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D5.2 Report on Technology Transfer Activities v2

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Scientific Large-scale Infrastructure for Computing Communication Experimental Studies **Starting Communities**

www.slices-sc.eu

Executive Summary

The objective of this document is to report the activities of the consortium partners towards promoting and fostering the technology transfer of SLICES-SC and the liaison with industrial stakeholders to engage industrial researchers to the use of the research infrastructures. The document includes the description of the methods and tools used to improve the awareness of the industrial users on the capabilities and the opportunities available at the different Research Infrastructures (RI). It also describes the brokerage activities of the partners to establish and grow an industrial network in order to raise the awareness of RI services to the industrial community and stimulate the engagement of industrial R&D staff. This report focuses on the above-mentioned activities that took place between months 19 and 40 (September 2022 – June 2024), since the activities that took place before that period have been described in deliverable D5.1.

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1. Introduction

1.1. Deliverable Objectives

This report describes the activities towards promoting and fostering the technology transfer of SLICES-SC and the liaison with industrial stakeholders that took place between months 19 and 40.

1.2. Intended Audience

This document is aimed at SLICES-SC consortium members, the external communities related to SLICES-SC, and in particular the industrial R&D staff targeting to use the SLICES research infrastructures. The document reports the activities of the consortium partners towards the technology transfer of SLICES-SC and the liaison with industrial stakeholders.

1.3. Objectives of SLICES-SC

SLICES-SC aims to develop and provide services related to experimentation in the context of digital sciences such as 5th and 6th generation cellular networks (5G, 6G), Network Function Virtualization (NFV), Internet of Things (IoT) and cloud computing.

1.4. Objectives of WP5

The aim of WP5 is to liaise with the relevant industry including Operators, Telecom providers, small and medium-sized enterprises (SMEs) and start-ups and to create strong links between them and:

- to promote and foster technology transfer especially for SMEs making scientific results more suitable for technological innovation.
- to engage the industrial researchers to the use of the RI by raising awareness of RI services to the industrial community and engaging industrial R&D staff.
- to organize an Industrial Advisory Board aiming at the engagement of a large number of external stakeholders.

2. Promoting and Fostering Technology Transfer

The standardization is a good mean to realize the technology transfer. SLICES is actively involved in the International Telecommunication Union (ITU) ITU-T Focus Group on Testbeds Federations for IMT-2020 and beyond (FG-TBFxG). This Focus Group is dedicated to the standardization of federated testbeds which are necessary to implement and test real technology deployment use cases coming from the industry. This Focus Group is composed by three Working Groups (WG). The 1st one, WG1, is exploring the use cases, applications, the business models and the demand coming from the industry. The 2nd one, WG2, is taking care of the Testbeds as a Service and the specifications of the required APIs to federate the testbeds. Finally, the 3rd Working Group, WG3, is focused on the instantiations of the reference model and APIs. More information on the Focus Group FG-TBFxG is available online at https://www.itu.int/en/ITU-T/focusgroups/tbfxg/Pages/default.aspx.

Since the beginning of the Focus Group FG-TBFxG, the needs of the industry are taken into account in the different deliverables produced by the Working Groups. In particular, a federation of testbeds should be able to test, evaluate and validate any applications developed by the ICT industry. Different stakeholders working in the industry were identified in the context of the Focus Group; these industrial

stakeholders are the vendors and suppliers of industrial solutions, the Communication Service Providers (CSPs) and the enterprises which are involved in research and development linked to ICT.

The collaboration with the industry in the Focus Group FG-TBFxG is concretely done through the participation and contributions from these different industrial companies involved in ICT development and testing: Algérie Télécom SPA, A1 Telekom Austria AG, China Mobile Communications Co. Ltd., China Telecommunications Corporation, Orange, Vodafone GmbH, Telecom Italia S.p.A, NTT Communications Corporation, Ericsson Canada Inc., Rohde & Schwarz GmbH & Co., Corning Incorporated, Altran Capgemini, MOBIGEN, Salconst, IXP-Consulting, Smart Home, Spirent Communications, Data Machines Corp., Huawei Technologies Co. Ltd. and Veltris.

The standardization activities undertaken in the ITU-T Focus Group on Testbeds Federations for IMT-2020 and beyond (FG-TBFxG) permit to SLICES to exchange and collect the heterogeneous elements related to the needs and the requirements from the industry. In the context of the process, SLICES can align its internal developments to the industry needs and then, to fulfill the requirements elaborated to the industry, ensuring at the end that the SLICES offer corresponds to the demand expressed by the industry.

Standards that are relevant in the networking area are developed by multiple organizations. ITU is one of them, with focus on telco-specific standards. The Internet Engineering Task Force[1] (IETF) is a standardization organization that focuses on the development of Internet standards, such as IP or TCP and QUIC. The IETF also standardized YANG to models and describe packet processing devices. These models and the configuration described by these standardized models can then be used to configure entire (wide area) networks. The relevance of these standards is demonstrated in the active community in the IETF working group on Network Management Operations (nmop) involving companies such as Huawei, Orange, Telefonica, Swisscom, Nokia, and Cisco. Due to their high practical relevance, we aim to support these already established standards in SLICES where possible.

3. Engaging Industrial Users to the Use of RIs

The interaction with industry will contribute towards ensuring the long-term success of SLICES-SC. To achieve this goal, SLICES-SC partners have been engaged in a number of activities with the purpose of creating links with industrial partners and raising awareness of RI services to the industrial community. Such activities include the organization of workshops with industrial partners and the participation to industry events such as Mobile World Congress, CES, etc. These activities are listed below for each partner, focusing on the activities that took place during months 19 and 40 (September 2022 – June 2024), since the activities that took place before that period have been described in deliverable D5.1.

3.1. Activities to create links with the industry (September 2022 – June 2024) – SU

SU is highly engaged into the strategy for making SLICES-RI highly visible and to onboard as early as possible industrial requirements as recommended by ESFRI. Most initiatives are related to raising awareness with respect to important target groups and present SLICES in various venues where industry is present. In particular, 6G-IA is an important target as European 5G industry is present and active, as well as stream C of the program is related to test platform. As a consequence, SU has been leading the dialogue between SLICES and various proposals addressing 6G-IA calls. In particular, being

[1] IETF website, https://www.ietf.org/ [Last accessed 27 June 2024]

visible from Stream C successful project is an important asset. For instance, SU signed on behalf of SLICES an MoU with Keysight representing the 6G-Sandbox project. A first meeting was organized at EUCNC 2023 between the two communities and the dialogue is ongoing. Likewise, SU is involved as a partner is two 6G-IA projects that started early 2024:

- SUNRISE-6G[2] that is developing an overarching solution to federate most if the 6G-IA facilities;
- 6G-XCEL[3] that is dealing with the EU-US cooperation related to IA for telecommunications.

Industrial participation is high in both projects and the objective is to position SLICES as a preferred test facility for 6G-IA projects.

In addition, SU has been organizing and chairing several workshops where industry has been involved such as:

- Globecom 2022, Rio de Janeiro, 5th December 2022, Future G Research Platforms;
- NetworldEurope General Assembly, 13th December 2022, online, presentation of SLICES-RI;
- IoTBDS 2023, 22-24 April 2023, Prague, keynote talk on SLICES;
- COMSNETS 2023, Bangalore, 8th January 2023, TASIR workshop: Testbeds for Advanced Systems Implementation and Research;
- Midscale Experimental Research Infrastructure Forum (MERIF) 2023, 22nd-24th May 2024, Boston, Liaison between SLICES and US-based testbeds and initiatives;
- 26th Conference on Innovation in Clouds, Internet and Networks, 8th March 2023, Keynote #2 Title: Slices: European Scientific Large-Scale Infrastructure for Computing/ Communication Experimental Studies;
- PSNC Days 2023, 14th September 2023, Poznań, "Future Internet, 5G and beyond – SLICES RI";
- The 18th Asian Internet Engineering Conference (AINTEC), 13th December 2023, Hanoi, talk "SLICES: The first Scientific Instrument for Computing/Communication Experimental Studies";
- Globecom 2023, Kuala Lumpur, 8th December 2023, FutureG Experimental Test Platforms for Advanced Systems Implementation and Research;
- EUCNC Workshop: 3rd – 6th June 2024;
- IFIP Networking 2024 Workshop: 3rd June 2024.

and the following journal special issues that are highly visible including for industry:

- https://www.comsoc.org/publications/magazines/ieee-communications-magazine/cfp/experimentation-large-scale-wireless
- https://www.sciencedirect.com/journal/computer-communications/about/call-for-papers#large-scale-experimental-platforms-for-computer-and-networking-research-recent-advances-and-challenges

Finally, SU also did a SLICES presentation at the ORAN NGRG working group in 2023.

SU will continue to support a strategy for broad awareness and adoption of SLICES by industry.

3.2. Activities to create links with the industry (September 2022 – June 2024) – UTH

The University of Thessaly is well connected with the local industry. Most of the initiatives undertook are related with awareness raising and presentation of SLICES-RI opportunities within different sectors. UTH is a member of the 6G Smart Networks and Services Industry Association (6G-IA) where

[2] SUNRISE-6G website, https://sunrise6g.eu/ [Last accessed 27 June 2024]

[3] 6G-XCEL website, https://www.6g-xcel.eu/ [Last accessed 27 June 2024]

all European Industrial organization are participating. UTH is involved in two recent projects of 6G-IA-IA:

- SUNRISE-6G that is developing an overarching solution to federate most if the 6G-IA facilities;
- NATWORKS that develops a novel bio-inspired cybersecurity and resilience framework for networking distributed systems that transcend a single administrative domain and cross a heterogeneous fabric of resources.

Industrial participation is high in both projects and the objective is to position SLICES as a preferred test facility for 6G-IA projects.

In addition, UTH is member of the International Data Spaces Association (IDSA) and is linked with GAIA-X, where industrial participation is high. UTH within its research activities on Data Spaces and through its alignment with Gaia-X and IDSA, places a strong emphasis on data sovereignty and trust. UTH presented SLICES both of the above association within different events and meetings.

UTH will continue to support the liaison with industry and present SLICES' offerings to the industrial community.

3.3. Activities to create links with the industry (September 2022 – June 2024) – IoT Lab, MI

The IoT Lab infrastructure provides a Testbed as a Service for the researchers. It combines into a common platform crowdsourcing tools together with several testbeds on the Internet of Things. It provides a unique tool to ease all kinds of multidisciplinary research and experiments. It also facilitates reporting and sharing the most relevant results of the different research activities with the participants. The crowdsourcing tools are composed by the IoT Lab smartphone application enabling participants to join the IoT Lab community with the possibility to suggest, initiate and participate in research projects. It enables participants to accept privacy-friendly interactions with researchers, including crowdsensing on a voluntary basis and with a very strong personal data protection. This enables end-users to be at the core of the research cycle in order to better align the research with the real end-users needs and requirements. A LimeSurvey server is also a part of the crowdsourcing tools allowing the creation of surveys for the participants.

Mandat International and IoT Lab have organized in the context of the edition 2022 of Digital Around the World[4] a session dedicated to the international collaboration for research infrastructure, targeting notably the stakeholders working in the industry. Different partners, namely Mandat International, IMEC, IMDEA and the University of Thessaly, presented the services offered by the SLICES-SC testbeds and which kinds of experiments could be conducted by the users, including the industrial stakeholders.

Mandat International is active in the standardization, mainly through the ITU-T Focus Group on Testbeds Federations for IMT-2020 and beyond (FG-TBFxG) which has worked on the specifications and use cases linked to the new generation of federated and distributed testbeds dedicated to ICT. Mandat International has a role of vice-chair of this Focus Group and is chairing the Working Group 2 (WG2) working on all the aspects associated to the concept of Testbeds as a Service, including the APIs. The Focus Group permitted to create a strong collaboration between the SLICES-SC project and the industrial partners also involved in the Focus Group. More information on the standardization

[4] Digital Around the World 2022 website, https://digitalaroundtheworld.org/digital-around-the-world-2022/ [Last accessed 27 June 2024]

activities realized by the Focus Group is available in the chapter 3 named “Promoting and Fostering Technology Transfer”.

IoT Lab organized an online conference on 6th October 2022, titled "Conference on SLICES Pan-European Research Infrastructure for Digital Innovation & Transformation – Swiss Cluster Event" with the aim of fostering connections between academia and industry at the Swiss national level. The conference provided a valuable platform for researchers and innovators to delve into various aspects of the SLICES initiative. This included discussions on accessing the largest European research infrastructure, opportunities for research collaboration, and forging partnerships with European counterparts.

Participants engaged in in-depth conversations surrounding innovative research infrastructure for future technologies, highlighting the importance of collaboration at both national and European levels through the SLICES initiative. Specifically, during the session titled "Research Infrastructures Perspectives and Opportunities," representatives from esteemed Swiss research institutions such as ETH Zürich, University of Geneva, EPFL Center for Intelligent Systems, and University of Applied Sciences and Arts of Western Switzerland (HES-SO) had the opportunity to showcase their research infrastructures. This session culminated in discussions about a proposed action plan that would involve collaboration between Swiss institutions and SLICES-RI.

3.4. Activities to create links with the industry (September 2022 – June 2024) – PSNC

In SLICES-SC, PSNC is responsible for the coordination of interaction with the Industrial Advisory Board (IAB). In this reporting period, two meetings with the IAB were organized, where PSNC lead the preparations from the project perspective, proposed the agenda, invited speakers and manage the meetings.

Moreover, PSNC as the operator of National Research and Education Network (NREN) maintains its own strong links with Industry by organizing internal meetings to understand the progress industry has made and its impact on the networking infrastructure maintained as part of the NREN.

Additionally, PSNC maintains strong links with industrial partners collaborating with PSNC within the umbrella of projects from National Roadmap of Research Infrastructures. In the reporting period several meetings were held, with the objective to learn about new infrastructure components deployed in the RI projects. The list of meetings held includes meetings with Nokia, Spirent, Dell Technologies, Adva, Juniper Networks and others.

In June 2024, the conference closing PL-5G project was held. This meeting was the opportunity to demonstrate capabilities of the PL-5G infrastructure and services to industrial representatives and explain the role of SLICES, as a coordination effort at the European level to build an ICT scientific instrument for scientific users and industry.

3.5. Activities to create links with the industry (September 2022 – June 2024) – IMDEA

IMDEA Networks and University Carlos III of Madrid have been very active in organizing and participating in different events with a fruitful collaboration with the industry. The most relevant activities can be summarized as follows:

- Organization and participation of the Spanish SLICES National Roadshow on 3rd October 2023 with a high participation of the Industry in the program (Telefonica and Interdigital) as well as of the audience during the online broadcasting of the event;

- Presentation of SLICES on the 1st Industry Workshop of the H2020 DAEMON projects on 23rd April 2023 in Barcelona;
- Participation of IMDEA Networks at the XIII edition of Madrid is Science Fair where hundreds of people visited the IMDEA Networks stand at the 'Madrid is Science Fair' which took place from Thursday, March 7th to Saturday, March 9th at IFEMA's Pavilion 5;
- Presentation of SLICES in the Steering Board of 5TONIC Lab with discussion on the engagement of Industry within SLICES. Industrial members (SMEs included) involved in that regular meetings are Telefonica, Ericsson, Commscope, Interdigital, Capgemini Engineering, ABB, Nokia, Intel, Rohde & Schwarz, Utek, Telcaria, Fivecomm, YVVR, GMV, ATOS, OpenNebula and NEC;
- Organization of SLICES UC3M Conference on 31st January 2024 a national event to disseminate SLICES. The event was broadcasting and with local and online participation. The objective of that event was to engage the national ecosystem from academia and industry.

3.6. Activities to create links with the industry (September 2022 – June 2024) – CNR

CNR is well connected with the industry, as it is a member of ARTES 4.0[5], an Industry 4.0 Competence Center for Advanced Robotics and enabling Technologies & Systems, which provides training and orientation services to companies on Industry 4.0 areas. For instance, in 2023, CNR has co-organized a university master on Cybersecurity, where we raised awareness about SLICES-RI opportunities. CNR is also a member of the 6G Smart Networks and Services Industry Association (6G-IA) where all European Industrial organization working on next-generation services and networks are participating. CNR is involved in two recent projects of 6G-IA:

- SUNRISE-6G that is developing an overarching solution to federate most if the 6G-IA facilities;
- 6GREEN that develops green technologies for the 5G/6G Service Based Architecture.

Industrial participation is high in both projects and the objective is to position SLICES as a preferred test facility for 6G-IA projects.

In addition, CNR is member of the Industrial Board of the Smart Cities & Communities national lab[6] of CINI, consisting of 25 nodes located at different Italian universities. CNR presented SLICES to the association on March 2023 with a dedicated seminar.

CNR will continue to support the liaison with industry and present SLICES' offerings to the industrial community.

3.7. Activities to create links with the industry (September 2022 – June 2024) – OTE

OTE (former COSMOTE), being the leader of WP5, manages activities regarding the Project liaison with industry and other stakeholders. Of particular interest to SLICES is the engagement of industrial researchers to the use of research infrastructures, as it is done for academic researchers. To achieve this goal OTE co-organized and participated in several industry-oriented events including the INFOCOM 2022 event in Athens, which is one of the largest industry-oriented conferences organized each year in Athens attracting several hundred participants from Greece and abroad, as well as EUCNC 2023 in Gothenburg and EUCNC 2024 in Antwerp where SLICES participated with a booth which also

[5] ARTES 4.0 website, https://www.artes4.it/en/ [Last accessed 27 June 2024]

[6] CINI Smart Cities & Communities lab website, https://www.consorzio-cini.it/index.php/en/national-laboratories/laboratorio-smart-cities [Last accessed 27 June 2024]

served the purpose of fulfilling the commitment of the project for two additional SLICES-SC Industry Days (the first Industry Day was organized in the first reporting period as an online event, and it was reported in D5.1). The purpose of these events was to promote and advertise SLICES research infrastructure to industry users, since EUCNC is an industry-oriented conference with several industry representatives participating each year.

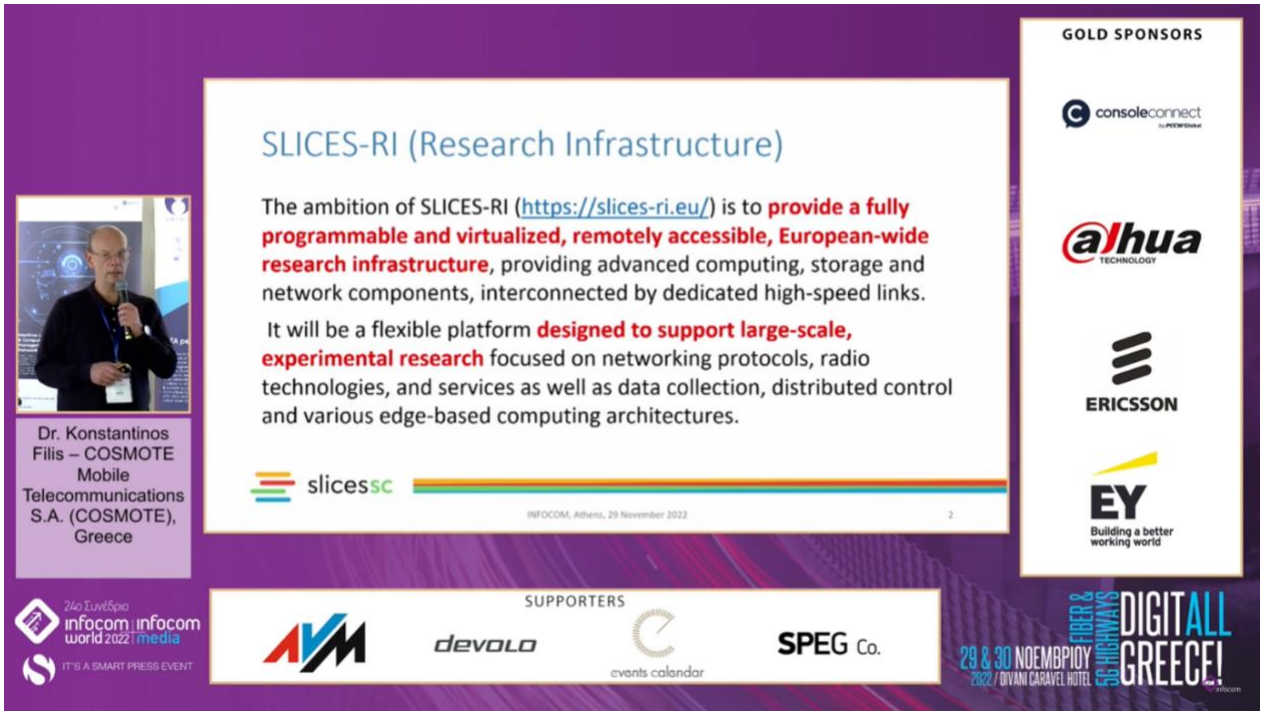

Figure 1. The SLICES presentation at INFOCOM 2022

2nd SLICES-SC Industry Day – booth at EUCNC 2023

The 2023 EuCNC & 6G Summit took place in Gothenburg from 6th to 9th June 2023. SLICES participated with a booth, where the visitor could be informed about the experimentation with distributed post-5G architectures within SLICES-RI. The key objective of the exhibition was to demonstrate the latest achievements of the SLICES consortium in providing a first version of the SLICES infrastructure available to external researchers. The exhibition featured, besides the demonstration, a separate section on informing on tools available under the SLICES ecosystem, including the post-5G blueprint, the SLICES portal, the SLICES Academy and the Orchestration across different clusters for the post-5G era. This booth served also as the SLICES-SC 2nd Industry Day.

EUCNC | 6G Summit
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BOOTH #H06:13

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Experimentation with distributed Post-5G architectures within SLICES-RI

SLICES is defined and planned as a distributed research infrastructure (RI), with 15 national nodes and centralised governance and a central hub. SLICES is a flexible platform designed to support large-scale, experimental research focused on networking protocols, radio technologies, services, data collection, parallel and distributed computing and in particular cloud and edge-based computing architectures and services. SLICES-RI entered the ESFRI Roadmap in 2021. The design phase of SLICES ended in 2022, and the preparation phase started in September 2022 and will run up to December 2025. The underpinning of SLICES is based on the scientific excellence of our community and presents the articulation of the required technologies, services and the foreseen components including the reference architecture that will rule them all. The identified technologies are evolving around the latest trends in research in digital infrastructures, as well as the services that can be offered over the top. The starting point of SLICES has been identified as a mixture of the most mature research infrastructures in Digital Infrastructures covering different resources, including advanced programmable radios, mature off-the-shelf radios, configurable wired/optical multi-Gbps transnational links, and a wide range of IoT devices backed by special purpose processors and vast computing resources.

Objectives of the exhibition: The key objective of the exhibition is to demonstrate the latest achievements of the SLICES consortium in providing a first version of the SLICES infrastructure available to external researchers. The exhibition will assist towards raising awareness and extending the SLICES community, by targeted dissemination to all relevant researchers and industrial stakeholders who can take advantage of SLICES. The exhibition will feature besides the demonstration, a separate section on informing on tools available under the SLICES ecosystem, including the portal for accessing resources, Transnational and Virtual Access activities, services offered for enabling access, scheme on funded researcher mobility (long and short mobilities), as well as the integration of the data dimension, with datasets that can be exposed through the European Open Science Cloud (EOSC). Details will be offered on how the SLICES consortium is organized, and the process on including new potential nodes during the implementation phase of SLICES.

Figure 2. Snapshot of the SLICES exhibition in the EUCNC 2023 site

Figure 3. The SLICES booth at EUCNC 2023

Figure 4. The SLICES booth at EUCNC 2023

3rd SLICES-SC Industry Day – booth at EUCNC 2024

The 2024 EuCNC & 6G Summit took place in Antwerp from 3rd to 6th June 2024. SLICES participated with a booth, where the visitor could be informed about the latest achievements of the SLICES consortium and the post-5G blueprint. This booth served also as the SLICES-SC 3rd Industry Day.

Figure 5. Snapshot of the SLICES exhibition in the EUCNC 2024 site

Figure 6. The SLICES booth at EUCNC 2024

3.8. Activities to create links with the industry (September 2022 – June 2024) – OULU

The University of Oulu and its faculties are overall very active in engaging with industry. A large number of programs utilizes several labs in their research together with industry partners. One of the labs is 5GTest Network, the world's first open access 5G Test Network, which is currently developed towards 6G. The complete test environment, from infrastructure to apps and services, allows unique testing possibilities from prototypes to solutions in a controlled environment. The open 5G Test Network (5GTN), upgraded with 5G new radio and sensors, has attracted over 200 companies to test 5G prototype devices and to explore higher frequency bands, cognitive management functionalities, and system testing tools for new solutions. 5GTN has boosted trials in numerous EU projects as well.

In faculty of ITEE's Center for Wireless Connectivity and 6G Flagship research program where 5GTN is developed more further, are different programs linking with industry partners and utilizes testing services offered by 5GTN. There are 56 organizations in 5GTN community, most of them SMEs or big corporations who have done or are doing testing in the 5GTN in one way or another. The 6G Flaghisp research program has five dedicated vertical areas where research and technology transfer to industry is done daily. Those vertical areas are Health, Energy, Vehicular, Industry and Security & Defense.

Several dedicated matching events have been organized locally and internally. EuCNC&6GSummit[7] 2022, 7th – 10th June 2022 in Grenoble and 6th – 9th June 2023 in Gothenburg. The last EuCNC&6G Summit was arranged in June 2024 in Antwerp, Belgium.

Another large event where industry and research are together discussing technology transfer and project co-operation are 6G Symposiums organized by 6GWorld[8] and 6G Flagship research program. There are annual fall and spring editions. 6G Flagship has been co-organizing them since spring 2022, when it was unfortunately a full virtual event. Fall event 11th – 12th October 2022 in Washington DC

[7] EuCNC&6GSummit website, https://www.eucnc.eu/ [Last accessed 27 June 2024]

[8] 6G World website, https://www.6gworld.com/past-events/ [Last accessed 27 June 2024]

USA, again Spring event 24th – 25th April 2023 in London, UK and fall event 18th – 19th October in Washington DC. The latest edition, a Spring 2024 event was organized at the Levi, Finland, from 9th – 11th April 2024.

Additionally, a number of special research to industry events has been arranged during the years. Matchmaking events like "Veturivarikko" event (31st January 2024, Tampere Finland) where Business Finland, Research Council of Finland, Industry partners, 6G Flagship and other Flagship programs in Finland were discussing about current and new co-operation projects. The University of Oulu and 6G Flagship together with Business Oulu have organized specified research to business events in different verticals during spring 2024. Events have been Business Breakfast type of events with different themes. Security & Defense 28th February 2024, Energy 9th Arpil 2024, 23rd April 2024 Vehicular, 7th May 2024 Industry and 21st May 2024 Health. SLICES-RI has been discussed and been on the agenda, particularly on those events where testing services have been promoted. In some events SLICES-RI Roll-Up has been presented to gather interest for it.

3.9. Activities to create links with the industry (September 2022 – June 2024) – INRIA

Inria is deeply engaged in the overarching strategy of the SLICES-SC project to attract industrial users. Inria contribution has been primarily focused on the development and dissemination of the SLICES Post-5G Blueprint. This Blueprint is aimed at sharing a unified vision and solutions among partners, as well as proposing a plan for the design and deployment of SLICES-RI. This effort is aimed also at making it easier for users, including industrial partners, to deploy parts of the research infrastructure in their own networks and premises, thereby fostering greater industrial engagement with SLICES. Every SLICES blueprint is provided with a reference implementation that works on the SLICES-RI infrastructure and that is supported by the community.

Key activities undertaken by Inria in this period (September 22 – June 24) include:

- **Development of the Post-5G Blueprint**: Inria has actively participated in developing the SLICES Post-5G Blueprint, which proposes a plan for the design and deployment of SLICES RI by defining an infrastructure baseline augmented with a reference implementation. This approach keeps the project focused on its goals while identifying technological challenges and breakthroughs early on. The blueprint, which has already been deployed by several SLICES-RI partners, provides the baseline service for experimenters related to the post-5G realm as SLICES transitions into its operational phase, starting with a continuous integration and pre-operational deployment strategy in 2024. Additionally, this blueprint is designed to evolve continuously, incorporating lessons learned and recommendations from both the academic and industrial communities.

- **Organization of a Hackathon and a BoF session**: To promote hands-on engagement and practical application of the 5G Blueprint, Inria has co-organized one hackathon and one BoF session. These events provide a platform for academic and industry professionals to collaborate, innovate, and directly engage with the SLICES infrastructure community.
    - The *hackathon*: Thought experiments, data and reproducibility for networking and FutureG research, IFIP Networking 2024, 3rd – 6th June, 2024, Thessaloniki, Greece[9].
        - 4 projects have been implemented during this hackathon:

[9] IFIP Networking 2024 – Hackathon, https://networking.ifip.org/2024/index.php/hackathon [Last accessed 27 June 2024]

- integrating SLICES portal authentication service to the blueprint VPN access.
- expose CEPH volumes to the 5G blueprint clusters.
- automatic deployment of split 7.2 in bare metal equipment
- RBAC support for the post-5G blueprint backend.

  - The *BoF*: Birds of a Feather session, Integrated Support of Large-Scale Research Instruments, TNC24, 10th – 14th June 2024, Rennes, France[10].

- **Participation in Conferences and Project Meetings:** Inria has actively participated in numerous conferences, projects meetings, and summer schools. These events have been instrumental in disseminating information about SLICES Blueprint. In particular Inria participated to the following events:
  - Presentation entitled "Rethink testbeds with blueprints" at Academic Salon on High-Performance and Low Latency Networks and Systems, TUM-IAS Institute of Advance Studies, 30th November 2023, Munich, Germany[11].
  - IEEE HPSR 2023: Tutorial entitled "An Overview of a Distributed Post-5G Network Architecture within the EU SLICES-RI Research Infrastructure", at IEEE International Conference on High Performance Switching and Routing, 5th – 7th June 2023, Albuquerque, NM, USA[12].
  - IEEE INFOCOM 2024: Blueprint-based reproducible research with the SLICES Research Infrastructure, demo at IEEE International Conference on Computer Communications, 20th – 23rd May 2024, Vancouver, Canada[13].
  - PEPR 2024: Demonstration of the SLICES-Blueprint at the Open Scientific Day of the Future Networks and Electronics PEPRs (Priority Research Programs and Equipment), 20th March 2024, Grenoble, France[14].

- **Participation in SLICES-RI Summer schools**
  - Oulu: "Blueprint architecture and concept", Hands-on session at SLICES-SC 2nd Summer School on Efficient wireless communication and computing experimental research in 6G-era, June 2023, Radisson Blu, Oulu, Finland[15].
  - Lipari: "How to run reproducible post-5G experiments with blueprints", Hands-on session at SLICES-SC 3rd Summer School on Open and programmable 6G networks in the cloud/edge continuum: research challenges and experimentation tools in SLICES Research Infrastructures, July 2024, Lipari, Italy[16].

Through these activities, Inria continues to support the strategic goal of broadening the awareness and adoption of SLICES by the industry, thereby contributing to the overall success of the SLICES project.

[10] TCN 2024 programme, https://tnc24.geant.org/programme/ (Session on June 12) [Last accessed 27 June 2024]

[11] Academic Salon on High-Performance and Low Latency Networks and Systems programme, https://net.in.tum.de/events/academic_salon_23/academic_salon_23.html [Last accessed 27 June 2024]

[12] IEEE HPSR programme, https://hpsr2023.ieee-hpsr.org/day-1-monday-june-5/ [Last accessed 27 June 2024]

[13] IEEE INFOCOM 2024: demos and posters sessions, https://infocom2024.ieee-infocom.org/program/postersdemos [Last accessed 27 June 2024]

[14] PEPR 2024 day, https://peprelecreseaux.sciencesconf.org/resource/page/id/5 [Last accessed 27 June 2024]

[15] SLICES-SC 2nd Summer School, https://slices-sc.eu/events/slices-sc-2nd-summer-school/ [Last accessed 27 June 2024]

[16] SLICES-SC 1st Summer School, https://www.slices-ri.eu/events/slices-summer-school-2024/ [Last accessed 27 June 2024]

3.10. Activities to create links with the industry (September 2022 – June 2024) – IMEC

IMEC has a very active link with industry, also in the field of SLICES. The most important and specific event was 1,5 days event about SLICES Flanders, organized in Gent, Belgium on 6th – 7th April 2023. The first half day was virtual to reach more people and was about SLICES in general and SLICES Flanders specifically. Also, use cases were introduced as well as example experiments. The second day was a hands-on training in Gent using a variety of infrastructure such as bare metal, Kubernetes, machine learning and wireless and IoT experimentation.

Besides this, IMEC was involved in the ITU standardization activities together with international industry as described in 4.9. In 2024, IMEC organized also the EuCNC and 6G event in Antwerp on 3rd – 6th June.

The last important link with industry for IMEC is through research projects where SLICES is promoted for any experimentation activities. A very important collaboration with industry is SolidLab[17]. The goal is to set a new standard in data protection with the Solid technology. This is a big ecosystem of industry and research groups and for experimentation SLICES is the platform that is used.

3.11. Activities to create links with the industry (September 2022 – June 2024) – TUM

The Chair of Network Architectures and Services at the Technical University of Munich is a research group dedicated to network research with a special focus on performance measurement. To perform these measurements, the research group operates a testbed that allows the creation of complex network architectures to recreate specific, real-world network configurations. The testbed uses the plain orchestrating service (pos), a framework that ensures the reproducible creation and execution of network experiments.

The German Ministry for Research and Education has launched a national research initiative called 6G Platform Germany[18]. This platform develops use cases and researches the fundamental technologies that are required to create the next generation of cellular networks. Multiple projects with strong industrial participants are organized under the 6G platform. TUM is part of multiple projects organized under this platform, namely 6G-life and 6G-ANNA. Through these projects TUM is in regular contact with industrial partners. The 6G platform also organized a meeting in Berlin (26th – 29th June, 2023) with participants from all projects organized under the 6G platform.

TUM also participated in the National IT Security Conference 2023 (13th – 15th March, 2023 in Berlin). There, we presented the pos testbed and SLICES to the German IT security community. We also participated in multiple events organized by the VDE, a German association of electrical engineers, two examples are the WueWoWas[19] (28th – 30th June, 2023 in Würzburg) and the ZdN Conference[20] (4th – 7th September, 2023 in Potsdam), where we also presented SLICES. TUM also organized multiple

[17] SolidLab website, https://solidlab.be/ [Last accessed 27 June 2024]

[18] 6G Platform Germany, https://www.6g-platform.com/[Last accessed 27 June 2024]

[19] WueWoWas Workshop, https://lsinfo3.github.io/WueWoWAS2023/[Last accessed 27 June 2024]

[20] NetSys & ZdN 2023, https://www.vde.com/de/veranstaltungen/veranstaltungsuebersicht/veranstaltung-detailseite?id=21818&type=vde%7Cvdb [Last accessed 27 June 2024]

events on Networks and Systems[21] [22], with contributions from multiple German universities and participants from industry.

Besides regularly presenting the goals of SLICES-RI at the respective events, we also had fruitful discussions with industrial and scientific partners. We conducted a survey among contacts that we met at the listed events. Over 90% of participants approved the participation of Germany to SLICES-RI. Through an in-depth survey with multiple selected partners, we tried to evaluate the specific requirements of industrial partners. Multiple different partners named two specific benefits from SLICES:

1. Through a tight integration of SLICES in academic education, testbeds can help prepare students with up-to-date tooling and hardware platforms. The testbeds can also help sensibilize students for relevant problems with large-scale infrastructures that are currently underrepresented in academic education due to a lack of a cost-efficient platform. The European industry can benefit from students that are aware of the specific problems relevant for large-scale software development and deployment.
2. Another outcome of these interviews is the willingness to use SLICES resources for industrial research. SLICES testbeds can be used to quickly realize prototypes without investing time to acquire specify hardware. However, to make efficient use of the SLICES platform, established APIs should be used by SLICES and the costs should be kept at a reasonable level. If costs are too high, higher management levels need to be involved, creating organizational overhead and slowing the entire process. Lower costs can be easily justified and spent without involving other departments increasing the attractiveness of the SLICES testbeds for industrial users.

TUM is currently preparing for the 6G platform event that will happen in July 2024. We plan to organize a dedicated session on testbed-driven research with participation by several SLICES partners.

4. Training and Mobility for Industrial Researchers

SLICES-SC has developed SLICES Academy[23] that offers an ideal environment for novice researchers to explore the potential of SLICES-RI. To this end, we have constructed a platform for online coursing. In SLICES Academy, we have defined three target groups of students and potential users of SLICES-RI: the testbed developers, the experimental researchers, and the industrial engineers, who want to be familiar with the SLICES supported technologies. They can choose from a range of courses that teach them how to efficiently use the SLICES testbeds to become familiar with new protocols, software tools, and hardware resources.

In addition, SLICES-SC has set-up the procedure to offer mobility opportunities to industrial researchers as well as to academic ones. So far only academic researchers have taken advantage of these opportunities, but there are plans for industrial researchers also to take advantage of these opportunities and visit our testbed sites to perform experiments in the near future.

[21] Munich Internet Research Retreat Raitenhaslach, https://www.ce.cit.tum.de/cm/events/mir3/mir3-2023-11/ [Last accessed 27 June 2024]

[22] Academic Salon on High-Performance and Low Latency Networks and Systems, https://net.in.tum.de/events/academic_salon_23/academic_salon_23.html [Last accessed 27 June 2024]

[23] SLICES Academy portal, https://www.slices-ri.eu/slices-academy/ [Last accessed 27 June 2024]

5. Industrial Advisory Board

SLICES-SC has also formed the Industrial Advisory Board (IAB) which provides a forum to establish dialogue with business and industry in relation to the vision and mission of SLICES. The primary function of the Industrial Advisory Board in SLICES-RI is to assist and advise the project in the following areas:

- Industry trends and technology roadmaps
- Industrial needs and requirements for digital research infrastructures
- Strategic guidance to improve short- and long-term collaboration between science and industry
- Evaluation of services offered by the research infrastructure

IAB consists of 10 members who come from various sectors of industry representing some quite influential companies including TIM, Keysight, INTEL, and Verizon.

During the SLICES-SC project course two meetings with the IAB Members had been organized. Both meetings were well represented by the IAB Members, considering the involvement of the experts in their day-to-day duties in the companies they are working. During the first meeting 60% of the members of the IAB attended, while in the second meeting 50% of the members of the IAB attended.

Both IAB meetings went smoothly, involving discussions and feedback from the IAB members. Several recommendations were also provided to the project consortium, highlighting the areas in which the project could improve in the future. These recommendations will be a subject of further investigation as part of the SLICES-RI as a whole.

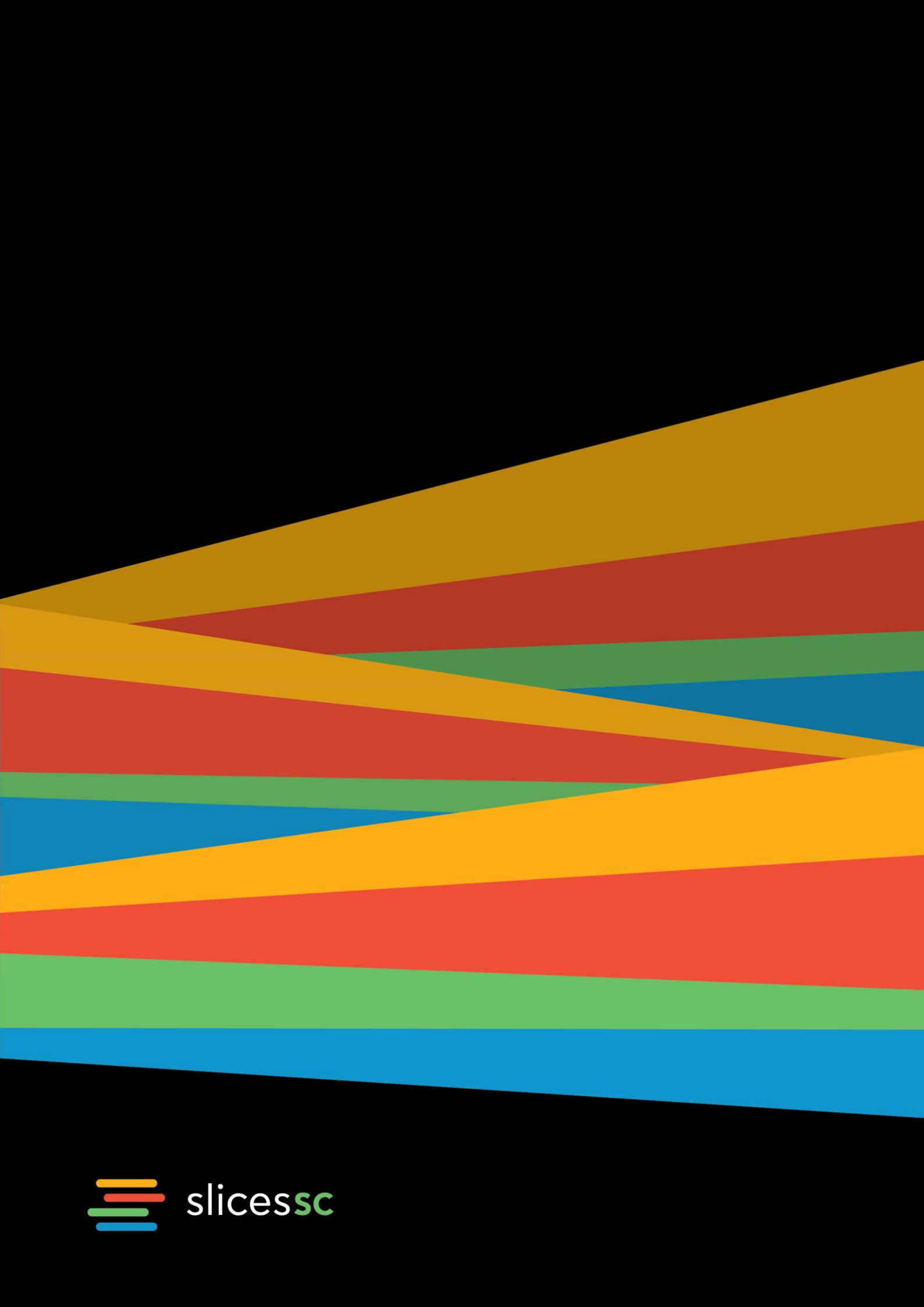
More information on the meetings with IAB can be found in deliverable D5.3.

Conclusions

This deliverable reported the activities of the consortium partners towards the technology transfer of SLICES-SC and the liaison with industrial stakeholders that took place between months 19 and 40 (September 2022 – June 2024), since the activities that took place before that period have been reported in deliverable D5.1. The document started with briefly describing the objectives of SLICES-SC and WP5. Then, it presented the methods and tools used to improve the awareness of the industrial users on the capabilities and the opportunities of the SLICES-RI. The activities to establish and grow an industrial network in order to raise the awareness of RI services to the industrial community were presented next by each individual partner. Finally, a short description of the activities of the Industrial Advisory Board towards the engagement of a larger number of external stakeholders was presented.

The consortium partners were very active in raising awareness of RI services to the industrial community, and, in particular, engaging industrial R&D researchers. Activities towards this direction included the organization of Industry Days with demos, presentations, posters, panel discussions, and booths demonstrating research results, in collaboration with the EUCNC conference, to ensure a bigger impact. Additional activities included the organization of workshops with industrial partners and stakeholders, and the participation in industry events such as EUCNC, INFOCOM, Globecom, as well as in national events.

Finally, the establishment of the Industrial Advisory Board (IAB) will help to improve the communication and collaboration of SLICES with the industry by providing recommendations to the project consortium, highlighting the areas where SLICES could improve in the future and engage more industrial stakeholders.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