# D6.1 Market analysis and initial business models

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# Legal disclaimer

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# ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| **5G-PPP** | 5G Infrastructure Public Private Partnership |
| **5GAA** | 5G Automotive Association |
| **6G-IA** | 6G Infrastructure Association |
| **AF** | Application Function |
| **AI** | Artificial Intelligence |
| **AOEP** | Automotive Open Experimental Platform |
| **API** | Application Programming Interface |
| **AR** | Augmented Reality |
| **CAGR** | Compound Annual Growth Rate |
| **CCAM** | Cooperative, Connected and Automated Mobility |
| **CPU** | Central Processing Unit |
| **DL** | Download |
| **DML** | Distributed Machine Learning |
| **DMP** | Digital Management Plan |
| **EaaS** | Experimentation as a Service |
| **EC** | European Commission |
| **EU** | European Union |
| **FL** | Federated Learning |
| **GPU** | Graphical Processing Unit |
| **GUI** | Graphical User Interface |
| **HD** | High Definition |
| **HW** | Hardware |
| **ICT** | Information and Communications Technology |
| **IMT** | International Mobile Telecommunications |
| **IT** | Information Technology |
| **ITU** | International Telecommunication Union |

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|---|---|
| **KPI** | Key Performance Indicator |
| **LCM** | Lifecycle Management |
| **LTE** | Long Term Evolution |
| **MNO** | Mobile Network Operator |
| **MEC** | Multi-Access Edge Computing |
| **ML** | Machine Learning |
| **NF** | Network Function |
| **NGBR** | Non-Guaranteed Bit Rate |
| **OBU** | On Board Unit |
| **RAM** | Random Access Memory |
| **RAN** | Radio Access Network |
| **RSU** | Road Side Unit |
| **SA** | Stand Alone |
| **SC** | Steering Committee |
| **SME** | Small and Medium Enterprise |
| **SW** | Software |
| **UC** | Use Case |
| **UI** | User Interface |
| **UL** | Upload |
| **VNF** | Virtual Network Function |
| **VR** | Virtual Reality |
| **WG** | Working Group |
| **WP** | Work Package |

# Executive Summary

The aim of this deliverable is to provide details about the 5G-IANA ecosystem along with the initial envisioned business model for the 5G-IANA platform. In addition, to provide the results of a survey that was conducted with the scope to collect the expectations that third parties have from the 5G-IANA platform. Finally, it presents the devised plan for engaging third parties to the open calls that will be organized by the project[1].

The roles around the 5G-IANA platform have been identified, and the interactions among them have been presented in the reference model that has been created. The incentives for participating in the 5G-IANA platform has been identified for all the roles in in the ecosystem. The initial business model for the 5G-IANA model has been presented. The main offering is the Experimentation as a Service and the supporting activities such as consulting and training service to experimenters.

A survey was created and conducted online in order to capture the expectations that third parties have from the 5G-IANA platform. The survey was broadly communicated to possible experimenters and relevant stakeholders and a total of 23 responses have been captured. One of the most important remarks is that the majority of the participants are interested in open Virtual AFs and NFs, which stresses the need for providing reusable functions.

The project will have an open call in two cycles in which third parties will have the opportunity to experiment with the platform, create their own services and validate them. A detailed engagement plan to increase the impact of this activity has been drafted and will be implemented for the rest of the project's duration. The plan is implemented in different phases that align with the technical work performed in the project.

[1] *Note: The scope of this deliverable has been reoriented as per the project's interim review (June 2022), so as to move from a purely state-of-the-art market analysis (as anticipated by the DoA) to a study that aims to identify the expectations of third parties from the 5G-IANA AOEP platform. The feedback from this survey will be therefore a useful input for the project-wide activities towards developing an attractive platform and towards engaging external SMEs to experiment on top of it. Moreover, the deliverable has been enriched so as to include the project's devised plan for third party experimentation.*

# 1. INTRODUCTION

## 1.1. 5G-IANA concept and approach

5G-IANA aims at providing an open 5G experimentation platform, on top of which third party experimenters, i.e., Small and Medium Enterprises (SMEs) in the Automotive-related 5G-PPP vertical will have the opportunity to develop, deploy and test their services. An Automotive Open Experimental Platform (AOEP) will be specified, as the whole set of hardware and software resources that provides the computational and communication/transport infrastructure as well as the management and orchestration components, coupled with an enhanced nApp Toolkit tailored to the Automotive sector. 5G-IANA will expose to experimenters secured and standardized Application Programming Interfaces (APIs) for facilitating all the different steps towards the production stage of a new service. 5G-IANA will target different virtualization technologies integrating different Management and Orchestration (MANO) frameworks for enabling the deployment of the end-to-end network services across different domains (vehicles, road infrastructure, Multi-access Edge Computing (MEC) nodes and cloud resources). 5G-IANA nApp toolkit will be linked with a new Automotive Virtual Network Functions (VNFs) Repository including an extended list of ready to use open accessible Automotive-related VNFs and nApp templates, that will form a repository for SMEs to use and develop new applications. Finally, 5G-IANA will develop a Distributed Artificial Intelligence / Machine Learning (AI/ML) (DML) framework, that will provide functionalities for simplified management and orchestration of collections of AI/ML service components and will allow ML-based applications to penetrate the Automotive world, due to its inherent privacy preserving nature. 5G-IANA will be demonstrated through 7 Automotive-related use cases in 2 5G Stand Alone (SA) testbeds. Moving beyond technological challenges, and exploiting input from the demonstration activities, 5G-IANA will perform a multi-stakeholder cost-benefit analysis that will identify and validate market conditions for innovative, yet sustainable business models supporting a long-term roadmap towards the pan-European deployment of 5G as key advanced Automotive services enabler.

## 1.2. Purpose of the deliverable

The objectives of this deliverable are the following: to identify the ecosystem that will interact with the 5G-IANA Automotive Open Experimental Platform (AOEP), to define the initial business plan for the service provisioning of the AOEP, to identify the expectations of third parties from the AOEP and to present the engagement plan for third parties.

This deliverable presents the work undertaken in T6.1: Market research and actor-role analysis, enriched though as described below.

The deliverable has the following structure:

- In section 2 the ecosystem around the 5G-IANA platform is presented: the roles and the actors are defined along with their interactions. The main incentives for each of the actors to participate in the AOEP are presented. In addition, the initial business model envisioned for the AOEP is presented.
- In section 3 the results of an online survey regarding third party expectations from the AOEP are presented.
- In section 4 the details of the engagement plan for third parties is presented.

The scope of this deliverable has been reoriented as per the project's interim review (June 2022), so as to move from a purely state-of-the-art market analysis (as anticipated by the DoA) to a study that aims to identify the expectations of third parties from the 5G-IANA AOEP platform. The feedback from this survey will be therefore a useful input for the project-wide activities towards developing an attractive platform and towards engaging external SMEs to experiment on top of it. Moreover, the deliverable has been enriched so as to include the project's devised plan for third party experimentation.

## 1.3. Intended audience

The dissemination level of D6.1 is 'public' (PU) and available to members of the consortium, the European Commission (EC) Services and those external to the Project. This document is intended to serve as a guideline and reference for all 5G-IANA beneficiaries regarding the expectations from third parties, the same information can also be used by facilitators of similar experimental platforms. Third parties can use the document to learn more about the timeline and the steps towards the open call.

# 2. 5G-IANA ECOSYSTEM

In the ICT sector, the rise of the Over The Top (OTT) players has shown, in the last years, the prominent role that Platform-based business models can have in the market. Some of the biggest companies are built around platform-based business models and experience higher valuations than other businesses with other business models.

Big cloud providers or hyperscalers (e.g., Amazon, Google, Microsoft, etc.) have been among top business players in past years and they continue to remain such. Starting by hosting general IT applications, they have also taken the advantage of their cloud computing capabilities by expanding their portfolios with their own offers of private 5G, and most have also completed strategic acquisitions and hired from the mobile industry [1]. Thus, they have become important players in 5G field and therefore they cannot be neglected within the discussion on actors with potential impact to the market addressed by 5G-IANA. Although the biggest cloud players are not EU companies, it must be anyway added that certain stake of the cloud services market has been also adopted by multiple (EU-based) network operators providing their own infrastructure for both their own services and for third parties hosted services as well.

In particular, MNOs are quite significantly able to capitalize their cloud infrastructures on the 5G Stand Alone (5G SA) network architecture which introduces Service-based Architecture and cloud-native functions. Advanced 5G functionalities such as Multi-Access Edge Computing (MEC), utilizing on MNOs' wide geographical distribution of their infrastructure, give them even better opportunities compared to their competition having more centralised infrastructure. Although 80% of data processing takes place in centralized infrastructure today and 20% in smart connected objects, this ratio is expected to reverse over the next couple of years, thus shifting data processing paradigm from cloud-centric to cloud-continuum [2].

With the introduction of 5G, the number of verticals that are designed around platform-based business models is growing quickly. We expect that this growth will continue to exist and there will be a stronger connection between the verticals and the mobile ecosystems. In that new era there is a lack of experimental facilities in which developers can test their services before they bring it in the market. Since the automotive vertical is considered one of the most important for 5G and several Use Cases (UC) are examined, the need for an experimentation platform that provides all the necessary resources in order for experimenters to deploy and test their services is eminent. It is also important to understand the new business model that will be formed around the experimental platforms like 5G-IANA.

The section describes all the relations and interactions among the different roles in the 5G-IANA ecosystem. This first step is very important towards the better understanding of the ecosystem

and its characteristics and will help in the investigation of the associated business models around the 5G-IANA platform in the upcoming phases of the project.

Initially some concepts that are essential for the description of the ecosystem are presented, followed by the description of the different roles of the actors that participate in the ecosystem. The 5G-IANA platform has the central role in that ecosystem in order to examine the possible interactions that the different roles will have within that ecosystem. The section concludes with the initial business model for the 5G-IANA AOEP platform.

## 2.1. Actors and roles

In order to understand the business model around the 5G-IANA platform, it is important to capture how value is created in a complex system with a lot of interdependencies. In this analysis we will use the value network to describe all the inter relations within the ecosystem.

The following definitions are used in the following sections:

- **Actor**: an entity that participates in the business model, it can provide or consume services.
- **Role**: the functionality of each actor that participates in the business model. An actor can take one or more of the roles, while a role can be undertaken by several actors.
- **Relationship**: the interaction between two roles in the model.

This section provides an overview of the different roles that have been identified in the 5G-IANA ecosystem (the work has been made in WP6 but is also included in D2.1).

- **Mobile Network Operators (MNO)**: they deploy and operate the telecommunication infrastructure that is required for connectivity (core and Radio Access Network - RAN). They own the physical equipment such as base stations, antennas, switches, etc.
- **Cloud Infrastructure Providers**: they provide all required storage, cloud computing and corresponding networking resources (CPUs, RAM, storage). These can be in a central (cloud location) or local location, in edge servers.
- **Road Infrastructure operators**: they are responsible for the deployment, operation, and maintenance of the road infrastructure. They can also own and operate road-side facilities such as ICT equipment, cameras and sensors located in the road networks.
- **HW Vendors**: they provide all type of hardware to all interested parties, for example base stations, antennas, switches, routers, servers, network cards, sensors, cameras, CPUs, RAM, Road-Side Units (RSU), On-Board Units (OBU), entertainment systems, etc.
- **SW vendors**: they provide all the necessary generic software that is required by all other parties. For example, the firmware that is required for the hardware devices, all type of

software for the entertainment systems, etc. This role does not include the development and provision of nApps and Application and Network Functions (AFs/NFs).

- **Vehicle Manufacturers**: entities that are in charge of manufacturing all type of vehicles.
- **R&D**: research centres and academic institutions that are responsible for the development and testing of upcoming technologies and applications.
- **Service Creators**: all type of service creation entities such as SMEs, and software developers.
- **Service Providers**: they are responsible for providing the service to end users (for example Intelligent Driving, HD maps, etc.).
- **Application and Network Functions Developers:** they develop the Application Functions (AFs) and Network Functions (NFs) that can be used as building blocks for creating nApps.
- **Application and Network Functions Providers:** they are responsible for providing the AFs and NFs to be on-boarded trough the functionalities provided by the nApp Toolkit platform component.
- **nApp Developers**: they are responsible for the development of nApps.
- **nApp Providers**: they are the ones that provide the nApps either to end users or service creators/providers.
- **End Users**: includes all type of users that are the recipients of the services. They can be individual users (B2C) or business customers (B2B). Some examples are vehicle owners, drivers, passengers or pedestrians for end users and transport operators, traffic management, freight and logistics, or providers of public services.

Evidently, a certain stakeholder in the emerging ecosystem may well hold more than one of these roles. Characteristic examples include Service Creators, who may be a SW Vendor; a nApp Provider can be a Service Provider; a nApp Developer may be a SW Vendor. The identification and this fine-grained distinction between roles aim to highlight the focus areas and different specializations, not indicating necessarily the emergence of distinct stakeholders.

## 2.2. Incentives/Benefits for the different roles to use/participate in the platform

In 2021, the global telecom services market was valued at USD 1.75 trillion, and it is expected to grow at a compound annual growth rate (CAGR) of 5.5% [3]. In 2020, the mobile data services segment held a share of about 33.0%, whereby Over-The-Top (OTT) channels are the customers' preferred option, offering video, audio, and other media content over the Internet [4]. 5G was and is developed based on the 2015 targets by the International Mobile Telecommunications-

2000 (IMT-2000), which looked at potential future consumer demands and positioned them the three central trends of massive mobile broadband communications, massive machine type communications, and ultra-reliable low latency communications.

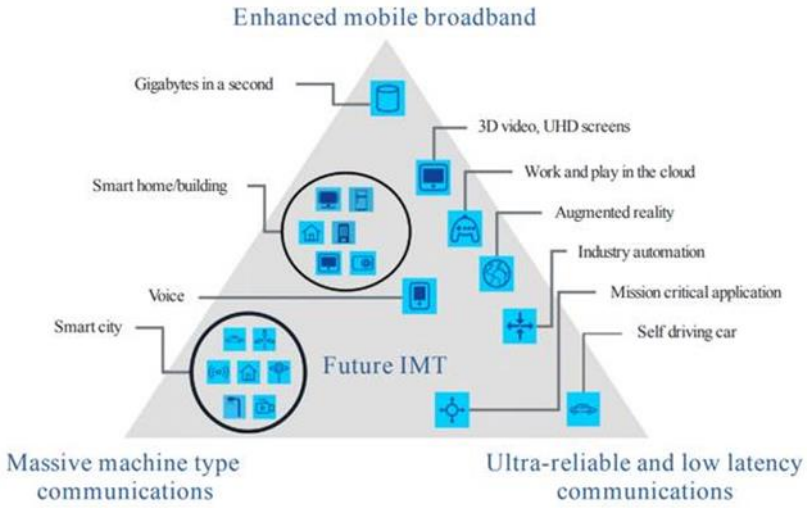


**Figure 1: Usage scenarios of IMT-2000, source [5]**

The three development trends were driven by a range of use cases, which were expected to push the future demand of mobile communication services [5],[6], such as:

- *healthcare* including telemedicine, connected ambulance with Augmented/Virtual Reality (AR/VR),
- *entertaining* including virtual reality events,
- *manufacturing*, including machine-to-machine (M2M) communication and remote robot control,
- *public safety*, including done control and improved rescue services,
- etc.

The *automotive* sector with its potentially new services in remote vehicle maintenance, remote assistance of automated and autonomous driving, platooning, infotainment, update of high-definition (HD) map updates, etc., was also included as a sector driving the demand for novel solutions in future mobile communication systems such as 5G.

5G is standardized by the 3GPP [7], which introduced and still develops a range of new or updated 5G features to address the diverse needs of beforementioned new user groups. Key features [8] especially for the automotive sectors are:

- *Quality of Service (QoS):* A user can have several QoS Flows in uplink (mobile phone to network) and downlink (mobile network to mobile phone). The standard distinguishes between two categories of QoS Flows:

- *Guaranteed bit rate (GBR)* provides a guaranteed bit rate to a user, which is typically used for time sensitive applications such as voice, V2X, or real-time gaming. While GBR typically offers latencies in the order of 100ms, delay critical GBR QoS Flows may work in the order of 10ms.
- Non-guaranteed bit rate (NGBR) is typically used for non-time sensitive applications, such as web browsing. In 3GPP TS 23.203 [9], section 6.1.7, a set of QoS Flow with specific packet forwarding behaviour were specified and are identified with a label called QoS class identifier (QCI). Two QCIs for V2X message exchange are already specified.

- *Network Slicing:* This allows the selection and allocation of mobile network resources isolated from other services to fit the requirements of a specific service. For instance, a network slice for steering of a vehicle remotely, radio resources can be allocated to guarantee a transmission of video from the vehicle to the remote driver with low latency and a guaranteed minimum latency.
- *Edge Computing:* Latency is critical for many automotive services. While still most delay occurs on the radio interface, the transmission latency between a base station and a server infrastructure can be reduced by locating the server infrastructure topologically close to the base station location. The end-user experience is both improved by the reduced latency, while also the network efficiency can improve by reducing the backhaul requirements.

Nowadays, cloud computing resources can be easily ordered and used. It is the aim that customer can easily commission a virtual mobile network resources with specified QoS, network slicing setting, and edge computing resources in the future. The 5G products, however, have not reached this maturity level, yet. It is this gap in the service creation and especially in the automotive vertical that 5G-IANA aims to tackle. By providing an open experimentation platform that will give access to 5G and automotive resources, third parties can have the opportunity to develop, deploy and test their services making a step closer to commercialization of their developments.

Testing new 5G use cases, features, and solutions before their commercial roll-out is a crucial aspect of innovation, since it identifies and resolves potential bottlenecks, while it is vital for large-scale rollout facilitation and mass adoption. Before release to the general public, service providers test M2M communication in a 5G testbed to understand and evaluate the performance of their application/solution/service in a real 5G radio environment and to accelerate end-user adoption.

The AOEP of 5G-IANA includes a set of hardware and software resources that provides the compute and communication/transport infrastructure, as well as the management and orchestration components, coupled with an enhanced nApp (Network Application) Toolkit, tailored to the Automotive industry. The toolkit's purpose is to provide ready-to-use building blocks that can serve the needs of multiple use cases. The 5G-IANA management and orchestration components and the nApp Toolkit expose to experimenters secured and standardized APIs for facilitating all the different steps towards the production stage of a new service. The 5G-IANA VNFs Repository integrates already existing 5G-PPP repositories of open-source VNFs. The 5G-IANA AOEP provides capabilities and functionalities for designing, validating and benchmarking Intelligent nApps and their components, as well as for monitoring and dynamically adapting them at run-time.

In this section the incentives or benefits for each of the different roles (that have identified in the ecosystem) to participate in the 5G-IANA platform are presented.

### 2.2.1. MNOs

The interaction with 5G-IANA platform can help MNOs to identify new market and business challenges, realize possible opportunities and early identify the new business models. In addition, it can help MNOs to enter the lucrative automotive market and to expand their portfolio of mobile applications and services. By using the platform, they can get a better understanding of the automotive applications in their virtualized environment and may manage to deploy such applications faster in the future. The 5G-IANA platform can simplify the procedures of service provisioning and monitoring and can simplify access to network resources. With the tools included in the 5G-IANA platform, MNOs can gain advantage against competitors in applications such as logistics services and traffic management applications, which are essential for commercial success of 5G mobile network in the automotive vertical. The platform as an open and flexible environment can attract innovators to deploy their original ideas that would not be possible to the commercial network of an MNO, thus, they can establish new relations with actors from the automotive vertical and with new start-ups and experimenters. Finally, the participation in efforts like the 5G-IANA platform can give advantage to MNO's 5G network users as they would be able to quickly access new and advanced services.

### 2.2.2. Cloud Infrastructure providers

With regard to the 5G-IANA AOEP platform and potential use cases that the platform is suitable for support them, it is expected various cloud topologies (i.e., centric-oriented, cloud-

continuum) would be suitable for hosting the platform and use cases, however, it would depend on certain requirements of the component/components hosted. The AOEP platform, as a central tool responsible for orchestrating the resources required for specific use case components onboarding, managing components life cycle, and providing resource monitoring tools among other functionalities, may not have such strict latency, round-trip time, and data throughput requirements as it would be a case for certain automotive nApps dealing with autonomous driving and related challenges. For implementing use cases with challenging requirements as already mentioned, cloud infrastructure providers with distributed infrastructure will most likely have certain advantage comparing to competitors utilizing cloud-centric infrastructure. Nevertheless, as long as service providers will provide services nation-wide, EU-wide or world-wide, it would be a must for cloud infrastructure providers to provide capable, reliable and secure inter-connections. The latter will be, for example, also demonstrated within UC #7.

Besides meeting the technical requirements necessary for successfully operating nApps/use cases, potential cloud infrastructure providers may further attract customers by providing a virtual environment customized for reducing deployment and operating costs, improving time to market, providing extensive resource and network monitoring tools, life cycle management tools, etc. As it is obvious the 5G-IANA AOEP platform and nApps onboarded and managed over it cannot be realized without reliable cloud infrastructure support, and it is on cloud infrastructure providers how innovative they will be to advance from it.

### 2.2.3. Road Infrastructure providers

Road infrastructure providers will be one of the main beneficiaries of the 5G-IANA platform in the long term. The creation and adoption of new services in the automotive vertical will increase the safety in the roads and will allow them to provide new targeted services to their customers. In addition, the usage of their infrastructure during the experimentation phase can give them valuable information regarding any upgrades that need to be made to their infrastructure like for example the introduction of new RSUs that offer more capabilities than the existing equipment. The collaboration with third parties is considered essential since they can provide their expectations and requirements from the future 5G automotive applications that must be created.

### 2.2.4. HW Vendors

Vendors of mobile communication equipment and mobile operators observe very closely the mobile communication market and its evolving trends. While many technical features are

standardized in 3GPP, vendors focus in their product development on those features where the markets indicate a growing and stable future demand and revenue. Similarly, mobile network operators emphasize in their 5G network rollout both areas and technical features which promise a solid return of investment. A strong demand by the automotive industry in products such as the 5G-IANA platform is also a strong indicator for both vendors and mobile operators to focus their 5G development plans accordingly.

With their participation in the 5G-IANA platform HW vendors will have the opportunity to promote their products through the platform and get in contact with potential customers that will participate in the experimentation phase. In addition, the utilization of equipment during the experiments can assist into the validation of their products in new applications and services and help them identify future improvements that need to be made to meet the new requirements. An additional benefit will be that they will increase their knowledge in techniques and technologies such as AI, ML, etc., while this engagement can provide useful insights on how they can add these advanced features in their upcoming products.

### 2.2.5. SW Providers

The user-oriented service management is one of the main trends in 5G, and a core feature in the design of 6G. The role here of the 5G-IANA platform is critical as it provides the missing link between the vertical end user domain and the network resource control and management layers expanding in general over multiple infrastructure domains from core to edge and even the extreme-edge.

The platform is designed in a fully modular approach and adopts open development principles. These two features essentially enable the growth of dedicated SW development teams that are focused on the development of platform solutions, expansions and interfaces. The key benefit of the modular approach is that different parts of the platform can be developed or extended independently of the other parts as long as the interfacing conditions are properly met. As an example, such parts may include: a) The nApp and component catalogue which may evolve into a marketplace repository with advance query features or adaptive catalogues for different vertical types, b) the application orchestration real time management logic which may be enhanced with advance analytics and monitoring features for automated end-user responses to application or network related changes, c) the slice management and resource handling mechanism that can be further adapted to different end-user domains, with extreme-edge or even swarm processing capabilities. Moreover, the open access feature enhances further the aforementioned capabilities providing a common seamless development environment allowing

developers to focus easily on specific development features while reusing common and well-established platform parts.

Platform SW providers originate typically from the vendors as providers of supporting control and management solutions. However, with the 5G-IANA platform solution, independent SW platform providers (e.g., SMEs) may provide dedicated solutions tailored to different vertical sectors or even advance addons to the platform (e.g., to orchestrate where resources for AI-based applications). Furthermore, the adoption of the overall 5G-IANA application deployment and management model directly by a service or telecom provider offers the capability to the later to expand their range of services directly to the end users (e.g., focusing especially on private 5G end users).

It is important to note that there are no standards specifically related to the application-level management, and these are expected to start emerging as technology moves towards 6G. This indicates a good opportunity for platforms like 5G-IANA to promote their features and benefits to the broader developer's community and infrastructure management stakeholders, exposing the alternative market opportunities that it offers.

### 2.2.6. Vehicle manufacturers

Emerging trends like shared mobility and autonomous driving are expected to disrupt the traditional business model of car sales. In this highly competitive landscape, vehicle manufacturers will have to compete with new players as other actors in the ecosystem such as SW and HW vendors are targeting the automotive vertical customer segment. The predictions estimate $100billion for data connectivity services such as apps, navigation, entertainment, remote services, and service upgrades. The introduction of 5G promises to bridge two distinct until recently worlds: that of telecommunications and vehicle manufacturers. The participation in 5G-IANA platform will give car manufacturers increased knowledge and interaction with players outside their current ecosystem increasing their competitive advantage. By providing their vehicle to the platform they can take a look at the new services that expected to enter the market the next years and thus plan their moves accordingly. The results from the executed experiments can help them understand the requirements for running the new services and thus modify the HW and SW in their cars in order to be ready when the applications enter the market.

### 2.2.7. Application, network function and network application developers (nApp developers)

nApp developers can benefit from the usage of the 5G-IANA platform in all the phases of the software development cycle, starting from the design up to the solution testing and validation steps, with particular reference to the system tuning for various operational environments where the applications will run when commercially distributed. This will facilitate the proposition of innovative 5G-enabled applications reducing the overall time-to-market and increasing the competitiveness of SMEs, which will not need huge investments in dedicated 5G infrastructures and specialised testbeds.

During the design phase, an application developer can use the 5G-IANA platform to simplify the design of complex virtual applications or services exploiting 5G network capabilities. For example, he/she can select existing multi-vendor AF/NF from the 5G-IANA portfolio and graphically chain them together with new application components developed to address the requirements of the automotive sectors. Moreover, the application developers could have the possibility to use some nApp examples, called “nApps starter kit”, as a starting point to simplify and speed-up the design and development of their own applications that can be deployed and integrated in the 5G infrastructure and interact with other applications or network services (e.g., using MEC services for localization or network information, etc.), to build more complex solutions.

The purpose of the "Starter-kit" concept is to make it easier for an application developer to create automotive vertical services, which can be automatically deployed and configured on top of 5G-enabled environments, fully exploiting the capabilities of mobile connectivity. The deployment of specific automotive services, in the form of virtualized AFs/NFs, may exploit the 5G-IANA platform and its orchestration functionalities in order to make use of extreme edge, edge, and cloud resources available in the 5G infrastructures, which includes also the possibility of orchestrating and running applications on top of OBUs and RSUs.

Moreover, the nApp developer may need a 5G-compliant environment for testing the nApps with the possibility to deploy and experimentally validate them in a realistic and configurable environment featuring OBU/RSU and edge computing resources. These resources, together with a flexible 5G infrastructure, are not easily accessible to SMEs and for those reasons, they might benefit from the employment of a ready-to-use platform that provides all the necessary components and extensive monitoring capabilities to better evaluate the behaviour of the applications in a variety of contexts before their roll-out in commercial environments. In particular, the testing phase will benefit from the use of the platform as it will be possible to measure, collect and evaluate network KPIs, a feature that is not available in commercial or public networks.

### 2.2.8. Application, network function and network application providers (nApp providers)

nApp providers can exploit the 5G-IANA platform as an additional opportunity to provide their nApps to a wide audience of actors. This possibility can enlarge their market, making them also reach SMEs or minor actors that may have trouble in establishing commercial relationships with large nApp providers.

Another benefit, that nApp providers can have, is to test their nApps in an automotive-specific platform. These could help them to identify the strengths and drawbacks of their nApps in this specific context improving in the future the selection of provisioned nApps.

Additionally, they may determine which categories of applications are more popular using their usage information. This information can make it easier for the providers to decide which nApps to look for in order to better customize their application portfolio to the automotive environment for future provisioning.

### 2.2.9. Service Creator

Service creators can benefit from the use of the 5G-IANA platform in multiple aspects related to development, implementation, integration, testing and provisioning of resources for their new or existing applications. The 5G-IANA platform offers SMEs the possibility of boosting and accelerating their business models. It permits service creators to be more efficient in the process of creating and then commercializing innovative applications, designed to take advantage of the benefits provided by 5G networks in the automotive sector, among others.

The use of the platform entails a series of advantages for this type of companies:

- One of the main incentives is the lower development time needed. This is because developers can make use of specific existing VNFs or even complete network applications for their own purposes or functional improvements.
- Moreover, there is no need to acquire or use specific hardware resources in the network, since the platform offers HW resources for computing and hosting applications. This reduces the acquisition and maintenance costs of this type of equipment.
- The 5G-IANA platform automatically provides the ability to orchestrate different applications and deploy the resources needed for them.
- It also entails the complete availability of a real test bench that can be used immediately, without the need to create a new one.
- It eases the obtention of network KPIs and the operation of applications. Naturally, this speeds up the maintenance and improvement of the services created.

### 2.2.10. Service Provider

Service providers are driven to invest in the 5G evolution by the increasing demand for greater bandwidths, ever-faster speeds and near-zero downtime. However, they require robust testing protocols and assurance of increasingly complex 5G architectures to deliver optimal network performance and service quality.

Overall, 5G-IANA provides a set of VNFs, tools and predefined nApps to ease the design and creation of application and services on top of existing Automotive services for new entrants. The potential incentives and benefits for service providers to use the 5G-IANA platform are:

- Opportunity for cost-less early prototyping and experimentation of new 5G features and use cases utilizing the nApp components, from 5G-IANA repository, labelled per domain availability and service type.
- Ability to understand faster the inherent challenges involved in deploying a new 5G service and how to overcome them, without the user starting the development from scratch.
- Access to a heterogeneous set of already existing virtualized management, communication and optimization functions for the Automotive industry and correlated business areas.
- Abstraction of complexity for nApp chaining by exposing to the user only the high-level information needed for building a comprehensive end-to-end service, hiding the network complexity in the background.
- Ability to deploy an end-to-end network services across different domains due to the virtualization offered and by proposing baseline functionalities to experimenters packaged in starter-kits, divided per type of service.
- Reduction in service creation time utilizing the ready-to-use building blocks from 5G-IANA nApp toolkit and the easily customizable nApp starter kits.
- Intuitive end-to-end service design and chaining to construct nApps with 5G-IANA's graphical nApp composer.
- Access to preconfigured distinct network slices for low latency (uRLLC) and higher data rates (eMBB), holding resources both from the Radio Access and the Core Network, to support a variety of different use case requirements.
- Ability to allocate network resources with the Network Slicing application to fulfil the requirements of a specific service. The QoS needed for a specific service is guaranteed by isolating the allocated resources from other network slices.

- Secured and trusted service provisioning for the Automotive 5G-PPP vertical, with virtualized infrastructure composed of 4 MANO platforms (OBU, RSU, Edge and Cloud Resources).
- Simplified management and orchestration of collections of AI/ML service components, functionalities provided from the DML framework.
- Ability to predict and manage QoS to provide low latency connectivity for mission critical scenarios, using the DMLO.

## 2.3. 5G-IANA reference model

The 5G-IANA reference model presents the relationships between the different roles in the ecosystem around the AOEP and is presented with all the details in Figure 2.

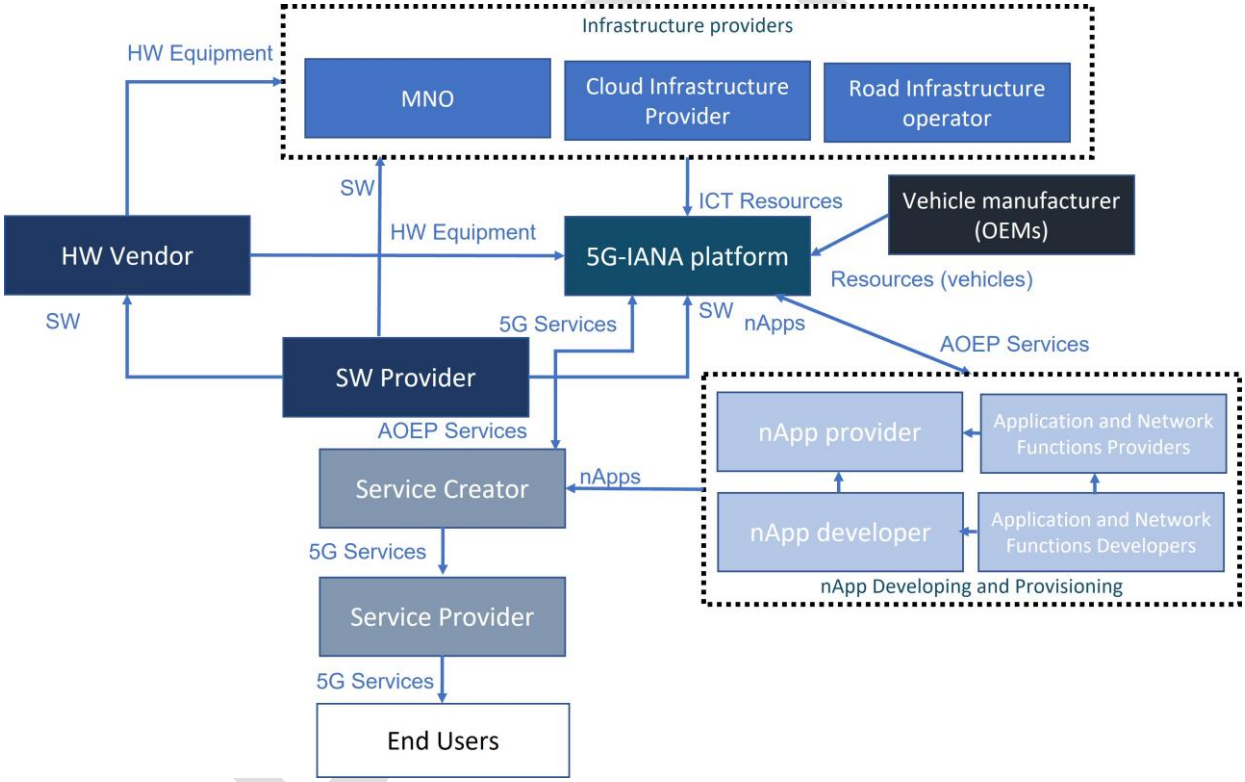


**Figure 2: 5G-IANA reference model**

In the reference model, the arrows indicate the relation among the different roles while the direction of the arrow represents the direction of the service flow. The flow of the revenue is on the opposite direction of the arrow, although in some cases there is revenue sharing agreement (in that case there are bidirectional flows and arrows). The rectangular boxes with solid line represent roles, while the ones with dotted lines grouping of roles. We have to note that there are also other relationships between the roles (for example HW vendors provide equipment to

all other members of the ecosystem) but these relationships are not examined since they are not affecting the business model of the AOEP.

The business relationships in the reference model are the following:

- **HW equipment**: it represents the relationship between actors for the provisioning of ICT related equipment. It is provided by the HW vendor to the infrastructure providers and the 5G-IANA platform.
- **SW**: it represents the provision of SW by the SW provider to the HW vendor, the infrastructure providers and the 5G-IANA platform.
- **ICT Resources**: it is a general term that includes all kind of resources (connectivity, computational resources, RSU, etc) that are provided by the infrastructure providers. This is a relation among the MNO, the Cloud Infrastructure Provider and the Road Infrastructure provider and the 5G-IANA platform.
- **Resources (vehicles)**: it includes the vehicles that are provided by the vehicle manufacturer to the 5G-IANA platform.
- **nApps**: these are the nApps developed by the nApp developers and are tested in the 5G-IANA platform.
- **5G Services**: it represents the provision of 5G services that are ready to be consumed by the end users. These are provided by the service creator to the service provider that is the one that interacts with end users. It can also be provided by the service creator to the 5G-IANA platform in case that it is a service that can be used by other services.
- **AOEP Services**: it describes the portfolio of services that are provided by the 5G-IANA platform, it includes the use of the platform for experimentation, consulting and training services.

## 2.4. 5G-IANA business model

The problems that the 5G-IANA AOEP aims to address are associated with the lack of specialised 5G experimental platforms that can be accessible by third party experimenters. In addition, there are no testbeds available that offer access to resources specific to the automotive vertical, while the VNF repository and the nApp toolkit can assist third parties to compose their own services even if their level of expertise is low.

Regarding the competition there are some generic emulators that have a number of limitations with the most important to be the lack of resources needed for the development of services in the automotive vertical. There are other experimental platforms from other 5G projects that are

developed under the same call, from 5G-PPP earlier phases or from national funded projects; but to the best of our knowledge no platform is targeting explicitly the automotive vertical.

The solution that the 5G-IANA platform offers includes 5G testbeds, HW resources, SW resources and toolkits, along with human capital that are difficult to be offered from other stakeholders, while MNOs that could potentially offer such resources are not for the moment eager to open up their networks to external parties.

The "Business Model Canvas" was developed by Osterwalder and Pigneur [10] and is used to represent the business model in a structured and comprehensive way. It is used as a blueprint to define business strategies for enterprises. The business model canvas can be split into three major groups of building blocks: The right part is the customer group, the left part focuses on resources of a business model while in the bottom the financial structure with revenue streams and costs is represented.

The business model canvas that has been created for the 5G-IANA platform is presented in Figure 3.

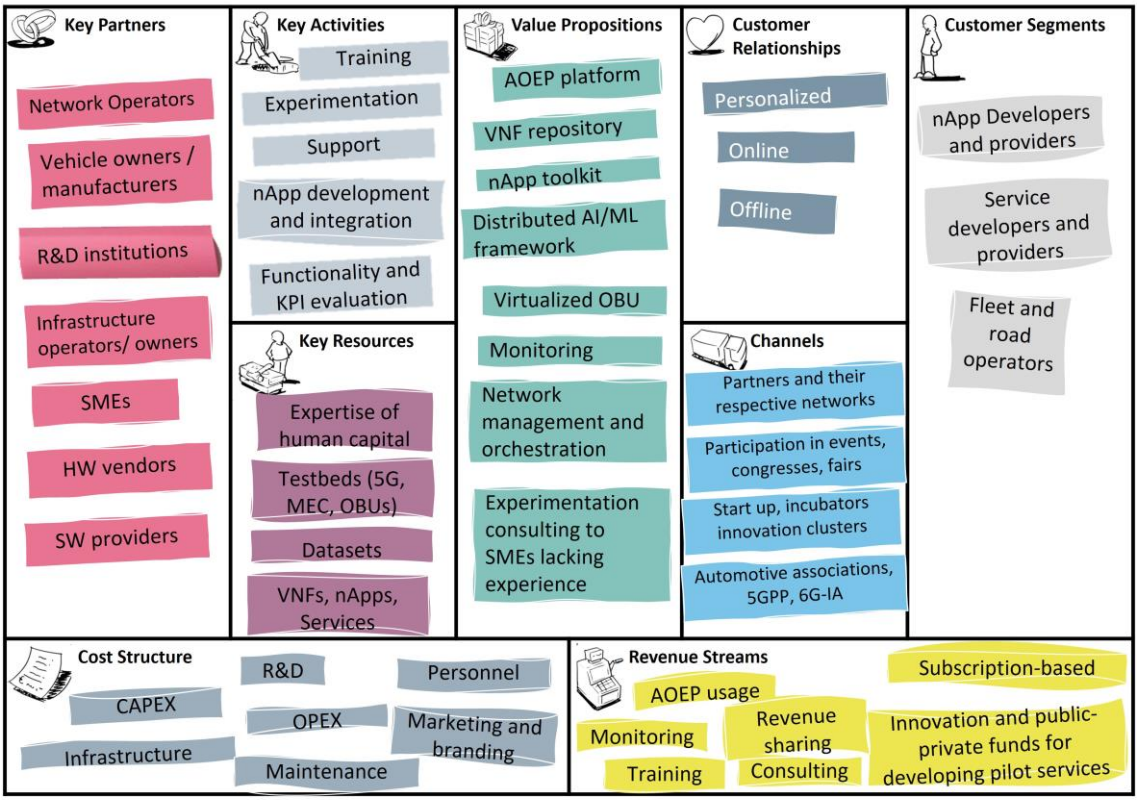


**Figure 3: Business Canvas for the 5G-IANA platform**

The description for each of the elements of the business model canvas:

**Key partners**

There are several key partners that are providing all the resources that are essential for the operation of the 5G-IANA platform as defined in the reference model. The network operators and other infrastructure operators or owners are providing the necessary ICT resources, which include connectivity, computational and storage resources (that can be either physical or virtual). The HW providers supply all the required HW that is required for the operation of the 5G-IANA platform such as computers, CPUs, GPUs, routers, switches etc. In case that a local private cloud will be built (the other option is getting it as a service from a cloud provider) there will be increased needs for these types of resources. The SW providers will provide the necessary SW that is essential for the operation of the platform. SMEs and R&D institutions are the partners that will provide the human capital with the expertise to operate the 5G-IANA platform (for example personnel of the partners that are part of the 5G-IANA consortium).

**Key activities**

The most important activity is the execution of the experiments from third parties that will use the 5G-IANA platform. The term Experimentation as a Service (EaaS) has been introduced from other platforms [11], and other 5GPP projects [12], [13] and will also be used here. The provision of EaaS allows a number of additional complementary activities such as consulting, training and support activities to experimenters that are targeting users of the platform with limited expertise or knowledge. The support service will provide assistance in case that third parties are experiencing technical difficulties with the platform. Training can be provided either for the operation and functionalities of the platform or for the design and execution of experiments. The consulting services can be provided to experimenters at different levels like for example provide insights on how they can create a service (for the ones that lack the expertise and knowledge), to technical assistance on improving their service or even mentoring to help them asses the market opportunities and develop a business plan for their offerings. Services like the improvement of functionality and the evaluation of the KPIs can also be provided or assistance in the development and integration of nApps.

**Key Resources**

All the parts that constitute the 5G-IANA platform and that will be used for the experimentation are considered key resources (HW, SW, testbeds, OBUs, MEC etc.) The expertise of the human capital is also another of the key resources since it can provide their knowledge to third parties that want to take advantage of the platform. The repository of VNFs is also an important resource since it can facilitate the creation of new services and reduce the service creation time. Existing datasets (like for example from previous experimenters that want to share them) can facilitate the validation of new services. Finally, the services that can be utilized from other

services (like for example the one in UC6) can be considered key resources (there will be some incentives for experimenters that want to share their services).

**Value propositions**

The main value proposition is the AOEP, that constitutes from a number of elements. The most important are the AF/NF repository, the nApp toolkit, the network management and orchestration, the distributed AI/ML framework, the virtualised OBU. The platform is offering also the human capital to allow third parties without expertise to develop their own applications.

**Customer relationships**

Regarding the customer relationships due to the nature of the provided services these must be personalised to the needs of each experimenter using both online and offline methods. The online can be through the website or using teleconference platforms.

**Channels**

To promote the platform the partners involved in the 5G-IANA platform and their respective networks should be utilised. The participation in events, congresses and fairs in which developers in the automotive industry participate will be used as it can attract an increased number of possible users that would not be possible with the other channels. The creation and presentation of demos and success stories can increase the chances of collaboration. The automotive association and 5G-PPP Working Groups in which experimenters participate is another channel that will be used. Finally, start-ups in the automotive vertical, incubators in each country and innovation clusters can be a promising contact point.

**Customer segments**

All the parties that have an interest in doing experiments in the 5G-IANA platform, the developers (and providers) of nApps and services that are targeting the automotive vertical. Also, users of services like for example fleet and road operators that want to test their applications or services.

**Cost Structure**

It includes the cost associated with the required resources of running the 5G-IANA platform. Personnel cost for type of employees like technical experts, those providing support, marketing and brand and other auxiliary roles like account department, legal, etc: these can be outsourced in the beginning and if the needs increase to become permanent stuff. The costs of the infrastructure include the necessary HW and SW licences, cost for initial installation, further development of the platform and system integration.

**Revenue streams**

There are different options regarding the revenue streams depending on the type of services that will be offered after the end of the project. In case that the platform will remain open to

third parties funding must be found from innovation and public funds at national or EU level. Since the sustainability of the platform depend on the funding another option would be to offer some of basic functionalities as free but with limited capabilities and support. A subscription-based model can be used providing access to a predefined packet of resources and support. In case some of the experimenters want to use some extra resources, the charging can be made based on the number and type of resources are used, the duration of the experiment, the level of required support and consulting. A revenue sharing agreement can be made with experimenters that want to share their applications or services or their data to other users in the platform. That could be beneficial for all involved parties and increase the impact of the 5G-IANA platform.

# 3. 5G-IANA SURVEY REGARDING THIRD PARTY EXPECTATIONS

The aim of this section is to analyse the expectations of potential third-party experimenters from the 5G-IANA AOEP. To collect the required input a questionnaire was created, and an online survey was designed. The survey was promoted through the project website and 5G-IANA partners and circulated through 5G-PPP and 6G-IA mailing lists (dissemination and communication leaders, working groups, technical board, verticals, associate members and members of the 6G-IA, SME working group) to SMEs that are working on the development and provisioning of nApps in the automotive vertical. It was also distributed to the other ICT-41 projects, to ERTICO partners, to our External Advisory Board, and to SMEs that were identified as possible users of the 5G-IANA platform. The complete list of the questions is presented in Annex I and is structured as follows:

- Introductory page with information about the survey.
- Profiling questions of the participants.
- Sections for comparison and classification of the different aspects of the platform using the Analytic Hierarchy Process (AHP) methodology such as the different technologies used in the platform, the offered resources and the support options.
- Questions regarding the most important use cases, the expectations of third parties for resources, the most important KPIs that should be monitored, the open data, and the participants' intentions to take part in the experimentation phase.

The following sections present the analysis of the collected responses for the different questions.

## 3.1. Online survey

The survey was conducted online and was created using an open-source tool (LimeSurvey). No personal information was collected from the responders (except, optionally, for the e-mails in case they wanted to be informed for upcoming activities). The link of the survey was shared among the 5G-IANA partners with the note to further communicate it to potential third parties that would like to experiment in the AOEP. Furthermore, it was disseminated through the 5G-PPP mailing lists with an introductory e-mail explaining the purpose of the survey. It remained open for three weeks and in total 23 participants have completed all the requested questions.

## 3.2. Profile of participants

Regarding the participants' profile (Figure 4) most of them were SMEs (20), two come from industry and one from academia and research institutions.

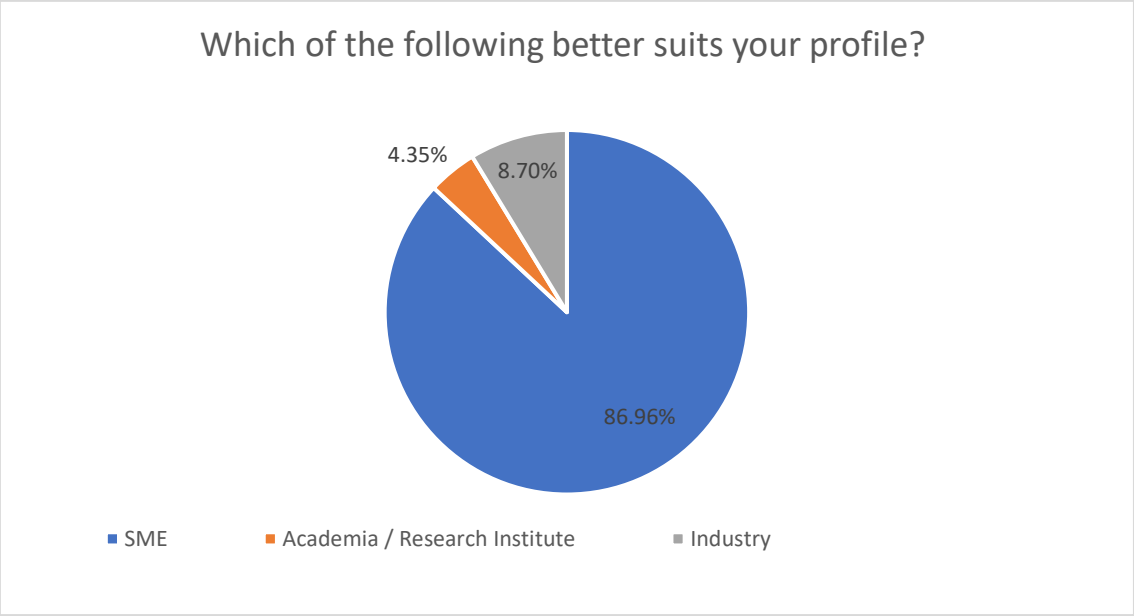


**Figure 4: Profile**

Regarding their field of expertise most of the responders responded that they are developing applications followed by researchers (the sum of numbers as presented in Figure 5 exceeds 100% as in this question more than one selection was permitted).

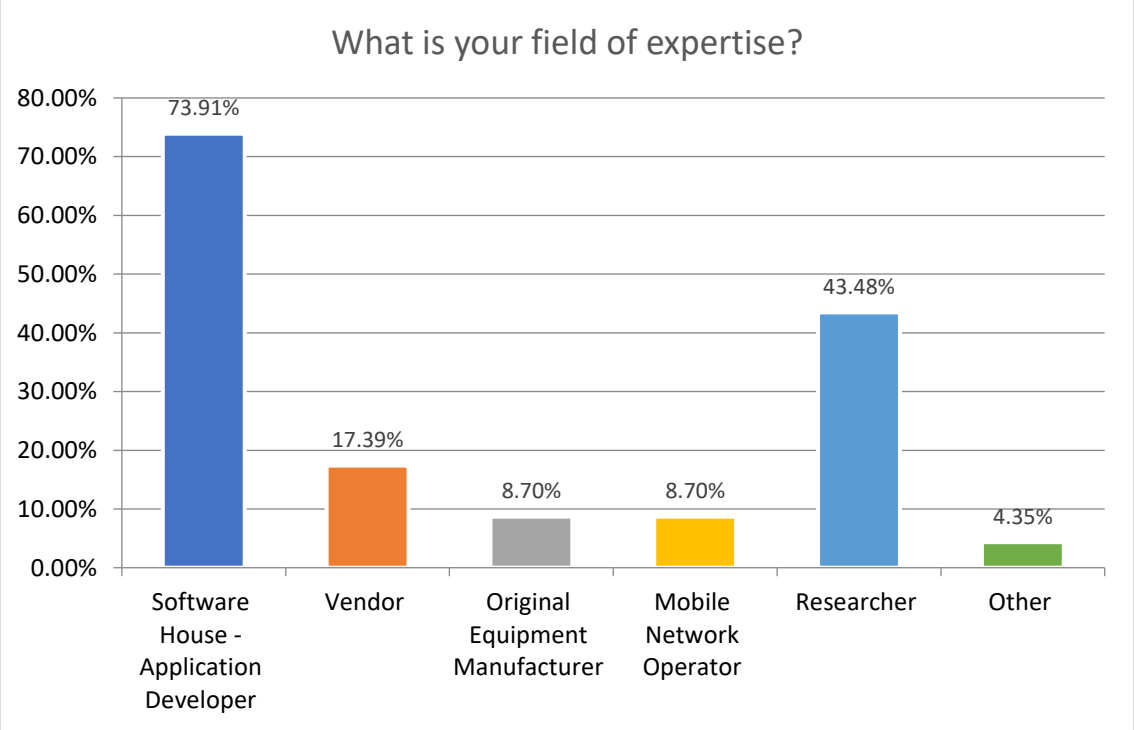


**Figure 5: Field of expertise**

The next question was about the participants' involvement in the automotive sector either by offering a service or a platform, a HW device or an application. The results (presented in Figure 6) reveal that almost half of them (10) have no such product or service in the automotive vertical (yet). Out of the rest of the 13 responders, most of them have software or an application (10), a platform or a service (7) and 4 of them have a HW device. In this question more than one choice can be selected, thus, the total percentage sums up over 100%.

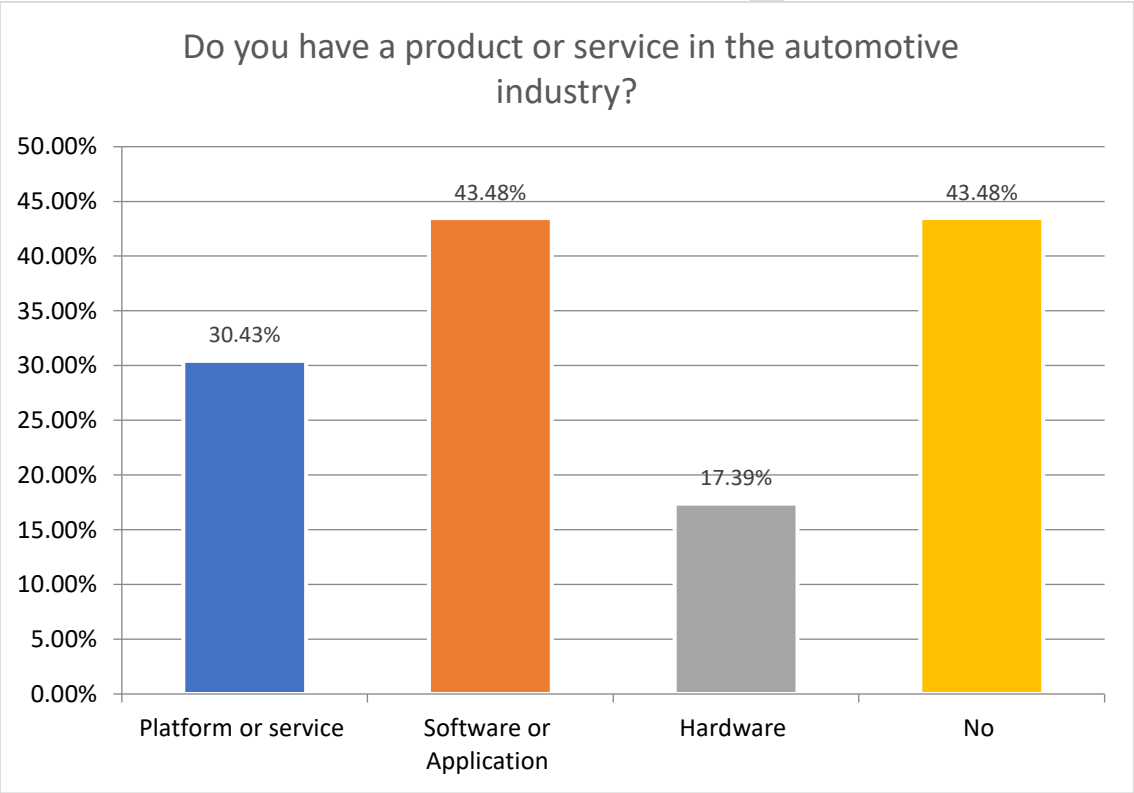


**Figure 6: Involvement in automotive industry**

The next question requested their familiarity with the 5G ecosystem and the creation of nApps. The results presented in Figure 7 reveal that 61% has developed or are developing a nApp (with 17.4% to have developed more than one). An equal percentage has not yet developed any nApp but they are considering to do it, and 13% are familiar with the term as part of their research activities. Only 8.67% (2 responders) are not familiar with the term and do not plan to do any development.

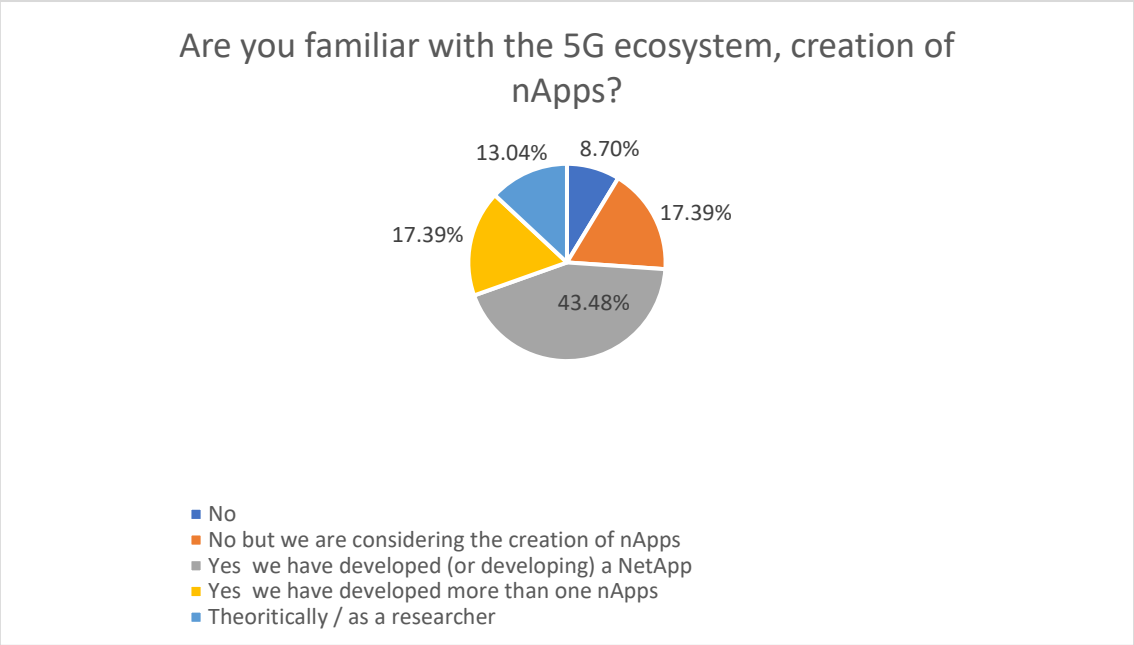


**Figure 7: Familiarity with 5G ecosystem**

## 3.3. Prioritization of platform general features

AHP is a technique for assisting taking complex decisions. It is based on a comprehensive framework that decomposes unstructured complex problems into a multi-level hierarchy that is composed of interrelated criteria and decision alternatives. Introducing the judgments of experts on both qualitative and quantitative criteria, AHP achieves to quantify the preferences of the experts. By combining all the different judgments, it provides priorities among the criteria and the alternatives.

The AHP method was developed by Thomas Saaty [14] and initially it was used for military applications. The last decades it has been applied in different sectors such as engineering [15], industry [16] and manufacturing [17]. More information about the method and how has been used as a tool to rank alternative options in the ICT domain can be found in [18],[19].

Several steps are required to reach the final result as illustrated in Figure 8. The first step is about the formulation of the problem, and it includes the determination of the criteria and sub-criteria that are necessary for the achievement of the final objective. These are defined by organizing workshops and interviews with the experts in which the various elements are discussed.

The multi-level hierarchy is then formulated, the primary level is the objective that must be achieved followed by the criteria in the next level. Finally, in the lower level there are sub-criteria (for each criterion) that are used to better present specific features that each criterion has.

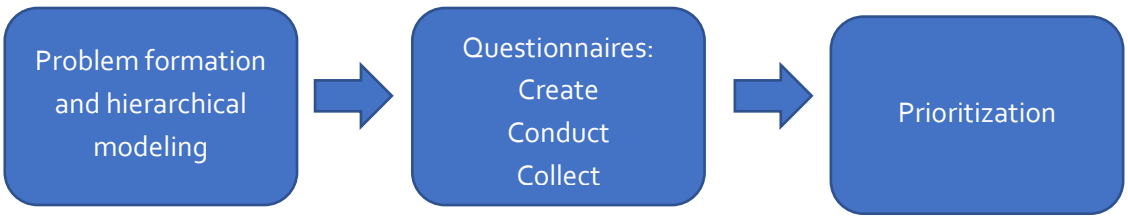


**Figure 8: Steps for analytic hierarchy process**

When the criteria and sub-criteria are determined, the hierarchical structure is completed and the questionnaires that must be answered by experts can be created (step 2). The questionnaires are created asking for pairwise comparisons from the experts among the same levels of the hierarchy. The comparisons are performed using the nine levels that are presented in Table 1 The last step included the calculation of weights for criteria and sub-criteria.

**Table 1: The Saaty Rating Scale**

| Intensity of | Definition | Explanation |
|---|---|---|
| 1 | Equal importance | The two criteria have equally contribution |
| 3 | Moderate importance | Experience and judgment favor one of the criteria |
| 5 | Strong importance | The criterion is strongly favored |
| 7 | Very strong importance | The criterion is dominant |
| 9 | Extreme importance | The criterion is favored by at least an order of magnitude |
| 2, 4, 6, 8 | Intermediate values | Intermediate values that used as alternatives between two of the above numbers |

The survey was designed by conducting workshops with partners organized by WP6 and the following set of criteria were identified:

- Technology
- Resources
- Support

Each of the above criteria was further analysed into sub-criteria, which are attributes that are closely related to the criteria. For the technology the following sub-criteria were identified:

- **Application Orchestration**: the entry point for service providers. It exposes functionalities for designing distributed services composed by nApps. This layer hosts also a catalogue of available nApps that can be used and chained to realize the desired service.
- **Network Orchestration Platform**: this layer implements the functionalities for verifying the availability of a network slice instance suitable for supporting the operation of the vertical service. It also handles the orchestration of computational resources to be allocated to run the nApps.
- **Distributed AI/ML Framework:** provides explicit support for ML-oriented services, including FL primitives.
- **Evaluation and KPI testing**: it realises the collection of data from distributed data sources (i.e., Network Application, infrastructure hosts etc.) and provides analytics based on service-level policies to optimize the Lifecycle Management (LCM) operations.

For the resources the following type has been identified as the most important:

- HW resources (OBUs)
- Virtualised Application Functions / Network Functions (AFs/NFs)
- HW resources (MEC)

Finally, for the support the most important aspects have been identified:

- Support by email / on-line form
- Ticketing System
- Webinars / Videos (interactive)
- Training by experts

The pair wise comparisons were introduced in the survey, an example is illustrated in Figure 9. After the completion of the survey the responses were imported in MATLAB in order to estimate the priorities of the sub-criteria.

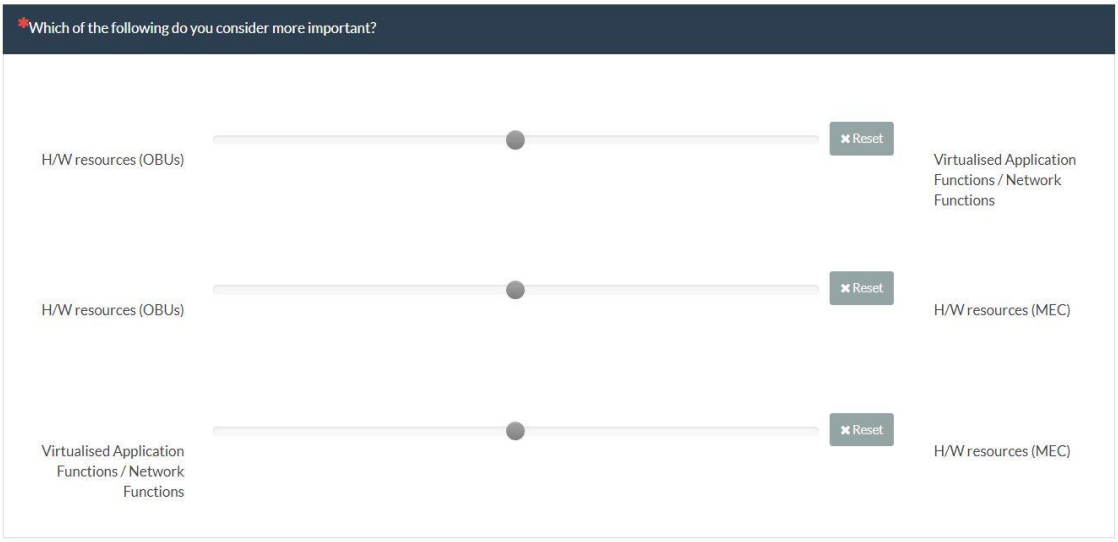


**Figure 9: Example question**

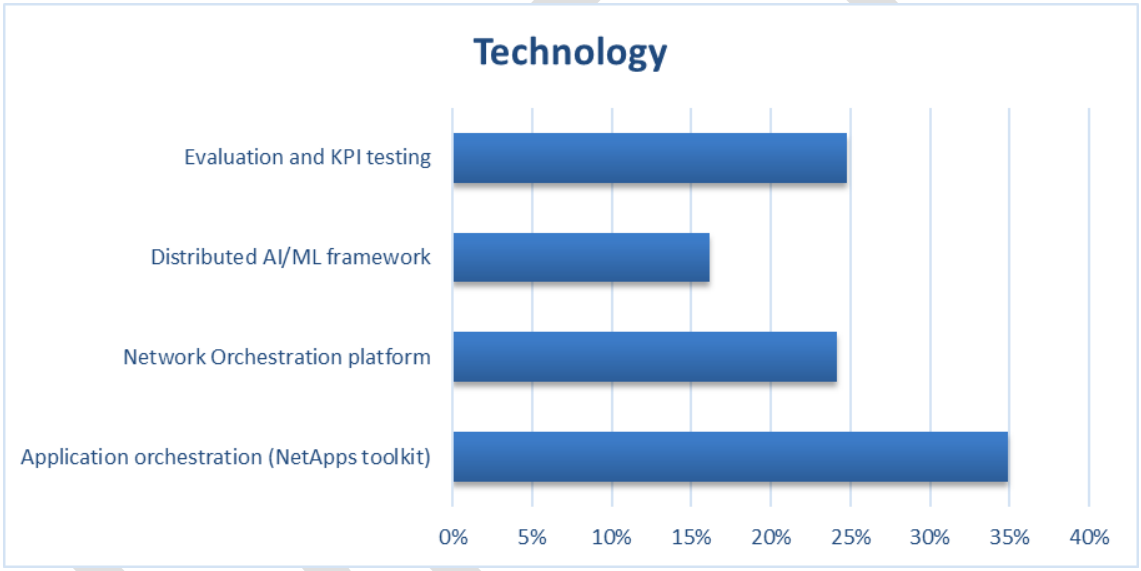


**Figure 10: Prioritization of technology sub-criteria**

The results for the technology sub-criteria are presented in Figure 10. According to the opinion of the experts the most important technology used in the AOEP is the Application orchestration with a weight of 35%. Evaluation and KPI testing, and the Network orchestration platform are following with weights of 25% and 24% respectively, while the distributed AI/ML framework has a weight of 16%. The application orchestration is highly valued among the experts as it can facilitate the deployment of new services and reduce the service creation time.

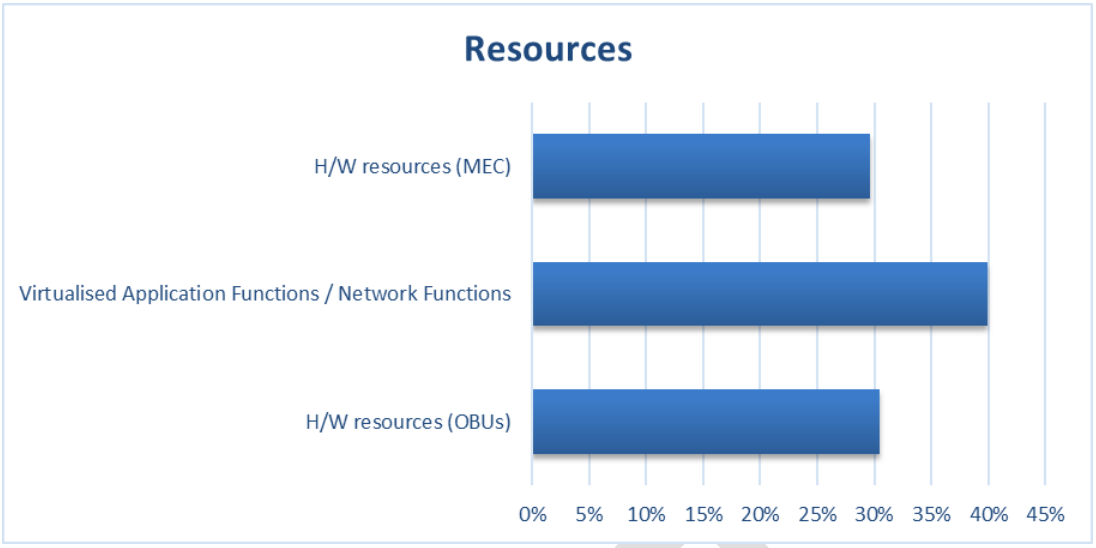


**Figure 11: Prioritization of resources sub-criteria**

Regarding the sub-criteria related to the offered resources the opinion of the experts are divided almost equally (Figure 11). The Virtualized AFs/NFs have a slightly higher weight of 40% compared to the two different types of resources (MEC and OBUs) that both have a weight equal to 30%. There is no distinct difference among the valuation of the different resources; experts seem to consider them of almost equal value for running their experiments.

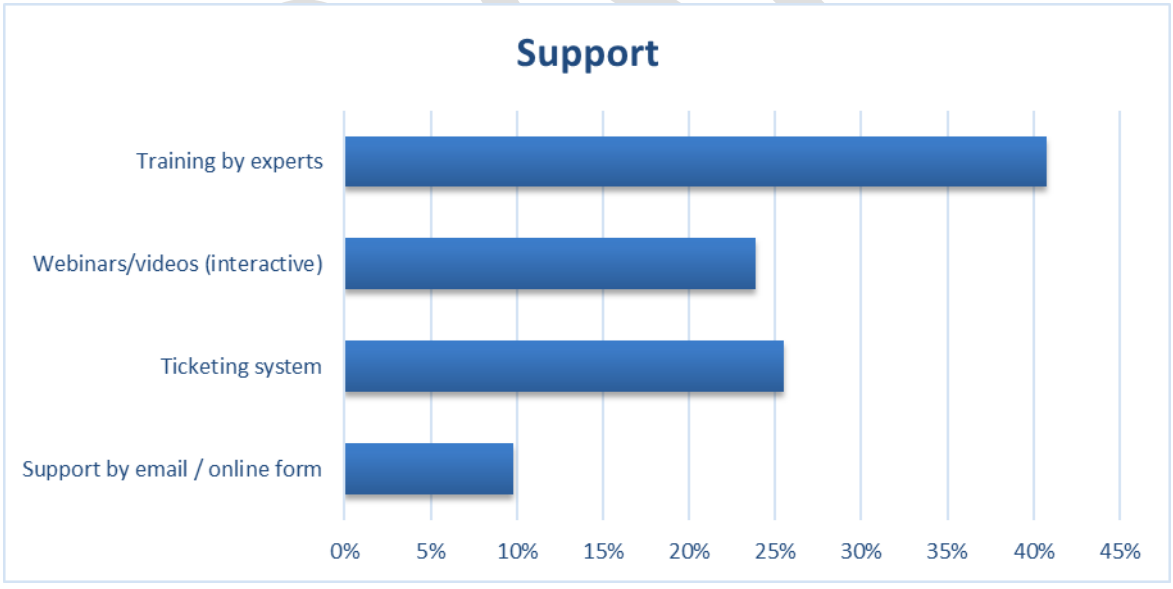


**Figure 12: Prioritization of support sub-criteria**

For the different options for support (Figure 12), the training by experts has a weight of 41%. Two other options have similar scores: ticketing system (26%) and webinars and videos (24%), while the support with methods such as email and an online form have the lower weight equal with 10%.

Experts have the opinion that the human capital of the 5G-IANA platform is one of the most important assets and thus want to benefit as much as they can from it. They also prefer the interactive ways of communicating instead of traditional communication using e-mails and online forms.

## 3.4. Technical expectations from the 5G-IANA platform

The first question that we raised to the participants of the survey required their feedback about the most important use case categories for the automotive sector. The participants could choose between the following categories:

- Hazard notification, such as high-risk driving detection (5G-IANA UC5 and UC7 belong to this broad category);
- Vehicle movement, such as remote driving (5G-IANA UC1 and UC2 belong to this broad category);
- Infotainment purposes, such as in-vehicle AR/VR applications (5G-IANA UC3 and UC4 belong to this category);
- A vertical-agnostic category, acting as an "umbrella" to any use case, which concerns for instance network status monitoring for predictive QoS (5G-IANA UC6 belongs to this category).

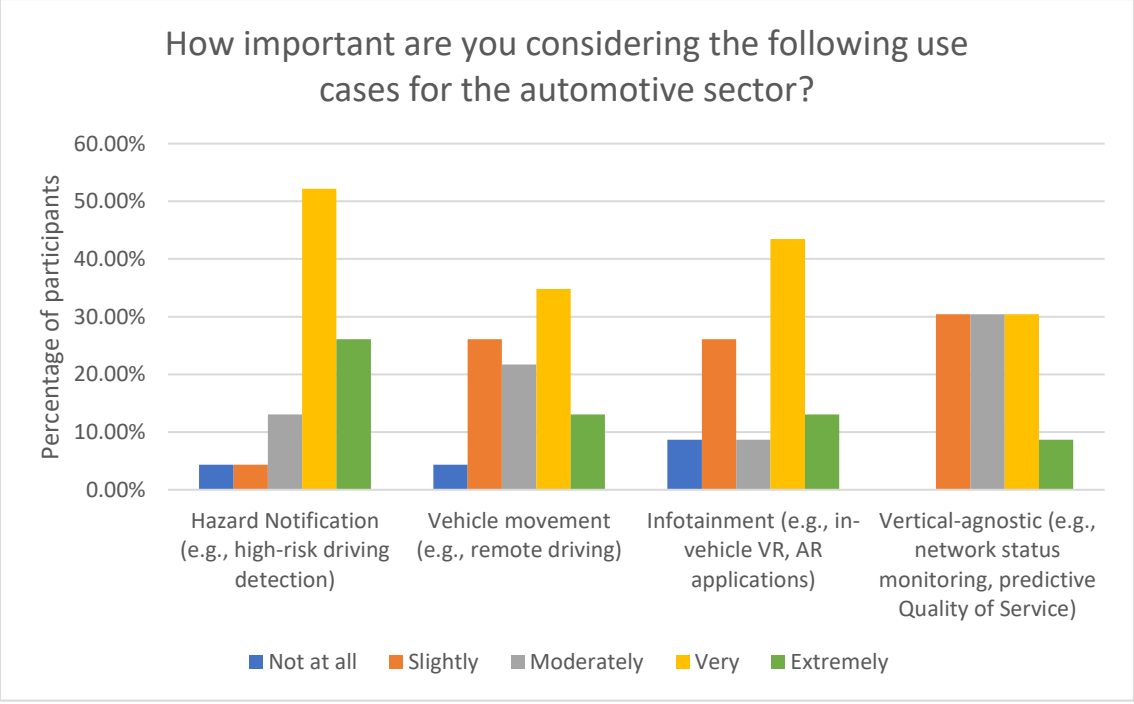


**Figure 13: Importance of different UC categories**

The results (Figure 13) reveal a rough prioritization of the interest of the automotive use cases, as well as, indirectly, of the project's own use cases: 1. Hazard-notification, 2. Infotainment, 3. Vehicle movement, 4. Vertical-agnostic. We believe that the industry is not yet well-familiarised with vertical-agnostic use cases though; thus, the provided feedback. The project will therefore contribute towards emphasizing the potential benefits for OEMs from AOEP-enabled network status monitoring, by showcasing the UC6 in parallel with other use cases (related to vehicle movement, infotainment, etc.). The detailed results for each of these graphs are presented in Appendix II.

**Exploitation**: The feedback from this question helps the project identify the expected public interest and potential impression from the respective to-be-organised demos towards the end of the project. Overall, this can be valuable input for 5G-IANA while a) promoting the AOEP platform capabilities (to give emphasis on specific supported use cases) to potentially attract more third-party experimenters, b) organising and advertising the demo activities, to attract industrial interest, c) preparing AFs/NFs with the mindset that hazard-notification- and infotainment-related ones may be the ones of most interest and reusability potential by third parties.

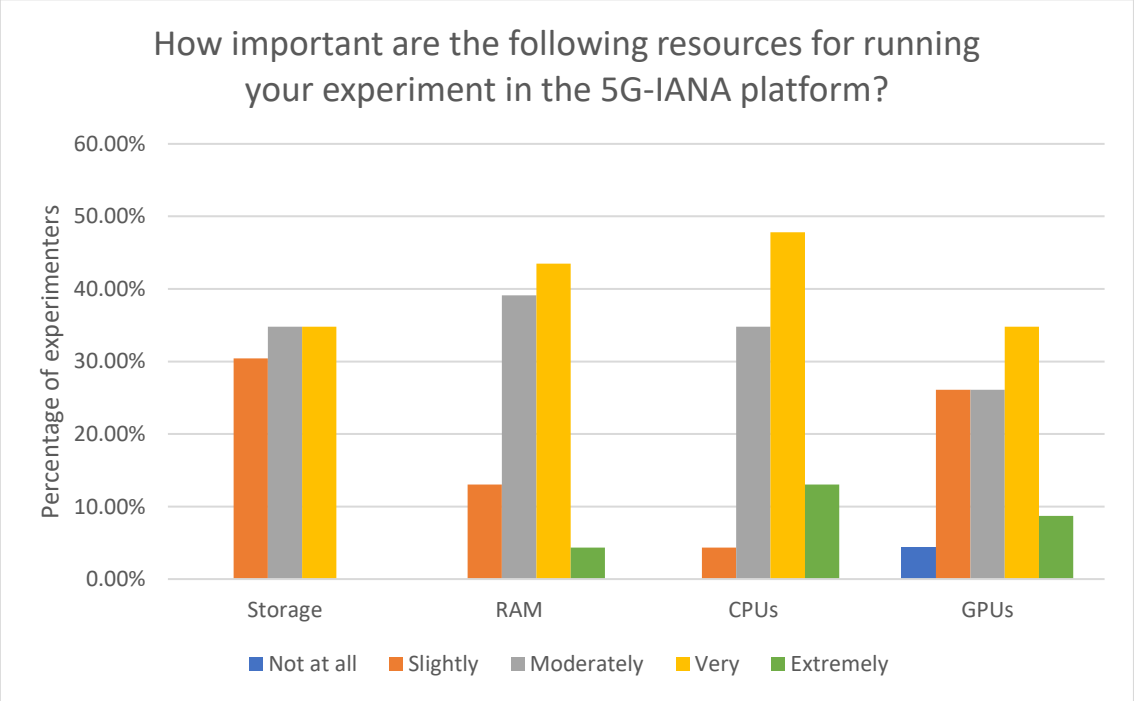


**Figure 14: Importance of HW resources**

The next question that we raised to the participants of the survey concerned the importance of HW-related resources for potentially running their experiments on the AOEP platform. The third parties seem to require central processing the most, followed by the need for RAM, and storage/graphics processing. Some of the experiments might not need GPUs at all, which provides us an insight about such types of experiments, while others consider the use of GPU extremely important.

**Exploitation:** Since we did not require specific values for RAM/CPU/etc. at this early stage (such a request might discourage some of the participants and potentially lead them to abandon the survey), we mainly used it to get a rough idea about what kind of experiments the 5G-IANA should be able to support in terms of resource requirements. We conclude that in order to support the broader possible spectrum of experimenters, we should pay attention equally to all factors and make sure that the platform can support central/graphics-processing-hungry applications, as well as memory/storage-hungry ones, as we would not like to exclude any potential experimenters due to the platform's HW resources insufficiency.

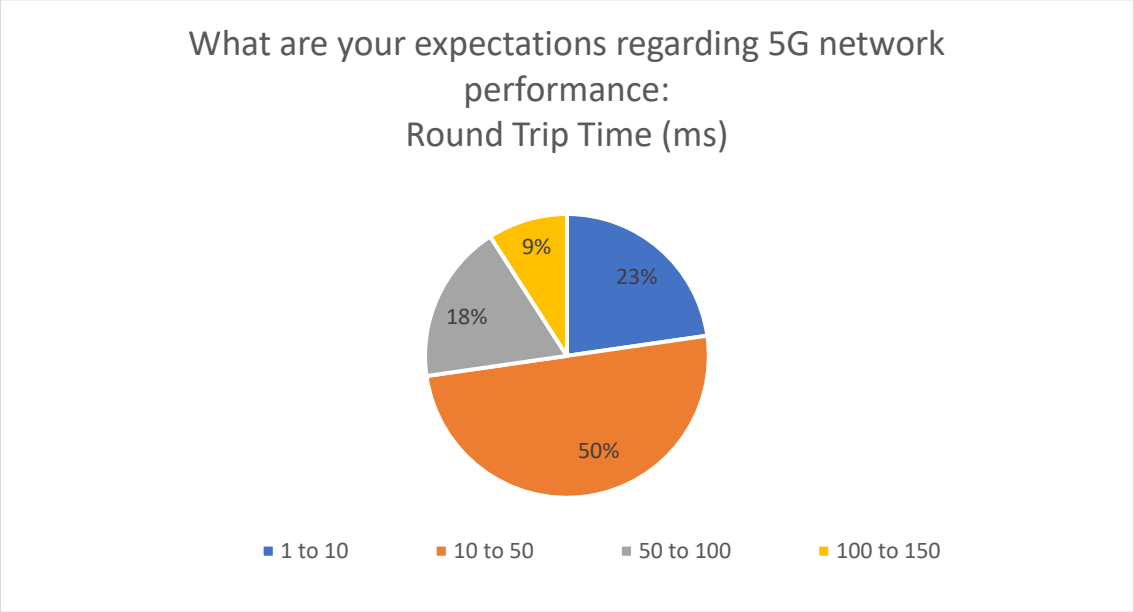


**Figure 15: Expectations for maximum Round-Trip Time**

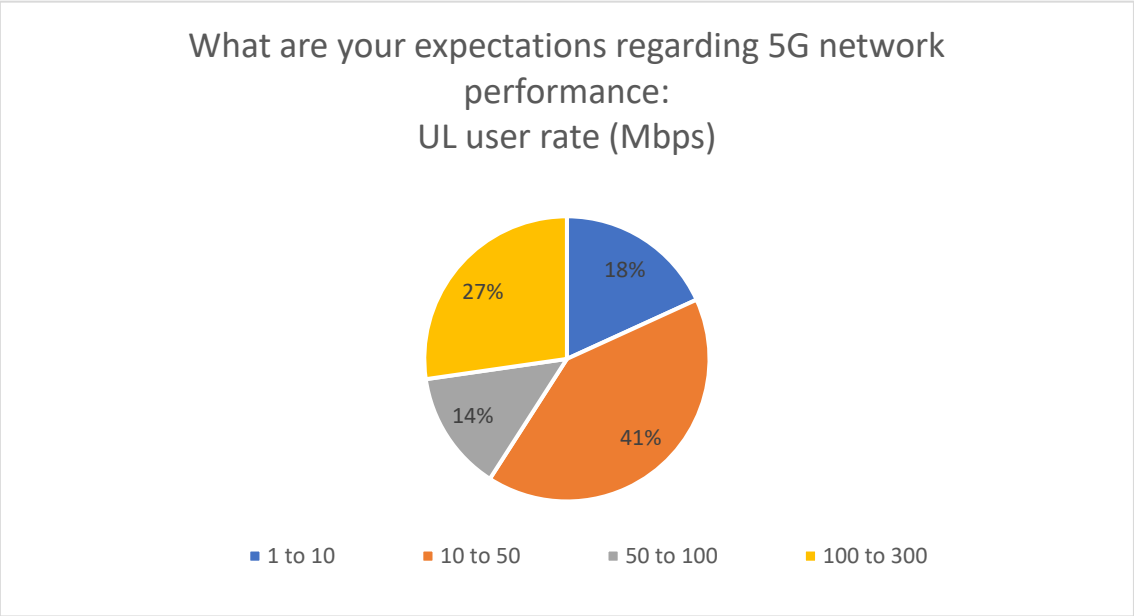


**Figure 16: Expectations for minimum UL user rate**

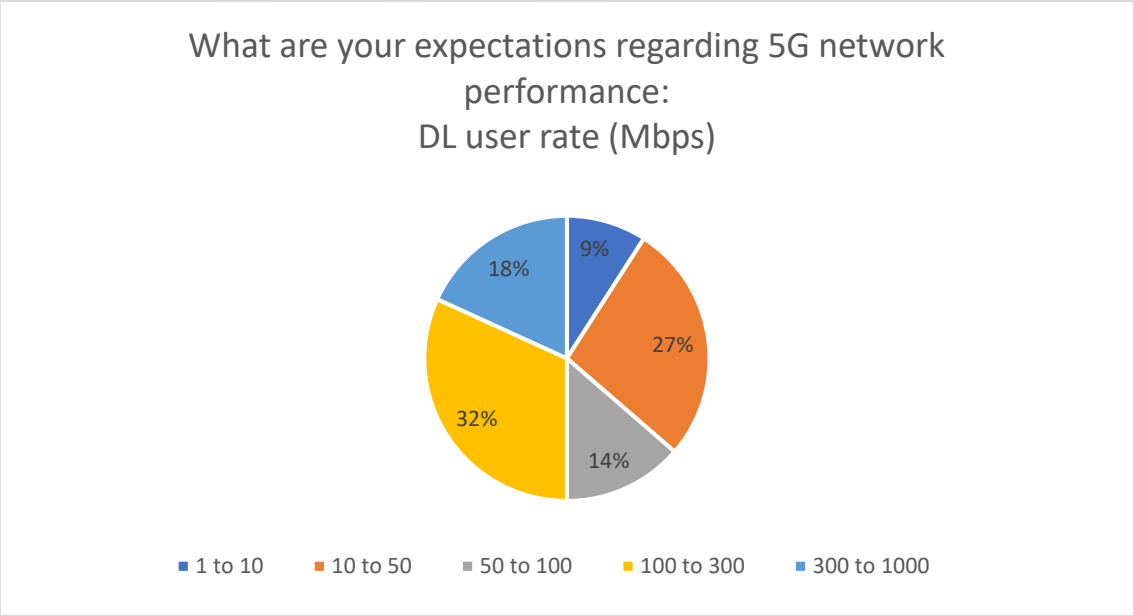


**Figure 17: Expectations for minimum DL user rate**

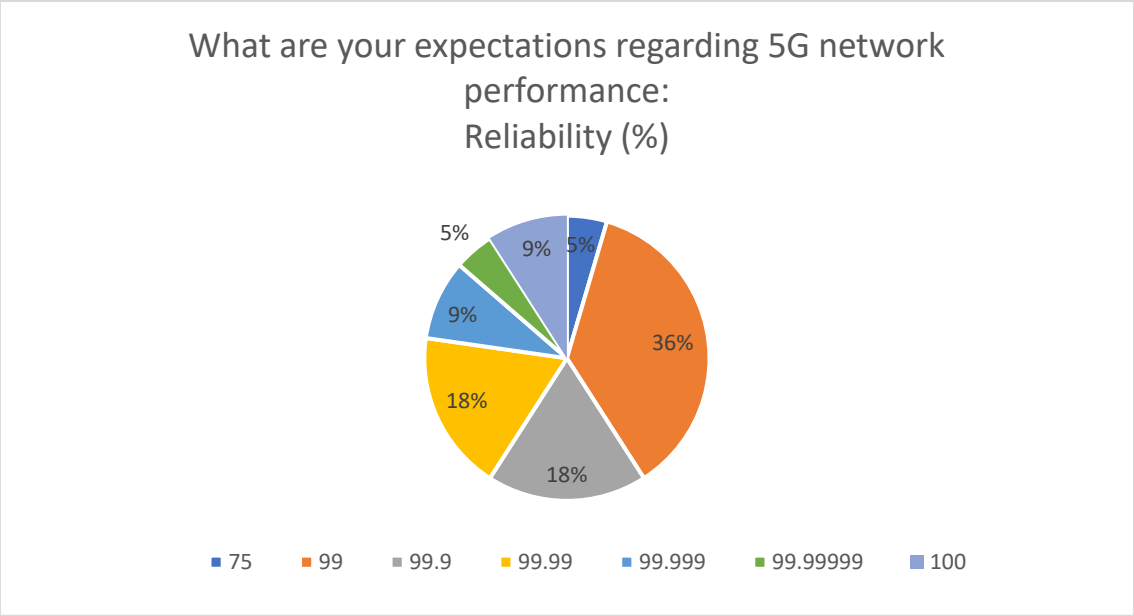


**Figure 18: Expectations for minimum Reliability**

The purpose of the previous four-part question is to record the third parties' feedback regarding the "at least" values for specific metrics, so that their applications may run smoothly with 5G support, namely: maximum Round Trip Time (RTT), minimum Upload and Download rate, as well as the minimum reliability required for the application to function properly (the definitions of all these metrics have been provided in the respective survey question – see Appendix).

With the responses of the participants, we have had the opportunity to get numerical values regarding the expectations from the 5G network, and the requirements that it would have to fulfil in the "worst case scenario". In terms of RTT, we realise that third parties may wish to run either time-insensitive (27%: 50-100ms) or, more often, time-critical applications (73%: 1-50ms). In terms of throughput required, the majority would need a minimum of 10-50Mbs UL, and 100-300Mbps DL. Reliability is very critical, as 95% would need more than 99%.

**Exploitation:** This feedback will be provided to NOKIA and Telecom Slovenia testbeds, for further processing.

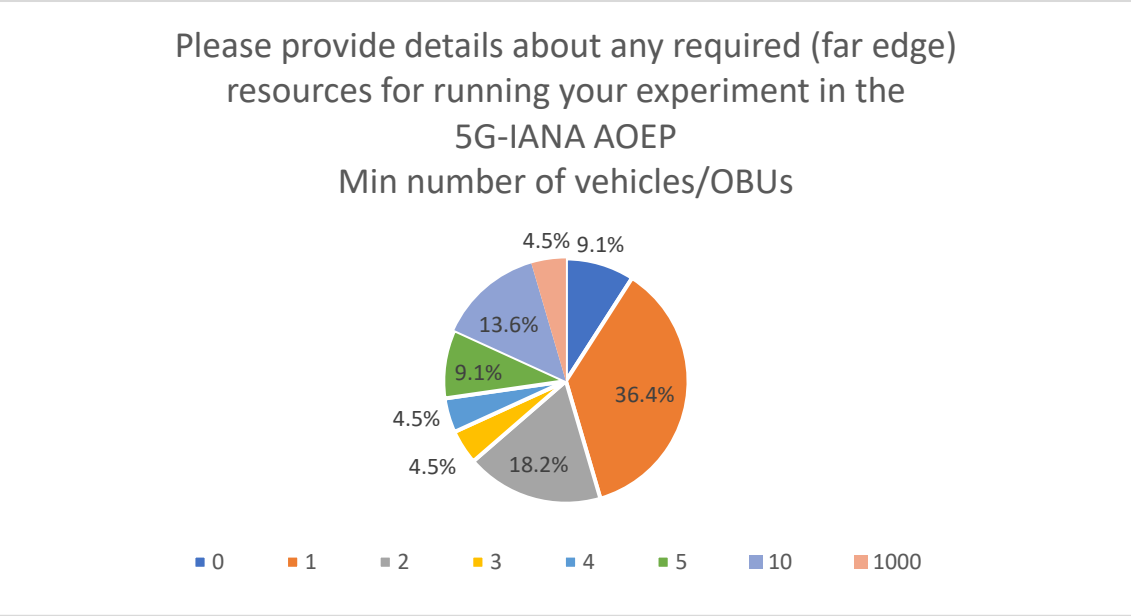


**Figure 19: Minimum number of vehicles/OBUs**

The purpose of this question (free text question) on the need for any far edge resources will help 5G-IANA understand the various application requirements regarding vehicle and OBU availability. 9.1% of the experiments would not require any vehicles, 59.1% would require 1-3 vehicles, 27.3% would need 4-10 vehicles, and 4.5% declared 1000 vehicles (which cannot be supported by the project though).

**Exploitation**: This information will be used by the project in order to better prepare for the third-party experimentation activities. However, there is a constraint on the number of available OBUs that the project can support (provided by LINKS and UULM). Since there seems to be a need though for even more vehicles by some parties, the project will consider the possibility of emulated OBUs (virtualised OBUs) as well, integrated into CARLA [20].

The next question required feedback on the anticipated time for the actual execution of an experiment using the 5G-IANA platform. Most of the experimenters (43%) would require more than a week, around 48% between 2-7 days, and the rest approximately 9% for 1 day or less.

**Exploitation**: This question has provided us with valuable feedback in order to understand a) the timely nature of anticipated experiments, b) the maximum number of third party experimenters that we would be able to support during the project's Open Calls, c) the estimated occupancy of the project's testbeds, and d) the expected time for providing technical support to the experimenters.

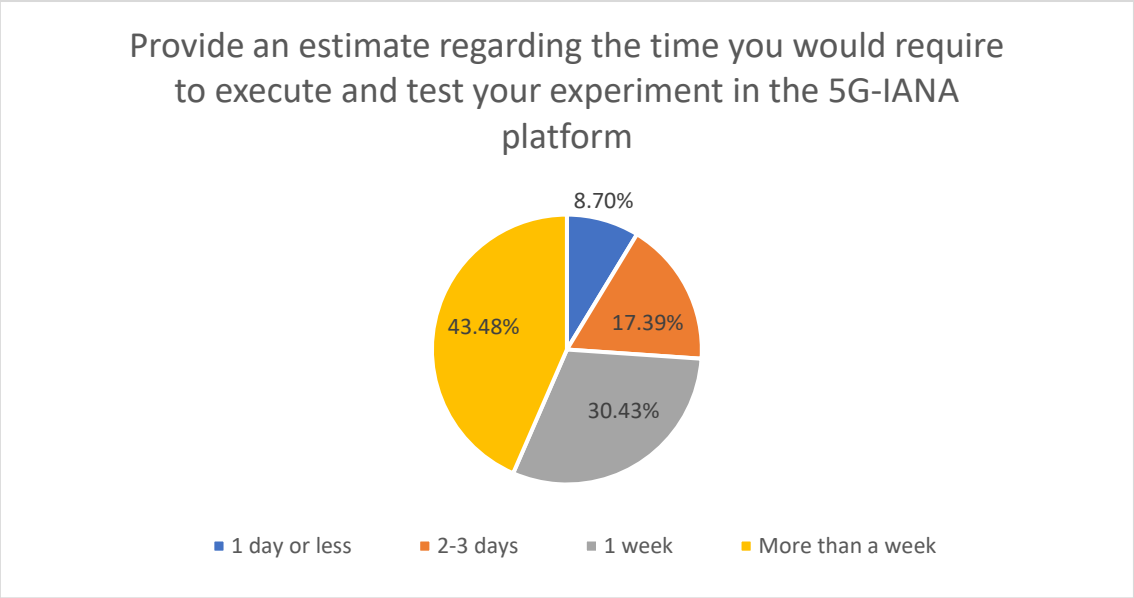


**Figure 20: Required experimentation time**

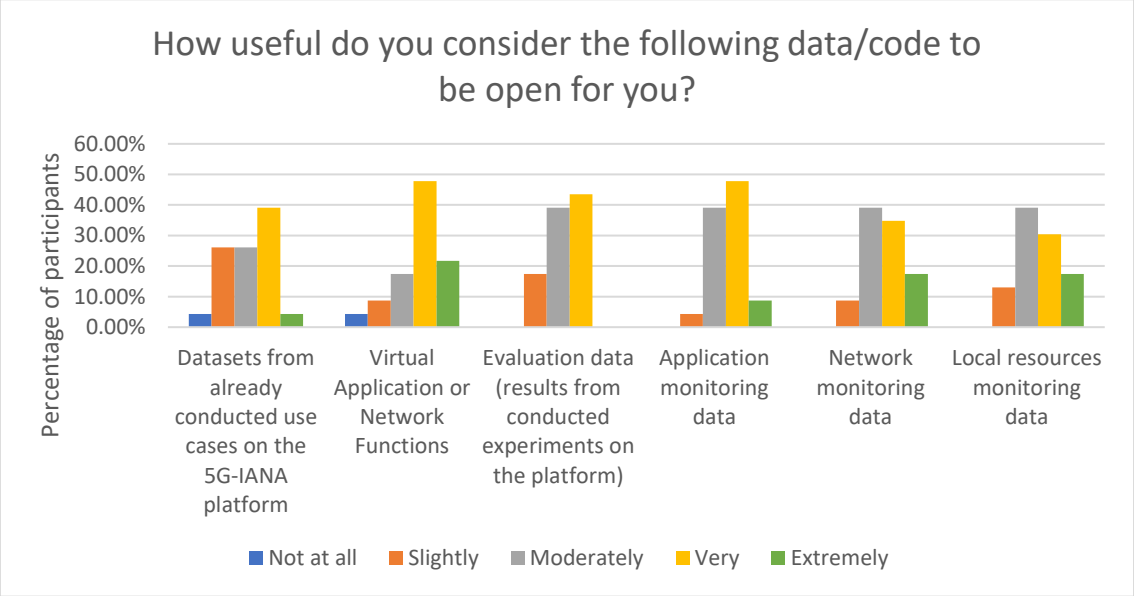


**Figure 21: Open data**

The following question required feedback about the usefulness third parties find in the data that will be openly available by the project (with respect to the Data Management Plan). It is observed that the majority of the participants are interested in open Virtual AFs and NFs, which stresses the need for providing reusable functions (and nApps, thereof), that could be further exploited through the project's use cases. Equally important are application monitoring data, something that emphasizes a) the need for collecting application-related data and b) this also extends to the need for developing a user-friendly GUI "on top of" the platform, to assist the experimenters directly observe the behavior of their applications. Existing datasets seem to have

less value for the experimenters, which can be attributed to the participants' assumption that such datasets would be too use-case specific and thus, not help them in some direction; so, we will try to mitigate this impression when defining datasets in the revised DMP (we already define one such generic dataset related to network status monitoring – UC6). Finally, evaluation data, network monitoring data and local resources monitoring data seem to be of moderate value.

**Exploitation**: 5G-IANA plans to create open datasets, offer AFs/NFs to the third parties, publish evaluation metrics' values, and also collect and keep logs of application-, network-, and local resources monitoring-data. This question has helped us verify that the project is indeed in the right direction with what concerns industrial interest for such openly available information, and will help us also when revising the DMP, and when designing the AOEP GUI (as explained above).

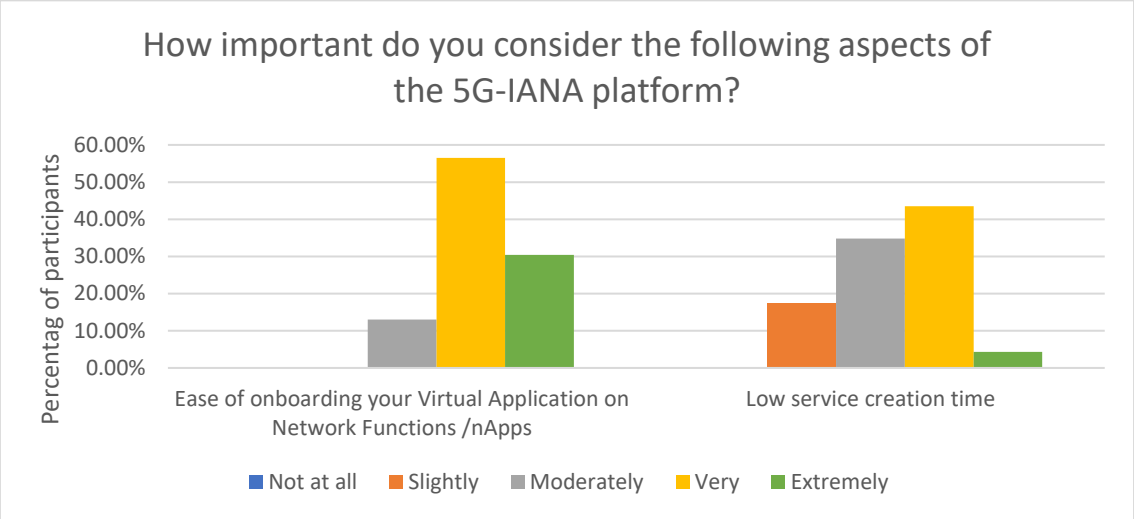


**Figure 22: Importance of different aspects (onboarding ease, service creation time)**

The following question was targeted to understand the third parties' impression regarding the importance of two very specific aspects of the AOEP:

- The ease of onboarding the virtual applications or nApps on the AOEP;
- The need for low service creation time.

It has been shown that the former is critical for third party experimenters, while the latter is also very important.

**Exploitation**: The project is already working on (and indeed verifies) that the platform should be as experimenter-friendly as possible, especially with what concerns the onboarding of AFs/NFs/nApps. Except for designing the nApp toolkit, and related components (e.g., graphical nApp composer, nApp Catalogue) in an intuitive way, the project will prepare technical manuals

and webinars in order to help the interested parties become easily acquainted with the platform. Besides, in the context of the third party engagement plan (see Section 4), the consortium will offer both training (before the actual experimentation) and support (during the actual, live onboarding and validation phase).

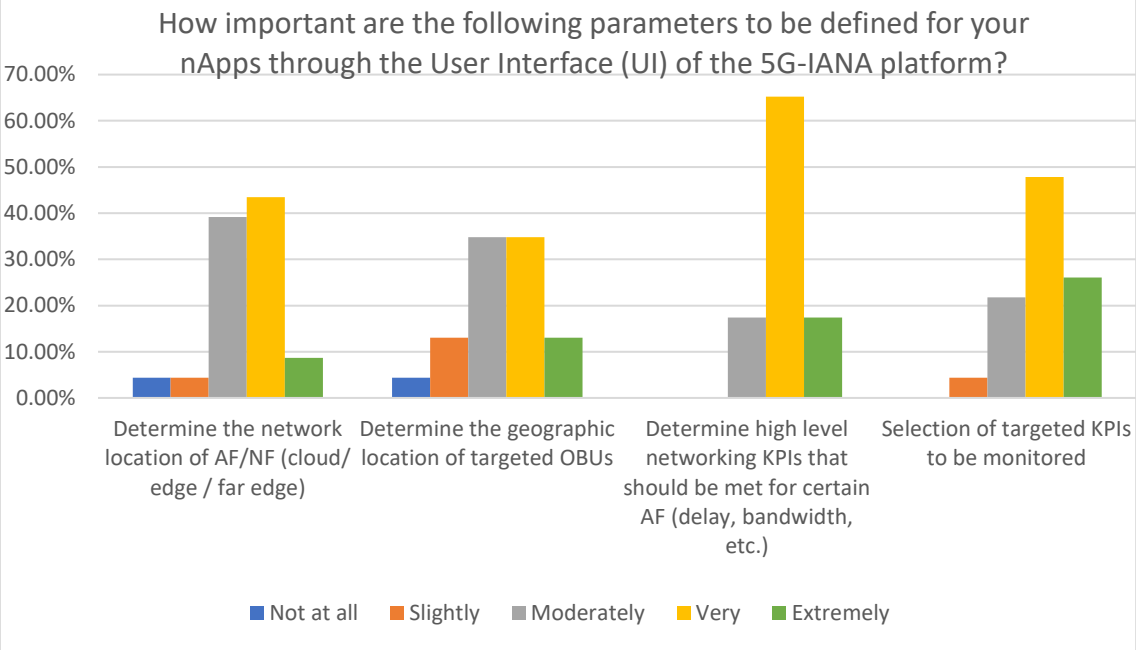


**Figure 23: Parameters that should be defined through the UI**

The following question concerned the importance of specific parameters that would be valuable to be offered through the AOEP GUI. Our goal has been to identify to which parameters the experimenters add value, and we should therefore offer them as manageable capabilities:

- Determining the network location of AF/NF. The third parties would therefore have the freedom to select on which segment they wish these functions to be onboarded (cloud / edge / far-edge).
- Determining the geographical location of targeted OBUs. This would give them the capability to select a subset of available vehicles (and OBUs, thereof) based on any application-specific criteria.
- Determining high level networking KPIs that should be met for a certain AF. This means the experimenters could be given the possibility to define the desired value for network KPIs such as RTT, data rates, etc., and the platform should manage to meet such declared expectations. This option has been considered of utmost importance among the provided options.

- Finally, determining which targeted KPIs to be monitored. This would ease the experimenters to monitor only KPIs of interest, and not be overwhelmed by too much and unnecessary information.

**Exploitation**: 5G-IANA will take these aspects into consideration while designing the AOEP GUI.

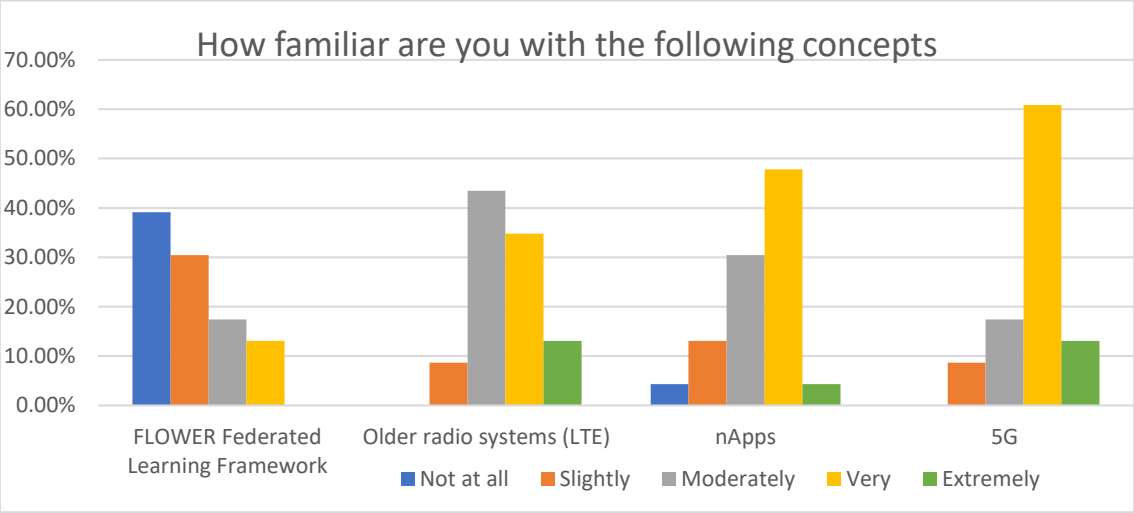


**Figure 24: Familiarity with different technical concepts**

The following question was targeted to understand the level of familiarisation of the potential third parties with concepts/technologies embraced in 5G-IANA, namely: the FLOWER framework for federated learning, LTE and 5G radio systems, and nApps in general. Based on the participants' feedback, we understand that third parties on average are not so familiar with FLOWER, while around half of them are very familiar with the nApp concept; this is an encouraging result as it implies high interest of third parties to platforms offering nApp capabilities such as 5G-IANA. Finally, the participants are very familiar with 5G (and less with LTE).

**Exploitation**: Such information provides us insights about the profile of interested third parties and about the expected time and effort of the 5G-IANA human capital for the purposes of third party experimentation (both pre-testing and validation phases – Section 4).

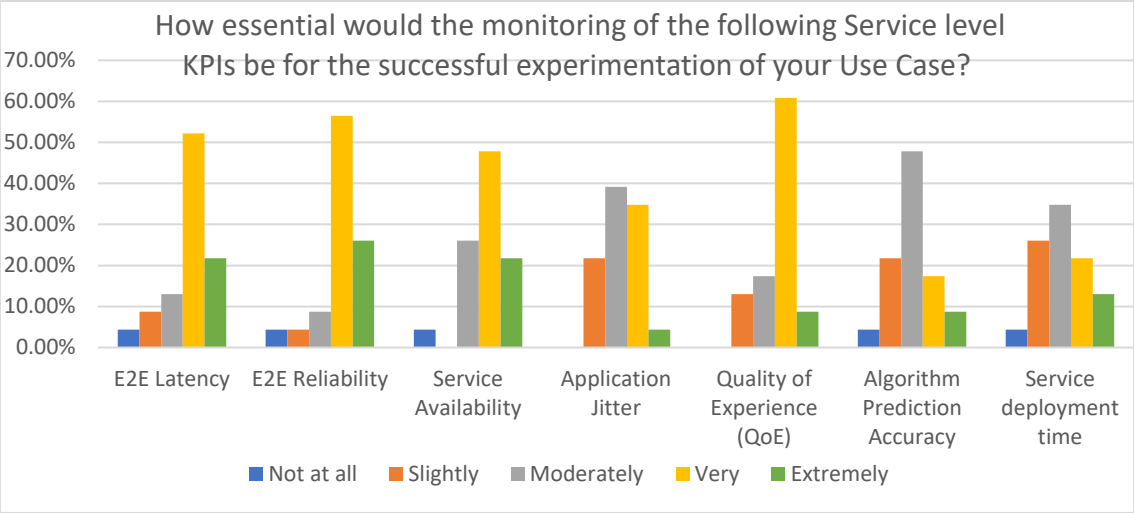


**Figure 25: Monitoring of service level KPIs**

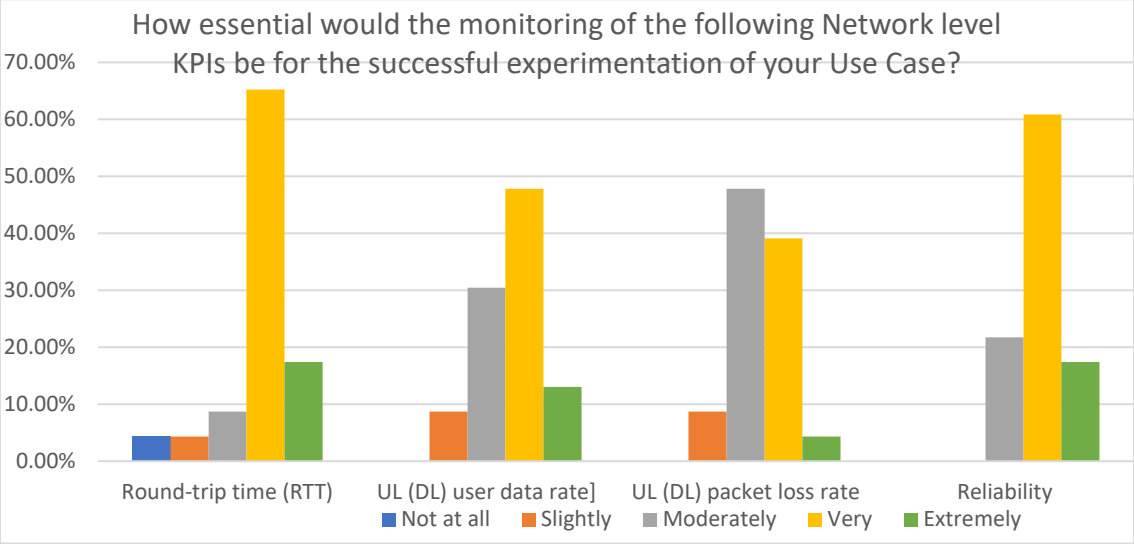


**Figure 26: Monitoring of network level KPIs**

The next two questions concerned the feedback from third parties regarding the a) service-level and b) network-level KPIs that they consider as essential to be monitored for the successful experimentation of their application. The definitions of these KPIs were also provided to ensure common understanding (see Appendix I). In order of priority, they are ranked as follows (taking into account the sum of "very" and "extremely" votes):

- E2E reliability (as also recorded in a previous question, a lot of emphasis is put on the reliability factor)
- E2E latency
- Service availability and Quality of Experience (QoE)
- Application jitter

- Service deployment time
- Algorithm prediction accuracy

Regarding network-level KPIs, the respective ranking is as follows:

- RTT
- Reliability
- UL (DL) user data rate
- UL (DL) packet loss rate

**Exploitation**: 5G-IANA will take this feedback into consideration while a) designing (revising) the validation methodology (within Task 5.1) and b) designing the GUI of the AOEP, so as to put emphasis on the most essential KPIs from an experimenter's point of view.

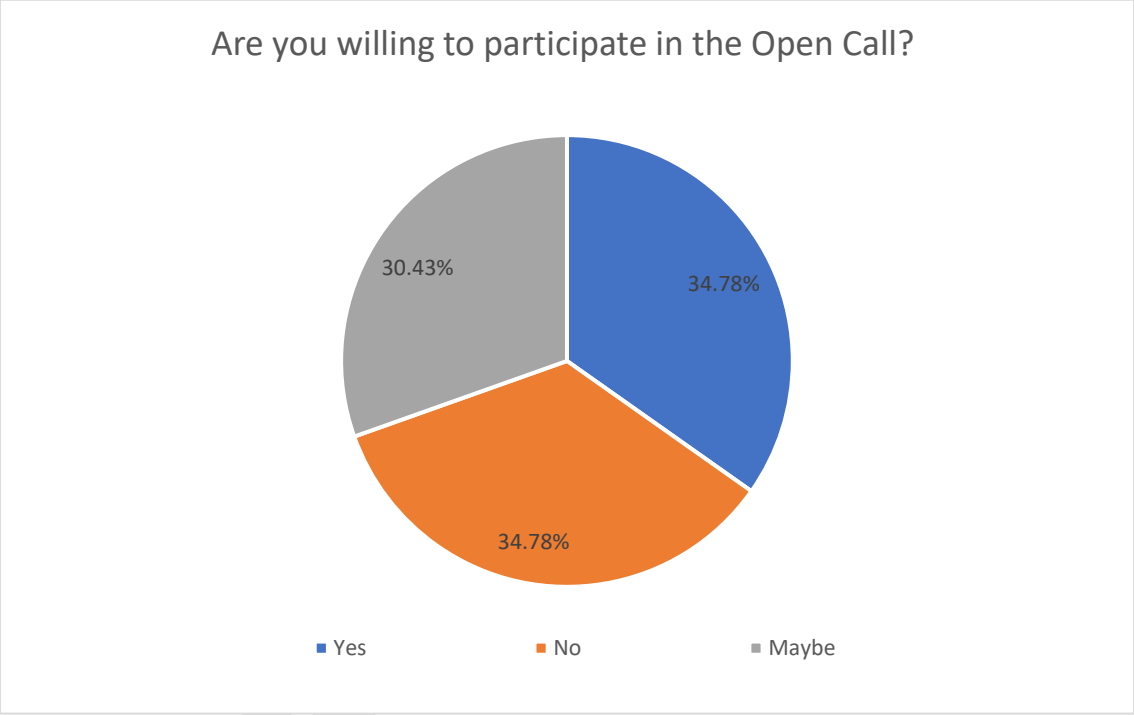


**Figure 27: Participation in the Open Call**

The next question concerned the interest of the participants of the survey in the planned project's Open Call (the concept of the Open Call was described first – see Appendix). Approximately one third of the participants has replied positively, and another one third has replied "maybe". Moreover, participants had the option to provide us with their e-mail address (as the survey was totally anonymous) in case they would like to be informed when the Open Call is announced (we have received 6 e-mail addresses through this process).

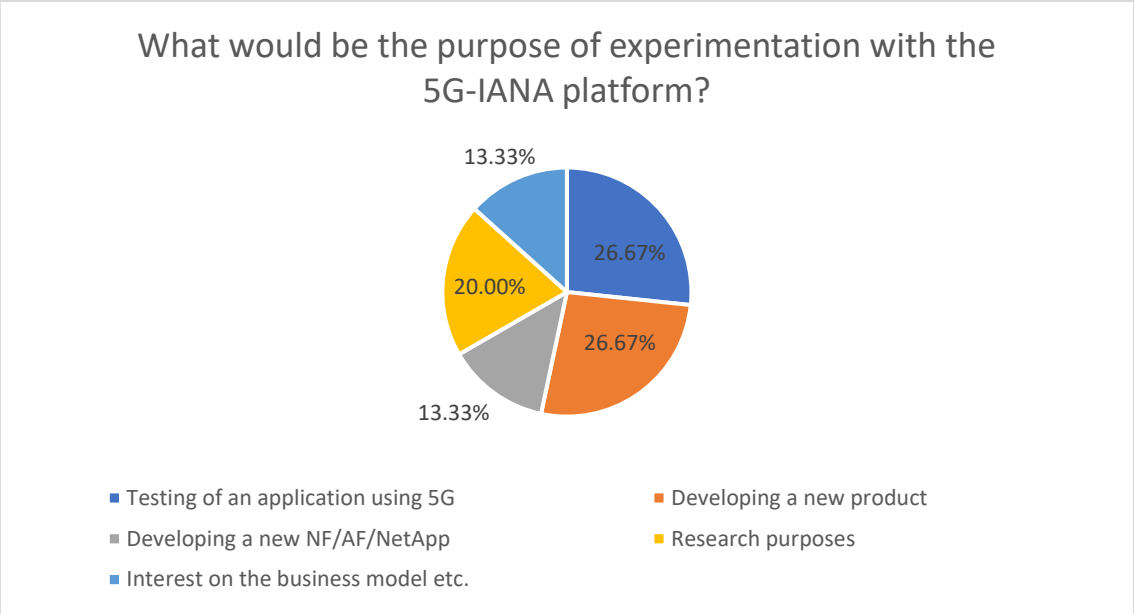


**Figure 28: Purpose of experimentation**

In case the answer to the previous question was "yes" or "maybe", the final question appeared to the participants, in order to understand the motivation behind their interest to potentially experiment with the AOEP platform. We have received diverse answers to this question (in order of priority): some of the third parties would be interested in testing an application using 5G or in developing a new product, while others would be interested in being involved just for research purposes, or they have an interest in the business model in general or they are interested in developing a new NF/AF/nApp.

For the sake of completeness, we also present below the provided free text regarding "*any other important aspect that was not covered by the survey*":

- "Interested in the info/entertainment use case on moving vehicles or nApps"
- "We would like to exchange data with vehicles, control them remotely, stream the vehicle cameras"
- "Trusted communication between edge deployed functions and connected far edge nodes (here OBUs)".

# 4. ENGAGEMENT PLAN FOR THIRD PARTIES

The engagement of third parties with the 5G-IANA platform is crucial for achieving a high impact. In order to increase the participation of third parties to the activities of the project, an engagement plan has been created that will be followed until the end of the project. The plan is comprised of different phases that align with the technical work that is being implemented in the other WPs of the project. This section presents more details about the engagement plan (A brief version of this plan is also included in D5.1, together with the overall project workplan).

Initially desk research has been performed in order to identify best practices regarding the engagement activities that have been performed by other projects. Based on the collected information and discussions among the partners of the 5G-IANA consortium the engagement plan and the associated phases that are described in this section was drafted. As a last step, the detailed timeline for the third-party engagement plan has been aligned to the overall development, integration, and verification workplan of the project.

The objective of the engagement plan is to attract third parties in order to experiment during the open calls that the project will organize. Two phases of the open call are foreseen that are aligned with the development cycles of the project. The timeline is presented in Figure 29.

The engagement plan is divided in the following phases:

- **Research and preparation**: includes the review of the engagement activities performed by other projects that have implemented open calls and the preparation of the necessary material for the upcoming phases. This phase starts on M15 and is concluded on M19; it will run again from M27 to M28 just before the second open call to provide any updates that have been identified from the first phase of the Open call.
- **Promotion**: during that phase the capabilities of the 5G-IANA platform will be communicated to third parties, while the preparation of material such as presentations, info day and webinars will be completed. The activities of this phase are planned to start on M19 and last until the end of the project but will be more intense just before the opening of the open calls (M19-M21) and M29 to M31.
- **Open call**: during that phase external parties will be requested to submit their proposals regarding the experiments that want to run in the 5G-IANA platform. This phase is also completed in two cycles:M21-M24 and M31 to M34. During the last month of the open call (for each of the cycles) the selection process will be initiated.

- **Pre-testing**: it includes closer collaboration between the selected third parties and the 5G-IANA consortium, while training activities are foreseen to take place in this phase. The duration of this phase is two months for each of the cycles (M25-M26 and M35-M36).
- **Validation and report**: the developed solutions from third parties will be validated using the same procedures that are defined for the internal UC. This phase has a duration of 4 months for each of the two cycles (M27-M30 and M37-M40). The last month of this phase is allocated to the reporting of the performed activities.

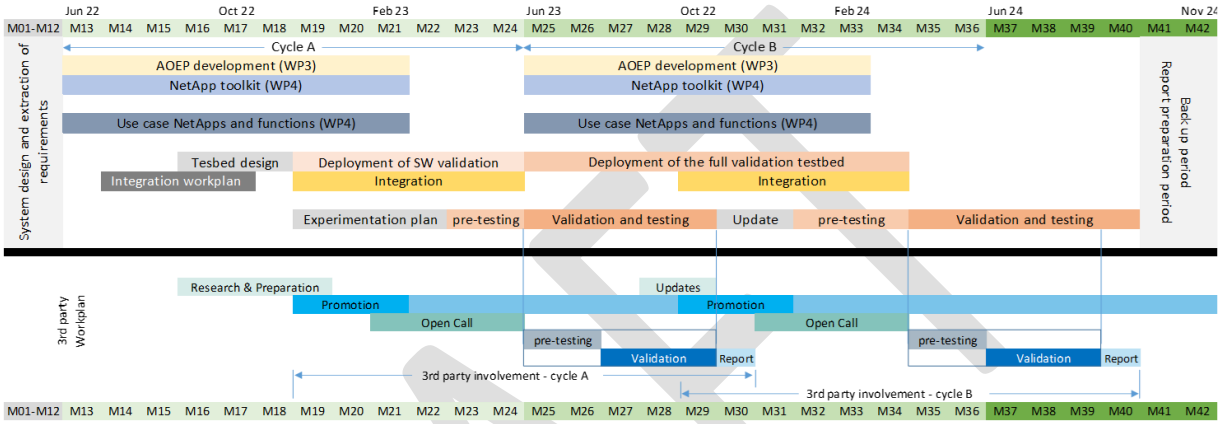


**Figure 29: Timeline of the engagement plan in alignment with the project workplan**

In the following sections more details for each of the activities that take place in each of the phases of the engagement plan are provided.

## 4.1. Research and preparation

The objective of this phase is to identify all the required material that needs to be prepared for the successful implementation of the upcoming phases of the engagement plan. An additional activity is to identify possible third parties that might be interested in participating at the open call. Towards that direction each of the partners of the 5G-IANA consortium was asked to provide their input in order to compile an initial list of SMEs. In addition, an e-mail was drafted with basic information about the project and the open call that will be circulated during the promotion phase to the network of each partner, to the different lists of 5GPPP and 6G-IA, the other projects of ICT-41 call, the 5GAA and ERTICO, among others.

The activities that must be completed before the open call include the definition of both the technical and managerial procedures that must be followed (in collaboration with the other WPs), to decide on the eligibility criteria and the evaluation procedure.

The identified list of material that must be prepared and used in the upcoming phases includes the following information:

- List of all AFs/NFs/nApps (nApps starter kits) that will be available and the associated licences
- A simplified description of the AOEP
- The rules and procedures for third-party experimentation
- Technical manual (user guide)
- Information about the technical support
- Template in which third parties can declare their interest
- Exemplary use cases
- Creation of webinars and videos that will be used in the upcoming phases
- Preparation of Info Day material (to announce the Open Call)
- Legal documents that are required for accessing the platform

Part of this material will be organised also in a downloadable "Guide for applicants" document (more details below).

## 4.2. Promotion

The promotion phase of the engagement plan will start on M19. WP7 will be actively involved the "third-party workplan" by leading and executing promotional activities. The project's Communication management has defined an approach and communication strategy specifically for this activity.

The first action on this strategy is the creation of a particular section on the project's website aiming to attract third parties. This section is being created at the time of writing this document and its launch is planned for January 2023 just before the announcement of the first Open call. The website will be the main tool for advertising as well as for soliciting the interest regarding the two Open Calls to third parties that the project will arrange. This section will provide visitors with key information about the project, the platform, the instructions to get involved as well as any technical and legal details required for their involvement.

This communication strategy defines as well concrete communication and promotional activities oriented to the promotion of the Open Calls. These activities will be implemented in three phases:

- **Phase 1: announcement of the Open Call and preliminary communication | Cycle A (M19-M21), Cycle B (M29-M31)**

  The main objective of this phase is to approach the SMEs ecosystem targeted through the project's communication channels (press releases, website, social media, newsletters, promotional materials) and the partners' own communication channels and networks

(internal & external contacts, website, social media, mailing lists and different working groups).

The main activity of the Phase 1 will be the announcement of the Open Call process in February 2023. Additionally, an intense promotional e-mail campaign has been also foreseen prior to the announcement of the Open Call - to target groups (T1.4), SMEs identified by the consortium, other projects, partner's networks, etc.-.

- **Phase 2 : main Open Call communication | Cycle A (M21-M24), Cycle B (M31-M34)**

  The core activity of this second phase will be the intense promotion of the Open Call process for attracting SME applicants. This will be done through active website and social media campaigns from a project level, extensive use of internal and external communication channels and networks of all partners, and liaison activities with ICT-41 projects and other associations (5G-PPP/5G-IA and WGs, 5G-PPP Comms, etc.).

  The project also foresees the organisation of at least one "Info Day" about the Open Call and the release of promotional materials specifically created for the Open Call.

- **Phase 3: follow-up communication | Cycle A (M25-M30), Cycle B (M35-M40)**

  The scope of this phase will be to follow up Open Call communication for making known in public the Open Call results and achievements (winners, results and activities/events). Activities during this phase will be executed through active website and social media campaigns from a project level, as well as press releases and Open Call events. Again, the partner's communication channels will be used for promotion as well when relevant.

  During cycle B of this phase, it is also planned to run the hackathon (M35-M36) to widely disseminate the 5G-IANA solutions to entities willing to enter the Automotive-related 5G-enabled services.

A document describing the approach and the Open Call communication strategy will be released to the consortium internally with the aim of aligning the efforts and activities defined under the different phases. Sample texts for mailing, posts and news announcements and campaigns will be also included. The information on this document will be regularly monitored and updated by the project's Communication leader in order to provide the latest information and guidelines for the prompt and efficient communication of 5G-IANA's Open Calls.

A very detailed plan of the Open Calls promotion activities and communication phases (scope, channels, activities) will be provided in D7.3 - Communication strategy and plan V2 (M21).

## 4.3. Open call

The 5G-IANA Open Calls will take place in two phases (cycles): Cycle A (M21-M24) and Cycle B (M31-M34). The announcements of these Open Calls coincide with the finalisation of the integration processes in the two development cycles, and thus, they follow the release of the two versions of the 5G-IANA platform.

***Audience:*** The Open Calls will be targeted to SMEs, outside of the consortium of the project; moreover, it will be ensured that they are not addressed to any SMEs with conflicts of interest with the consortium members. The SMEs where 5G-IANA will reach out will come from the following channels, among others: 5G-PPP channels (especially SME WG and 5G for CAM WG), 5GAA, ERTICO, Incubators, as well as the broader network of the partners and of the External Advisory Board.

***Stages:*** Each Open Call consists of two stages: a) the application stage, and b) the evaluation (selection) stage.

During the **application stage**, the Open Call will be intensely promoted as presented in the previous section. The goal will be twofold: not only to massively reach out to special groups of potential interest (e.g., 5GAA, Info Day, etc.), but also to reach out in a more personalised way to specific SMEs that the partners have identified. The consortium has already (M18) collected a list of 27 SMEs[2] that may have a potential interest in experimenting with the 5G-IANA platform, and has made a first contact with them through the survey included in this deliverable. Also, two SMEs have reached out on their own, following the promotional e-mail of this survey, which also included a "Save the Date" and scope for the upcoming Open Call. More targeted and personal communication has been also initiated with a few of these SMEs (and will be extended during the promotional phase, M19-M24), so that through such interactions, the 5G-IANA partners will be in the position to clearly understand the needs of such SMEs and incentivise them to be actively engaged. Their needs will be discussed in terms of the applicability of current or potential future services/AFs/NFs/nApps that they would find value in onboarding on the AOEP platform or in testing using 5G, and to hopefully engage them to apply to the Open Call

During the **evaluation stage**, the goal is to process all the received applications and evaluate them. The total number of SMEs to be invited will be a function of a) testbed availability constraints, b) time window availability for pre-testing and validation phases, and c) time for experimentation declared by each SME. A clear set of eligibility criteria will be transparently available when publishing the Open Call, based on which, all applications will be graded and

[2] Specifically, we are collecting the following information: SME name, Website, Area of expertise, Contact information, How could they benefit from 5G-IANA, How did you find this SME?, Are they involved in research projects? If yes, explain: ICT/etc.?, Response/status, Conflict of Interest (Y/N)

prioritised. We will create an Evaluation Committee as well, composed of key 5G-IANA members as well as members of our External Advisory Board. As an example, prioritization will be given to SMEs that do not have a research/academia profile (i.e., pure industrial SMEs) - subject however to the amount of interest that we will receive -, to SMEs that use the innovative AOEP and 5G capabilities "the best" (to be defined), and to SMEs that bring the highest value by the proposed service or product for the final user – these criteria still need to be defined though in more detail. Following this stage, the administrative/legal arrangements for experimenting on the testbeds will start.

***Produced material:*** To support the Open Calls, 5G-IANA is in the process of preparing the following material. This will be used for the purposes of a) publishing the Open Calls, b) preparing the logistics behind the Open Calls, c) helping the applicants/potential experimenters understand the capabilities of the 5G-IANA platform, supporting them if selected, and facilitating them in raising any questions:

Publishing:

- A Guide for Applicants document will be prepared, presenting the administrative procedure with regard to the Open Calls, i.e., a document that contains all useful information for the submission of a proposal from third parties. A tentative ToC is the following:
    - Project overview, platform capabilities, testbed facilities
    - Scope and terms of the Open Call
    - Intended audience / What is expected from third parties
    - Timeline for open calls
    - Eligibility criteria
    - Evaluation process, assessment criteria & selection committee
    - Mentors
    - Award criteria & Selection committee
    - How to apply: Application template (online interest form) & respective instructions
    - Agreement template (legal requirements)
- The recording of the webinar (Promotion of the 5G-IANA AOEP Release 1, explaining the offered capabilities/facilities and reusable functionalities (e.g., NFs/AFs), description of repositories (nApp toolkit), type and accessibility of exposed information, open features, KPIs/monitoring options, degrees of freedom given to the experimenters, business-related benefits from using the platform) and the recording of the Info Day announcing the Open Call.

Logistics:

- Rules and procedures for third parties' experimentation (to help ensure that any required conditions are met for the admission of third parties to the project testbeds). Also, this includes the administrative procedure for the distribution of funding to the third parties, i.e., the at least 3 awards of approx. 10-15K each to be given to selected SMEs (type of contract).
- Legal documents/contracts that will need to be signed between the third party experimenter and ICCS/other partner for accessing the testbeds.

Supporting:

- Technical manual (user guide). This manual will be used in conjunction with the Guide for Applicants document but includes more technical details. This manual will be a useful tool to help the experimenters better understand how UCs and nApps can be implemented, onboarded and run on the AOEP platform (as a guide/example to develop their own UCs), what monitoring KPIs are offered, etc. Some examples of the information to include are: how third parties can access the platform, technical requirements if any for their applications, options/capabilities that the AOEP provides, manual for onboarding AFs/NFs, creating nApps and distributed Vertical Services, type of open interfaces offered, manual regarding the available nApp repository, KPI monitoring options, reference to technical support. Moreover, it will include examples of use cases, and specifically: a) description of the 5G-IANA UCs as baseline examples of possible services to be realized), b) examples of customizations applicable to the 5G-IANA UCs, and c) examples of additional UCs/services that can be realized using the 5G-IANA nApps /AFs/NFs.
- Regarding the AFs/NFs provided by the project, an already available manual with their description will be provided (Description, Input required, Output provided, Examples of communicating AFs/NFs), so that third parties can understand how they could combine their proprietary functions with 5G-IANA's AFs/NFs, in order to form new nApps.
- Technical support: this will include a simple ticketing system using Trello, so that when users send an e-mail to helpdesk@5g-iana.eu, this will be automatically onboarded on the Trello ticketing workspace, where it will be monitored and resolved. We consider also creating a forum on the website so that any responded questions are visible to anyone else.
- Business model guidance: workshops will be organised to assist third parties to develop their business plan and thus speed up the process of getting their results closer to the market.

## 4.4. Pre-testing

The pre-testing phase marks the initiation of the overall third party experimentation phase in each of the two cycles. The main goal in this phase is to define in detail the targets of the selected third party contributions and go through a series of functional tests in order to verify the interoperability of the solution to the platform and other linked nApp components. In turn, this will provide to the involved third party an understanding of the 5G-IANA platform environment, and to the associated 5G-IANA partner(s) an understanding of the targeted nApp capabilities. This phase is considered as a preparation phase for the validation and testing phase that follows. Any potential misalignments or updates are intended to be identified and corrected in this phase or identify functional alternatives.

The duration of the pre-testing phase is two months and includes the following activities:

- The extraction of a detailed validation plan for the third party involvement with clear deployment and testing targets, as well as identification of the required 5G-IANA infrastructure requirements.
- The familiarisation of the third party with the 5G-IANA platform capabilities and additional nApp components that may be linked or reused.
- The examination of the nApp component(s) to fulfil the deployment requirements (e.g., in terms of exposed and required parameters, compatibility with Kubernetes structure, exposed interfaces and interconnection with targeted end user hardware, etc.).
- The functional pre-testing of the proposed nApp, (or nApp component extending an existing nApp) including at least,
    - the correct editing of the required parameters through the front-end interface,
    - the registration of the offered nApp component(s) to the catalogue,
    - the deployment of the targeted nApp within the SW testing environment, showing the proper creation of slice intent and the slice response,
    - the evaluation of the proper communication between linked nApp components required for the overall validation and testing.
- Identification of any potential changes or updates that may be required.

## 4.5. Validation and reporting

For the validation of the services that will be run and validated in the 5G-IANA platform the same methodologies as for the internal UCs will be used. WP5 (5G-enabled Automotive nApps validation and demonstration) is defining the methodologies that will be used to evaluate the capabilities of the 5G-IANA architecture in order to support and develop new, advanced

automotive-related services as defined and to be deployed in the UCs. Later on in the project, WP5 will evaluate and demonstrate the proposed UCs in terms of technical improvement, quality of life impact, and user acceptance. This evaluation will logically include testing of the underlying 5G-IANA platform, its network applications and application and network functions.

Beyond this 5G-IANA-focused work of defining the specifications of the experimentation platforms/testbeds to be used for the evaluation, considerations are underway to make this specification more universally available to third party experimenters.

At the time of writing the present deliverable, task 5.1 (Validation methodology and plan) has already defined research questions and the metrics/KPIs that will be used for the validation of the components/mechanisms developed and used in the 5G-IANA platform including definition of suitable acceptance criteria per component/mechanism. The result of this work is available in deliverable D5.1 (Initial validation KPIs and metrics) submitted in M16.

Work is now ongoing on the definition of the exact validation methodology to be used which will be reported in deliverable D5.2 (Validation methodology) in M22.

In terms of engagement of third parties through WP5 activities, the definition of open interfaces to monitor and operate UCs enabling automated testing and the preparation and deployment of a testing framework to automate and homogenize the UC validation will lead to a 5G-IANA testing toolkit. This testing toolkit will offer a perfect sandbox environment as an essential asset to attract third party experimenters allowing them to use, extend, and test 5G-IANA components thus permitting the development of new 5G-based services in an efficient manner ensuring an accelerated time-to-market for new products.

The validation phase ends with the creation of the reports describing the activities that have been performed during the validation phase. A questionnaire will be created in order to collect feedback from the experimenters in order to make adjustments for the second cycle of the open call. The validation phase concludes with the announcement of the winners of the awards, at least three awards of up to €15,000 will be given to the best the top experiments. More details about the process and criteria that will be used for the awards will be announced during the first cycle of the open calls.

# 5. CONCLUSION

This deliverable presented the main roles of the ecosystem that is created around the 5G-IANA platform. The reference diagram provided details about the interactions among the actors. The initial business model of the 5G-IANA platform was presented with a detailed explanation of all building blocks of the created business canvas.

The results of the online survey that has as an objective to capture the expectations of third parties from the 5G-IANA platform were presented and commented. One of the most important aspects is that the majority of the participants are interested in open Virtual AFs and NFs, which stresses the need for providing reusable functions.

Specific steps regarding the engagement plan for third parties for the next phases of the project have been presented, with details on the activities that will take place around the open call for experimenters.

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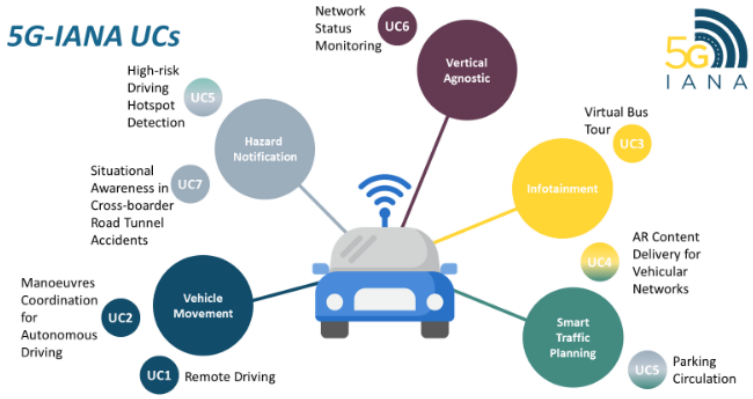
# APPENDIX I – QUESTIONNAIRE

## 5G-IANA survey regarding third party expectations

Welcome to the 5G-IANA survey with the objective to collect the expectations from potential third party experimenters regarding the 5G-IANA Automotive Open Experimental Platform (AOEP).

5G-IANA is a H2020 ICT-41 Innovation Action project that aims at providing a 5G AOEP in which third party experimenters in the Automotive-related 5G-PPP vertical will have the opportunity to develop, deploy and test their services. An example of such services is illustrated in the next figure




AOEP will include a set of hardware and software resources that provide the compute and communication/transport infrastructure as well as the management and orchestration components, coupled with Network Applications (NetApp) Toolkit tailored to the Automotive industry.

The survey is expected to last 15 minutes.

You can learn more about the project on the website and follow us on the social media:

- Twitter: @IANA_5G
- LinkedIn: 5G_IANA

5G-IANA project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101016427.

This survey is anonymous.

The record of your survey responses does not contain any identifying information about you, unless a specific survey question explicitly asked for it.

If you used an identifying access code to access this survey, please rest assured that this code will not be stored together with your responses. It is managed in a separate database and will only be updated to indicate whether you did (or did not) complete this survey. There is no way of matching identification access codes with survey responses.

Next

**Figure 30: First page of the survey**

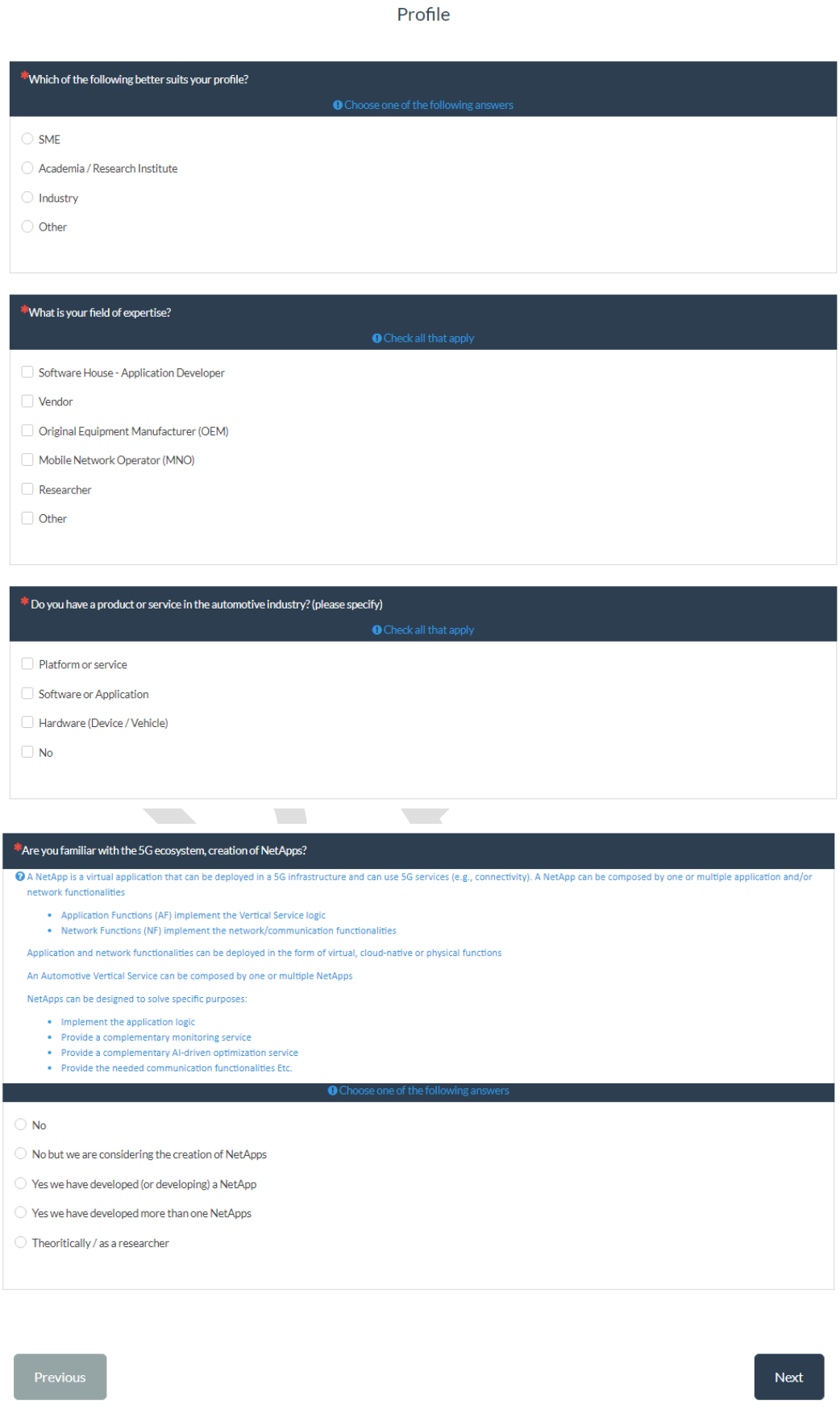



**Figure 31: Profile section**

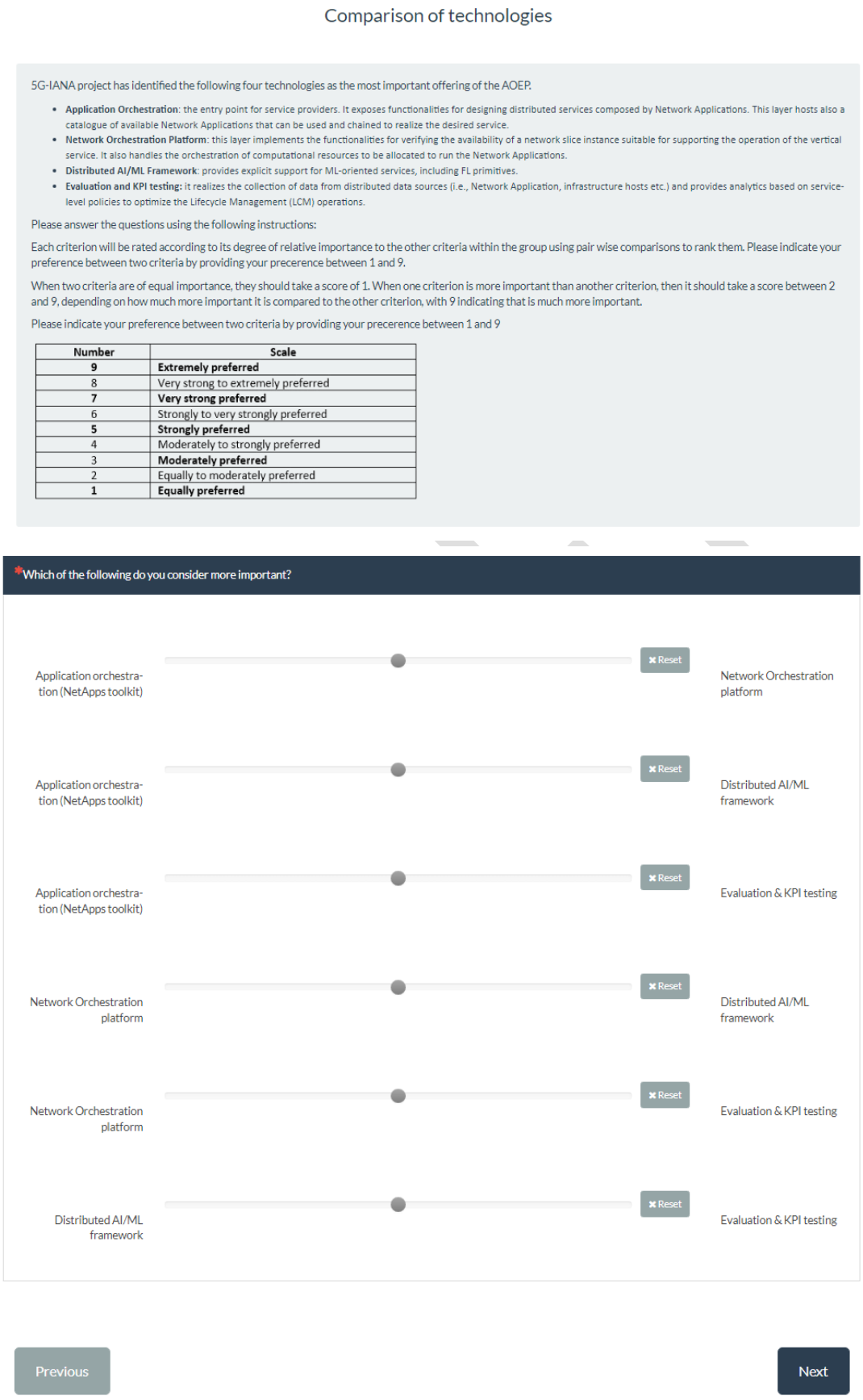



**Figure 32: Comparison of technologies section**

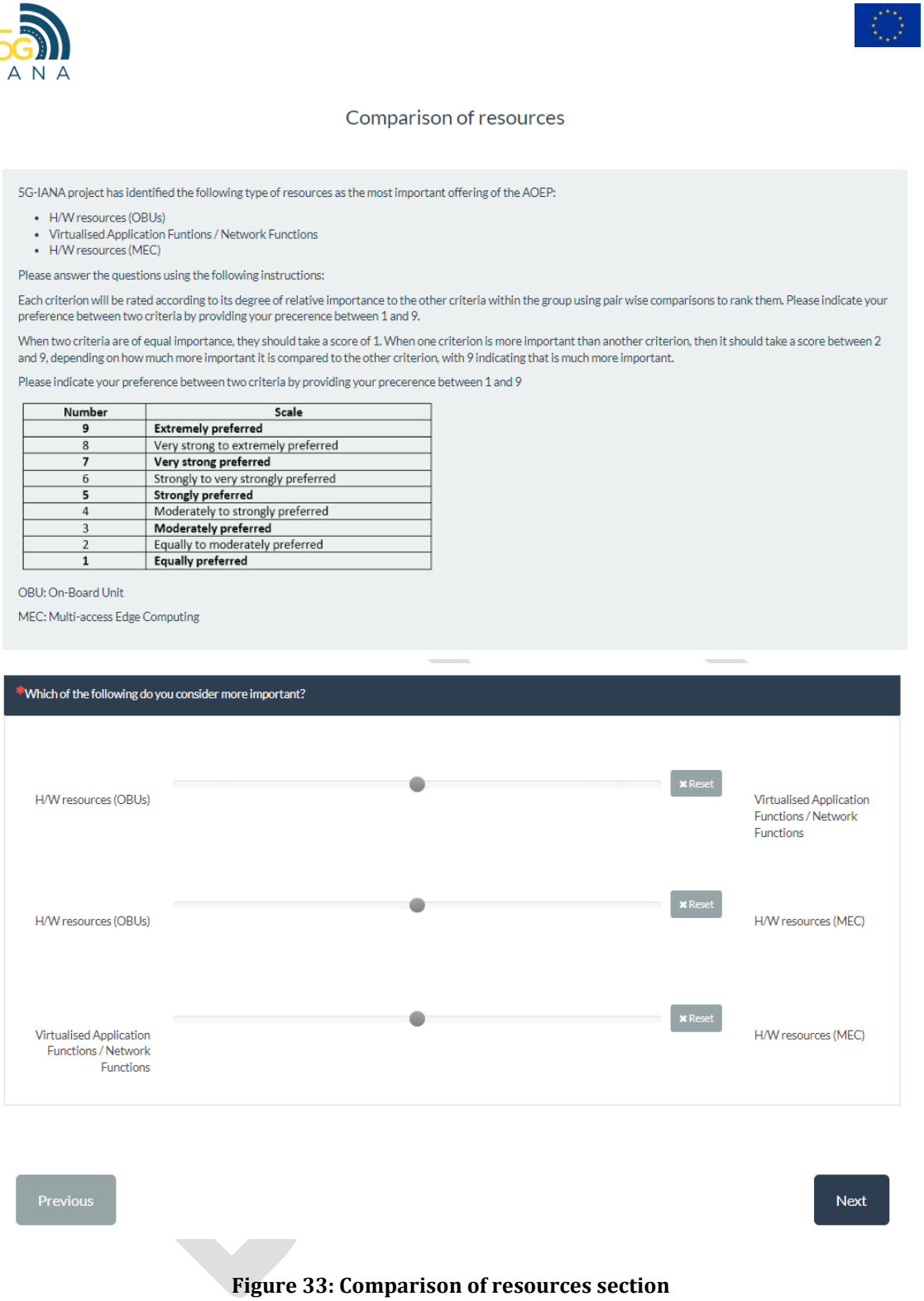



**Figure 33: Comparison of resources section**

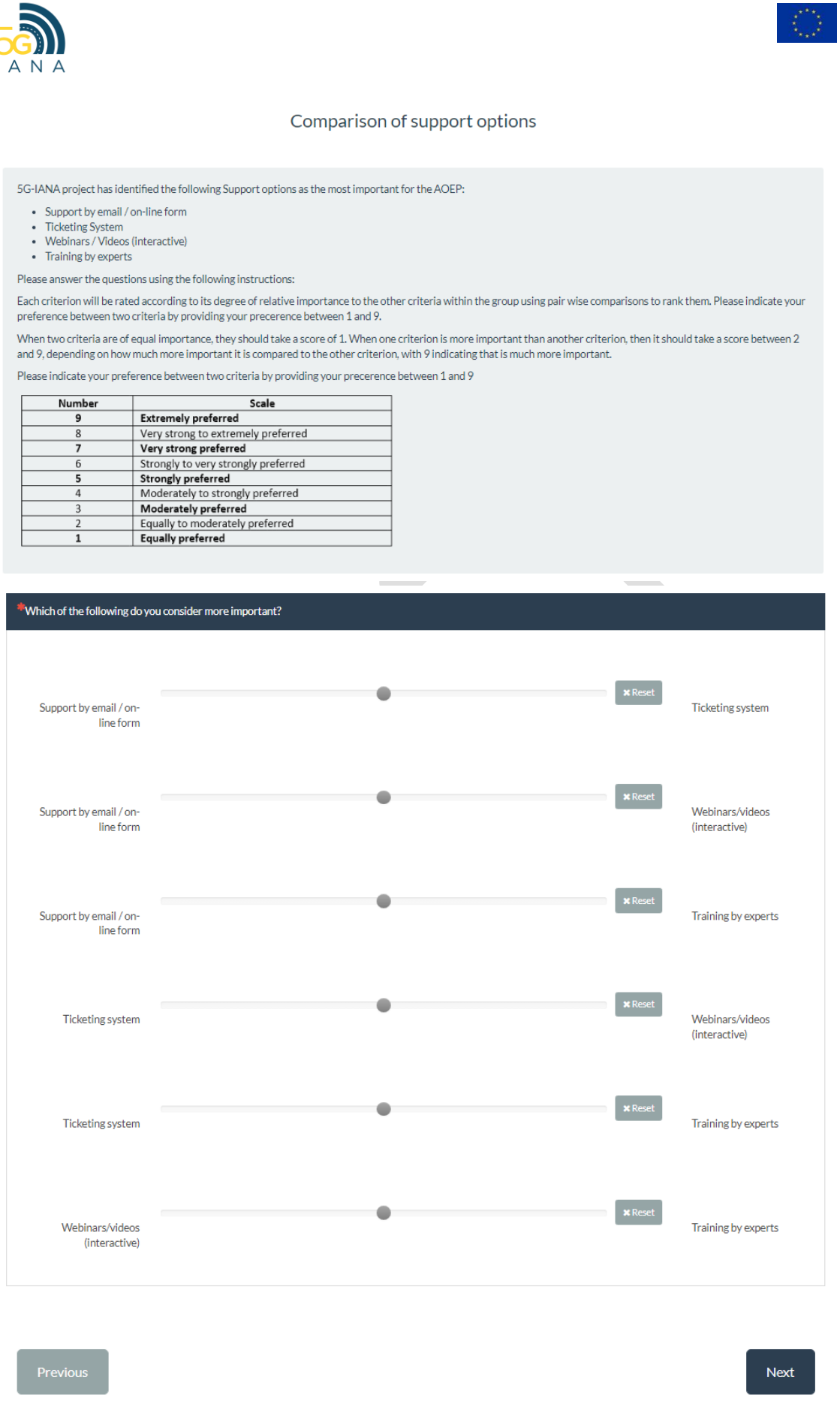



**Figure 34: Comparison of support section**

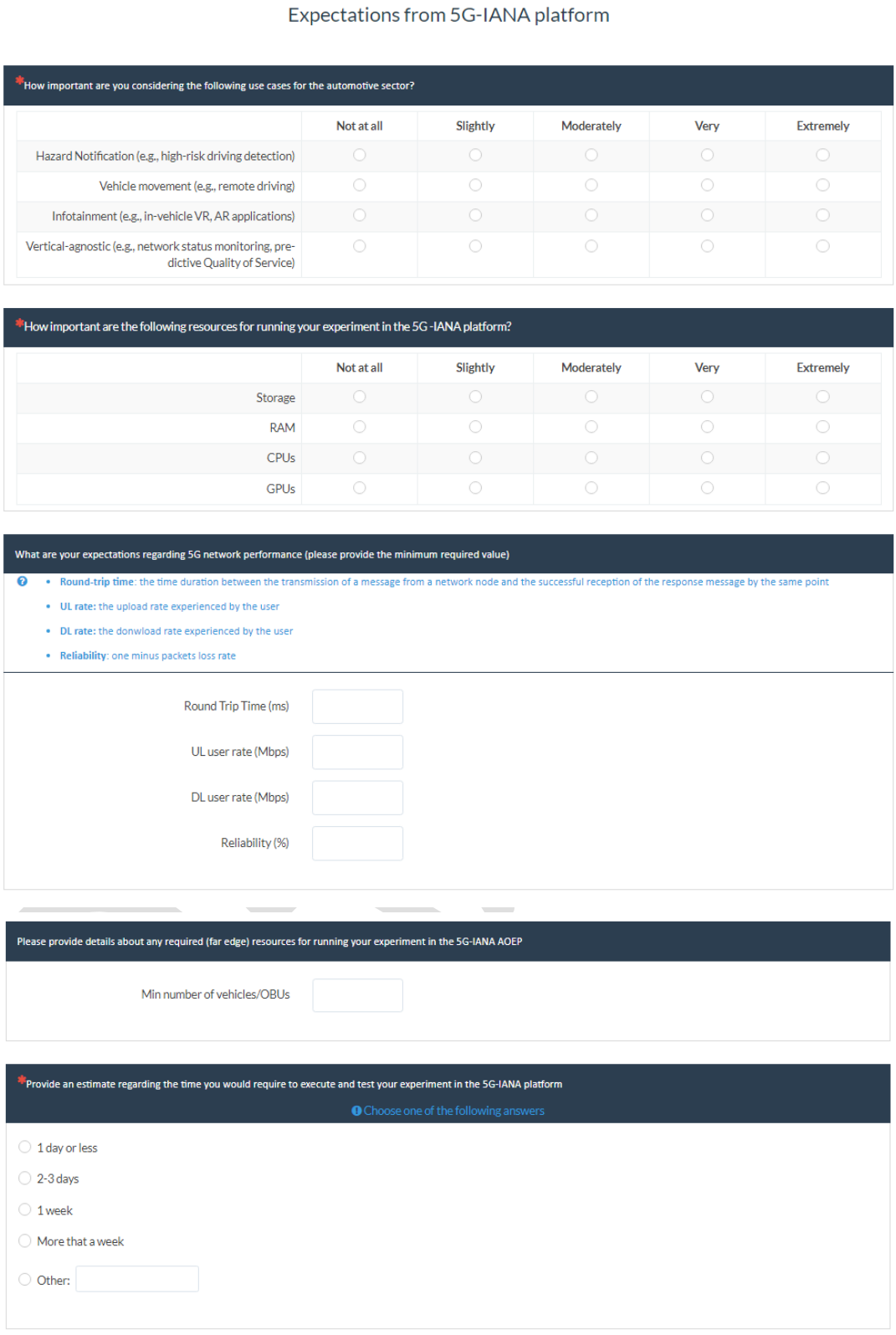



**Figure 35: Expectations section (part 1)**

*How useful do you consider the following data/code to be **open** for you?

| | Not at all | Slightly | Moderately | Very | Extremely |
|---|---|---|---|---|---|
| Datasets from already conducted use cases on the 5G-IANA platform | ○ | ○ | ○ | ○ | ○ |
| Virtual Application or Network Functions | ○ | ○ | ○ | ○ | ○ |
| Evaluation data (results from conducted experiments on the platform) | ○ | ○ | ○ | ○ | ○ |
| Application monitoring data | ○ | ○ | ○ | ○ | ○ |
| Network monitoring data | ○ | ○ | ○ | ○ | ○ |
| Local resources monitoring data | ○ | ○ | ○ | ○ | ○ |

*How important do you consider the following aspects of the 5G-IANA platform?

| | Not at all | Slightly | Moderately | Very | Extremely |
|---|---|---|---|---|---|
| Ease of onboarding your Virtual Appllication on Netwotk Functions /NetApps | ○ | ○ | ○ | ○ | ○ |
| Low service creation time | ○ | ○ | ○ | ○ | ○ |

*How important are the following parameters to be defined for your NetApps through the User Interface (UI) of the 5G-IANA platform?

| | Not at all | Slightly | Moderately | Very | Extremely |
|---|---|---|---|---|---|
| Determine the network location of AF/NF (cloud/ edge / far edge) | ○ | ○ | ○ | ○ | ○ |
| Determine the geographic location of targeted OBUs | ○ | ○ | ○ | ○ | ○ |
| Determine high level networking KPIs that should be met for certain AF (delay, bandwidth, etc.) | ○ | ○ | ○ | ○ | ○ |
| Selection of targeted KPIs to be monitored | ○ | ○ | ○ | ○ | ○ |

*How familiar are you with the following concepts:

| | Not at all | Slightly | Moderately | Very | Extremely |
|---|---|---|---|---|---|
| FLOWER Federated Learning Framework | ○ | ○ | ○ | ○ | ○ |
| Older radio systems (LTE) | ○ | ○ | ○ | ○ | ○ |
| NetApps | ○ | ○ | ○ | ○ | ○ |
| 5G | ○ | ○ | ○ | ○ | ○ |

*How essential would the monitoring of the following Service level KPIs be for the successful experimentation of your Use Case?

- **E2E Latency** is the maximum accepted latency across the entire service chain (of a UC).
- **E2E Reliability** is defined as the percentage of correctly received packets over the total packets transmitted in the complete service chain.
- **Service Availability** is the percentage of time that an application is accessible and usable within a predefined QoS level e.g., the fraction of time a software component is functional (up) or the fraction of requests that are serviced correctly.
- **Application Jitter** is the statistical variation of the end-to-end latency for the communications across the entire service chain of the vertical service.
- **Quality of Experience (QoE)** is defined as the overall acceptability of an application or service, as perceived subjectively by the end-user.
- **Prediction Accuracy** in classification tasks is a measure of how well an algorithm correctly identifies or excludes a condition i.e., the proportion of correct predictions among the total number of cases examined.
- **Service Deployment titime:** the duration required for setting up E2E logical services characterized by respective network level guarantees (such as bandwidth, end-to-end latency, re-liability, etc.).

| | Not at all | Slightly | Moderately | Very | Extremely |
|---|---|---|---|---|---|
| E2E Latency | ○ | ○ | ○ | ○ | ○ |
| E2E Reliability | ○ | ○ | ○ | ○ | ○ |
| Service Availability | ○ | ○ | ○ | ○ | ○ |
| Application Jitter | ○ | ○ | ○ | ○ | ○ |
| Quality of Experience (QoE) | ○ | ○ | ○ | ○ | ○ |
| Algorithm Prediction Accuracy | ○ | ○ | ○ | ○ | ○ |
| Service deployment time | ○ | ○ | ○ | ○ | ○ |

**Figure 36: Expectations section (part 2)**

*How essential would the monitoring of the following Network level KPIs be for the successful experimentation of your Use Case?

**Round-trip time**: the time duration between the transmission of a message from a network node and the successful reception of the response message by the same point

- **UL rate:** the upload rate experienced by the user
- **DL rate:** the download rate experienced by the user
- **Reliability**: one minus packets loss rate

| | Not at all | Slightly | Moderately | Very | Extremely |
|---|---|---|---|---|---|
| Round-trip time (RTT) | ○ | ○ | ○ | ○ | ○ |
| UL (DL) user data rate | ○ | ○ | ○ | ○ | ○ |
| UL (DL) packet loss rate | ○ | ○ | ○ | ○ | ○ |
| Reliability | ○ | ○ | ○ | ○ | ○ |

*As part of the 5G-IANA project, an Open Call will be opened for SMEs, which will aim to invite third parties with their network applications so as to run them on top of the platform provided by the project, making use of 5G connectivity. The Open Call will take place in 2 phases, with the first starting in early 2023, and the second towards the end of 2023, and will award 3 prizes of 15K each to 3 selected SMEs.

Are you willing to participate in the Open Call?

Choose one of the following answers

- ○ Yes
- ○ No
- ○ Maybe

If you would like to be informed with more information regarding the 5G-IANA open call please provide your email adress

*What would be the purpose of experimentation with the 5G-IANA platform?

Choose one of the following answers

- ○ Testing of an application using 5G
- ○ Developing a new product
- ○ Developing a new NF/AF/NetApp
- ○ Research purposes
- ○ Interest on the business model etc.
- ○ Other:

If you would like to be informed with more information regarding the 5G-IANA open call please provide your email adress

Do you consider any other aspect as important that was not covered by the survey? If yes please elaborate:

Provide more details about any potential experiment that you would like to run in the 5G-IANA platform or describe your network applications

**Figure 37: Expectations section (part 3)**

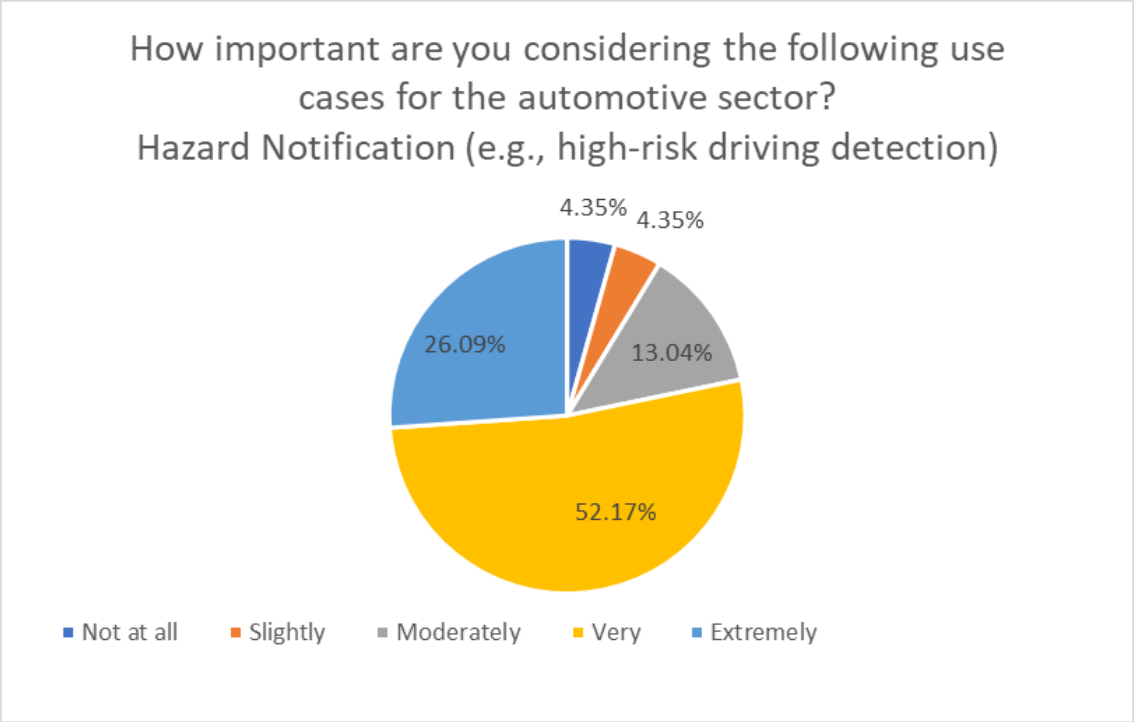



**Figure 38: Importance of Hazard Notification UC**

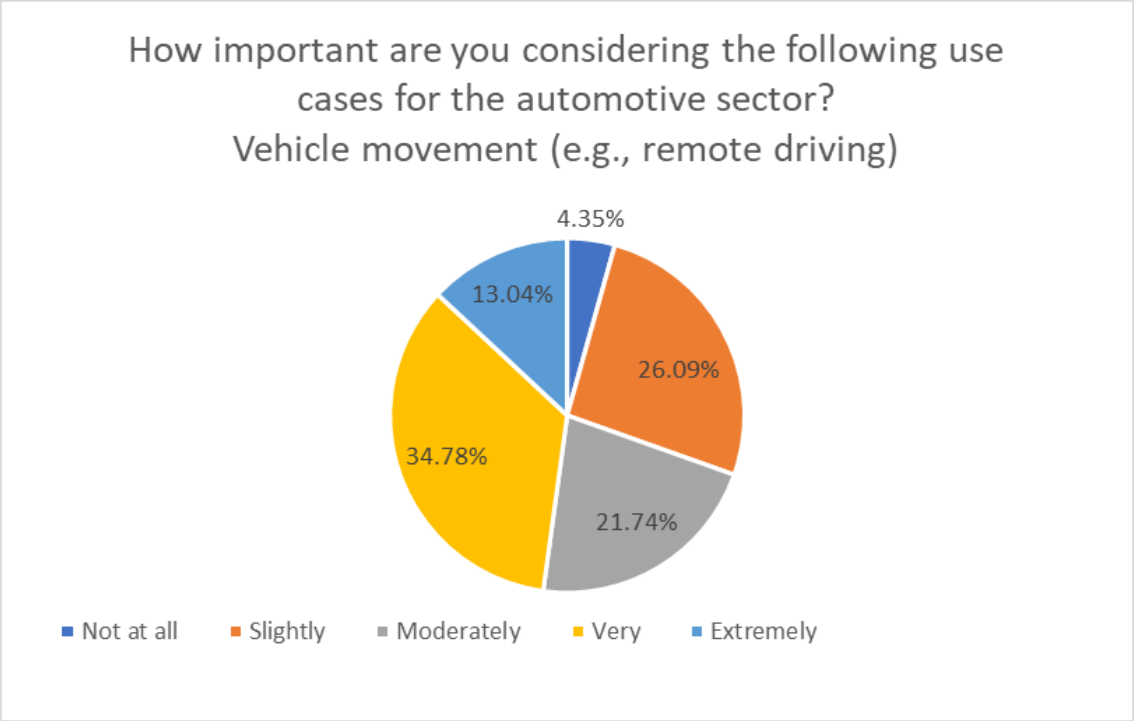



**Figure 39: Importance of Remote Driving UC**

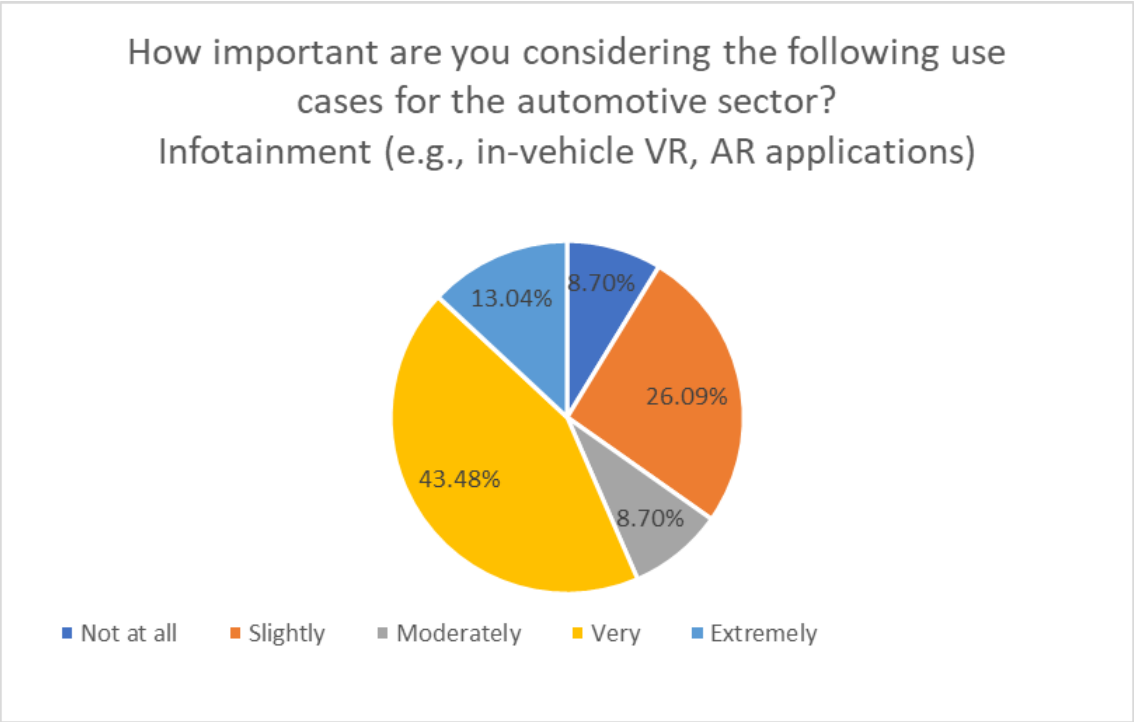



**Figure 40: Importance of Infotainment UC**

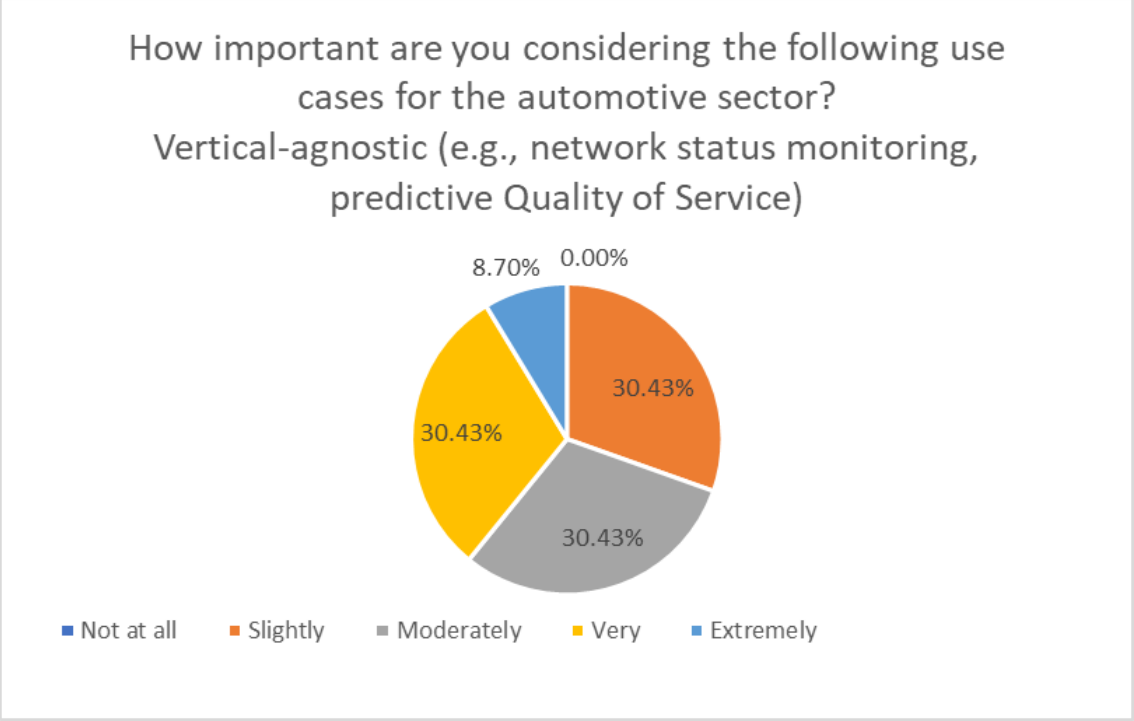



**Figure 41: Importance of Vertical agnostic UC**

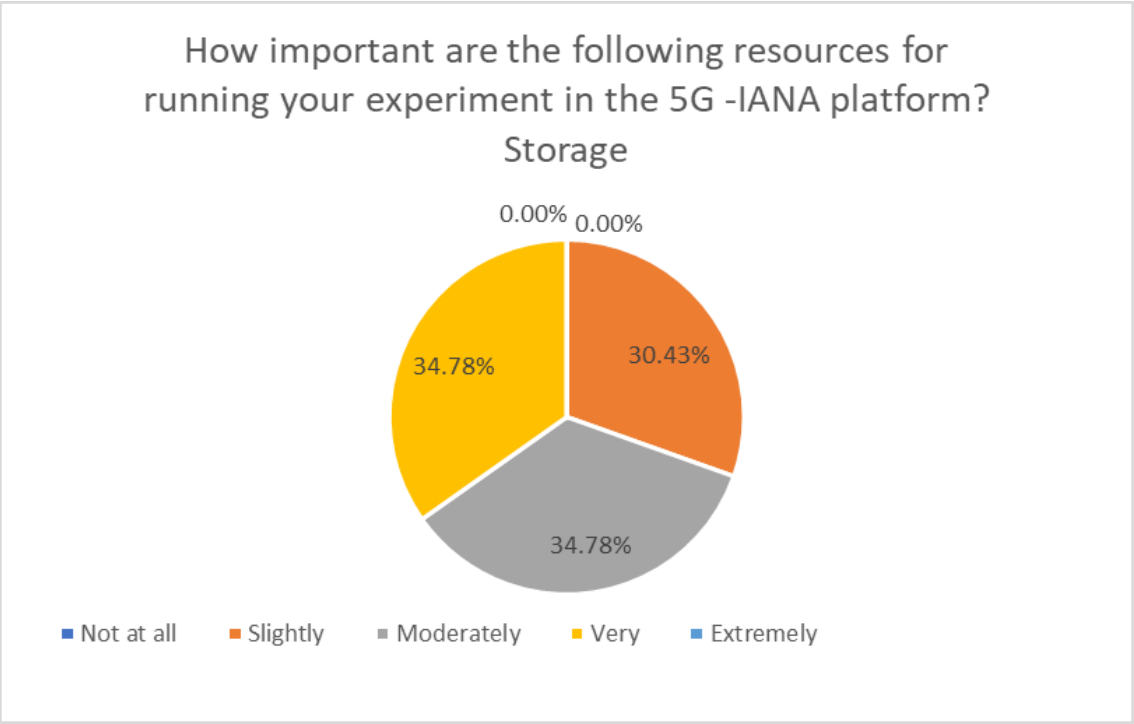



**Figure 42: Importance of Storage**

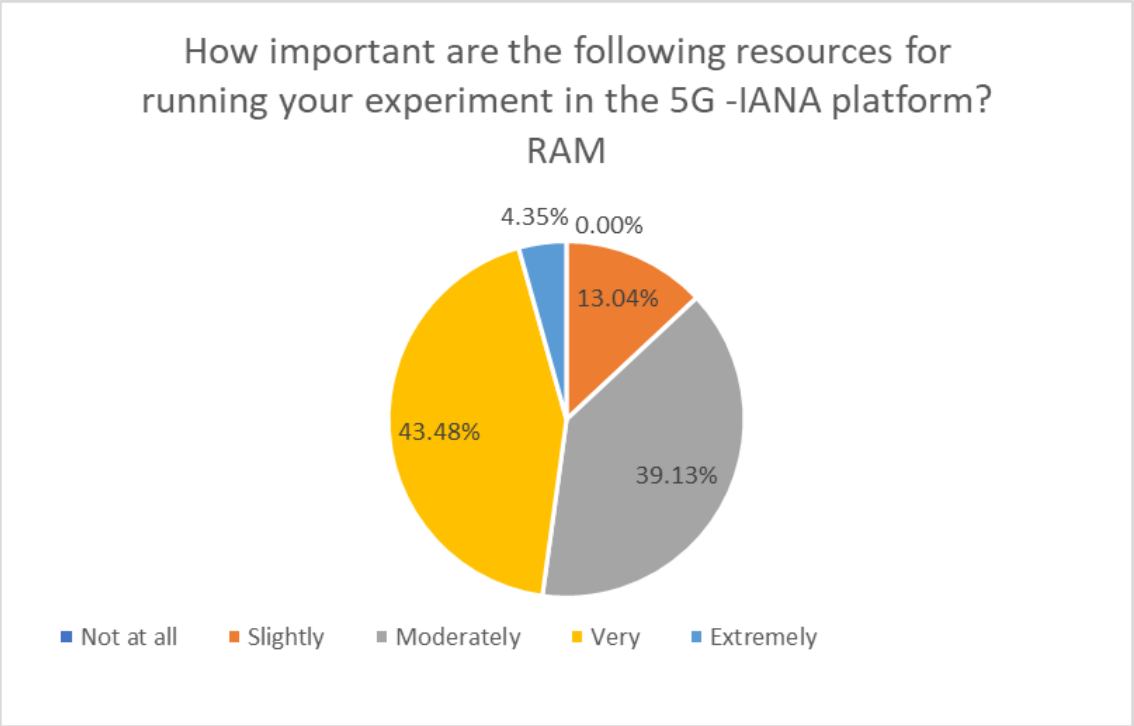



**Figure 43: Importance of RAM**

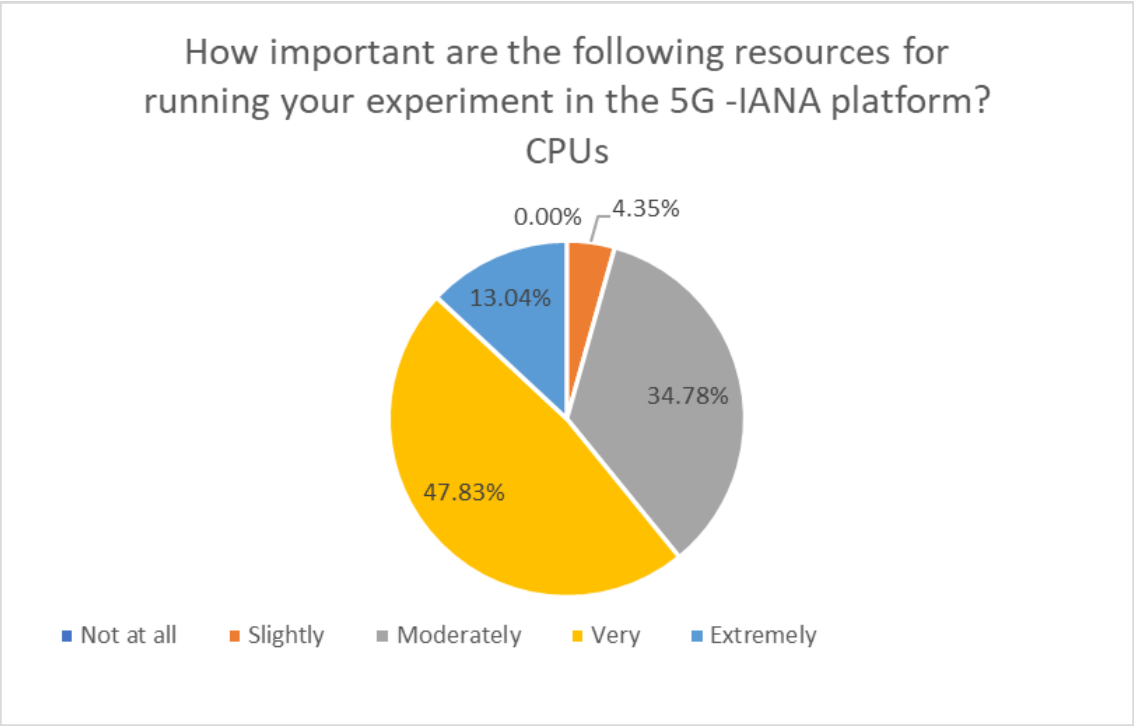



**Figure 44: Importance of CPUs**

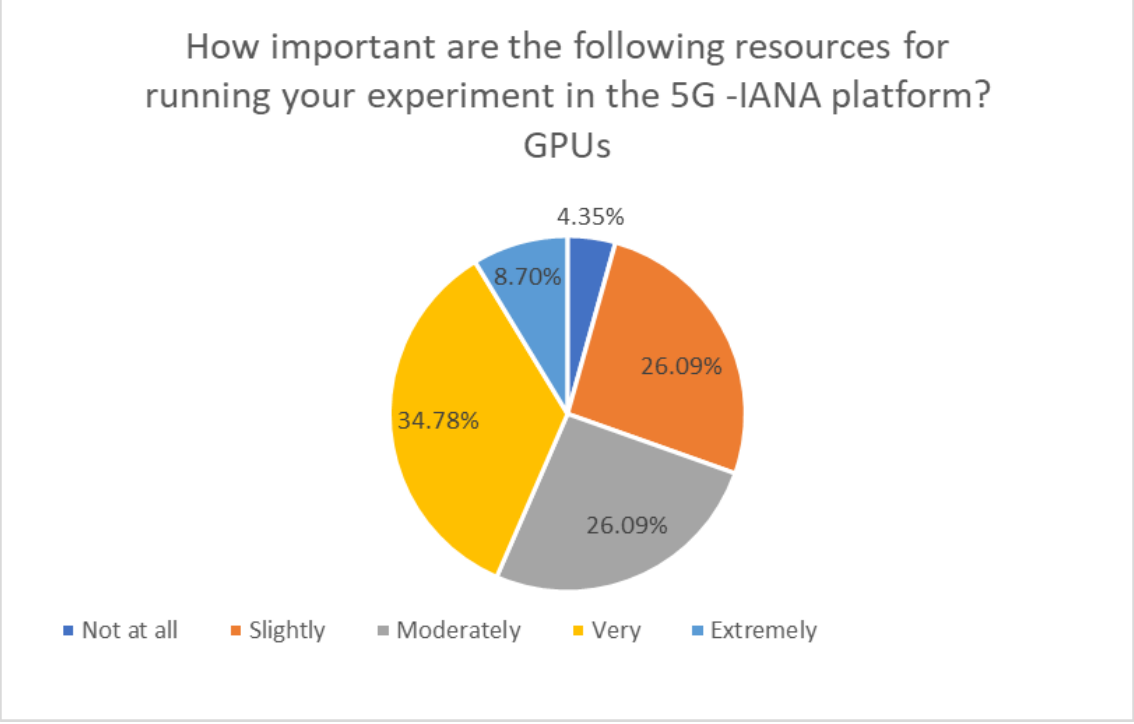



**Figure 45: Importance of GPUs**

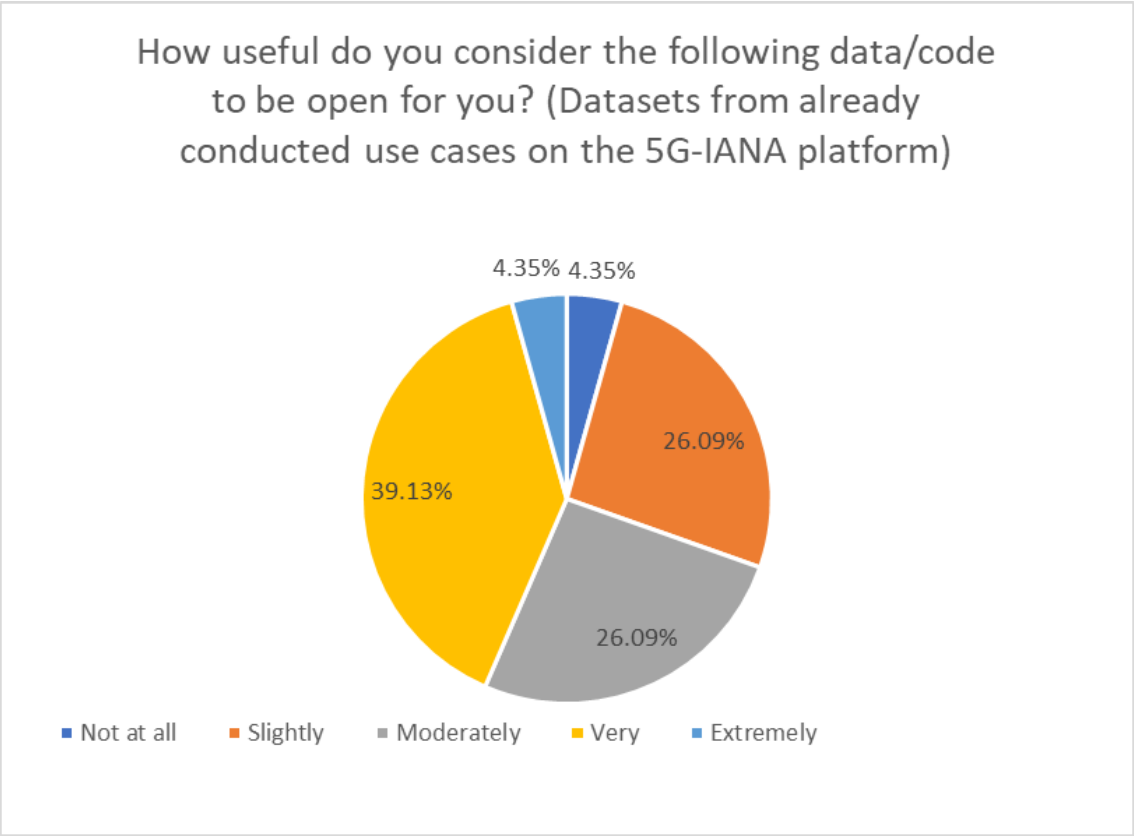



**Figure 46: Open data (Datasets from already conducted use cases on the 5G-IANA platform)**

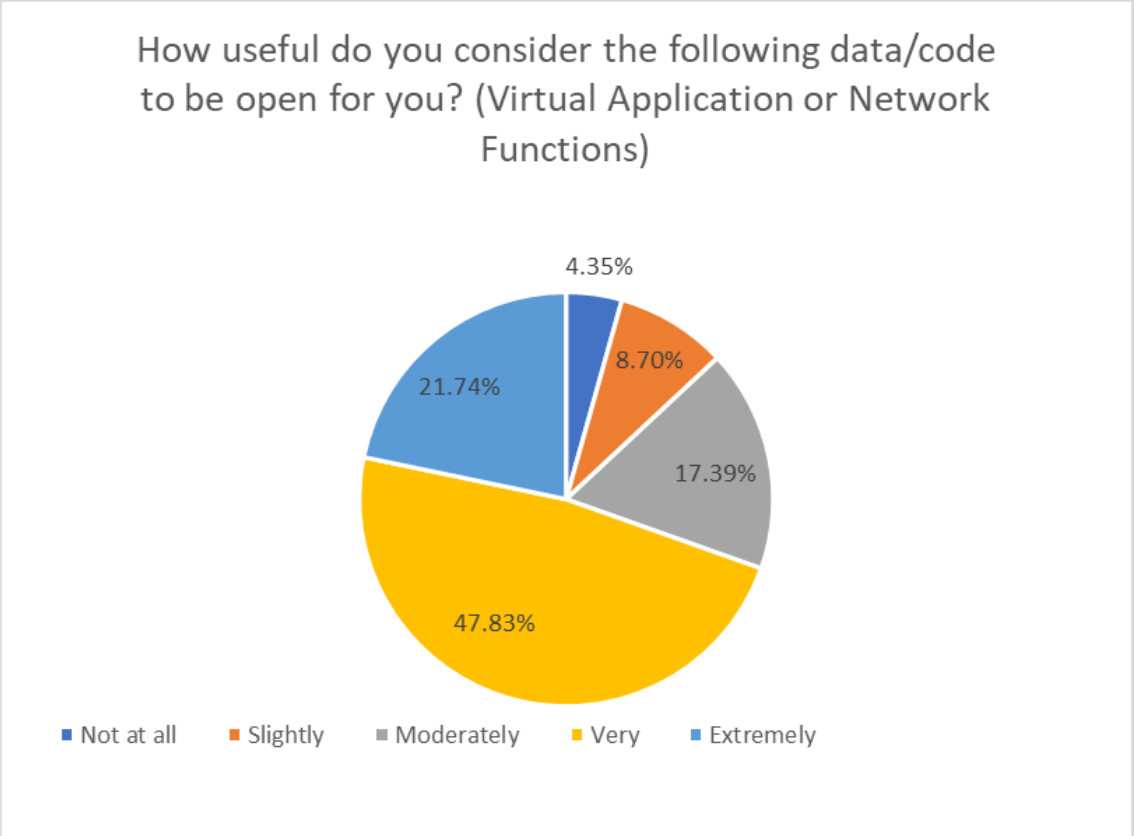



**Figure 47: Open data (Virtual Application or Network Functions)**

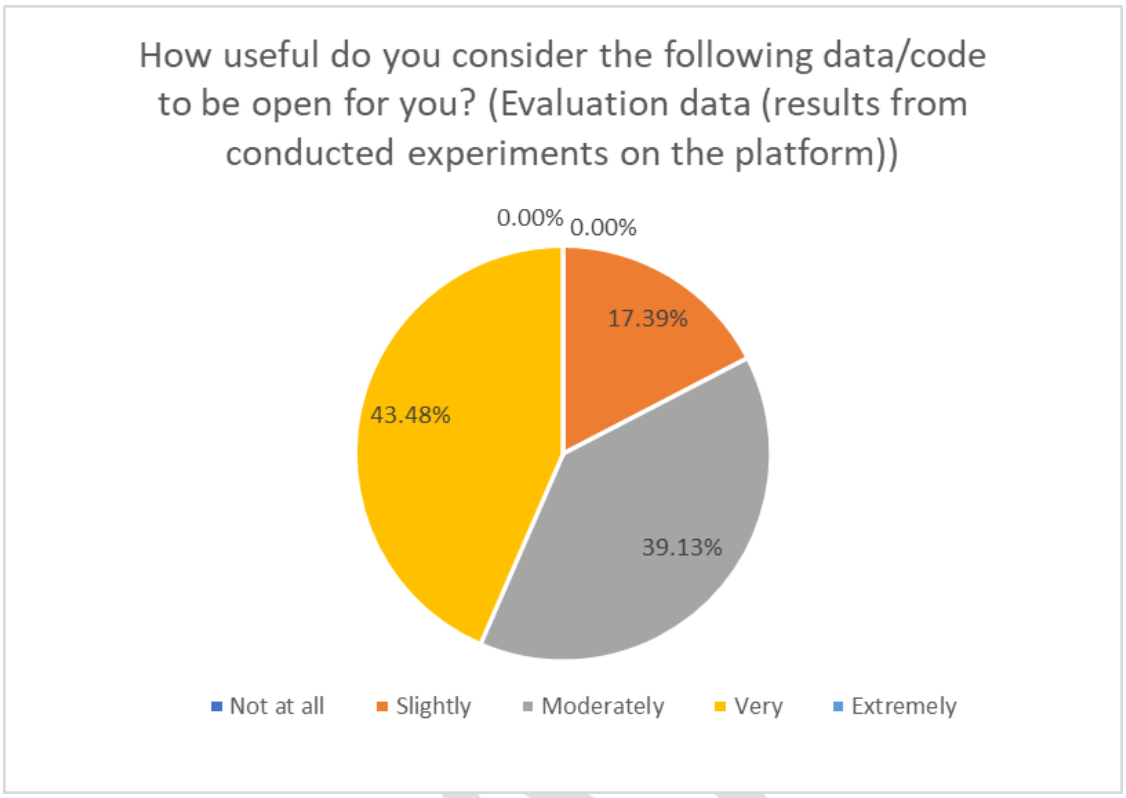



**Figure 48: Open data (Evaluation data (results from conducted experiments on the platform))**

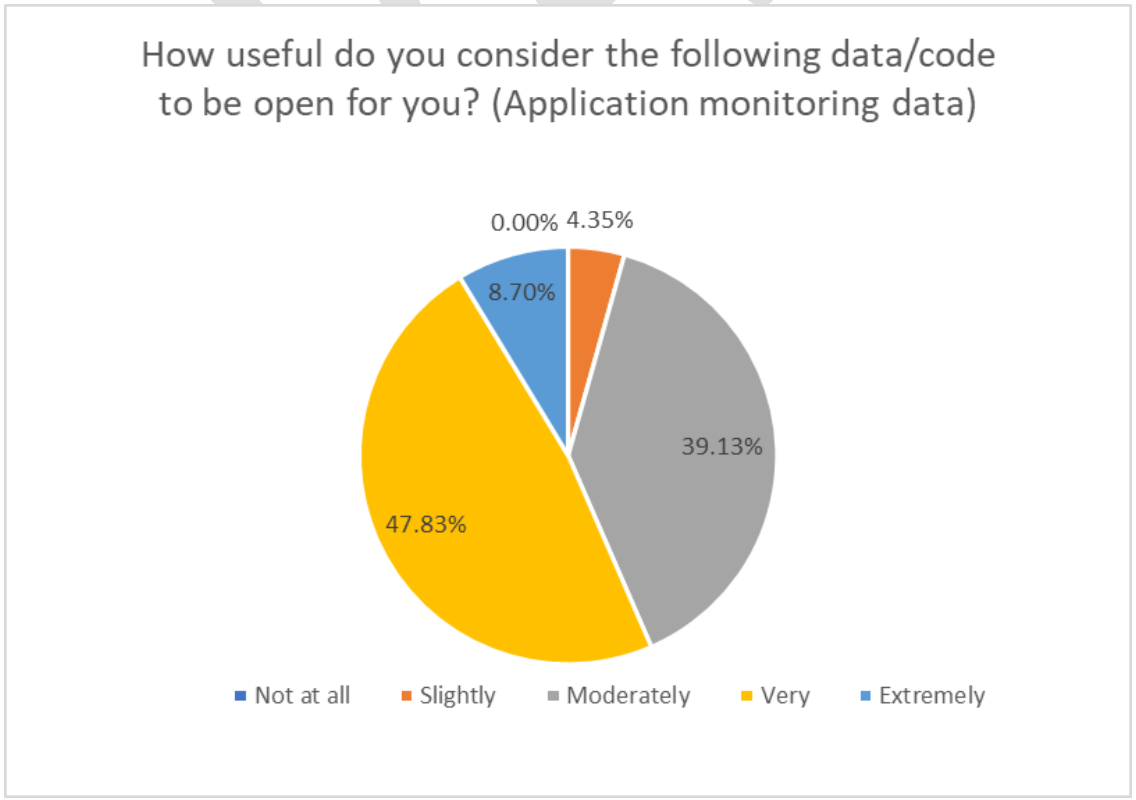



**Figure 49: Open data (Application monitoring data)**

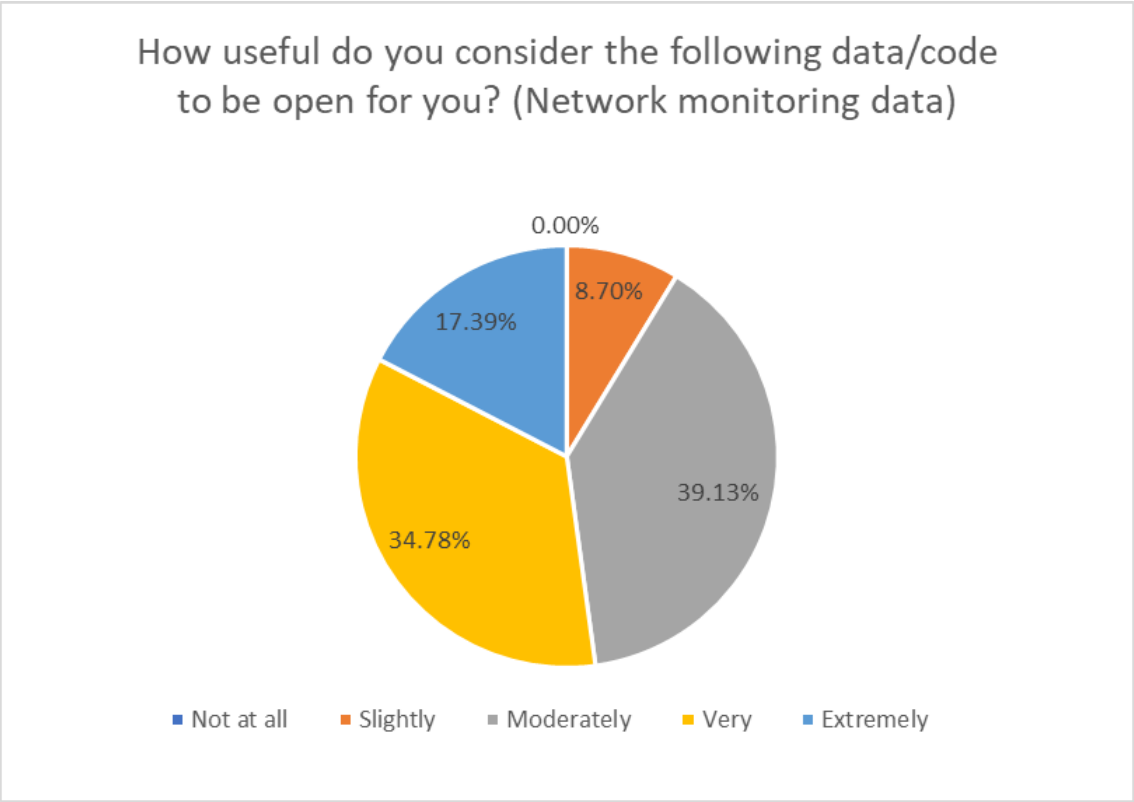



**Figure 50: Open data (Network monitoring data)**

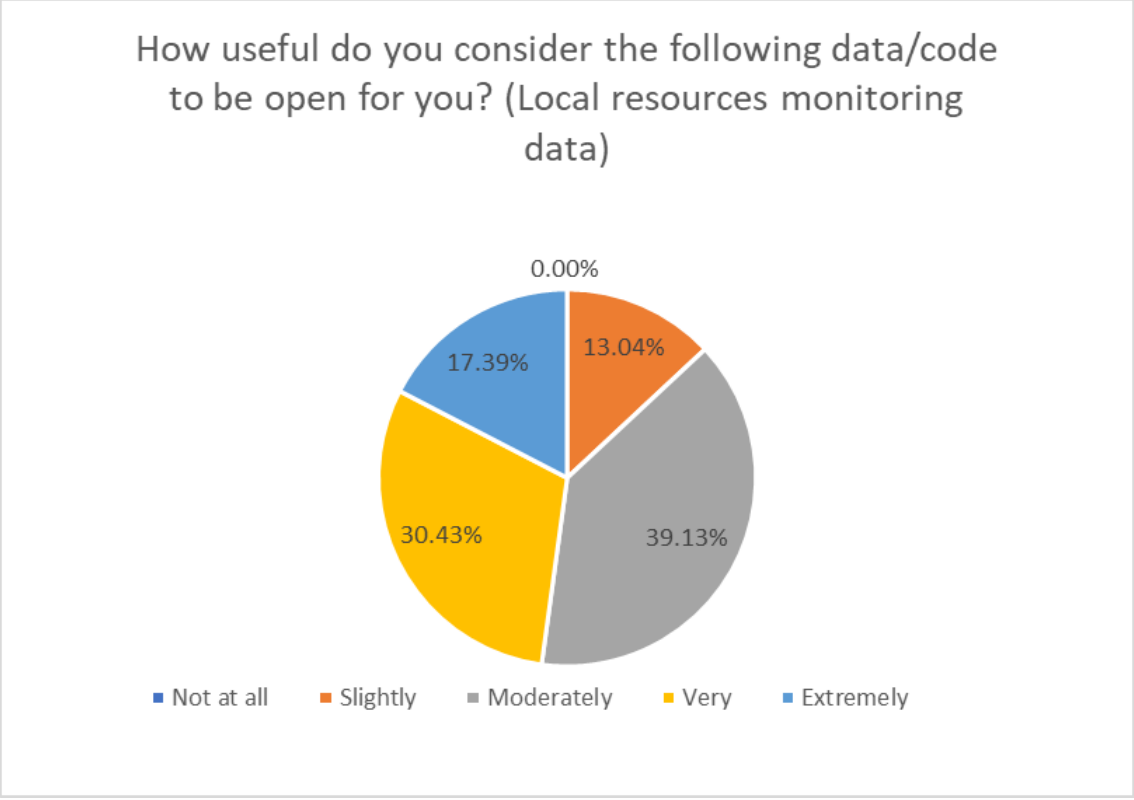



**Figure 51: Open data (Local resources monitoring data)**

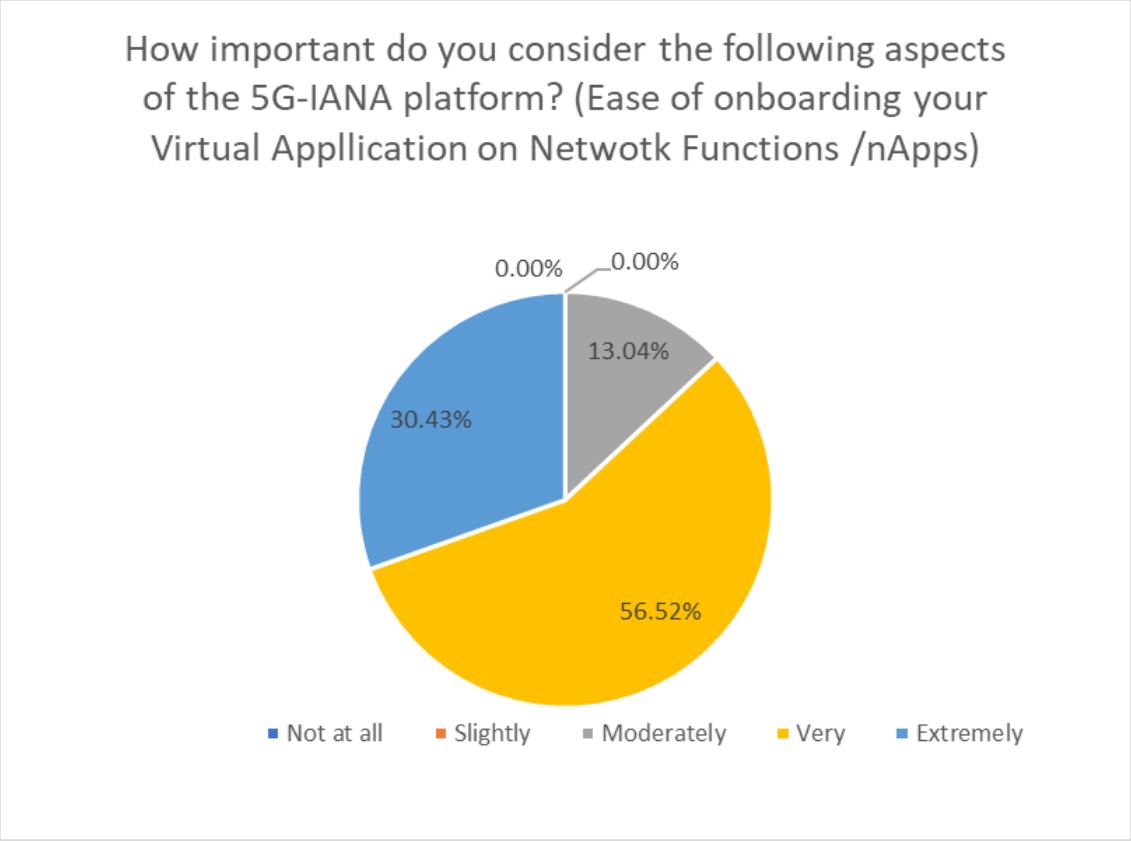



**Figure 52: Importance of different aspects (onboarding ease)**

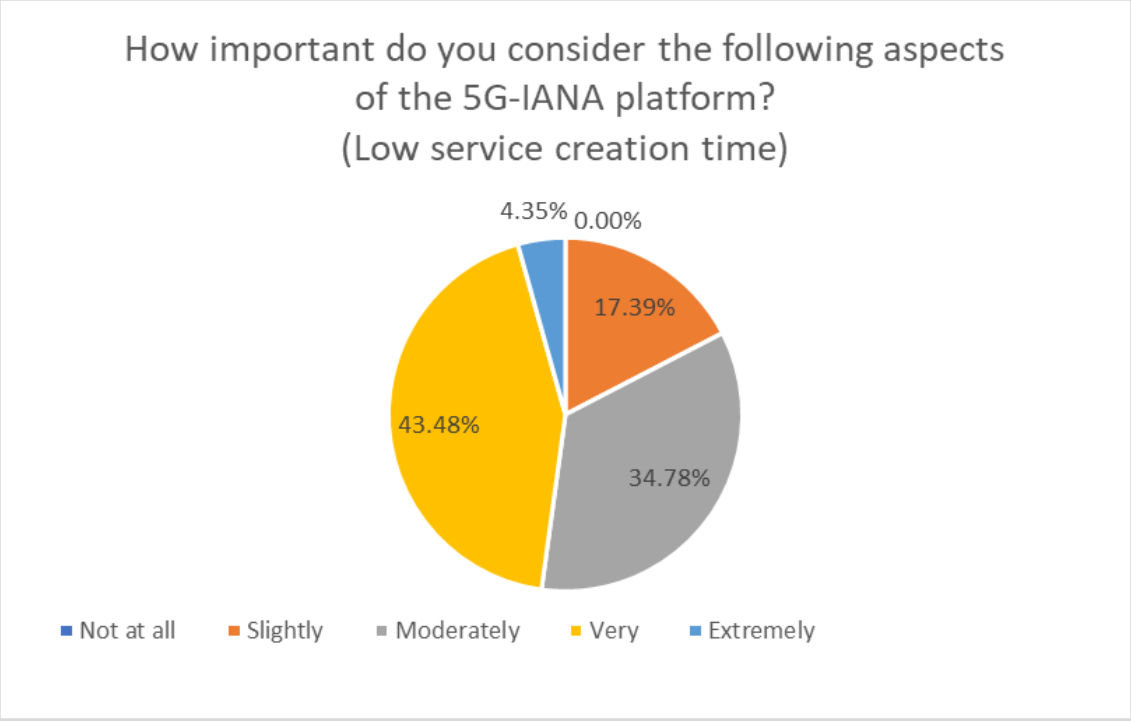



**Figure 53: Importance of different aspects (service creation time)**

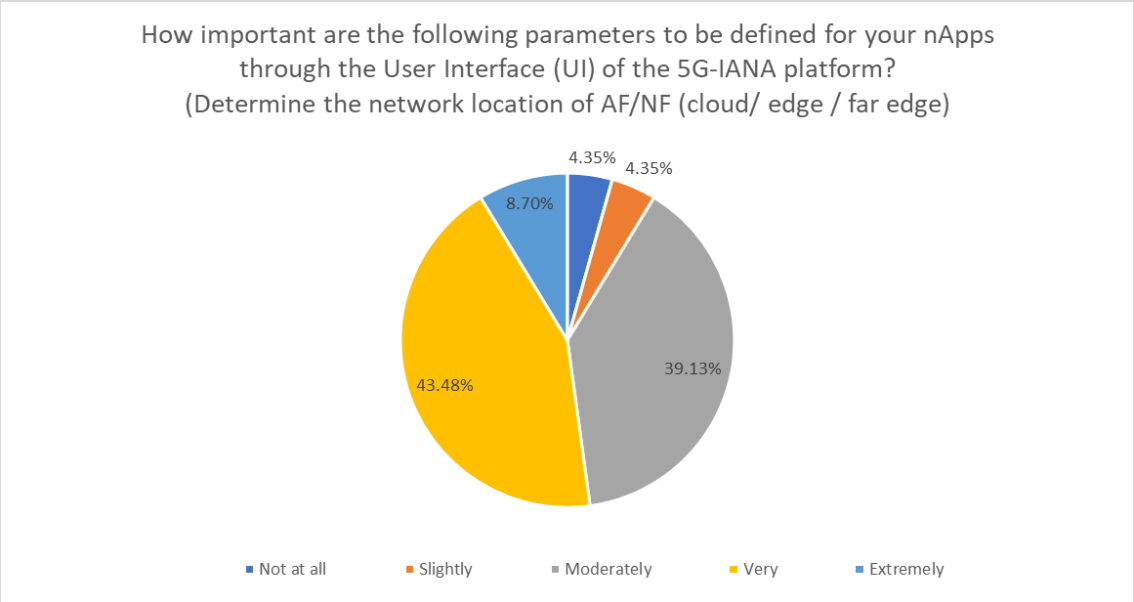



**Figure 54: Determine the network location of AF/NF from UI**

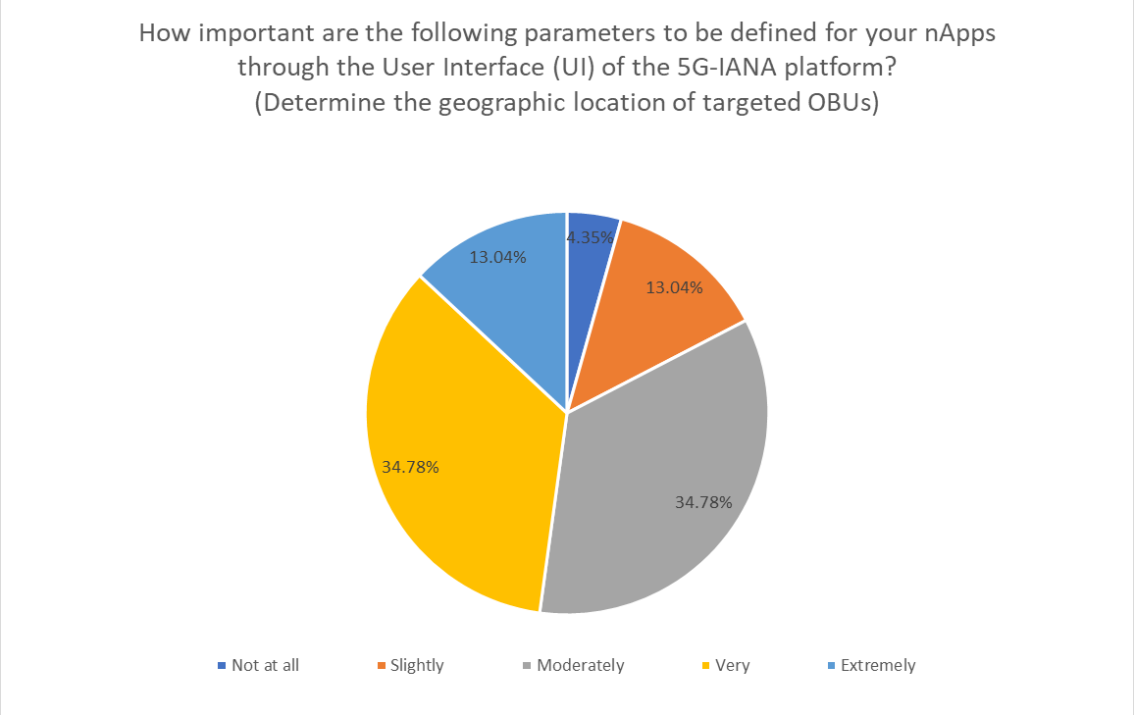



**Figure 55: Determine the geographic location of OBUs from UI**

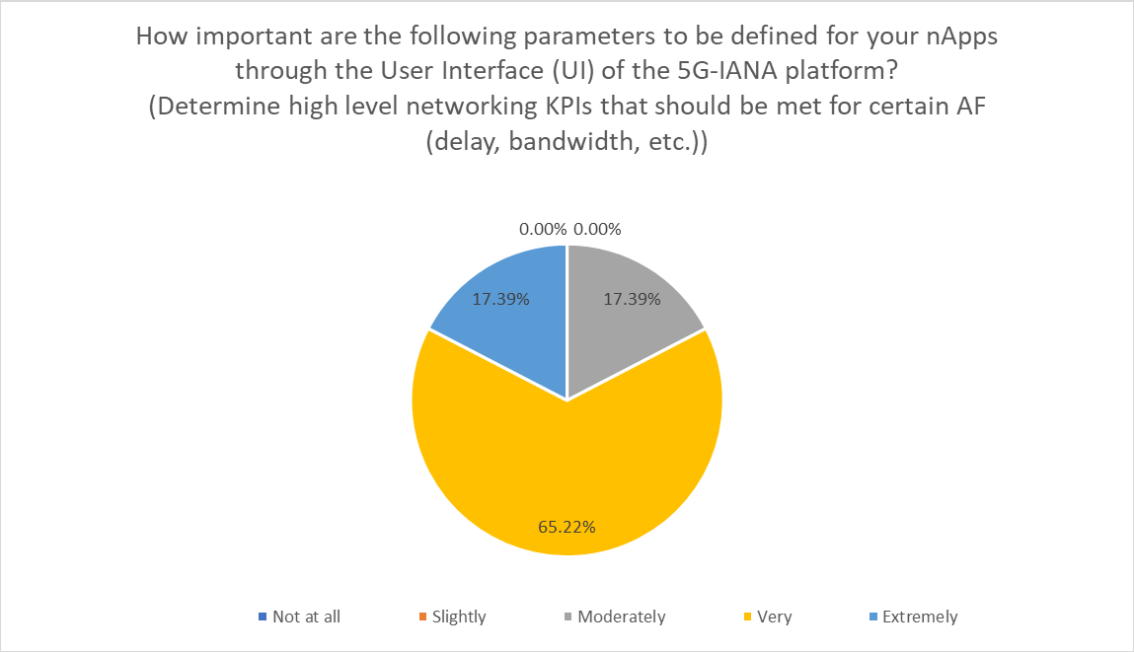



**Figure 56: Determine high level networking KPIs from UI**

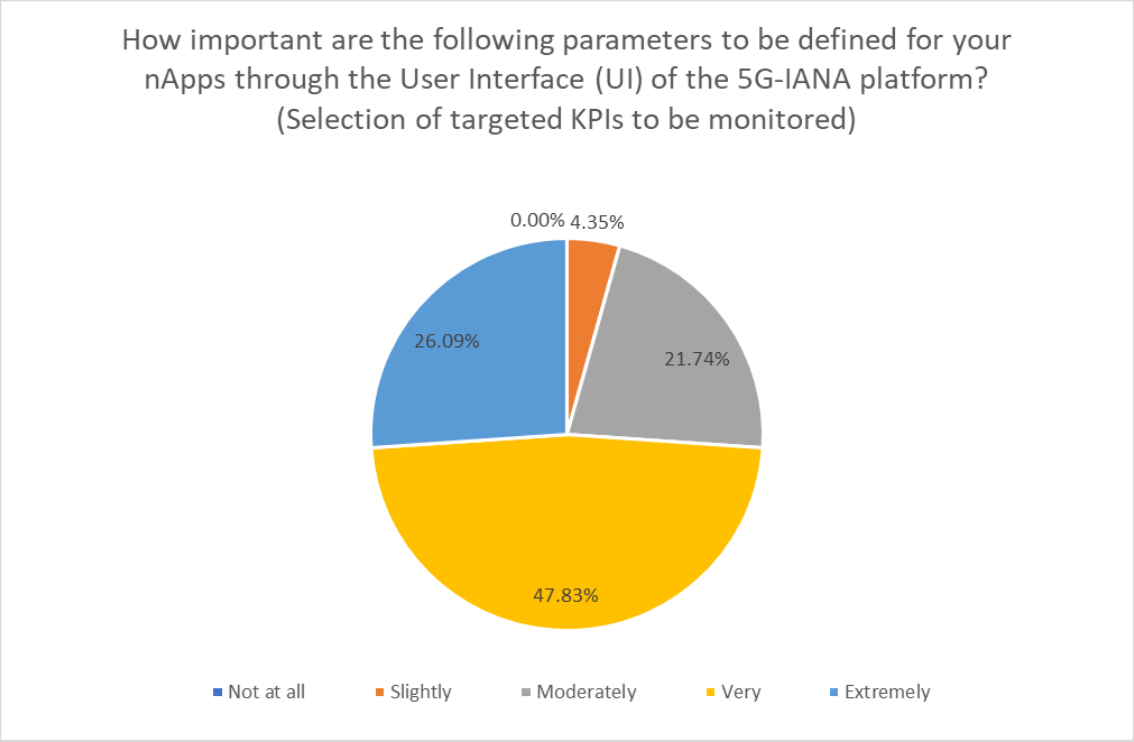



**Figure 57: Select targeted KPIs from UI**

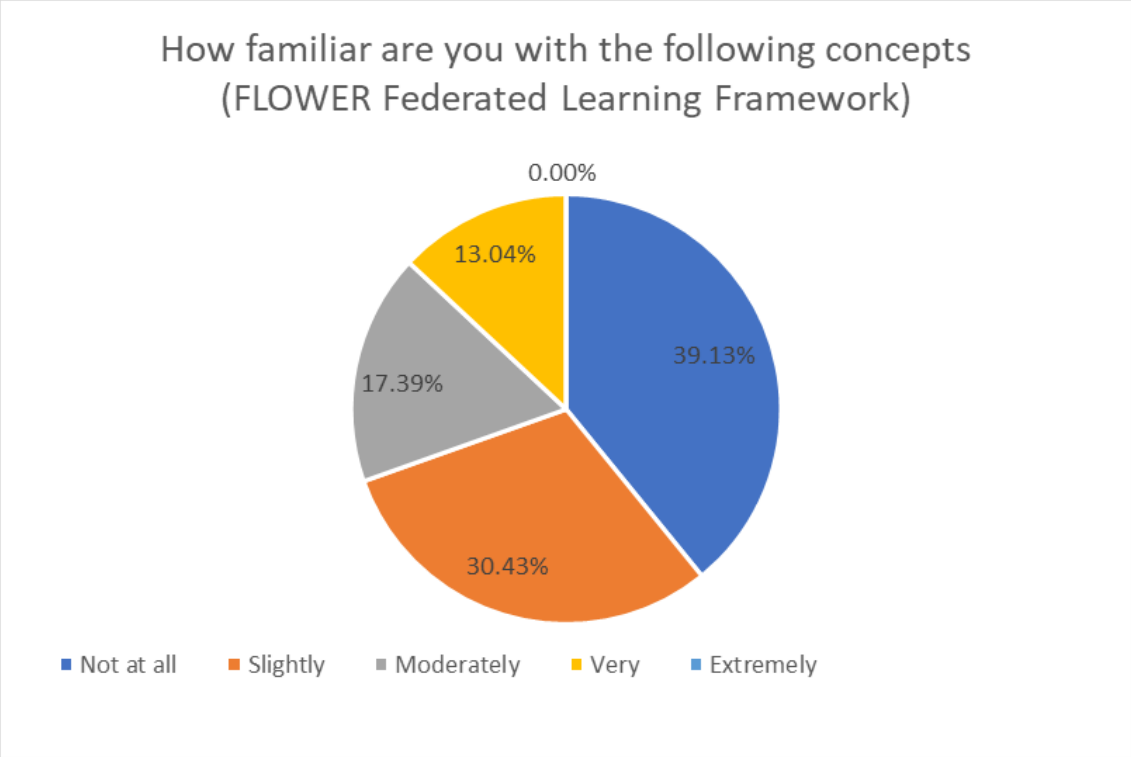



**Figure 58: Familiarity with FLOWER framework**

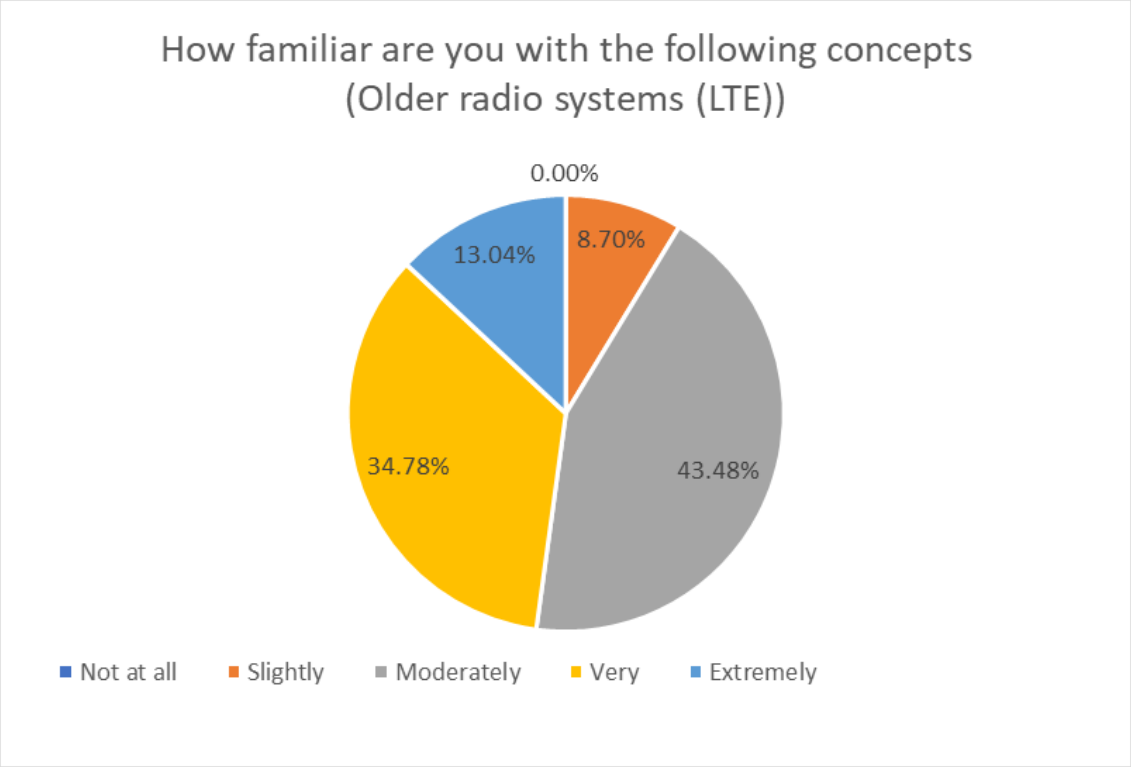



**Figure 59: Familiarity with LTE**

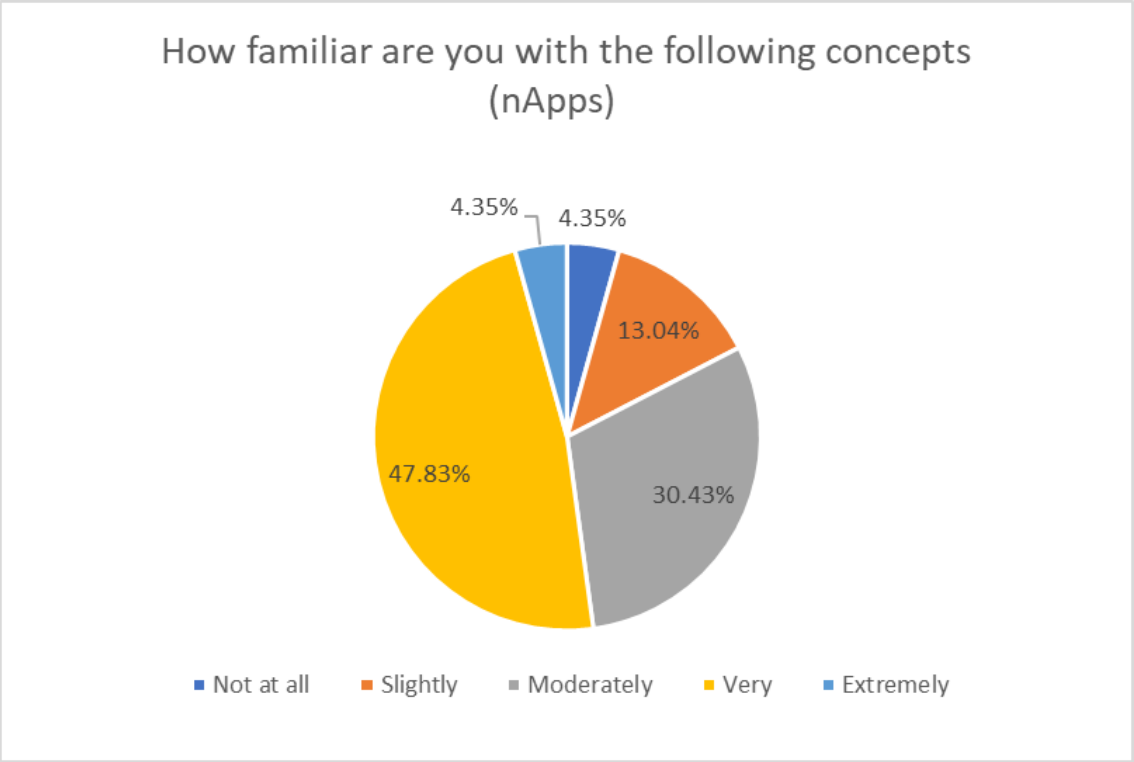



**Figure 60: Familiarity with nApps**

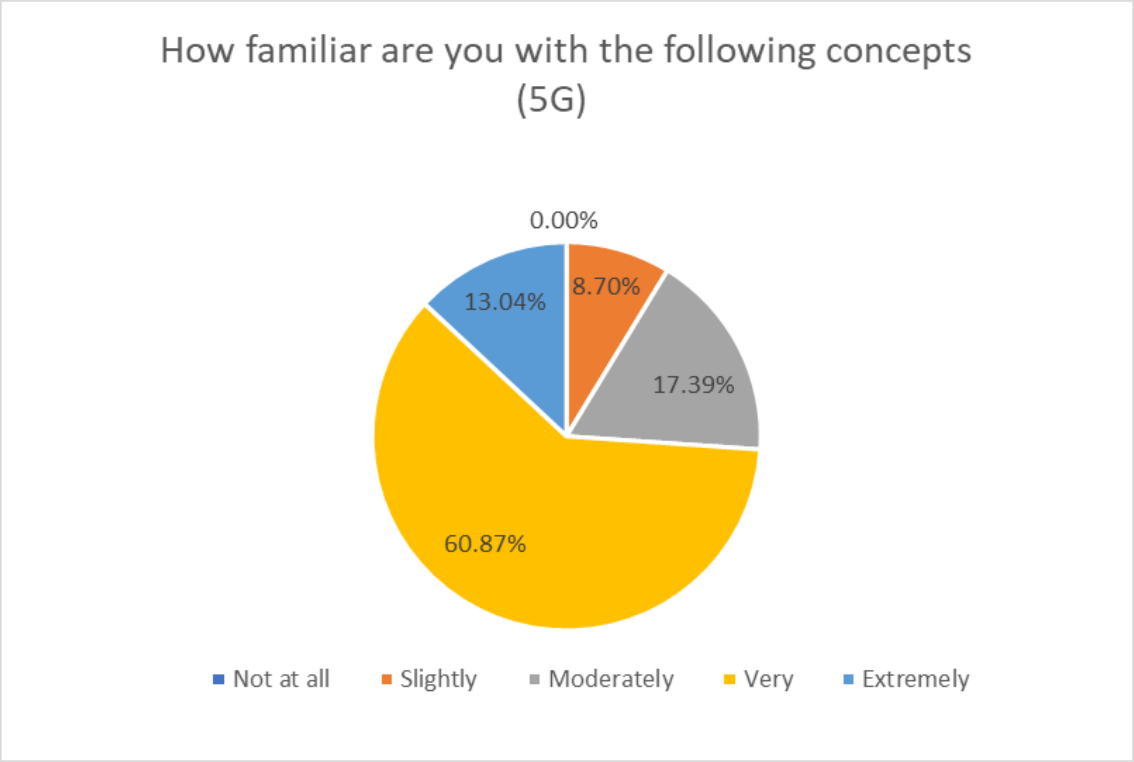



**Figure 61: Familiarity with 5G**

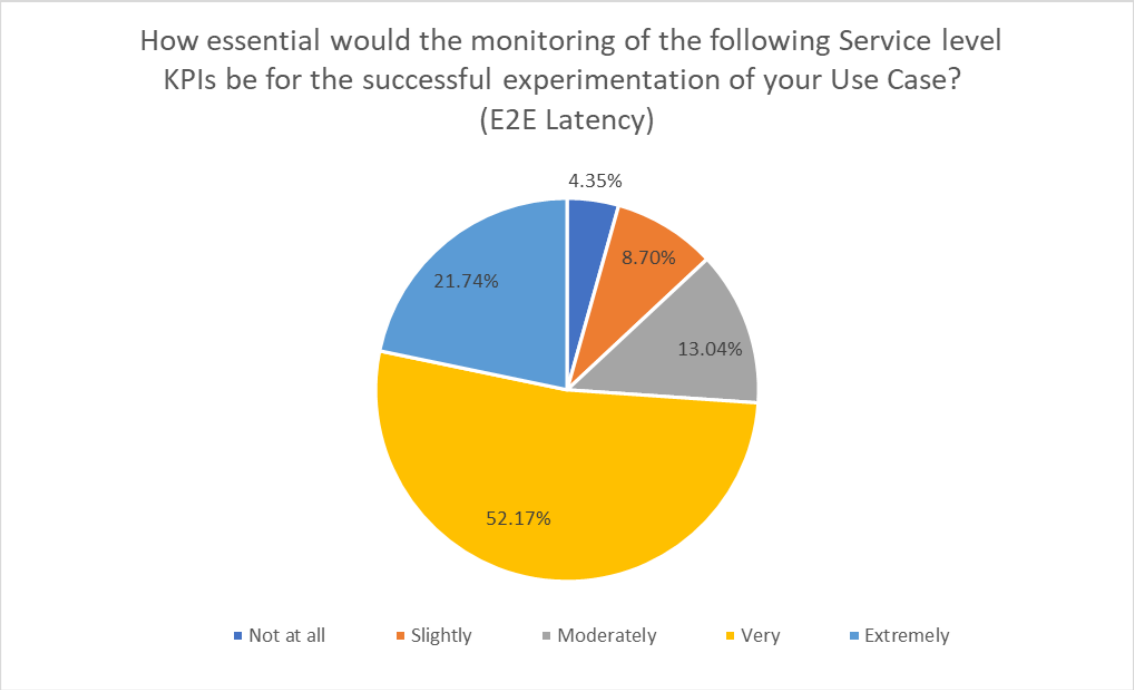



**Figure 62: Monitoring of service level KPIs (E2E latency)**

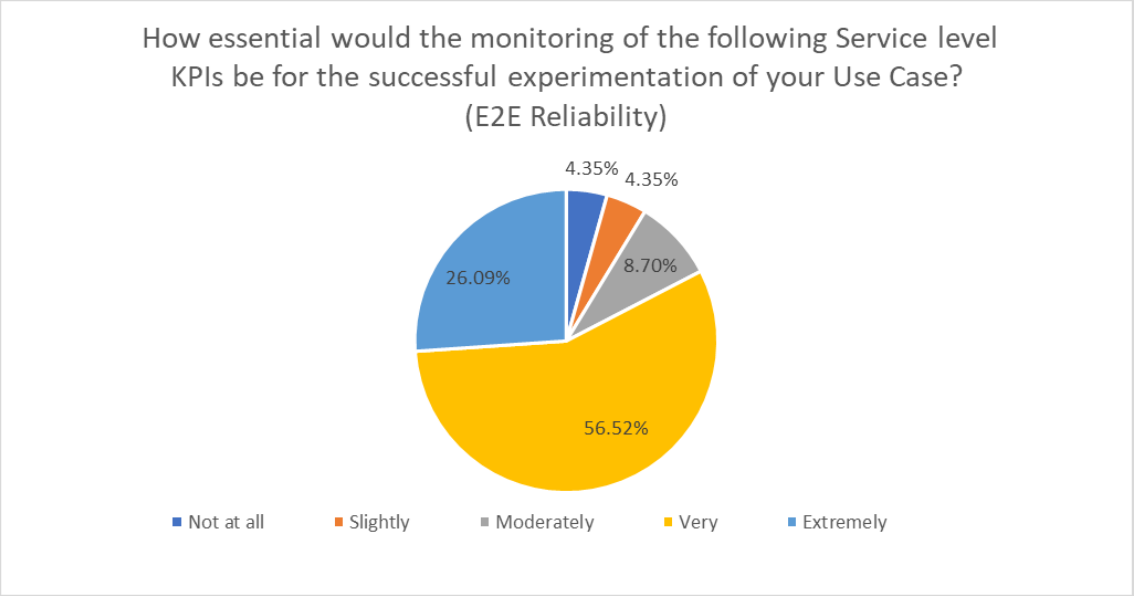



**Figure 63: Monitoring of service level KPIs (E2E reliability)**

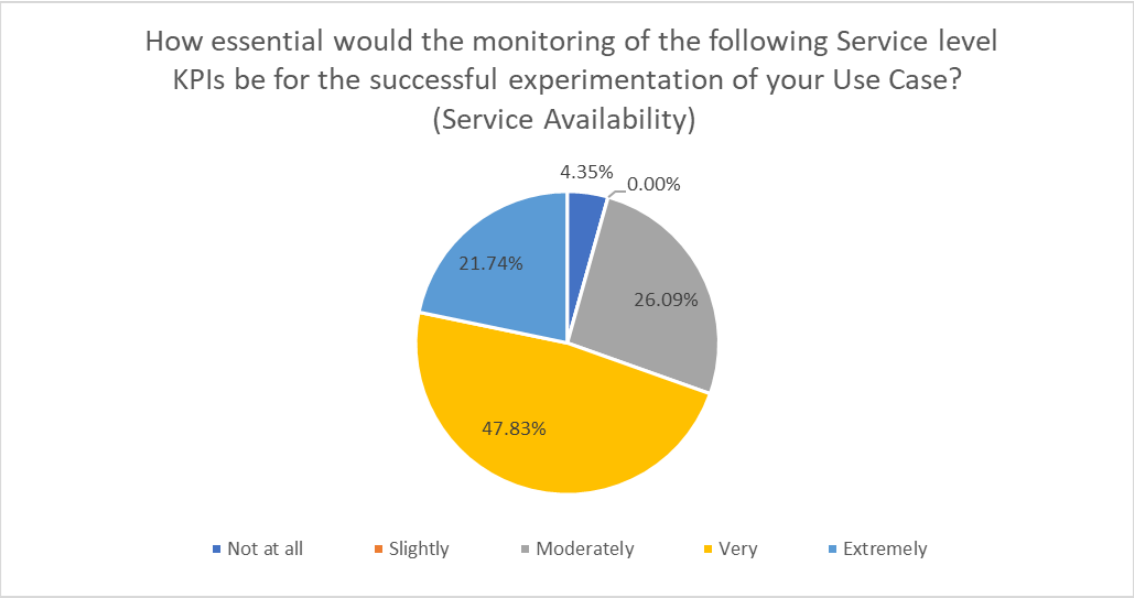



**Figure 64: Monitoring of service level KPIs (Service reliability)**

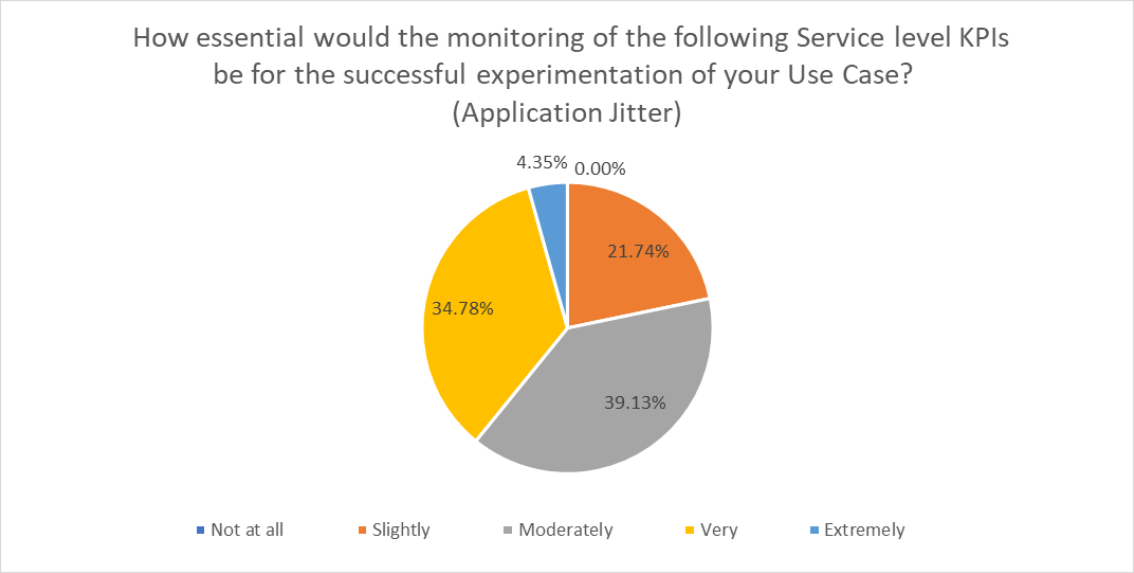



**Figure 65: Monitoring of service level KPIs (Application Jitter)**

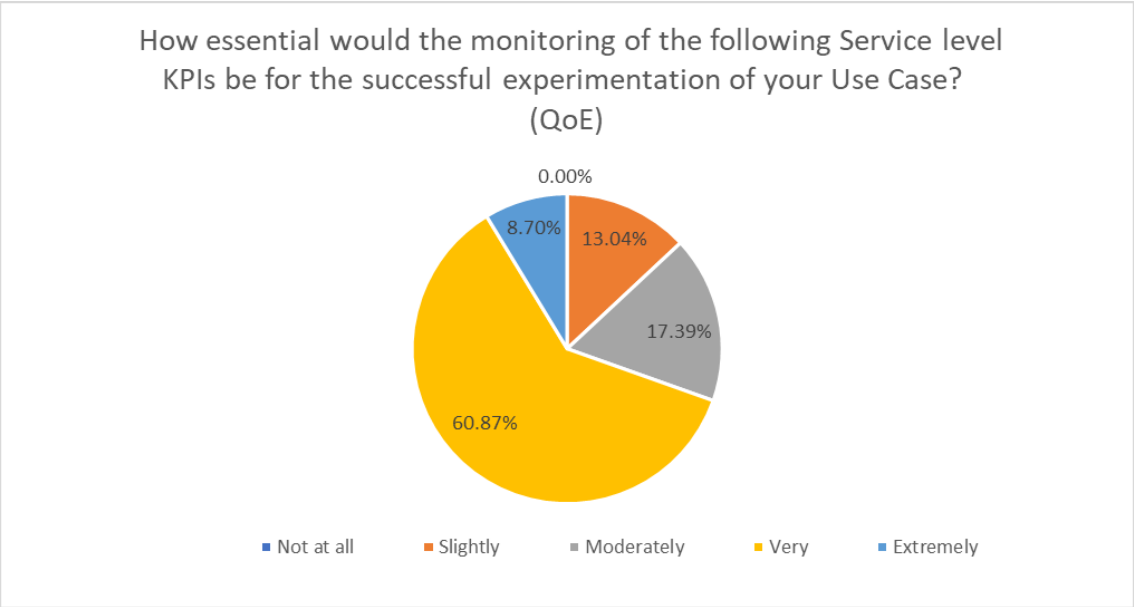



**Figure 66: Monitoring of service level KPIs (QoE)**

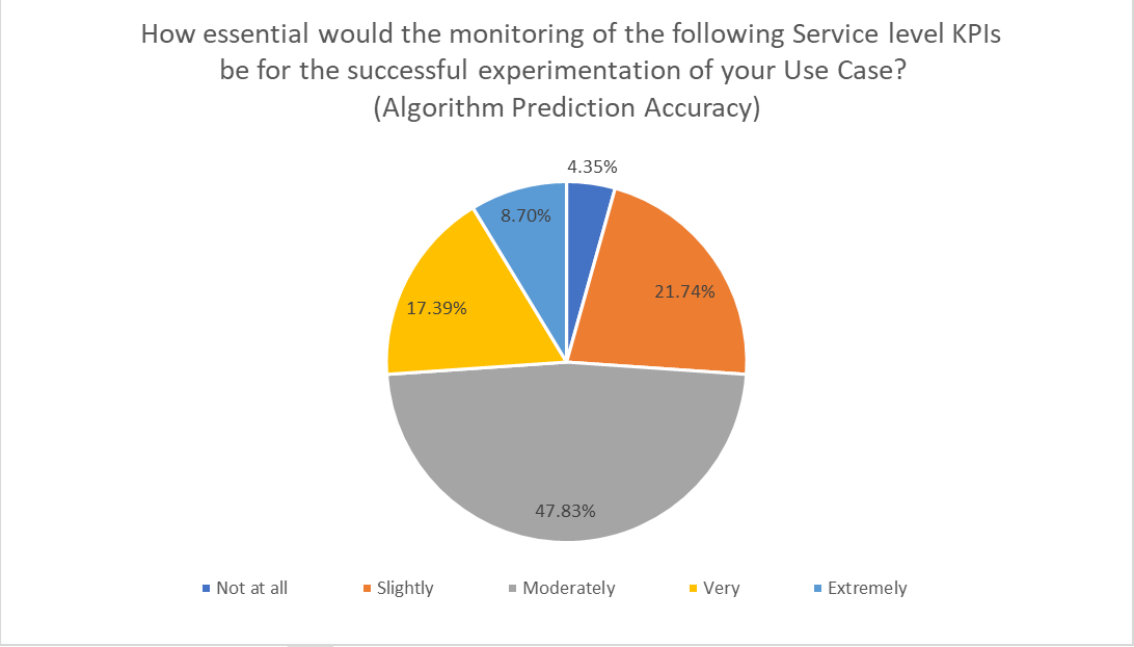



**Figure 67: Monitoring of service level KPIs (Algorithm Prediction Accuracy)**

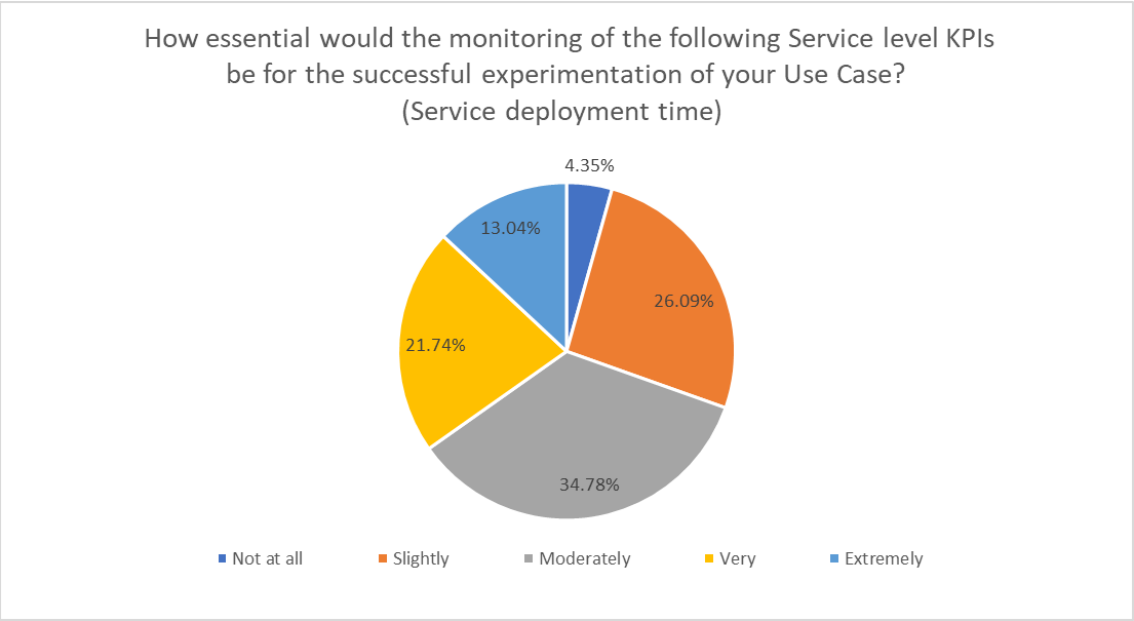



**Figure 68: Monitoring of service level KPIs (Service deployment time)**

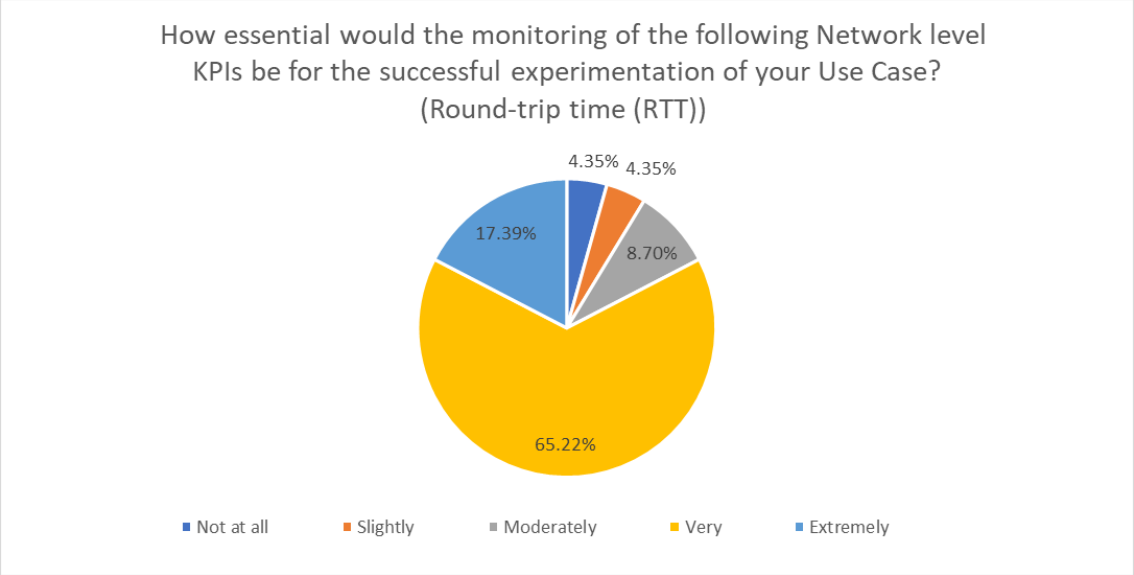



**Figure 69: Monitoring of network level KPIs (RTT)**

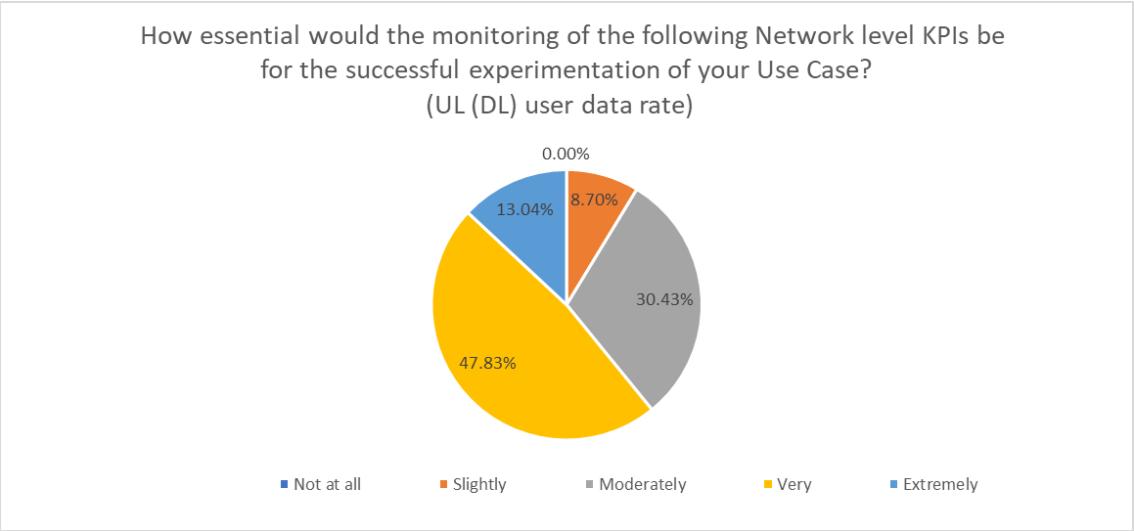



**Figure 70: Monitoring of network level KPIs (User data rate)**

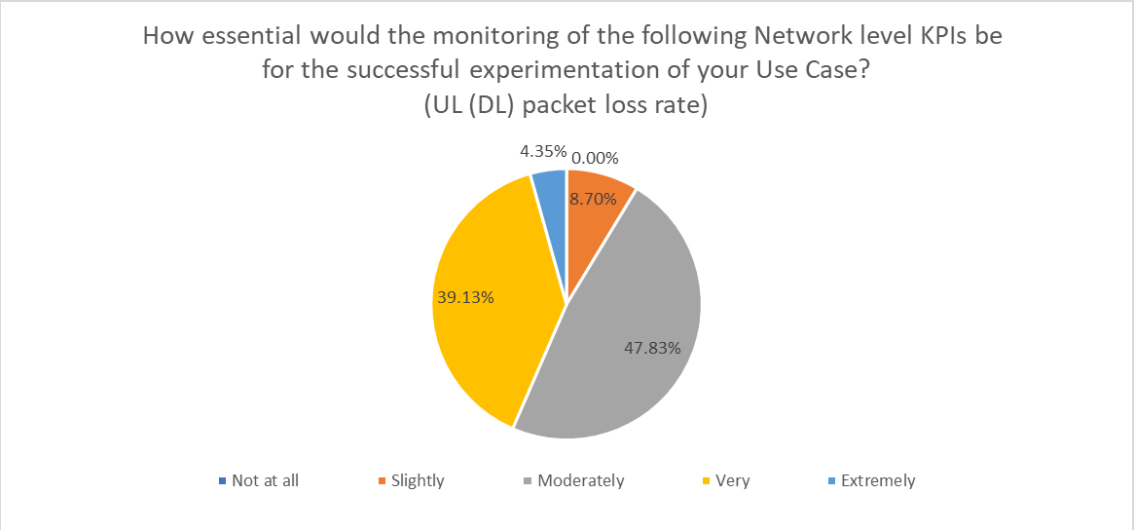



**Figure 71: Monitoring of network level KPIs (packet loss rate)**

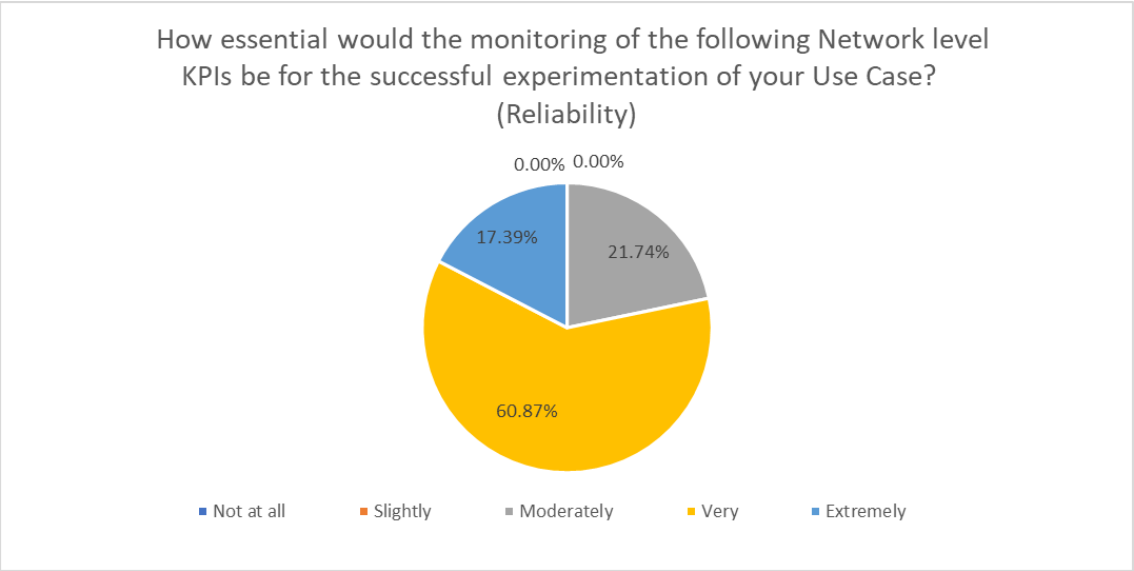



**Figure 72: Monitoring of network level KPIs (reliability)**