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D2.6 Plans for deployment of SLICES core

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Authors	Christian Perez (Inria), Panayiotis Andreou (UCLan), Bartosz Belter (PSNC), Cédric Crettaz (MI), Carmen Guerrero (UC3M).
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Scientific Large-scale Infrastructure for Computing Communication Experimental Studies **Design Study**

www.slices-ds.eu

Executive Summary

This deliverable provides a first analysis to set up the plans for the deployment of the SLICES core, i.e., the operational part of the platforms including the central hub and some SLICES nodes. It also deals with criteria for the initial site selection as well as it provides some insights on the decommissioning issue.

The first part of the deliverable provides an overview of the architecture of SLICES as well as its services. SLICES will be a highly distributed infrastructure, to reflect the fact that the environments we aim to study are themselves distributed (e.g., Fog/Edge computing), towards supporting a large variety of viable topologies in distributed computing systems. Hence, SLICES will provide a fully programmable remotely accessible infrastructure to the Digital Infrastructure scientific community. The software architecture of SLICES needs to organize the different geographically dispersed site facilities in a single pan-European facility, which experimenters will access seamlessly thanks to SLICES services.

The second part discusses the criteria and procedure to select the initial sites of the central hub as well as nodes. The central hub will hold main common services and some experimental facilities though the main part of the testbed will be located in the nodes. Thanks to the flexible architecture of SLICES, it will be possible to add (or remove) some sites or nodes. Therefore, this work is a first step in defining the criteria and procedure to drive these actions.

The third part is a review of some of the platforms identified in Deliverable D1.1 that may candidate to become a node of SLICES. This preliminary analysis takes into account the three following considerations: i) scientific value, ii) technological issues (e.g., potential costs of migration, the deployment of required SLICES components, etc.), and iii) human staffing.

The last part of this deliverable deals with the issues related to decommissioning. Most of the hardware of SLICES will be IT hardware. Hence, standard procedures to decommission provide a solid starting point to define procedure. The decommission of hardware running services could be envisioned almost transparently to end users most of the time. An important moment is at the final decommission that should deal with retrieval of end user data and to the long-term preservation of SLICES data while respecting data protection regulation.

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1 Overview of SLICES

SLICES aims at providing high quality experimentation services with emerging technologies around the area of digital sciences. The goal is to build a large-scale infrastructure for experimental research in computer science, and more precisely in networking and distributed systems, targeting scientific challenges in the fields including wireless networking, IoT, edge/fog/cloud computing and distributed systems.

1.1 SLICES Architecture

SLICES will be a highly distributed infrastructure, to reflect the fact that the environments we aim to study are themselves distributed (e.g., Fog/Edge computing), towards supporting a large variety of viable topologies in distributed computing systems. SLICES shall not be a light federation of independent sites, but rather a coherent environment to perform large scale distributed experiments. The knowledge and experience gathered from previous efforts and initiatives have resulted in the design of several tools and platforms that shall manage this infrastructure in a coordinated way, providing users with a consistent environment that shall overcome the technical challenges of multi-sites experiments.

As described in Deliverable D2.1 "Initial description of the SLICES architecture" [D2.1], SLICES will provide a fully programmable remotely accessible infrastructure to the Digital Infrastructure scientific community. The respective frameworks are designed and they will be developed for ensuring seamless and easy access to the experimental resources. The different site facilities will form an integrated single pan-European facility, which experimenters will access seamlessly, without noticing (if not needed by specific experimental requirements) the fact that resources might come from different facilities. The integrated facility will adopt common tools for managing and orchestrating experiments over the infrastructure, as well as provide a single access and credentials to users. An initial version of its architecture used for the management is described in Figure 1.

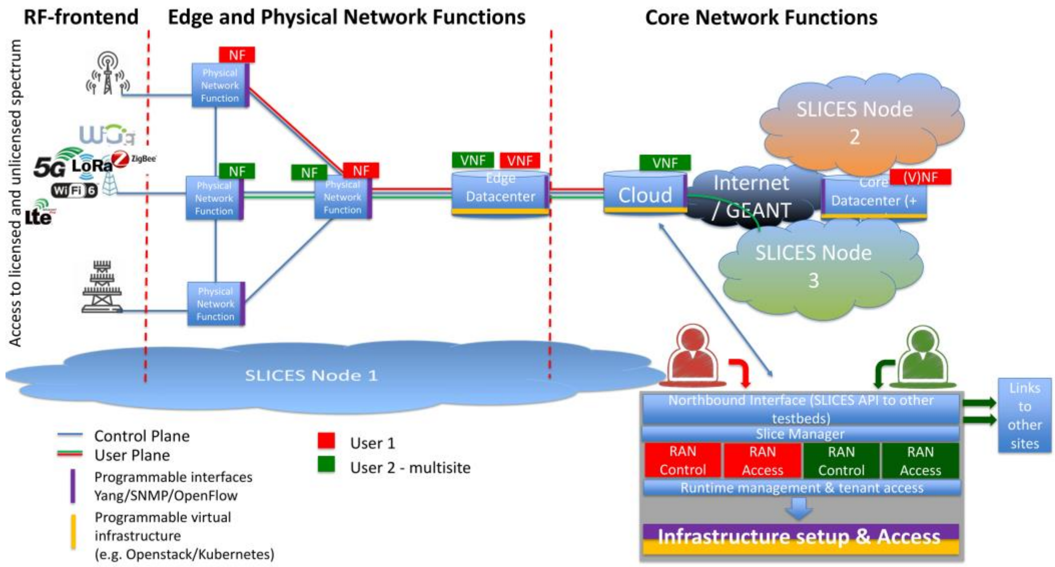

Figure 1: SLICES Architecture Layout Overview

The foundation principles of SLICES shape and derive the ability to build a distributed RI, where the distributed nodes are appropriately articulated into a centrally controlled and managed infrastructure. Disaggregated and geographically scattered "national" deployments need to be integrated into a single pan-European facility accessible through a single-entry point (e.g., a portal service) with state-of-the-art design tools, taking into consideration best practices and methodologies based on current state of the art and state of practice. This prior work defined the minimum set of functionalities that a test platform has to include in order to be integrated into a global facility, i.e., a common resource description framework, a trusted architecture and a standardized control plane and API. The main finding shows that there exists a broad community of researchers focusing on a wide range of topics from very specific research (wireless protocols) to more global architectural concepts (inter-cloud and Edge, for instance) to disruptive Internet paradigms. The examples of key technologies include (but are not limited to) evolution of 5G towards 6G in the telecommunication sector, evolution of public/private cloud technologies, Internet of Things, Fog/Edge computing, human-centric networking.

SLICES has to be designed considering the experimental environment as a fully controllable, programmable and virtualized digital global infrastructure test platform. This architecture will provide high quality experimental services using emerging technologies around the area of digital sciences. The **primary technologies and approaches** to address the requirements for SLICES testbed are the following:

- Software Defined Network (SDN) and Network Function Virtualization (NFV): SDN is a technology that separates routing control traffic from data traffic, and that allows a centralized software to dynamically control the network. In the 5G ecosystem, the SDN architecture includes 3 different layers: 1) A WAN Resource Manager (i.e., SDN application) that represents the functional element that triggers SDN control plane operations. It translates the abstracted view at orchestrator level into a network domain-specific view; 2) Two kinds of SDN controllers, one used to configure the core network domain and the other one dedicated to the configuration of the RAN domain; 3) A data-plane composed of Core NFV Infrastructure (NFVI), backhaul network, Edge NFVI, fronthaul network, WLAN Access Points and LTE small cells. NFV transforms the way network operators and providers design, manage and deploy their network infrastructure by exploiting virtualization technologies. It enhances the delivery of network services to end users while reducing CAPEX and OPEX.
- Network Slicing: Slicing which allows a single 5G physical network to be segmented into multiple isolated logical networks of varying sizes and structures dedicated to different types of services. It is a multi-tenant virtualization technique in which the various network functionalities are extracted from the hardware and/or software components and then offered in the form of slices to the different users of the infrastructure (tenants).
- Network disaggregation: Network device disaggregation is the ability to source switching hardware and network operating systems separately. This concept has been extended to the radio access network: RAN disaggregation was specified by 3GPP and detailed by the Open Networking Foundation (ONF) as an important step allowing for dynamic creation and lifecycle management of use-case optimized network slices.
- Distributed Platform: All the aforementioned techniques SDN/NFV, network slicing and disaggregation can be combined in a distributed platform to test advanced networking scenarios in realistic large-scale environments. This could be done by leveraging virtualized computing and networking resources in a flexible way to provide support for solutions based on the use-case, geography and experimenter choice.
- Control and User-plane Separation: Control and User Planes (CUPS). In fact, with the densification of the next generation radio access networks, and the availability of different spectrum bands, it is more and more difficult to optimally allocate radio resources, perform handovers, manage interfaces, and balance load between cells. It is therefore necessary to adopt centralized control of the access network in order to increase system performance.
- Configuration and Orchestration of Experiments: An experiment is composed of a list of steps that include a specific set of tuning parameters for the system components, the

configuration parameters for background traffic components, and the deployment and execution of the components to the testbed nodes and network elements. Orchestration of experiments is thus the process of running the sequence of steps that define the experiment. It is a complex task due to the concurrent, heterogeneous, asynchronous, and prototype-based systems that must be integrated into realistic scenarios to conduct trustable evaluations.

- Data-Storage Design: Data storage is an important feature to support in order to understand how the execution evolves during the experiments that generate detailed log traces with multiple levels of detail. Depending on the type of experiments, logs can be huge and saved locally on the testbed nodes as well as managed by a log collector and for instance saved in a MongoDB database in different locations, e.g., at the network edge infrastructure or in the public cloud.

Based on the above, the architecture of SLICES-RI is organized as follows in terms of hardware and software. SLICES hardware facilities and can be categorized into four basic sub-systems:

- Inter-Facility Interconnections and Intra-Facility Switching Fabric;
- Real-time and Non-real-time Computing;
- Radio Infrastructure;
- End-user devices.

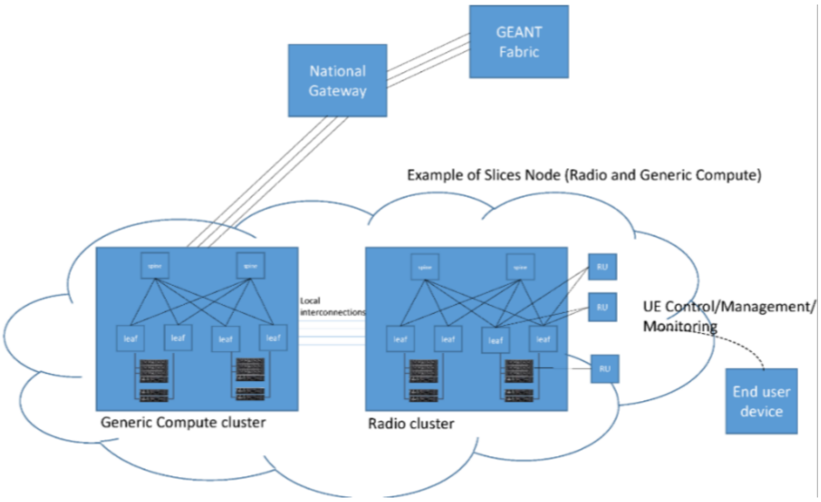

Figure 2: A high-level view of a SLICES node from an equipment standpoint

An example SLICES node is shown above. It comprises two interconnected clusters in the same geographic region, one of which is equipped with radio-units and the other is a more generic computing platform. The left cluster has a long-distance interconnection with the national gateway, which itself is interconnected with the GEANT fabric and the rest of the SLICES network. In the following subsections we provide some initial guidelines for the architecture of the various components.

In turn, the software architecture of SLICES needs to organize the different geographically dispersed site facilities in a single pan-European facility, adopting common tools for managing and orchestrating experiments over the infrastructure, as well as providing a single access and credentials to users. A first attempt to sketch our reference architecture, with respect to the tools used for its management, is described in Figure 3.

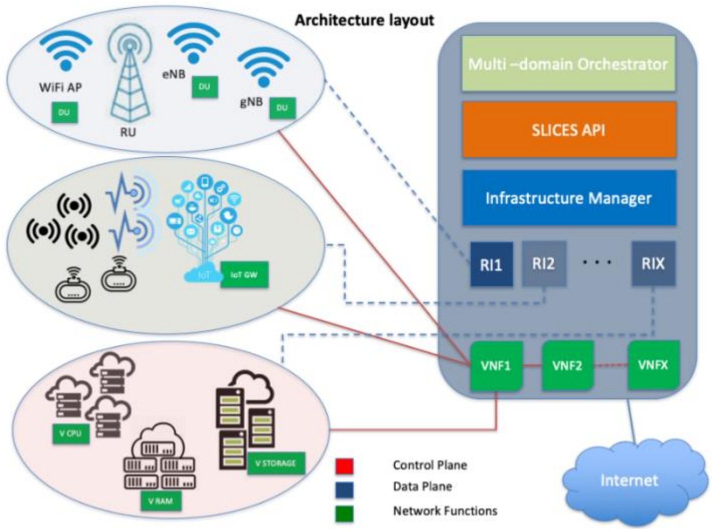

Figure 3: SLICES conceptual architecture

Towards achieving this integration, the sites will adopt network virtualization for their resources, compatible/stemming for example from the Management and Orchestration (MANO) architecture[1] for managing and deploying new services over the physical equipment. Each node will be considered as a single domain for experimentation, while the overall orchestration of experiments will be performed through a centralized infrastructure. Site and node selection frameworks will be developed in the context of SLICES, towards ensuring the optimal use of resources among the sites.

Moreover, and towards ensuring the smooth operation of the infrastructure, tools for facilitating access will be developed and deployed. Open-source software shall be employed, based on the paradigms of existing testbed access schemes, user authentication and authorization. This software will be appropriately tailored with new modules for managing the new equipment described in the previous section. Complete guidelines for the software and hardware architecture of the SLICES RI are presented in depth in D2.1 “Initial Description of the SLICES Architecture and Services”.

1.2 SLICES Services

The Deliverable D2.4 “*SLICES as a Service*” [D2.4], an updated version of Deliverable D.2.2 “*SLICES as a Service, baseline*” [D2.2] presents an initial set of 12 services for SLICES users, i.e., experimenters, based on the long experience of SLICES members in running smaller and less diverse testbeds. These services can be structured in four main categories:

1. **User and platform management services**

    1.1: [USERS_MGT] User and group management

    1.2: [DOCUMENTATION] Documentation and Online Experiment Helpdesk

    1.3: [ACCOUNT] Accountability & billing

2. **Resource management services**

[1] Mijumbi, R., Serrat, J., Gorricho, J. L., Bouten, N., De Turck, F., & Boutaba, R. (2016). Network function virtualization: State-of-the-art and research challenges. IEEE Communications Surveys & Tutorials, 18(1), 236-262.

2.1: [DISCOVERY] Resource discovery and description

2.2: [RESERVATION] Resource reservation

2.3: [CONFIGURATON] Resource configuration

2.4: [MONITORING] Resource monitoring and profiling

3. **Data oriented services**

3.1: [DATA] Data Management Service

3.2: [ANALYSIS] Experiment data validation and correlation with other experiments

4. **Experiment management services**

4.1: [EXP_MGT] Experiment management

4.2: [ORCHESTRATION] Experiment control and orchestration

4.3: [DASHBOAD] Dashboard

At least a basic version of most of these services are needed for the initial deployment. For being able to run a toy experiment, USERS_MGT, DISCOVERY, and RESERVATION services are required. To set up interesting experiments, CONFIGURATION, and DATA are needed while ORCHESTRATION, EXP_MGT and ANALYSIS will be needed for more advanced scenarios that SLICES target. Moreover, to learn how to use the platform and to supervise experiment, DOCUMENTATION, MONITORING, and DASHBOARD will be of particular importance. For the management of the platform ACCOUNT is of course vital.

We can derive an order of priority in the setting up of the services.

- Highest level of priority of services: USERS_MGT, ACCOUNT, DISCOVERY, and RESERVATION
- Second level of priority of services: CONFIGURATION, DATA
- Third level of priority of services: DOCUMENTATION, MONITORING, and DASHBOARD
- Fourth level of priority of services: ORCHESTRATION, EXP_MGT, ANALYSIS

It is not expected to open the platform to external users at least before services of third level of priority are available.

2 Initial Site Selection Criteria and Procedure

2.1 Objective of the site selection

Offering or choosing a site for the construction of a pan-European research infrastructure is an important, far-reaching and crucial science policy issue for a scientific community, a country and for Europe. SLICES can be seen as “complex research facilities” in addition to, for example traditional centralized infrastructures. Even each site or node can be seen as centralized or distributed infrastructure itself, depending if we are considering a geographical scale of each particular node (national, regional, supra national) or if we are considering a political scale (single organization with one location or several organization with several locations). The site selection process has a scientific phase and a political phase. It is important and crucial to transfer the process at the right time from the first to the second phase and to have recognized scientists in the first phase and a high political level in the second one.

SLICES is considered as a very dynamic ecosystem that initially could be very simple, but with a high potential of being finally a very complex ecosystem. The objective of this section is to set the roots of initial site selection criteria and procedure.

SLICES is an infrastructure where many researchers working in different centers are contributing data, tools/services and knowledge and where the major task of the research infrastructure initiative is to create a virtually integrated suite of resources allowing researchers to carry out state-of-the-art research. SLICES principles work on the FAIR dimension: Findability, Accessibility, Interoperability and Reusability. The definition of the FAIR principles and their wide acceptance can be seen as a confirmation of what SLICES is doing and it gives new impulse to close still existing gaps. SLICES research infrastructure also seems to be ready to take up the next steps, which will emerge from the definition of FAIR maturity indicators. Experts from SLICES should bring in their 10-years' experience in this definition and building process of the infrastructure. SLICES is going to include also the FAIR principles in the site selection criteria and procedure dimension.

SLICES site selection decision making procedure need to be adapted across the lifetime or the research infrastructure from the planning to construction and operation procedures. At a first step, we are going to define initial criteria and procedures during the current status of the SLICES that is ending the design study phase and it is entering the preparation phase. In this first phase, a strong and lasting scientific support is essential. It is important to take the dynamics and debates within the scientific community into consideration. Scientists may have a strong national orientation or concentrate too much on their specific field.

A site quality assessment procedure should be defined at an early stage that includes an analysis of all relevant technical, political, financial, legal and socioeconomic aspects of all proposers' sites by independent experts. The procedure should be as open and transparent as possible.

2.2 Criteria

SLICES can formulate the following initial set of criteria for site selection procedure; however, the SLICES Supervisory Board is the body in charge of redefining this criteria when open new calls for interest in hosting:

- The site should have a clear name and legal status
- The site should have a management structure (director and/or board of members/directors)
- The site should have a strategy and development plan
- The site should have a well-defined access point for users, single website and a single or unified process for user's proposals and access
- The site should have an annual report
- The site should demonstrate technical excellence and scientific performance of the infrastructure
- The site should demonstrate European added value
- The site should demonstrate Regional added value
- The site should demonstrate National financial and political support
- The site should demonstrate socioeconomic impact at national and European level
- The site should demonstrate the impact of its location on the European objective of a balanced territorial
- The site should demonstrate the availability of enough resources (building, scientific equipment, human resources)

2.3 Procedure

SLICES has analyzed the OECD Global Science Forum (GSF)[2] initiative to provide options to facilitate the development, operation and use of very large research infrastructures. The objective is to give support to make the research infrastructures more responsible to global crisis or major disciplinary shifts, where possible and to provide long-term perspectives for their worldwide development
The GSF has a standardized procedure for the site selection of distributed research infrastructures. We have adopted in SLICES the philosophy of the GSF procedure and adapt it to the particularities of SLICES objectives and ambition and its governance framework described in the deliverable *D3.4 on SLICES final governance structure* and the deliverable *D3.5 on the Roadmap for the implementation of the governance and sustainability.*

We have outlined a process for the new site selection with selection criteria that is showed in the following figure. The final decision takes place within the Supervisory Board body of the SLICES governance model.

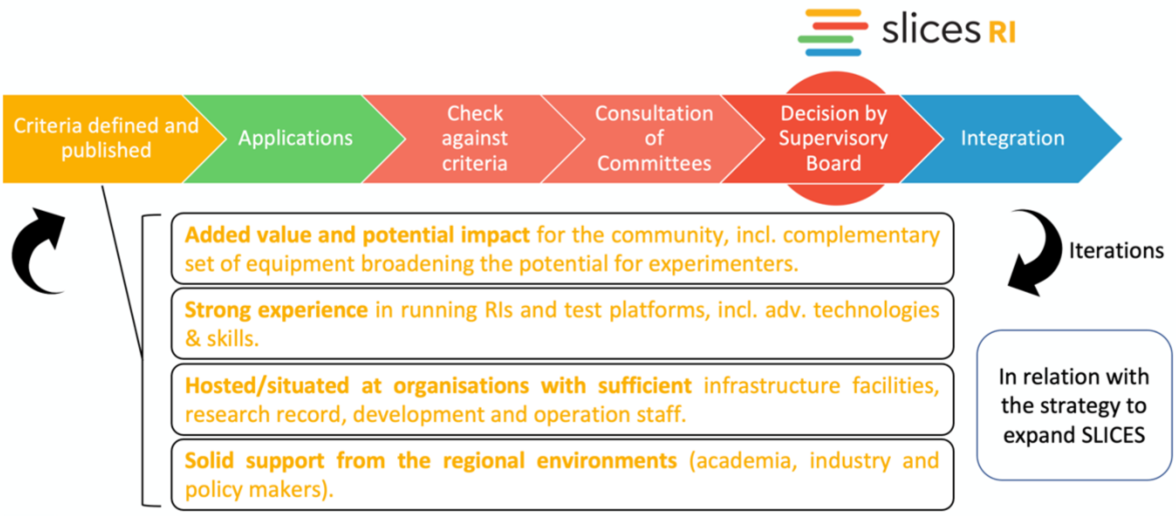

Figure 4: SLICES New site selection procedure and criteria framework

The SLICES procedure for a new institution starts within the SLICES Supervisory Board by declaring the interest of SLICES on hosting new members. Based on this, a call for interest in hosting a new institution is formulated and a detailed document is sent out by the SLICES Supervisory Board. Key factor for this call is a detailed negotiated consensus list of criteria enumerated in a Request for Proposals (RFP) document. Required contents of a bid can be:

- Location, description of facilities and services agreed to in an arrangement between host and institution
- Eligibility: A bid may be submitted on behalf of a government or its representative institution of a country that intends to be a member of the new institution.
- Legal Status of the new institution, of the Host and employment status of the staff.
- Funds: process for receiving, holding, managing and accounting for funds from contributing countries, private company sponsors, and other entities.
- Disbursing of funds: Specification of how goods and services will be purchased at the request of the new institution.
- Procedures for using the funds of the institution.
- Voluntary Contributions of the Bidding Country and or Institution.
- Guidelines and Procedure for Submission, Review and Selection.

[2] OECD Global Science Forum, https://www.oecd.org/sti/inno/global-science-forum.htm, [Last accessed 5 October 2022]

After receiving the proposals, the SLICES Supervisory Board sets up of a small committee of independent, neutral experts for evaluation of the responses to the RFP by the bidders. The committee formulates its recommendations for the site on the base of a set of evaluation criteria. A preliminary exercise of evaluation criteria can be the following ones:

1. Completeness of responses to the RFP
2. Bidder's organizational & institutional ability to provide the services listed in the RFP
3. Bidder's technical approach & project organization, as given in response to the RFP
4. The extent to which the Bidder can host the new institution as an independent legal/administrative entity with purchasing and contracting autonomy
5. Additional amenities offered by the Bidder
6. Financial support and incentives, including but not limited to tax-exempt status and cost of host-provided services, offered by the Bidder.
7. Experience of the Bidder in hosting other international programs

Based on the recommendations of the expert committee, the SLICES Supervisory Board makes the final siting decision usually by majority vote.

3 Analysis of the Reuse of Pre-Existing infrastructure

Implementing a large-scale research infrastructure for ICT scientists and industry is a challenging task. The design and preparation for the deployment phase should reflect the efforts done in the past in this area in Europe to enable smooth transition between loosely coupled RI developed individually by particular Member States to a truly integrated, distributed but centrally managed European RI.

In March 2021 the SLICES-DS members made an effort to analyze the current technological status and capabilities of existing ICT Research Infrastructures and e-Infrastructures in Europe. The work has been reported in Deliverable D1.1 "Technological status and capabilities of existing ICT Research Infrastructures". The following figures summarize the findings reported in the deliverable.

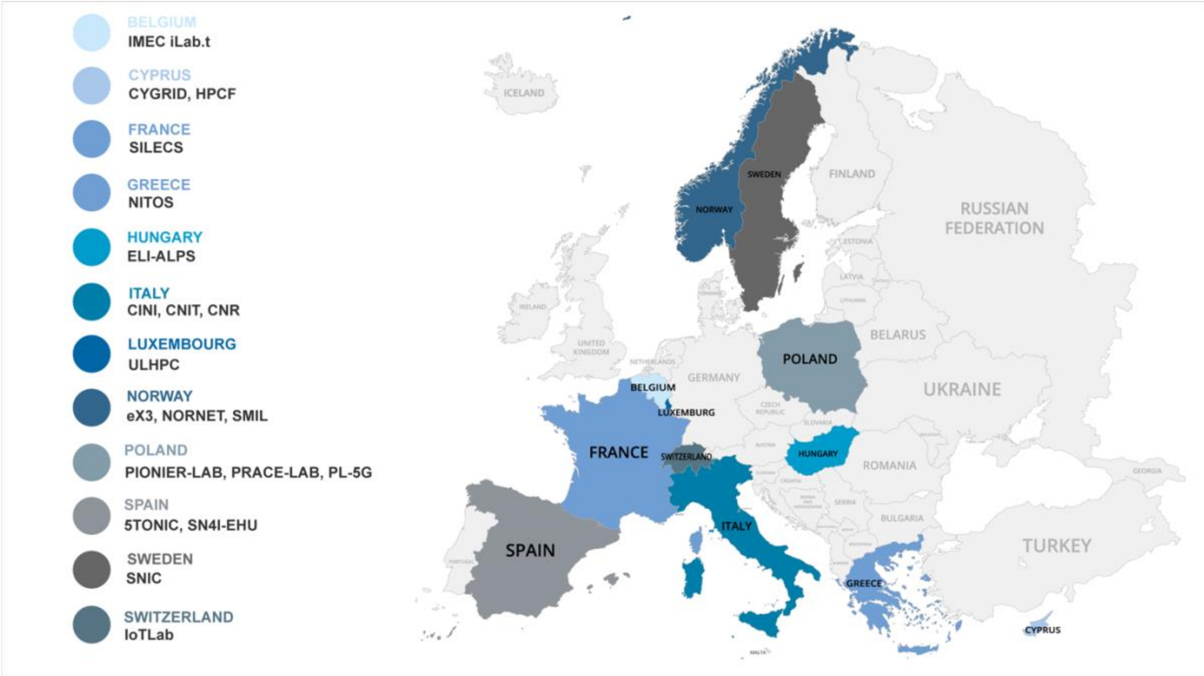

Figure 5: Geographical coverage of the survey - Research Infrastructures

Figure 6: Geographical coverage of the survey - e-Infrastructures

In this section an update of the analysis is reported. The analysis of potential integration with SLICES is presented, taking into account the following considerations:

- Scientific value;
- Technological issues (e.g., potential costs of migration, the deployment of required SLICES components, etc.);
- Human staffing.

The analysis is not exhaustive. It intends to provide some insights to further analysis the needed evolution to the set-up of SLICES nodes.

3.1 Research Infrastructures

3.1.1 Cyprus

Cy-Tera		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	The High-Performance Computing Facility provides compute and data resources to the research community of Cyprus and the Eastern Mediterranean region, and to establish itself as the national supercomputing facility of Cyprus. Cy-Tera is an innovative hybrid machine, which is the first supercomputer in Cyprus, and the biggest open access supercomputer in the Middle East.
Technological issues (none, minor, major)	Minor	The Cy-Tera production machine is an IBM Hybrid CPU/GPU cluster consisting of 98 twelve-core compute nodes and 18 dual-GPI compute nodes with a peak performance of ~30 Terraflop/s, supporting an excess of 600 software packages. The total storage capacity is 2 Petabytes. User support and help-desk services to facilitate access to the machine are provided by dedicated operations personnel. A section of the facility serves the needs of government agencies (e.g., the Cyprus Meteorology Department). The facility is a regional supercomputing eco-system and is part of European Super-computer infrastructures (PRACE).
Human staffing (available, not available)	Available	The facility is supported by dedicated staff.

3.1.2 France

SLICES-FR		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	SLICES-FR is a large infrastructure for experimental research on various aspects of distributed computing and networking, from small wireless objects to large data centers of tomorrow. It enables end-to-end reproducible experimental research on the entire data chain (from its capture to its processing, through its wired and/or wireless transmission) and it supports an open data approach. SLICES-FR provides a large pallet of heterogeneous devices fully programmable,

		everywhere in the network, from end devices to cloud servers going through Internet routers with software and applications at all levels of the software layers. It enables to experiment, prototype and test wireless communications (cellular, IoT, wifi, etc) in different environments and topologies, including anechoic rooms, indoor and outdoor deployments. SLICES-FR also includes advanced experimentation tools and facilities for HPC and distributed computing and it provides an interface to Cloud infrastructures like Cloudlab and Edgenet. SLICES-FR also provides advanced monitoring and measurement features for trace collection of networking and power consumption as well as full traceability of infrastructure and software changes on the testbed.
Technological issues (none, minor, major)	Minor	The infrastructure is under construction. It is based on the experience gained with testbeds such as Grid'5000 and FIT that are in production for more than 10 years.
Human staffing (available, not available)	Available	The facility is supported by dedicated staff.

3.1.3 Greece

NITOS		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	NITOS Facility is an integrated facility with heterogeneous testbeds that focuses on supporting experimentation-based research in the area of wired and wireless networks. NITOS is remotely accessible and open to the research community 24/7. It is used from hundreds of experimenters and is federated with several infrastructures all over the world and it is also part of the OneLab federation. The main experimental components of NITOS are: 1) a wireless experimentation testbed, which consists of 100 powerful nodes that feature multiple wireless technologies 2) a wireless city-scale sensor network in Volos city 3) a Software Defined Radio testbed 4) a Software Defined Networking testbed 5) a mmWave testbed 6) a Cloud infrastructure. The facility is able to support different configurations in order to mix resources from different testbeds, in order to create repeatable experiments with high scientific value. The testbed is also part of the Greek Roadmap of Research Infrastructures since 2014, under the HELIX-GR/HELNET

		action.
Technological issues (none, minor, major)	Minor	The facility has been operational for more than 15 years, with new equipment being integrated to it. There are no specific issues for the integration of the facility with the overall SLICES-RI, though specific equipment might use specific interfaces for the overall integration. In such cases, the testbed support team is able to smoothly integrate the testbed specific APIs with the overall SLICES-RI. Moreover, user support and help-desk services to facilitate access to the testbed are provided by dedicated operations personnel.
Human staffing (available, not available)	Available	The facility is supported by dedicated staff.

3.1.4 Poland

SLICES RI will be supported by at least two RIs from the list reported in D1.4.

PIONIER-LAB		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	PIONIER-LAB is a research project from the Polish Roadmap of Research Infrastructures. The Project concentrates on the creation of eight closely related research laboratories, creating a shared cooperation space, the PIONIER-LAB research platform: 1. Laboratory of innovative network technologies; 2. A distributed laboratory of time and frequency; 3. Smart Campus as a Smart City Lab; 4. Regional "Living" Innovation Laboratories inspired by ICT; 5. Cloud Services Laboratory; 6. Multi-Scale Simulation Laboratory; 7. Laboratory of e-training services; 8. Pre-incubation laboratory.
Technological issues (none, minor, major)	Minor	The research infrastructure is still under construction. Operational phase is planned from 1st January 2024. Potential integration with other infrastructures is predicted in mid-2024, however, at this moment no specific issues preventing integration with SLICES RI have been identified.
Human staffing (available, not available)	Available	The project will be supported by dedicated staff during the whole operational phase, starting from 2024.

PL-5G		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	The aim of the PL-5G "National Laboratory for Advanced 5G Research" is to build a unique on a national scale research infrastructure for performing experiments of new techniques and solutions in the area of 5G network and services.
Technological issues (none, minor, major)	Minor	The research infrastructure is still under construction. Operational phase is planned from 1st January 2024. Potential integration with other infrastructures is predicted in mid-2024, however, at this moment no specific issues preventing integration with SLICES RI have been identified.
Human staffing (available, not available)	Available	The project will be supported by dedicated staff during the whole operational phase, starting from 2024.

3.1.5 Switzerland

IoT Lab		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	IoT Lab is a research infrastructure composed by several federated testbeds. The main server is hosted in Geneva, Switzerland. The IoT Lab testbeds are dedicated to do research, development and experimentation in the context of the Internet of Things (IoT). Different servers are available: 1. Cisco ESXi server hosting the IoT Lab platform and related services/tools; 2. OpenStack cluster offering virtual machines dedicated to R&D activities, including for European projects.
Technological issues (none, minor, major)	Minor	The IoT Lab research infrastructure is based on the components developed and used by Fed4FIRE. The IoT Lab testbeds are integrated since 2019 in Fed4FIRE+ testbed federation. Technically, IoT Lab is using a SFA client to realise and manage experiments.
Human staffing (available, not available)	Available	The project will be supported by dedicated staff during the whole operational phase.

3.1.6 Spain

SLICES will be supported by at least the following two nodes:

5TONIC		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	The 5TONIC facility is an open research and innovation laboratory focusing on 5G technologies founded by IMDEA Networks and with participation of the University Carlos III of Madrid. The objective of 5TONIC is to create a global open environment where members from industry and academia work together in specific research and innovation projects related to 5G technologies with a view to boost technology and business innovative ventures. The laboratory will promote joint project development and entrepreneurial ventures, discussion fora, events and conference sites in an international environment. The 5TONIC laboratory includes a solid baseline of facilities, infrastructure and equipment to support advanced experimentation in the Beyond 5G and 6G virtual network function and wireless systems areas. In other words, 5TONIC will serve to show the capabilities and interoperation of pre-commercial 6G equipment, services and applications, by leading global companies in the 6G arena. Apart from the initial members, 5TONIC welcomes new members to join and gain from the benefits of an advanced research and innovation laboratory, oriented to research, debate, field-testing and demonstration of all technologies and equipment to support 5G communications, services and applications. The main 5TONIC research & innovation laboratory site is located at IMDEA Networks Institute, a research institute on the forefront of technological innovation and with an extensive track record in European Beyond 5G and 6G Research Projects. IMDEA Networks is one of the main leaders at European level in the field of 6G networks.
Technological issues (none, minor, major)	Minor	The facility has been operational for more than 8 years, with continuous integration of new equipment and service provisioning for experimentation. The facility is currently running and has already evaluated the integration within the SLICES distributed architecture. Dedicated equipment and staff are supporting the integration with SLICES.
Human staffing (available, not available)	Available	The facility is supported by dedicated staff.

SN4I		
	Self-evaluation	Explanation
Scientific value (low, medium, high)	High	The SN4I (Smart Networks for Industry) facility, is a 5G-enabled, NFV and SDN aware communication network that supports advanced Industry 4.0 applications deployed between the Faculty of Engineering in Bilbao, the RedIRIS Point of Presence in Leioa and the Aeronautics Advanced Manufacturing Research Centre (CFAA) in the Technological Park of Bizkaia in Zamudio. The SN4I infrastructure leverages NFV to provide a flexible way to deploy virtual services and SDN to allow the programming of network elements in order to interconnect these virtual services. After having deployed some use cases for NB-IoT and LTE/M it has recently been upgraded to support 5G within a National 5G Pilot and as a result of own investments. This deployment also allows to study the integration of NFV technologies with the Industrial Internet protocols and the coexistence with other networks like TSN (Time Sensitive Networks). Therefore, SN4I will complements advanced manufacturing technologies, with state-of-the-art communication technologies like high bandwidth, low delay, on demand service creation, mission critical communications, SDN based security, etc. The integration of all these technologies with cutting-edge machine tools and manufacturing processes provides a mixed R+D+I centre in advanced and connected manufacturing technologies that represents state of the art 5G applications for Industry 4.0 and beyond.
Technological issues (none, minor, major)	Minor	The facility is currently running and has already evaluated the integration within the SLICES distributed architecture. Dedicated equipment and staff are supporting the integration with SLICES.
Human staffing (available, not available)	Available	The facility is supported by dedicated staff.

3.2 e-Infrastructures

One e-infrastructure is of particular importance for SLICES. It is GEANT that will provide interconnections between the various SLICES locations. Standard services of GEANT can be used to set up SLICES, i.e., interconnecting the central hub with the SLICES nodes. One limitation of such approach if that there are not any dedicated services for multi-SLICES node experiments (such as some latency or bandwidth control). Therefore, SLICES may require special services from GEANT to enable advanced multi-SLICES node experiments.

Many e-infrastructures are available and will be part of EOSC. One of the goal of SLICES is to interoperate with (some of) these e-infrastructures for three identified cases. First, an experiment may need input data that are stored outside SLICES and thus probably within another e-infrastructures. Second, in addition to store outside SLICES data generated by experiments, SLICES will also need to data its own generated data for long term storage, taking into account the data regulation in place at that time. Third, specific experiments may need to combine SLICES with an e-infrastructure such as PRACE. It will enable a very large-scale experiment.

In conclusion, there are two main cases in term of deployment and relationships with e-infrastructure. GEANT is a very particular case because it may require to integrate specific services of GEANT within SLICES. The integration with other e-infrastructures relies of the interoperability of services that will be ease with the participation of these infrastructures, including SLICES, to EOSC.

4 Strategy to Decommission

As described in Section 2, the hardware part of SLICES RI will consist mainly in computer, network, and storage. It will also include some specialized rooms to host part of them such as anechoic rooms for example as well as some outdoor deployments. Hence, two types of decommissioning strategies have to be identified:

- for short lifespan hardware, typically 5 years, such as computers and networking elements;
- for long lifespan such as specialized room such as anechoic rooms or the infrastructure for outdoor deployment.

Most of equipment will be operated by the national nodes. The central hub of SLICES will run some servers to host some services and some experiment dedicated IT hardware.

4.1 Short Lifespan Equipment

The short lifespan equipment is composed of IT hardware. Hence, a continuous update and thus decommissioning has to be set up. In particular SLICES RI will take care of recycling its IT hardware with respect to best practices. Two strategies have to be designed to handle the two types of short lifespan hardware that will compose SLICES-RI.

- For the hardware running the services of the infrastructure, classical IT decommissioning procedure could be applied. As noted in decommissioning procedures, special care will be given to the backup of data for the time of the decommissioning so as to not lose any data as well as to communicate to users well in advance of when is schedule the operation. As SLICES is not intended to provide long term storage for user data, users will be informed to download their data in general, and in particular if SLICES will not be able to backup all users' data for a particular large upgrade operation;
- For the hardware being part of the experimental part of SLICES RI, the same procedure could be applied with one particular consequence. As an experiment may depend on the actual type of hardware, the total removal of a type of hardware would prevent the full reproducibility of experiment. While it is possible to keep online or store some hardware elements, we believe it would not be a viable long-term solution.

As a consequence, the decommissioning of SLICES hardware is very common and should not generate specific difficulties. It should be also the case for outdoor decommissioning as of today outdoor deployment is planned in well accessible place like cities. If other types of outdoor deployments appear, the decommissioning procedure and cost will be updated.

4.2 Long Lifespan Equipment

This category includes various types of equipment that currently are under the control of the national nodes as the central hub. The procedures should be the same as the central hub will be mainly consists in commodity IT hardware.

As discussed previously, SLICES shall set up an anticipated communication procedure to let users retrieve their data in particular at the end of SLICES.

With respect to the data belonging to SLICES, a long-term storage solution has to be designed to guarantee their availability after the termination of SLICES while enforcing data protection regulation.

4.3 Cost

As the SLICES decommissioning procedures appear to be classical IT procedure, we have not identified any major costs or difficulties linked to the termination in the case of our digital infrastructure.

5 Conclusion

This deliverable provides a first analysis to set up the plans for the deployment of the SLICES core, i.e., the operational part of the platforms including the central hub and some SLICES nodes. It also deals with criteria for the initial site selection as well as it provides some insights on the decommissioning issue.

As SLICES will provide a fully programmable remotely accessible infrastructure to the Digital Infrastructure scientific community, the SLICES software architecture needs to organize the different geographically dispersed site facilities in a single pan-European facility, which experimenters will access seamlessly thanks to SLICES services. The first part of this deliverable provides an initial analysis of the order of deployment of the services to deal with a progressive deployment of SLICES. While four levels have been identified, it is not expected to open the platform to external users at least before services of the third level of priority are available.

The second part of the document discusses the criteria and procedure to select the initial sites of the central hub as well as nodes. This work is a first step in defining the criteria and procedure to drive these actions in conjunction with other aspects such as governance issues that will further detail in the SLICES-PP project.

The third part of this deliverable reviews some platforms identified in Deliverable D1.1 that may candidate to become a node of SLICES as they provide some features that can be used as a foundation for SLICES nodes, hence enabling a rapid deployment. Another conclusion is that there is a global experience of managing such kinds of testbed in Europe.

The last part of this deliverable deals with the issues related to decommissioning. As most of the hardware of SLICES will be IT hardware, standard procedures to decommission provide a solid starting point to define procedures. The hardware decommission of running services could be envisioned almost transparently to end users most of the time. An important moment is at the final decommission that should deal with the retrieval of end user data and to the long-term preservation of SLICES data while respecting data protection regulation.

6 Bibliography

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