, so that trust levels within the consortium is increased
C4	Attract vertical customers to run experiments	Offer customers the ability to extend the network	As an account manager, I want to allow customers co-finance and operate the network infrastructure, so that I can realize an extension of the network and enable serving further customers.