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5G-MoNArch
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5G Mobile Network Architecture

for diverse services, use cases, and applications in 5G and beyond

Deliverable 7.1

First report on dissemination, standards, and exploitation plan

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Abstract: This document is the first report on the 5G-MoNArch dissemination activities towards the general public and the scientific and industrial communities that have been conducted during the first project year. The report furthermore describes the initiatives towards the standards, and explains the exploitation planning with respect to the project outcome within the partners' organisations

Keywords: Dissemination, standardisation, exploitation plan, 5G-PPP, 3GPP, papers, journals, events, 5G-MoNArch, 5G, network slicing

Executive Summary

The 5G-MoNArch project is extending know-how and produces tangible results for the partners involved. An effective dissemination, both within and outside of the project, helps to leverage the gains from the project. Already during the first year, the 5G-MoNArch project had extensive activities on dissemination, standards contributions, and exploitation, with the results being according to the planning and objectives. These activities are summarised in this report.

For *dissemination*, the following audiences are targeted:

- General public: nine press releases have been launched during the first project year by partner organisations, highlighting the project as such, achievements on the test beds, or the presence at Mobile World Congress 2018. The public website that provides details on the project concept, objectives, a news blog, and the public deliverables, has received more than 30,000 visits. The social channels have been very active informing about the most important events.
- Scientific community: to support the adoption of 5G-MoNArch concepts in the long term, and increase the project's footprint, publications at scientific conferences and in journals have been a key target. However, the focus here was on quality events rather than the quantity of publications. Furthermore, several scientific events have been organised by the project, including a number of workshops and special sessions at international conferences.
- Industrial community: a central goal of the project is the commercial adoption of the developed concepts and technology, requiring the acceptance by key stakeholders. The project has conducted a number of activities towards industry, including presence at relevant events (MWC 2018) and fora (GSMA), and direct interaction with industry representatives.

In terms of *standardisation*, the project has defined a detailed plan to ensure that the key concepts of the developed 5G mobile network architecture are brought to relevant standards. A number of contributions have been submitted to 3GPP, both by individual partners as well as joint contributions. Some of the project's key innovations on machine learning and artificial intelligence are directly discussed with ETSI ISG ENI. Finally, 5G-MoNArch contributes to the second stage evaluation of the 5G radio interface, as input to ITU-R IMT2020, which is a key target from a European perspective.

Within the *5G-PPP* framework, 5G-MoNArch in particular contributes to – and chairs – the Architecture Working Group, but contributes to other WGs such as Pre-standards as well. The 5G-PPP framework furthermore allowed the cross-project organisation of activities such as joint workshops.

The use and adoption of project results within the partner's organisation is regarded as a central goal of 5G-MoNArch, in particular with respect to the experience gained with the testbed implementation. A detailed *exploitation* plan has been set up, which is continuously updated and monitored.

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List of Acronyms and Abbreviations

3GPP	3rd Generation Partnership Project
5G	5th Generation mobile wireless communication system
5G-PPP	5G infrastructure Public Private Partnership
5GIA	5G Infrastructure Association
AR/VR	Augmented / Virtual Reality
CN	Core Network
DoW	Description of Work
E2E	End-to-End
eMBB	Enhanced Mobile Broadband
ENI	Experimental Network Intelligence
ETSI	European Telecommunications Standards Institute
EuCNC	European Conference on Networks and Communications
GDPR	General Data Protection Regulation
GSM	Global System for Mobile communication
GSMA	GSM Association
IMS	Internet Protocol Multimedia Subsystem
ISG	Industry Specification Group
KPI	Key Performance Indicator
LTE	Long Term Evolution
mMTC	massive Machine Type Communication
MWC	Mobile World Congress
NEST	NEtwork Slicing Task force
NGMN	Next Generation Mobile Networks
NWMO	NetWork Management and Orchestration
QoS	Quality of Service
PoC	Proof-of-Concept
RAN	Radio Access Network
SA	System Architecture
SB	Steering Board
SDN	Software Defined Networking
SDO	Standards Developing Organisation
SI	Study Item
TB	Technical Board
TSG	Technical Specification Group
UMTS	Universal Mobile Telecommunication System
VNF	Virtual Network Function
WAN	Wide Area Network
WG	Working Group
WI	Work Item

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1 Introduction

All partners from the 5G-MoNArch project strive for strengthening their positions on 5G and network slicing within their respective environments. This deliverable reports on the dissemination and standardisation activities of 5G-MoNArch within the first year of the project, including the dissemination to general public, and to industrial and scientific communities. Within this first project year, the emphasis of the work was on identifying the requirements for the technical concepts being developed, and the first iterations of the concepts and innovations. This is reflected in the project's dissemination. Furthermore, this deliverable describes the ongoing and planned exploitation activities with respect to the achieved project results and achievements within the partners' organisations.

Communication and dissemination activities are essential not only to maximise the impact of the project and create general awareness of its results, but also to convince the industrial and scientific communities of the advantages of the technologies created by the project and thus facilitate the adoption of these technologies in the market, in future solutions and in standards.

Communication to the industrial community

One of the main measures to achieve the expected impacts of 5G-MoNArch is to foster the adoption of the project technology by manufacturers and operators outside the consortium. Towards this end, the communication of the 5G-MoNArch results to the industrial community is deemed as one of the key activities towards the success of the project.

One of the best ways to reach out and convince the industrial community of the advantages of the technology developed by the project is by showcasing the features of the technology as well as the performance of working prototypes. In parallel, in order to enable multi-vendor deployments of the technology that facilitate the adoption by MNOs, it is crucial to conduct standardisation activities that include the key interfaces of the envisaged architecture. Finally, to secure the commercial success of the technology it is of upmost importance to involve the end-customers of the technology, in particular the vertical industries.

Communication and dissemination to the scientific community

While the communication and dissemination to the scientific community may not necessarily have a short-term impact on the adoption of the technology, it does serve several important purposes: (i) it is a means to receive feedback about the value and potential drawbacks of the project ideas, (ii) it validates the novelty and scientific quality of the solutions devised by the project when published in top venues, and (iii) if widely accepted by the scientific community, this may contribute to the adoption of the idea in the long term.

Motivated by the above, 5G-MoNArch is disseminating its research results in high quality scientific journals and communicate them at conferences. When pursuing these efforts, we value the quality of the venues rather than the number of publications. Indeed, our target is to publish at the highest quality conferences and journals in the field, thus maximising the impact of these publication to the scientific community.

Other scientific events are also excellent means to interact with the scientific community for the mutual benefit. The organisation of journal special issues allows bringing together in a single publication the leading research groups in the area, reaching out a very specific but highly relevant audience. Scientific Workshop pursue a similar objective and can reach a wide audience, especially when co-located with leading conferences. Overall, these events help to spread 5G-MoNArch findings and collect feedback to further improve PATRON innovations.

Communication to the general public

Different social media (Twitter, LinkedIn, YouTube) as well as more traditional media (newspaper, TV, radio) are a good means to reach out to different sorts of audience, with particular emphasis on the general public. Social media serve to advertise the project results, announce events such as conferences and showcases, inform about the most recent results and reports, and provide a platform for discussion. Videos on streaming platforms (e.g., YouTube) present the project to a broad community of non-expert

actors. Special attention is paid to provide all this information in an accessible way that can be understood by a non-expert audience.

The project furthermore reaches out to traditional media by means of press releases, as this is a very effective way to make the general public aware of the benefits to society resulting from collaborative projects. When writing press releases, the emphasis has been drawn on the benefits of the project for the society, specifically to preserve users' privacy and foster transparency.

Finally, it is of upmost importance to set up and maintain a public website updated in a timely manner to cover all relevant activities. The website contains comprehensive information about the project, such as the consortium details, the project vision and objectives, the relation to the funding programme, and links to other projects in the same domain. The site is constantly updated with the public deliverables, publications, and public materials such as flyers, newsletter, and videos.

This deliverable is structured as follows: In Chapter 2 the dissemination initiatives towards the "General Public" are described, also focusing on Social Channels, Website, and press releases of the partners. Next, in Chapter 3 the standardisation and cooperation with 5G-PPP are analysed. Chapter 4 is dedicated to the dissemination for the "Scientific Community", with all the publications, invited talks, presentations and workshops in which 5G-MoNArch has been active in the first year. Chapter 5 is an insight into the contacts and cooperation with the Industrial community, also mentioning the Project Advisory Board interactions that occurred in the period. Finally, Chapter 6 is about the exploitable results with a table summarising the most relevant achievements.

2 Dissemination to the general public

2.1 Overview

Within the Work Package 7 of the 5G-MoNArch project, Task 7.2 handles the dissemination of the project progress (results and activities) to the general public. All the channels used will be listed and detailed in the following sections, as well as the impact they have had. They are used to expose the general public to the benefits that 5G-MoNArch will bring to 5G research and society.

The next three sections will detail the 5G-MoNarch website, social media channels (Twitter, LinkedIn, and YouTube) and the press releases published by partners. Following that, the final subsection will discuss the impact of our dissemination activities by mentioning some highlights and some statistics.

2.2 Public website

The main point of contact between the general public and the project is the public website (https://5g-monarch.eu/). It is a dynamic environment, with the main goal to be the main repository of material and news about the project, with other social media channels referring to the website. An interested party only requires access to the website to be fully informed about the project.

The website is hosted through a commercial German web hosting company and jointly maintained by UKL and NOK-DE.

The overall organisation of the website is as follows, see Figure 2-1. When the visitor accesses the home page, he or she will see on top the name on the project, the main area that contains the project blog with news about the project on the left, and a side-bar on the right. The sidebar has the following elements:

- The logo of the project,
- A short abstract giving a general description of the project and its goals,
- A list of links to different parts of the website,
    - "About the project" page introducing the project approach, objectives, and work packages, including a brief introduction to the work packages and providing an overview figure on the project approach
    - "Smart Sea Port use case" page, providing an introduction to the background, scope, setup, and use cases implemented into the Smart Sea Port testbed in Hamburg
    - "Touristic City use case" page, providing an introduction to the background, scope, setup, and use cases implemented into the Touristic City testbed in Turin
    - "Deliverables" page listing all 5G-MoNArch deliverables, and giving access to public ones which can be downloaded
    - "Publications and Workshops" page listing all dissemination activities of the project; for some publications, the corresponding documents can be downloaded
    - "Consortium and Facts" page giving information about the timeline, management and partners of the project
    - "Contact" page providing an e-mail address so that interested parties can contact the project if desired
    - "Privacy policy" page, providing the privacy information according to the European General Data Protection Regulation (GDPR) of 2018
- Links to social media channels of project, which are LinkedIn, Twitter and YouTube
- The logo of 5G-PPP and the European flag, linking to the 5G-PPP homepage and the Horizon 2020 website

Note that, in accordance with the European GDPR, pictures have been removed from the website (in particular from events organised by the project) that show people not being part of the project consortium, as no written consent could be gathered to publish these pictures.

5G Mobile Network Architecture

for diverse services, use cases, and applications in 5G and beyond

5G-MoNArch at the EuCNC 2018

Marcos Rates Crippa
2018-06-18

https://www.eucnc.eu/

Here is where to find us:

- 5G-MoNArch has a **demo booth** where we present a demonstrator on network slicing prepared by NOMOR, posters describing the concepts and features developed within the project and the brand new video
- Real Wireless presents 5G-MoNArch in the 2nd Workshop on **business models and techno-economic analysis** for 5G networks
  - *Monday, 18 June 2018, 09:00-18:00, Štih hall*
- 5G-MoNArch is represented in three **Special Sessions**:
  - Special Session 4a: Resource Elasticity for 5G Network Architecture
    - *Wednesday, 20 June 2018, 16:00-17:30, E3 hall*
  - Special Session 4b: 5G Mobile Network Architecture and New Radio Advances (5GMoNANeRA)
    - *Thursday, 21 June 2018, 09:00-10:30, E3 hall*
  - Special Session 5: 5G Architecture towards Verticals
    - *Thursday, 21 June 2018, 09:00-10:30, E2 hall*

Several **papers** from the project are presented during the conference:

Sina Khatibi, Kunjan Shah, Mustafa Roshdi	Modelling of Computational Resources for 5G RAN
Borislava Gajic, Christian Mannweiler, Diomidis S. Michalopoulos	Cognitive Network Fault Management Approach for Improving Resilience in 5G Networks
Anastasios Zafeiropoulos et al	Enabling Vertical Industries Adoption of 5G Technologies: a Cartography of Evolving Solutions
Julie Bradford, Simon Fletcher	The Economic drivers for network elasticity
Sina Khatibi, Irina Balan, Dimitris Tsolkas	Slice-Aware Elastic Resource Management
Antonio De Domenico, Nicola di Pietro, Ghina Dandachi, and Emilio Calvanese Strinati	Dynamic Deployment of Virtual Network Functions in Heterogeneous Telco Clouds

Check out our brand new project video:

5G-MoNArch - Project Introduction and Goals

EuCNC 2018, Ljubljana June, 18-21 – https://www.eu-cnc.eu/

Marcos Rates Crippa

5G-MoNArch be present at the EuCNC 2018 conference and exhibition, which

The focus of 5G-MoNArch is about a flexible, adaptable, and programmable architecture for 5G. Inter-slice control and cross-domain management, experiment-driven modelling and optimization, native cloud-enabled protocol stack are innovative enablers for the sliced network. The concepts and enablers are brought into practice through prototype implementations, deploying the devised architecture in two testbeds (the sea port in Hamburg and the touristic city in Turin) instantiating slices that include the functional innovations of network resilience and resource elasticity, respectively.

- Main
- About the project
- Smart Sea Port Use Case
- Touristic City Use Case
- Deliverables
- Publications and Workshops
- Consortium & Facts
- Contact
- Privacy Policy

- LinkedIn
- Twitter
- Youtube

RECENT POSTS

- 5G-MoNArch at the EuCNC 2018
  2018-06-18
- EuCNC 2018, Ljubljana June, 18-21 – https://www.eucnc.eu/
  2018-05-16
- Presentation by Real Wireless at the SPEED-5G workshop
  2018-04-23

Figure 2-1: 5G-MoNArch website home page

Website statistics:

The website can keep track of page views and sessions in an anonymised way, according to the conditions provided in the privacy policy. The corresponding tools are provided by the web hosting company and are in accordance to German data and privacy protection law. A page view is a count of HTML pages visited on the website regardless of user. In web analytics, a session is a unit of

measurement of access to the website by a user with unique IP address. Session also includes file downloads with a direct link. Session count stands close to the number of unique visitors visiting the website.

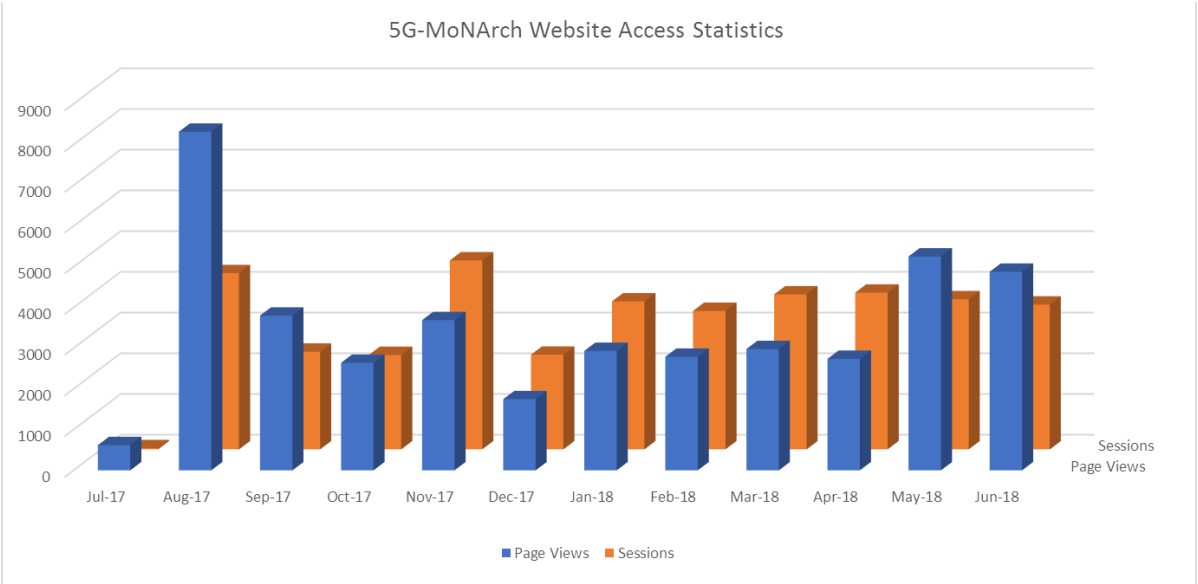

Figure 2-2: 5G-MoNArch website statistics

Statistics of 5G-MoNArch has been presented in the form of bar chart in Figure 2-2. Over the period of the first nine months of 5G-MoNArch (July 2017 to June 2018), the number of page views was 42392 and the number of sessions was 37979. The maximum number of page views was 8318 in August 2017, in the beginning of the project, and a second peak period in May / June 2018 after a major website update and some new deliverables uploaded. As the deliverables were being made available for download, the session count started increasing gradually with the peak count of 4642 in November 2017. The fact that the number of pageviews is typically lower than the number of sessions can be explained such that, with direct link access to the deliverables (e.g. via search engines), the corresponding web page is not visited.

Note that, in accordance to the European GDPR, no statistics are (and can) be collected that allow for the identification of individual visitors (neither by IP address nor by other individually identifiable attributes). In so far, no information can be given where the visitors come from, or to which organisation they belong.

2.3 Social media channels

In order to expand 5G-MoNArch's dissemination reach and directly engage with interested parties, different social media channel have been utilised. These channels promote key news about the project, upcoming events, cooperation plans with other 5G PPP projects, as well as providing a platform for hosting video material (e.g. via YouTube). As mentioned before, these social media channels will reference the material published on the project's website

5G-MoNArch's three social media channels are Twitter, YouTube and LinkedIn.

Twitter

https://twitter.com/5g_monarch

5G-MoNArch's Twitter account is mainly used to promote news about the project. New deliverables, participation in conferences, new videos, etc. It is also used occasionally to promote news about other 5G projects and 5G PPP. As of May 23rd, 2018, 5G-MoNArch's twitter account has made 27 tweets. 5G-MoNArch is following 71 accounts including another research projects, researchers and major 5G events. 5G-MoNArch has 133 followers.

Figure 2-3: 5G-MoNArch Twitter account

LinkedIn

Another dissemination medium for the project is LinkedIn, a social network for professionals and companies aiming to network professionals throughout the world. 5G-MoNArch can be found in https://www.linkedin.com/5g-monarch. LinkedIn is considered more relevant to research projects than Facebook, which reaches a more general audience. As many research projects are also in LinkedIn, this social media channel also helps in better reflecting cooperation with the other 5G PPP projects. The LinkedIn account has 58 connections. A short description regarding planned activities has been provided in the introduction section of the LinkedIn page

YouTube

5G-MoNArch's YouTube channel hosts any video material produced by the project; additionally, it promotes any of the project activities in other channels. The YouTube channel can be found under the URL https://www.youtube.com/channel/UCnwNJv-nxvxWGOcdjD0ZZ7Q.

From the 5G-MoNArch YouTube channel a two minutes video is available which provides an introduction to 5G-MoNArch, storyline, goals and innovations. Professional video editors were part of the preparation team. The video was shown at the 5G-MoNArch booth at MWC where interested visitors could discuss the video with members of the project present there. The video format and editing were optimised for this presentation context. As of June 27th, 2018, the video has 117 views.

A second video was uploaded to the channel on June 18th, 2018, in preparation for the 5G-MoNArch presence at the EUCNC conference. This six minutes video provides deeper insights into the storyline of the project, with core people from the project being interviewed (Coordinator, Technical Manager, WP2, 3, 4, 5 leaders, and WP6 representative on business impact), providing a deeper insight into the conceptual work and innovations being worked out in the project. As of June 27th, 2018, the video has 57 views.

2.4 Participation at the 2018 Mobile World Congress

5G-MoNArch was present at the 2018 edition of the Mobile World Congress (MWC) in Barcelona (February 26th to March 1st, 2018). The project has been selected by the 5G Infrastructure Association (5GIA) as one of three projects (out of 18 applications) to be present at the "5G Barcelona – Mobile World Capital" pavilion (see Figure 2-4). A project video was prepared (see Section 2.3) by to give a brief overview about the goals, storyline and approach. The preparation of the video was a joint activity of all the technical work packages, coordinated to ensure the best dissemination impact. It is also the basis for new versions of the overall project video, being updated regularly to illustrate the achievements during the project lifetime.

The participation to the MWC 2018 is a big achievement for the project in terms of getting a dissemination opportunity within the world's largest presence of the 5G community. During the four days event at the pavilion the Project Coordinator gave an overview presentation about the project, and the news was also reported to the 5GIA (see https://5g-ppp.eu/5g-ia-and-5g-ppp-at-the-mobile-world-congress-2018/).

Figure 2-4: 5G-MoNArch delegates at the 5G Barcelona pavilion in MWC 2018

2.5 Press releases and further partner dissemination

To further promote the project in general, and to point out dedicated project achievements, the dissemination channels of the participating companies have been used for launching various press releases during the first project year:

- Nokia announced the project start with a press release in August 2018, describing the cornerstones of the project setup and objectives. This press release gained quite some attention and was cited in a number of international tech news sites and blogs. The original press release is available at http://www.nokia.com/en_int/news/releases/2017/08/22/nokia-drives-key-european-research-project-5g-monarch-to-bring-5g-mobile-network-architecture-from-concept-to-real-world
- The finalisation of the initial infrastructure setup for the Hamburg Smart Sea Port testbed was jointly announced in press releases issued through Hamburg Port Authority, Deutsche Telekom and Nokia in February 2018. The focus in these press releases was on the use cases and services to be shown and tested in Hamburg, and they gained a considerable international attendance, especially because 5G-MoNArch provides one of the first real-world testbeds for industrial use cases in Europe. The original press releases can be found online:
  - https://www.hamburg-port-authority.de/en/press-latest-news/new-communication-standard-5g-industrial-environment-trial-platform-launched-in-the-port-of-hamburg/
  - https://www.telekom.com/en/media/media-information/archive/research-platform-for-5g-513988
  - https://www.nokia.com/en_int/news/releases/2018/02/02/nokia-deutsche-telekom-and-hamburg-port-authority-collaborate-in-5g-research-in-industrial-environment
- Hamburg Port Authority maintains a topic website on "5G Practical Test" which provides a brief description of 5G-MoNArch and links to the project website: https://www.hamburg-port-authority.de/en/themenseiten/monarch-5g/

- Huawei issued a press release in September 2017 focusing on its role as the WP2 lead in 5G-MoNArch: http://www.huawei.com/en/press-events/news/2017/9/Huawei-Joins-5G-MoNArch
- UC3M launched a press release for Mobile World Congress in February 2018 regarding their commitments to 5G development, including the contributions to 5G-MoNArch: https://www.uc3m.es/ss/Satellite/UC3MInstitucional/en/Detalle/Comunicacion_C/1371246358819/1371215537949/UC3M_and_IMDEA_Networks_commit_to_5G_development_at_Mobile_World_Congress_2018
- NOMOR Research links to the project from their website: http://nomor.de/resources/research-projects/5gmonarch-eu/
- Real Wireless posted the launch of 5G-MoNArch on their website: https://www.real-wireless.com/5g-monarch-started/
- Real Wireless also advertise on their website one of the 5G-MoNArch's video: https://www.real-wireless.com/introduction-to-5g-mobile-network-architecture-5g-monarch/

3 Dissemination to SDOs, fora and 5G-PPP

3.1 Overview

The goal of the dissemination work package WP7 is twofold: (i) to facilitate the exploitation of 5G-MoNArch results, and (ii) to create awareness of the project, its objectives and results. Several activities are carried out to present the project through the most appropriate communication channels. In this chapter, the following activities are presented in detail:

- Monitoring, alignment with, and contribution to the work of relevant standardisation bodies and fora for the definition of the future 5G access and core architecture.
- Setting up effective interactions with other related 5G projects (5G-PPP and other EU H2020 projects) as well as 5G industrial research bodies and institutes.
- Identification of how project results can be pushed into standards, and what are the most relevant standards activities to monitor and impact, particularly in areas relevant to 5G-MoNArch

Furthermore, 5G-MoNArch is committed to the 5G-PPP ecosystem. In that respect, the project appointed representatives to joint Working Groups (WGs) to provide technical contributions to (and, occasionally, edition of) deliverables and reports of the WGs. The following sections detail those contributions.

3.2 SDOs and fora

5G-MoNArch is committed to contribute to standardisation activities to facilitate the exploitation of innovation outcomes in commercial products, and to ensure the uptake of 5G technologies contributing to the transformation of European industry and services. Standards are an essential way to achieve this goal and are therefore of high importance for the project. All 5G-MoNArch partners share this view, and in particular the industrial partners are actively contributing and holding key leadership positions in different relevant Standards Developing Organisations (SDOs). Hence, the project aims at promoting the achieved conceptual results to the relevant SDO bodies and industry fora, which contribute to facilitating the future exploitation of these results. The task is thus designed to ensure collaboration and consensus-building among partners at an early stage before performing dissemination actions towards SDOs.

3GPP

As 5G-MoNArch covers a substantial number of technologies that are addressed by different SDOs, there are a number of opportunities where 5G-MoNArch innovations can be brought to the corresponding bodies. From the various SDOs that are targeted, the most relevant one is the 3rd Generation Partnership Project (3GPP), which defines the basis of the most widely used mobile network technologies, i.e., Global System for Mobile Communication (GSM), Universal Mobile Telecommunication System (UMTS), Long Term Evolution (LTE), and also 5G. 3GPP is organised in Technical Specification Groups (TSGs), which are subdivided into WGs. The following WGs have been identified to be of relevance to the project:

- System Architecture WG 2 (SA2), which identifies the main functions and entities of the network, how these entities are linked to each other, and the information they exchange;
- System Architecture WG 5 (SA5), which specifies the requirements, architecture and solutions for provisioning and management of the network, including Radio Access Network (RAN), Core Network (CN), Internet Protocol Multimedia Subsystem (IMS), and its services;
- Radio Access Network WG 1 and WG 2 (RAN1 and RAN2), dealing with the RAN-related aspects of mobile networks, where RAN1 covers radio layer 1 (physical layer), and RAN2 covers radio layer 2 and 3, including radio interface architecture and protocols, radio resource control protocols and management, which partially are of relevance for the project.

The work of 3GPP is divided into releases, where Release 15 (planned completion in June 2018) covers the first set of 5G standards as well as LTE-Advanced Pro specifications, and Release 16 (planned completion in December 2019) covers 5G Phase 2. From the different activities of the above mentioned

WGs, in 5G-MoNArch we have identified the following three work items (WIs) and study items (SIs) as particularly relevant for the project, as shown in Table 3-1.

Table 3-1: Relevant SI/WIs for 5G-MoNArch

ID number	Release	Name	WG	Planned end date	SI/WI description
750061	Rel-15	Highly Reliable Low Latency Communication for LTE	RAN1	Dec 18	RP-171489
760047	Rel-16	Study of enablers for Network Automation for 5G	SA2	Sep 18	SP-170383
780037	Rel-16	Network Resource Model (NRM) for 5G networks and network slicing	SA5	Jun 18	SP-170956

Of particular relevance is SA2's "Study of enablers for Network Automation for 5G (FS_eNA)", which aims to study and specify how to collect data and how to feedback data analytics to the network functions. Both slice specific data and non-slice specific data can be collected to generate data analytics, and feedback to the network functions for per slice/cross slice decision.

ETSI

A new Industry Specification Group (ISG) has been recently created within the European Telecommunication Standards Institute (ETSI) on Artificial Intelligence (AI)-based network management and orchestration called "Experiential Network Intelligence" (ENI). 5G-MoNArch's approach partly overlaps with the goal of ETSI ISG ENI, which proposes an engine that adds closed-loop AI mechanisms based on context-aware, metadata-driven policies to more quickly recognise and incorporate new and changed knowledge, and hence, make actionable decisions. It is worth highlighting that there is a use case in ETSI ENI currently being developed with focus on intelligent network slicing management, placing or adjusting the network slice instance (e.g., reconfiguration, Virtual Network Function (VNF) scale-in, scale-out) to achieve an optimised resource utilisation with a changing context. This use case highly correlates with the study of elasticity performed by 5G-MoNArch. ETSI ENI has several WIs open for contributions, including a PoC WI open for non-ETSI members. In that regard, a first collaboration call between ENI and 5G-MoNArch was set to explore synergies between both entities. The use case, architecture and PoC WIs were identified as possible areas of contribution for WP4 and WP2 within 5G-MoNArch, and further call and/or attendance to the SDO meetings is currently being considered to pursue further this collaboration.

GSMA

Global System for Mobile communications Association (GSMA) represents mobile network operators worldwide with around 800 operators and also includes further 300 companies from the broader mobile ecosystem, such as smartphone makers and internet companies. GSMA organises premium events in the ecosystem, namely, MWC, MWC Shanghai, MWC Americas, and the Mobile 360 Series of conferences. Considering the importance of network slicing, GSMA has established a working group titled "Network Slicing Taskforce (NEST)". The NEST analyses, for example, the vertical industries' requirements on network slicing and 5G networks in general, and how the design of the 5G architecture can fulfil these requirements. The GSMA furthermore communicates directly with SDOs, e.g., 3GPP, to highlight the outcomes of different working groups. On this basis, 5G-MoNArch has identified the NEST as one of the key fora to contribute to concerning 5G-MoNArch innovations, analyses, and findings. As a first step, an online meeting has been organised where vertical requirements were analysed with the participation of 5G-MoNArch partner HPA. In this first meeting, vertical use cases were highlighted and the associated requirements were detailed. The use cases include an mMTC use case, e.g., measuring emissions from ships, and an eMBB use case, e.g., for video surveillance or Augmented / Virtual Reality (AR/VR) applications in industrial context. This analysis has contributed to the ongoing white paper to be published by GSMA titled "Network Slicing Use Cases Requirements". Given the successful start of this collaboration, a further meeting was held, where the NEST presented the latest findings.

Accordingly, possible joint efforts were identified, e.g., on slice blueprint design and global reach of slice services.

NGMN

The Next Generation Mobile Network (NGMN) Alliance is an industry organisation of leading world-wide telecom operators, vendors and research Institutes. Its objective is to ensure that the functionality and performance of next generation mobile network infrastructure, service platforms and devices will meet the requirements of operators and, ultimately, will satisfy end-user demand and expectations. NGMN has launched a work stream that focuses on Network management and Orchestration (NWMO), which works on uses case and requirement with the deliverable "5G Network and Service Management including Orchestration". 5G-MoNArch has identified this deliverable to disseminate concepts and requirement on (inter-)slice management and orchestration (e.g., related to resource elasticity).

The list of contributions submitted to the standardisation bodies mentioned above is reported in Table 3-2. This list encompasses all the contributions that the partners of the project submitted in the first year of 5G-MoNArch and that are related to the activities performed in the project. Through these contributions the envisaged impact to the standardisation could be achieved.

Table 3-2: Relevant SI/WIs for 5G-MoNArch

Meeting / Date	Source Partner	Standard Body	Title	Reference	Status
SA2#125 22.01.2018	HWDU	3GPP SA2	New Key Issue: eV2X QoS Support	S2-180145	Accepted
SA2#125 22.01.2018	HWDU	3GPP SA2	New Key Issue: Network Slicing for eV2X	S2-180147	Accepted
SA2#125 22.01.2018	NOK	3GPP SA2	23.726: FS_ETSUN (Enhancing Topology of SMF and UPF) / 23.726 Scope	S2-181046	Approved
SA2#126 26.02.2018	HWDU	3GPP SA2	eV2X QoS Support Key Issue: AF function impact on QoS	S2-181951	Accepted
SA2#127 16.04.2018	HWDU	3GPP SA2	Clarification on Key Issue: Network Slicing for eV2X	S2-183735	Accepted
SA2#127 16.04.2018	HWDU	3GPP SA2	NWDA-assisting E2E QoS Assurance	S2-183634	Accepted
SA2#127 16.04.2018	HWDU	3GPP SA2	Solution for AF Data Exposure to/from NWDAF	S2-183637	Accepted
SA2#127bis 28.05.2018	SRUK	3GPP SA2	Use Case on UE-driven analytics sharing	S2-185816 (S2-185290)	Approved
SA2#127bis 28.05.2018	HWDU	3GPP SA2	Key Issue for NWDA-assisted determination of areas with oscillation of network conditions	S2-185277	Submitted
SA2#127bis 28.05.2018	HWDU, TIM	3GPP SA2	Solution for Key Issue 4: Interactions with OAM for Network Data Collection	S2-185279	Submitted
SA2#127bis 28.05.2018	HWDU	3GPP SA2	Updates on text of Key Issue 1 and General Architectural Assumptions with exposure to OAM	S2-185276	Submitted
SA2#127bis 28.05.2018	HWDU	3GPP SA2	Solution for Updated Key Issue 1: Exposure of Analytics to OAM	S2-185278	Submitted

SA2#127bis 28.05.2018	HWDU	3GPP SA2	Discussion paper and pCR on V2X slicing KI	S2-185475	Submitted
SA2#127bis 28.05.2018	HWDU	3GPP SA2	Solution for Key Issue 3: Interactions with 5GS NFs/AFs for Data Collection	S2-185280	Submitted
SA2#127bis 28.05.2018	HWDU	3GPP SA2	Solution for eV2X QoS Support Key Issue: AF function impact on QoS	S2-185342	Submitted
SA2#127bis 28.05.2018	NOK	3GPP SA2	Update to the general framework for 5G network automation (TR 23.791)	S2-186271	Approved
SA2#127bis 28.05.2018	NOK	3GPP SA2	TR 23.742: Solution for NF reliability	S2-186151	Approved
SA2#127bis 28.05.2018	NOK	3GPP SA2	Updated SID: Study on Enhancement of Network Slicing	S2-186185	Approved
SA2#127bis 28.05.2018	NOK	3GPP SA2	New SID on Enhanced support of Vertical and LAN Services	S2-186182	Approved
	TIM	NGMN NWMO	Cross-slice user stories		
22.01.2018	HWDU	3GPP RAN3	Slice Information Exchange over NG	R3-180479	Not treated
26.03.2018	HWDU	3GPP RAN3	Slice information exchange over NG	R3-181104	Noted
16.04.2018	HWDU	3GPP RAN3	Available slice Information exchange for NG mobility	R3-181904	Noted
RAN2 #101 26.02.2018	NOK	3GPP RAN2	Support for SRB duplication with CA	R2-1803233	Approved
RAN2 #101 26.02.2018	NOK	3GPP RAN2	RLC handling upon duplication deactivation	R2-1803318	Noted
SA5#119 18.05.2018	NOK	3GPP SA5	Add Data Analytics Management Service for Network Slice and Network Slice Subnet	S5-183560	Approved
SA5#119 18.05.2018	NOK	3GPP SA5	Add example of functional management architecture	S5-183409	Approved

3.3 Cooperation with 5G-PPP

5G-MoNarch is strongly committed to 5G-PPP activities, ensuring participation in, and providing input to the different 5G-PPP boards and WGs so that the results generated within the project can be properly injected in the broader context at the benefits of all 5G players in Europe and beyond. Furthermore, the 5G-MoNArch consortium is well-aware of the commitment of the 5G-PPP to leverage the cooperation between projects as well as its organisational structure. In the following, a detailed description of 5G-MoNArch's contributions to the 5G-PPP boards and WGs is provided.

- *Steering Board (SB)*: 5G-SB: 5G-MoNArch actively participates in the SB activities through the project coordinator, regularly joining virtual and physical meetings. In general, the main activities with 5G-MoNArch contributions are i) 5G-PPP Working Group reporting, coordination and planning, ii) planning and contributions of 5G-PPP projects to events (e.g., Mobile World Congress, European Conference on Networks and Communications (EuCNC) etc.) and further joint dissemination activities, and iii) the interworking / coordination between 5G-PPP Phase 1 / Phase 2

projects. Main SB topics relevant for 5G-MoNArch during the initial project phase were the event planning and contribution to MWC, and the planning and setup of the contributions of the project to the IMT-2020 evaluation.

- *Technical Board (TB)*: 5G-TB: 5G-MoNArch actively participates in the TB activities, regularly joining virtual and physical meetings. The representatives of the project in this working group contributed to the main activities carried out there: i) the definition of the Phase II project cartography, including the definition of the scope of the project with respect to the other projects, ii) the description of the 5G trials, with the Turin and Hamburg testbeds and iii) the participation in the KPIs discussion, with the objective of including the 5G-MoNArch view (developed in WP6) in the final WG outcomes.
- *5G Comms*: The dissemination activities of the project have been echoed through the group "5G Comms", led by the CSA projects in 5G-PPP Phase 2. In the same group the activities related to the presence of the project in the main conferences, events and industrial fora have been coordinated, in order to ensure an alignment with the activities of the other Phase 2 projects.
- *Architecture WG*: The 5G-PPP Architecture WG represents the most important WG for 5G-MoNArch in terms of the technical scope – mobile network architecture and network slicing. The corresponding work on the second phase of architecture concepts has been kicked off already during the start phase of 5G-MoNArch. From the beginning, 5G-MoNArch has actively contributed to this WG through several partners, and through the WP2 leader serving as co-chair of the WG. As the initial contribution, 5G-MoNArch presented the project scope and the envisaged architectural innovations. Furthermore, 5G-MoNArch contributed to the second version, and will contribute with project concepts and results to the third version of the Architecture WG white paper, which is scheduled for early 2019. The Architecture WG provides an excellent means to coordinate and align mobile network architecture topics with the other Phase II projects, but also with further stakeholders from operators, vendors, vertical industry and academia.
- *Pre-standards WG*: 5G-MoNArch actively participates in Pre-standards WG calls, and as part of the activities in this WG, a number of 3GPP SIs in the TSGs RAN and SA with the potential for contributions from the project in have been identified. The contributions to the Pre-standards WG are coordinated with the regular project internal activities on standardisation.
- *5G Automotive*: The group prepared a White Paper that was presented at the MWC 2018. 5G-MoNArch representatives attend the phone calls to be aligned with the outcome of the work performed therein, as the requirements defined for vehicular communications are an important input for the conceptional work on network slicing, despite the fact that 5G-MoNArch does not strongly focus on these use cases.
- *Trials WG*: 5G-MoNArch is involved in this WG in the role of an "observer", since the activities of the WG started far before the start of the project, and were primarily dedicated to the definition of the 5G-PPP Phase 2 pre-structuring model. In so far, the approach and objectives of 5G-MoNArch are partially based on the outcome of the Trials WG. Currently the WG focus is on the Version 3.0 of the so-called "Pan European Roadmap" for the trials towards the deployment of 5G.
- *5G Spectrum WG*: Real Wireless monitors the 5G-PPP Spectrum working group on behalf of the project.
- *IMT-2020 evaluation*: The goal of this working group is to perform the second stage evaluation of the 3GPP 5G New Radio Interface standards as an input to the ITU-R standards development for IMT-2020. The 5GIA is the responsible partner for Europe. The evaluation itself shall be conducted through running and upcoming 5G-PPP projects (Phase 2 / Phase 3) that have the necessary competence for simulations of the radio interface. Despite the fact that this activity is not within the core objectives of 5G-MoNArch, the project contributes considerably to the evaluation work coordinated within the IMT-2020 evaluation WG – through at least one of the project partners. 5G-MoNArch brings the necessary competence for the evaluation tasks, and the IMT-2020 evaluation of the 5G New Radio Interface is within an overall European interest and supported by the European Commission.

4 Dissemination to the scientific community

Besides the aforementioned contributions to standardisation and other 5G-PPP related communication channels, the results obtained during the execution of the project are also disseminated to the relevant scientific communities. Besides improving the project's visibility, promoting the results of the project to the scientific community provides 5G-MoNArch with useful feedback, which is leveraged for fine-tuning the project's conceptual work and further improving its outcome. Moreover, such activities provide discussion opportunities with other projects and set up the baselines which can lead to standardisation input, as described in Chapter 3.

In view of the above, we distinguish between two major classes for scientific dissemination, namely i) publications and invited presentations to scientific journals and conferences, and ii) workshops and special issues organised and carried out from 5G-MoNArch. Such dissemination activities are presented in detail in the ensuing Sections 4.1 and 4.2.

4.1 Publications, invited talks and presentations

5G-MoNArch sets specific guidelines for any publication that represents part of its framework. These guidelines include a certain timeline for internal project approval before any scientific work is submitted for possible publication in a journal or conference. This timeline allows for enough timing for all members of the project's consortium to review the content of the publication and object, where applicable, to any publication that poses a conflict of interest to project's beneficiary.

Next, we provide a list of the 5G-MoNArch publications per category, namely international conferences and workshops (see Table 4-1); scientific magazines and journals (see Table 4-2); and invited talks and presentations (see Table 4-3).

Table 4-1: Conference and workshop papers

Main author	Title	Event	Date	Place	Publisher	Status
Lars Christoph Schmelz, Albert Banchs, Mauro Boldi, Ömer Bulakci, Emilio Calvanese Strinati, David Gutiérrez-Estévez, Diomidis S. Michalopoulos, Jose Enrique G. Blazquez, Heinz Droste (Simon Fletcher presented)	Mobile Network Architecture: End-to-End Network Slicing for 5G and Beyond	Wireless World Research Forum Meeting #39	Oct. 18-20, 2017	Castelldefels, Spain	WWRF	Presented
Gines Garcia-Aviles, Marco Gramaglia, Pablo Serrano, Marc Portoles, Albert Banchs, Fabio Maino	SEMPER: A Stateless Traffic Engineering Solution for WAN based on MP-TCP	IEEE International Conference on Communications (ICC)	May 24, 2018	Kansas City, USA	IEEE	Presented
Diomidis S. Michalopoulos, Borislava Gajic, Beatriz Gallego-Nicasio Crespo, Aravinthan Gopalasingham, and Jakob Belschner	Network Resilience in Virtualised Architectures	International Conference on Interactive Mobile Communication, Technologies, and Learning, Special session on 5G Wireless and Optical Technologies for Mobile Communication Systems	Dec. 1, 2017	Thessaloniki, Greece	IEEE	Presented
David M. Gutierrez-Estevez, Marco Gramaglia, Antonio de Domenico, Nicola di Pietro, Sina Khatibi, Kunjan Shah, Dimitris Tsolkas, Paul Arnold, Pablo Serrano	The Path Towards Resource Elasticity for 5G Network Architecture	IEEE FlexNets workshop (2nd Workshop on Flexible and Agile Networks, co-located with IEEE WCNC)	Apr. 15-18, 2018	Barcelona, Spain	IEEE	Presented
Emmanouil Pateromichelakis, Konstantinos Samdanis	Graph Colouring based Inter-Slice Resource Management for 5G Dynamic TDD RANs	IEEE International Conference on Communications (ICC)	May 24, 2018	Kansas City, USA	IEEE	Presented
Sina Khatibi, Kunjan Shah, Mustafa Roshdi	Modelling of Computational Resources for 5G RAN	European Conference on Networks and Communications (EuCNC18)	Jun. 18-21, 2018	Ljubljana, Slovenia	IEEE	Presented

Cristina Marquez, Marco Gramaglia, Marco Fiore, Albert Banchs, Xavier Costa-Perez	How should I slice my network? A multi-service empirical evaluation of resource sharing efficiency Enabling technologies for multi-service networks	ACM Mobicom	Oct. 29 – Nov. 2, 2018	New Delhi, India	ACM	Submitted
Borislava Gajic, Christian Mannweiler, Diomidis S. Michalopoulos	Cognitive Network Fault Management Approach for Improving Resilience in 5G Networks	European Conference on Networks and Communications (EuCNC18)	June 18-21 2018	Ljubljana, Slovenia	IEEE	Presented
Anastasios Zafeiropoulos et al	Enabling Vertical Industries Adoption of 5G Technologies: a Cartography of Evolving Solutions	European Conference on Networks and Communications (EuCNC18)	June 18-21 2018	Ljubljana, Slovenia	IEEE	Presented
Sina Khatibi, Irina Balan, Dimitris Tsolkas	Slice-Aware Elastic Resource Management	European Conference on Networks and Communications (EuCNC18)	June 18-21 2018	Ljubljana, Slovenia	IEEE	Presented
S. Papadopoulos, A. Drosou, I. Kalamaras, D. Tzovaras	Behavioural Network Traffic Analytics for Securing 5G Networks	IEEE International Conference on Communications (ICC), 5th International Workshop on 5G Architecture (5GARCH)	May 24, 2018	Kansas City, USA	IEEE	Presented
Antonio De Domenico, Nicola di Pietro, Ghina Dandachi, and Emilio Calvanese Strinati	Dynamic Deployment of Virtual Network Functions in Heterogeneous Telco Clouds	European Conference on Networks and Communications (EuCNC18)	June 18-21 2018	Ljubljana, Slovenia	IEEE	Presented
Bin Han, Marcos Rates Crippa and Hans Schotten	5G Island for Network Resilience and Autonomous Failsafe Operations	European Conference on Networks and Communications (EuCNC18)	June 18-21 2018	Ljubljana, Slovenia	IEEE	Presented
Julie Bradford and Simon Fletcher	The economic drivers for network elasticity	European Conference on Networks and Communications (EuCNC18)	June 18-21 2018	Ljubljana, Slovenia	IEEE	Presented

Table 4-2: Scientific magazine and journal articles

Main author	Title	Title of the periodical or the series	Publisher	Status
Emmanouil Pateromichelakis, Ömer Bulakci, Chenghui Peng, Jiayin Zhang and Yuan Xia	LAA as a Key Enabler in Slice-aware 5G RAN: Challenges and Opportunities	IEEE Communication Standards Magazine, special issue on "Enabling 5G Verticals & Services through Network Softwarisation and Slicing" (invited)	IEEE	Accepted
P. Serrano, M. Gramaglia, D. Bega, D. Gutierrez-Estevez, G. Garcia-Aviles and A. Banchs	The path towards a cloud-aware mobile network protocol stack	Transactions on Emerging Telecommunications Technologies	Wiley	Accepted
P. Rost, M. Breitbach. H. Roreger, B. Erman, C. Mannweiler, R. Miller, I. Viering	Customised Industrial Networks – Network Slicing Trial at Hamburg Seaport	IEEE Wireless Communications Magazine, special issue on "Special Issue-5G Testing and Field Trials"	IEEE	Accepted
F. Gringoli, P. Patas, C. Donato, P. Serrano, Y. Grunenberger	Performance Assessment of Open Software Platforms for 5G Prototyping	IEEE Wireless Communications Magazine	IEEE	Submitted
Gg Garcia, M. Gramaglia, P. Serrano, A. Banchs	POSENS: a practical open-source solution for end-to-end network slicing	IEEE Wireless Communications Magazine	IEEE	Submitted
V. Sciancalepore, C. Mannweiler, F. Zarrar Yousaf, P. Serrano, M. Gramaglia, J. Bradford, I. Labrador Pavón	A Future-proof Management and Orchestration Architecture for 5G Multi-Domain Networking	IEEE Transactions on Network and Service Management Home	IEEE	Submitted
J. Rendon Schneir, A. Ajibulu, K. Konstantinou, J. Bradford, G. Zimmermann, H. Droste, R. Canto	A business case for 5G in a dense urban area	Telecommunications Policy - The International Journal of ICT Economy, Governance and Society	Elsevier	Submitted
Bin Han, Ji Lianghai, Hans Schotten	Slice as an Evolutionary Service: Genetic Optimisation for Inter-Slice Resource Management in 5G Networks	IEEE Access	IEEE	Accepted
Paul Arnold and Dirk v. Hugo	Future integrated communication network architectures enabling heterogeneous service provision	Advances in Radio Science 16, 2018, Special Issue: Kleinheubacher Berichte 2017	URSI	Accepted
L.C. Schmelz, A. Banchs, D. Michalopoulos, O. Bulakci, M. Gramaglia, D. Gutierrez Estevez	5G-MoNArch project description	5G-PPP TO- EURO-5G Annual Journal 2018	5G-PPP	Published

Table 4-3: Invited talks, tutorials and presentations

Main author	Type	Title	Event	Date	Place	Type of audience	Status
RW	Talk within workshop	5G-MoNArch project intro	SPEED-5G: Advanced spectrum management in 5G+ networks	Mar. 7, 2018	BT, London, UK	Participants of SPEED 5G workshop	Presented
SRUK	Talk within workshop	A Flexible 5G Mobile Network Architecture: The 5G-Monarch Approach	H2020 SONNET workshop	Mar. 23, 2018	London, UK	Participants of H2020 SONNET workshop	Presented
SRUK	Talk within Seminar	5G Architecture: Key Concepts & View from the 5G-MoNArch Project	Seminar at University of Pavia	Feb. 2, 2018	Pavia, Italy	Graduate and undergraduate students	Presented
DT HWDU TIM	Panel moderation and presentations	Network Slicing for 5G Systems	ISWCS Symposium 2017	Aug. 29, 2017	Bologna, Italy	Researchers and industrial delegates	Presented
SRUK HWDU NOK-DE	Panel moderation and presentations	5G/NR network architecture: Is it revolutionary or evolutionary?	CSCN 2017	Sep. 20, 2017	Helsinki, Finland	Researchers and industrial delegates	Presented
NOK-DE	Presentation	5G-MoNArch: Turning 5G mobile network architecture concepts into practice	MWC 2018	Feb. 28, 2017	Barcelona, Spain	Participants of MWC 2018	Presented
HPA	Talk	Höhere Geschwindigkeit, bessere Konnektivität von Maschinen und Geräten – Einblick in das 5G Projekt der Hamburg Port Authority AöR	http://voice-ev.org/node/1222	Mar. 21, 2018	Hamburg, Germany	CIOs from different Companies in northern Germany	Presented

TIM	Talk within conference call	5G-MoNArch project intro	NWMO periodic conference call	Mar. 28, 2018		NWMO members	Presented
HPA	Talk/ Conference	5G-MoNArch in the Port of Hamburg	Event at DIHK https://www.dihk.de/en	Apr. 19, 2018	Berlin, Germany	Stakeholder from German Industry	Presented
RW	Participation in panel session on business case for virtualised networks	Providing insights on the business drivers for flexible 5G virtualised networks (part of panel session)	Cambridge Wireless, "UK5G: Show me the money: Understanding the business case for NFV"	May 24, 2018	London, UK	Mobile network operators, vendors, UK government groups, infrastructure providers, industry analysts and consultants	Presented
SRUK	Workshop opening talk	5G-MoNArch project introduction	IEEE ICC - 5GArch workshop	May 24, 2018	Kansas City, MO, USA	Participants of 5GArch workshop	Presented
RW	Presentation and panel at 5G Huddle	Techno-economics of 5G in Ports and the Tourism Industry		May 29, 2018	Durban, South Africa	Government and regulatory policy makers, R&D institutions in the region, global MNOs	Presented
RW	Presentation and panel in 2nd Workshop on business models and techno-economic analysis for 5G networks	5G platforms for business value creation	EuCNC2018	Jun, 18 2018	Ljubljana, Slovenia	EC representatives, Mobile Network Operators, Vendors, business research organisations	Presented
RW	Brief presentation and panel participation in conference special session re 5G architecture towards verticals	Economic drivers for more engagement between verticals and mobile	EuCNC 2018	Jun. 21, 2018	Ljubljana, Slovenia	Mobile network operators, vendors and academics and other EC 5G-PPP project participants at EuCNC	Presented

4.2 Workshops and special issues

One of the goals of 5G-MoNArch is to disseminate the advantages of the developed concepts, technologies and innovations into the scientific community, to analyse such advantages within this community, and to accordingly attain technical feedback. To this end, the organisation of scientific events and special issues for journal publications provides an excellent means.

5GArch workshop at ICC

5G-MoNArch project partners that have already contributed to the 5G-PPP Phase 1 project 5G NORMA already organised a series of very successful 5GArch workshops, which is one of the prime events in the area of research on mobile network architecture. 5G-MoNArch organised a continuation of this workshop series, which took place as part of the IEEE International Conference on Communications (ICC) 2018 in Kansas City, Missouri, USA. The workshop placed its focus on the novel concepts, technologies and innovations required for the realisation of an E2E network architecture, such as, network slice control and orchestration, network elasticity, network reliability and resilience, and a cloud-based protocol stack. The workshop attracted high-quality papers, based on which a full-day program could be set. In order to maximise the impact, the workshop organisers invited a number of renowned speakers from academia and industry, and a panel discussion was organised as central part of the workshop. In the following, the list of invited speakers including their affiliation and the title of their talk is provided:

Academic Invited Presentations

- Zhisheng Niu, Prof. at Tsinghua University: "A Hyper Cellular Architecture for 5G and Beyond"
- Ben Liang, Prof. at University of Toronto: "Joint Offloading and Resource Allocation in Mobile Cloud with Computing Access Point"
- Klaus Moessner, Prof. at University of Surrey: "The Speed5G eDSA Framework and Future Dynamic Spectrum Access"

Industry Invited Presentations and Panel Discussion

- Arunabha Ghosh, Director of Advanced Wireless Technologies Group at AT&T: "A Self Backhauling Multi-hop Network Architecture for 5G"
- Mehmet Yavuz, VP of Engineering at Qualcomm: "5G Industrial IoT and Architectural Requirements"
- Devaki Chandramouli, Senior Standards and Architecture Specialist at Nokia: "Novelties of 5G System Architecture"
- Panel Discussion, "5G Architecture and Verticals"

EuCNC 2018

As a cross-5G-PPP effort, 5G-MoNArch organised a special session together with the 5G-PPP Phase 2 projectONE-5G at the European Conference on Networks and Communications (EuCNC) 2018 in Ljubljana, Slovenia. The special session had the goal to provide the latest results from both projects, and to leverage collaboration inside the 5G-PPP Phase 2 framework. The scope of this special session was on network reliability and resilience, presenting the latest results on the concepts on 5G radio and mobile network architecture. Both projects provided a comprehensive latest view on the specification and extensions of the 5G architecture as well as the developments for 5G New Radio Advanced, tackling 3GPP Release 16 and beyond.

5G-MoNArch organised a second special session which had the scope on the current results on resource elasticity for 5G network architecture. The program and presentations of this special session featured different aspects of the elasticity functional innovation which is worked out in WP4.

SPEED-5G

5G-MoNArch has participated in the SPEED-5G workshop on March 7th, 2018 in London, UK. The focus of the workshop was on spectrum management. In the presentation given by 5G-MoNArch, the potential implications regarding advanced spectrum management have been highlighted. More

specifically, this has included the spectrum implications of network slicing and more localised deployments targeting industrial applications.

SONNET workshop

5G-MoNArch participated in a workshop organised by the H2020 Marie Curie SONNET Project (http://sonnet-project.eu/) on 23rd of March 2018 in London, where the vision and key findings of the project were presented. In particular, the two 5G-MoNArch project testbeds (Smart Sea Port and Touristic City) drew some attention from the attendees who were interested to know more about the details and timeline of the deployments.

Journal special issue

5G-MoNArch partners serve as Technical Program Committee for a special journal issue to be published by Wiley-Hindawi, titled "Flexible and Adaptive 5G Mobile Network Architecture Design for E2E Network Slicing". As the special issue is of open access type, the dissemination level and the impact factor are expected to be high. The finalisation of the special issue is targeted for September 2018.

The following Table 4-4 provides a summary of the 5G-MoNArch activities regarding the organisation of workshops, special sessions, and journal special issues.

Table 4-4: Workshops and special issues organised by 5G-MoNArch

Organiser	Type	Title	Event	Date	Publisher
Mehrdad Shariat, Ömer Bulakci, Antonio De Domenico, Christian Mannweiler, Marco Gramaglia	Special Issue	Flexible and Adaptive 5G Mobile Network Architecture Design for E2E Network Slicing	Special Issue for Wireless Communications and Mobile Computing	Sep., 2018	Willey / Hindawi
David M. Gutierrez Estevez, Diomidis S. Michalopoulos, Vincent Wong	Workshop	5G Architecture (5GArch)	Workshop co-located with IEEE International Conference on Communications, ICC	May 24, 2018	IEEE
5G-MoNArch WP4	Special Session	Resource Elasticity for 5G Network Architecture	EuCNC 2018	Jun. 21, 2018	IEEE
5G-MoNArch, ONE-5G project	Special Session	5G Mobile Network Architecture and New Radio Advances (5GMoNANeRA)	EuCNC 2018	Jun. 21, 2018	IEEE

5 Contacts and cooperation with the industrial community

5.1 Project Advisory Board

The 5G-MoNArch Advisory Board is a voluntary project external group, which has, according to the description in the Grant Agreement, the role to provide advice on technical directions and potential challenges within the project, to expand and complement the expertise within the project consortium, and to further promote the project's results. The members of the External Advisory Board have been carefully chosen to maximise the geographic and topic diversity of the project beyond the addressed use cases and include representatives of vertical industries, operators, technology consulting and organisations that furthermore cover regulatory issues.

More specifically, during the initial phase of 5G-MoNArch, the Advisory Board shall ensure that a broader spectrum of opinions regarding the requirements for the mobile network architecture (WP2), and the use cases and functional innovations for resilience & security (WP3) and resource elasticity (WP4) is taken into account. The Advisory Board shall furthermore ensure that feedback on the project's conceptual work is provided beside the regular exploitation and dissemination activities. During the further course of the project, the progress of the conceptual work, but in particular results on the verification and validation of the concepts, and the implementation and results of the testbeds will be presented to the Advisory Board members, to allow for feedback and further advices regarding the applicability of the concept and implementation work to the use cases and applications of the Advisory Board members' organisations.

Confirmed members of the 5G-MoNArch Advisory Board are from vehicular and manufacturing industry, transport systems, tourism associations, telecom operators, regulation authorities, and telco research.

A first teleconference meeting with the 5G-MoNArch Advisory Board took place in March 2018. The purpose of this meeting was mainly to present the results and findings, and the selected baseline concepts of the initial project phase to the Advisory Board members. More specifically, this included a short wrap-up on the overall project setup and goals, the current status of the 5G-MoNArch initial mobile network architecture concept (WP2) together with the related enabling innovations, the concepts and functional innovations for network resilience and security (WP3), the concepts and functional innovations developed for resource elasticity (WP4), and the scope, planned use cases, and current implementation status of the two project testbeds in Hamburg and Turin (WP5). A number of comments and feedback were given by the Advisory Board members, in particular with respect to the applicability of the 5G-MoNArch network slicing concept to automotive use cases, and with respect to standardisation and regulatory aspects of the initial mobile network architecture and the functional innovations.

5.2 Contacts with verticals in the testbeds implementation

The project studies the application of the Network Slicing concepts in two testbeds: the Smart Sea Port testbed in Hamburg, and the Touristic City testbed in Turin. Within these two activities, the project exploits and promotes an effective cooperation with the industrial players involved in the testbeds.

In the Smart Sea Port testbed, the cooperation is mainly with the Hamburg Port Authority (HPA), that is also member of the consortium of 5G-MoNArch. HPA has established contacts with different service and infrastructure providers that are involved in the port infrastructure provision and adaptation for the testbed needs. In particular for the traffic lights control use case, HPA is cooperating with Hamburg Verkehrsanlagen GmbH (HHVA). HHVA is a public company that belongs to the city of Hamburg and is responsible for the planning, construction and operation of lighting systems and traffic engineering facilities in Hamburg. These include traffic monitoring and traffic telematics systems, and novel infrastructure such as charging stations for electric vehicles. HHVA prepares the traffic light, which will be connected through a dedicated network slice of the testbed to the HPA operations centre. Furthermore, for the environmental measurements use case, 5G-MoNArch has involved Flotte Hamburg that provides all the ships in the Hamburg port. HPA and Flotte Hamburg are cooperating with Fraunhofer CML, which is in charge of developing the environmental sensors which will be installed on the barges and connected to the HPA operations centre through a dedicated network slice of the

testbed. The cooperation with HHVA and Flotte Hamburg is a distinctive achievement of the project, enlarging the community of the players running towards the thorough implementation of the 5G in Europe, in this case for a dedicated industrial / transport & logistics use case.

In the Touristic City testbed, the project has established relations with the Municipality of Turin and with the Fondazione Torino Musei. The Municipality of Turin is the owner of the Palazzo Madama building, a historical building in the most central place of the city, once venue of the first Italian Parliament. 5G-MoNArch obtained the availability of some spaces inside the building to temporarily install the testbed equipment, and to perform the tests for the resource elasticity and network slicing concepts. Thanks to the involvement of the Municipality of Turin into the experimental framework called "Torino 5G", run by the Municipality in cooperation with Telecom Italia, the 5G-MoNArch testbed can be supported. The Fondazione Torino Musei, owned by the Municipality, is in charge of the management of the Palazzo Madama activities, and in this role, it is the first contact to perform the activities of 5G-MoNArch inside Palazzo Madama, which includes the installation of the video and network equipment, and the conduction of the actual tests. The cooperation with the Municipality of Turin and the Fondazione Torino Musei is a distinctive achievement of the project, enlarging the community of the players running towards the thorough implementation of the 5G in Europe, in this case for a dedicated media and entertainment use case.

6 Exploitable results

The exploitation of the activities performed in the project is an important objective for all the partners involved in 5G-MoNArch. The initial plans for the exploitation have been declared by each partner as part of the project's Grant Agreement. Within the first year of the project, those plans were continuously updated and worked out in more detail, based on the insights, gained knowledge, and solutions resulting from the project work on 5G mobile network architecture and network slicing. Furthermore, the planning and implementation of the testbeds as well as the progress in standardisation further contributed to these updates.

In order to represent vividly the extent of exploitation of the results achieved in 5G-MoNArch, reference Table 6-1 presents the identified set of "exploitable result/knowledge" items; for each item, further details are provided:

- *Exploitable products or measures in which the result/knowledge will be used*. In this column each partner indicated the ways specific results have been or will be exploited.
- *Sector(s) of application.* In this column the partners that have achieved a specific result or knowledge indicate the sector they will apply such achievements (for a sector we intend a wide set of choices, encompassing vendors, academies, simulation vendors and so on).
- *Timetable for use*. This column refers to the foreseen time window when the achieved results are considered to be valid for a full exploitation.
- *Deliverables*. The relevant project deliverable(s) are indicated, to which – if already available – the exploitation results are referring to.
- *Owner and other beneficiaries involved*. In this column the partners that have achieved or will achieve the exploitation results indicate their interest for the specific exploitation item.

The assessment of the exploitation results for each partner will be based on the initial statements provided in Table 6-1, and reviewed after the completion of the project in Year 2. Nevertheless, the following relevant exploitation areas for the different types of partners involved in 5G-MoNArch can be summarised.

Telecom operators

The relevant exploitation items are for these partners the knowledge on 5G mobile network architecture, on 5G network slicing, on orchestration in 5G mobile networks, on requirements and concepts to achieve resilience, security and resource elasticity in 5G mobile networks. The operators also aim at gaining experience in the planning and implementation of a distributed testbed platform, the implementation of network slicing for these testbeds, and the implementation and configuration of an orchestrator in a testbed. Moreover, they are also interested in the results on validation and verification of the KPI improvements and techno-economic benefits brought by the 5G-MoNArch innovations.

Equipment vendors

The relevant exploitation items for these partners are manifold with respect to future research activities and product development. Firstly, this applies to the knowledge building related to the development of 5G mobile network architecture concepts and functions, e.g., network function virtualisation, network slicing, and management and orchestration. Secondly, this applies to the functions developed to support the industrial and media & entertainment use cases, namely, network reliability, resilience, security and resource elasticity. Thirdly, the experience gained through the planning, implementation, commissioning and operation of the testbeds strongly contribute to the competence building in this area as well as to the verification of basic directions in research and product development. Fourthly, the results of the project's conceptional and research work shall be brought into the standards, which will enforce the implementation of these results into future 5G products. Finally, the interaction with stakeholders, and the corresponding requirements, KPIs and feedback received in the course of the project work contribute to 5G product development.

Universities and research centres

These partners are exploiting the knowledge on network slicing, on requirements and concepts to achieve resilience, security and resource elasticity in 5G systems. They contribute to, and are strongly

interested in the results of the validation and verification of the KPI improvements and techno-economic benefits brought by the 5G-MoNArch innovations. In the area of development, software solutions for E2E slicing, as well as the extension to simulation tools, are within the exploitable results expected from these partners. Finally, it is expected that 5G-MoNarch results will be included in higher education level courses, such as Master courses and seminars.

SMEs

5G-MoNArch provides an opportunity for SMEs to work directly together with vendors, operators, academia, and vertical industries. Based on the collaborative input provided by aforementioned industry stakeholders, the SMEs participating in the project are extending their simulation tools and prototype testbeds to support several 5G use cases (e.g., network slicing, inter-slice control, allocation of computational resources for telco cloud environment, techno economics for 5G etc.), which further enhances business opportunities for them.

Table 6-1: 5G-MoNArch exploitable results

Description of exploitable result / knowledge	**Exploitable product(s) or measure(s) in which the result / knowledge will be used**	**Sector(s) of application**	**Timetable for use**	**Deliverables / results does the topic relate to**	**Owner and other beneficiaries involved**
Extension of existing simulation tools	Research studies; verification of concepts and products; consultancy; participation in research projects; PhD theses;	Vendors; operators; research SMEs; simulation tool vendors; education; government and regulatory groups; wireless users and site and infrastructure providers.	2017-2020	D6.1 [5GM-D61]; D6.2 [5GM-D62]; D6.3 [5GM-D63]; D2.2 [5GM-D22]; D2.3 [5GM-D23]; D4.2 [5GM-D42]	NOK-DE NOMOR CEA LETI HWDU SRUK RW
Research contributions (CPU-aware elastic functions, network cartography, orchestration algorithms, NF scaling using AI)	Patents, Scientific papers, PhD theses, teaching material	Education and Research	2017-2020	D4.1 [5GM-D41]	UC3M CEA LETI SRUK
Open source software solution for e2e slicing to support intra-slice orchestration	Scientific papers, PhD theses, teaching, verification of concepts, development of NFV program	Prototypes, research proof of concepts	2018-2020	https://github.com/wnlUc3m	UC3M ATOS
Novel Master Courses	"Specialist in 5G Networks" (5 courses updated) For TI: novel 5G courses for TIM and its subsidiaries For UKL: exploration of 5G-MoNarch topics in Seminar courses	Education, Industry	2018-2019	https://www.uc3m.es/ss/Satellite/Postgrado/en/Detalle/Estudio_C/1371232764892/1371219633369/Master_in_NFV_and_SDN_for_5G_networks#program	UC3M TIM UKL
Knowledge on 5G mobile network architecture	Product development; competence building, service development for future 5G scenarios	Vendors; operators; research SMEs; simulation tool vendors; education	2017-2020 and beyond	D2.1 [5GM-D21]; D2.2 [5GM-D22]; D2.3 [5GM-D23]	TIM NOK-DE ATOS HWDU SRUK DT

Knowledge on 5G network slicing	Product development; competence building, service development for future 5G scenarios, adaptation of portfolio, service development, open new lines of investigation, enable new business opportunities; Scientific papers	Vendors; operators; research SMEs; simulation tool vendors; education	2017-2020 and beyond	D2.1 [5GM-D21] ; D2.2 [5GM-D22]; D2.3 [5GM-D23]	TIM NOK-DE ATOS HWDU SRUK DT UKL
Knowledge on orchestration in 5G mobile networks	Product development; competence building, service development for future 5G scenarios	Vendors; operators; research SMEs; simulation tool vendors; education	2017-2020 and beyond	D2.1 [5GM-D21]; D2.2 [5GM-D22]; D2.3 [5GM-D23]; D4.1 [5GM-D41]; D4.2 [5GM-D42]	TIM NOK-DE ATOS HWDU SRUK DT
Knowledge on requirements and concepts to achieve resilience in 5G mobile networks	Scientific papers, product development, competence building, service development for future 5G scenarios	Vendors; operators; research SMEs; simulation tool vendors; education	2017-2020 and beyond	D3.1 [5GM-D31]; D3.2 [5GM-D32]; D6.3 [5GM-D63]	TIM NOK-DE ATOS HWDU DT UKL
Knowledge on requirements and concepts to achieve security in 5G mobile networks	Scientific papers, product development, competence building, service development for future 5G scenarios	Vendors; operators; research SMEs; simulation tool vendors; education	2017-2020 and beyond	D3.1 [5GM-D31]; D3.2 [5GM-D32]; D6.3 [5GM-D63]	TI NOK-DE ATOS DT
Knowledge on requirements and concepts to achieve resource elasticity in 5G mobile networks	Service development for future 5G scenarios, service development for future 5G scenarios	Vendors, operators	2017-2020 and beyond	D4.1 [5GM-D41]; D4.2 [5GM-D42]	TIM ATOS SRUK DT
Knowledge on operators' view on importance and timeline for SON functions and on operators' view on SON management	Product development; competence building, service development for future 5G scenarios	Vendors; operators	2017-2020 and beyond	D2.2 [5GM-D22]; D2.3 [5GM-D23]	TIM NOK-DE ATOS HWDU

Experience on the planning and implementation of a distributed testbed platform	Product development; competence building; verification of concepts and products, service development for future 5G scenarios	Vendors; operators	2018-2020 and beyond	D5.1 [5GM-D51]; D5.2 [5GM-D52]	TIM NOK-DE ATOS HWDU
Experience on the implementation of network slicing in a testbed	Product development; competence building; verification of concepts and products, service development for future 5G scenarios	Vendors; operators	2018-2020 and beyond	D5.1 [5GM-D51]; D5.2 [5GM-D52]	TIM NOK-DE ATOS HWDU SRUK DT
Experience on the implementation of an orchestrator in a testbed	Product development; competence building; verification of concepts and products, service development for future 5G scenarios	Vendors; operators	2018-2020 and beyond	D5.1 [5GM-D51]; D5.2 [5GM-D52]	TIM NOK-DE ATOS HWDU DT
Experience with the implementation of multiple applications in a testbed	Product development; competence building; verification of concepts and products, service development for future 5G scenarios	Vendors; operators	2018-2020 and beyond	D5.1 [5GM-D51]; D5.2 [5GM-D52]	TIM NOK-DE ATOS HWDU
KPI improvement, techno-economics of 5G-MoNArch innovations	Methodology for verification & validation of 5G systems	Vendors; operators; research SMEs; simulation tool vendors; government and regulatory groups; wireless users and site and infrastructure providers.	2018-2020 and beyond	D6.1 [5GM-D61], D6.2 [5GM-D62]; D6.3 [5GM-D63]	DT RW CERTH UC3M UKL TIM NOK-DE NOMOR

7 Conclusions and outlook

This first deliverable of Work Package 7 has detailed the dissemination venues explored by the 5G-MoNArch project, as well as described the results of these dissemination efforts so far. Furthermore, the impact on standardisation as well as the partners' plans for exploitation are provided.

With the dissemination activities conducted by 5G-MoNArch so far, the project could clearly set a footprint in the scientific the industrial community as well as the general public, with a considerable recognition of the project as flagship research initiative in the area of 5G mobile network architecture and network slicing. The feedback received so far indicates that the project's objectives and goals to particularly work on the realisation of network slicing for dedicated use cases is well received.

All dissemination activities have contributed to this achievement. The website and the social media accounts in particular contributed to making the project known to the general public, and through these channels several requests for further information on the project or even contact requests on potential cooperation with other initiatives came in. The dissemination towards the scientific and industrial communities, together with the standardisation efforts conducted by 5G-MoNArch, could clearly support the project's goal to establish the developed concepts, innovations and technologies, and are an important step towards the commercialisation of network slicing as an essential part of 5G networks. Not to be forgotten in this context is the high relevance of the two testbeds, namely, the Smart Sea Port and the Touristic City, which can be seen as a central dissemination activity of the project. In so far, 5G-MoNArch is regarded as a successful continuation of the excellent work conducted in the preceding projects such as 5G NORMA and METIS-II, and emphasises Europe's leading position in mobile network technologies.

The success of the project work is also reflected by the partners' concrete plans on exploiting the results within their organisations. In particular, from the perspective of the industrial partners, the already achieved results within the first project year represent an important result for the respective businesses. It can furthermore be seen from the exploitation plans that the impact of the project will not be focused only in a single sector but can be applied across multiple areas.

With respect to the future dissemination plans, the project aims to further strengthen the impact on the industrial community during the second part of the project. Further efforts will be implemented to reach out towards the community of vertical industries, potential customers and adopters of 5G-MoNArch technology. On the one hand, this will follow the joint activities conducted with GSMA so far, and will also rely on direct contacts with vertical industries, to emphasise the specifics and advantages of the 5G-MoNArch technology. On the other hand, the testbeds, currently being in their build-up phase, will strongly contribute to this aim. The project will particularly focus on disseminating those innovations that have been selected by the innovation management activities, based on their expected potential impact on the market. Besides the dissemination to the industrial community, 5G-MoNArch will continue with its activities in the scientific community. With the consolidation of the projects' solutions developed in the technical work packages, and the results from the verification and validation, it is expected that a good number of contributions will be submitted to high-quality venues during the second half of the project.

8 References

[5GM-D21] 5G-MoNArch, Deliverable D2.1 “Baseline architecture based on 5G-PPP Phase 1 results and gap analysis”, October 2017

[5GM-D22] 5G-MoNArch, Deliverable D2.2 “Initial overall architecture and concepts for enabling innovations”, June 2018

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[5GM-D31] 5G-MoNArch, Deliverable D3.1 “Initial resilience and security analysis”, January 2018

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[5GM-D41] 5G-MoNArch, Deliverable D4.1 “Initial design of resource elastic functions”, May 2018

[5GM-D42] 5G-MoNArch, Deliverable D4.2 “Final design and evaluation of resource elastic functions”, March 2019

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[5GM-D61] 5G-MoNArch, Deliverable D6.1, “Documentation of Requirements and KPIs and Definition of Suitable Evaluation Criteria”, September 2017.

[5GM-D62] 5G-MoNArch, Deliverable D6.2 “Methodology for verification and validation of 5G-MoNArch architectural innovations”, June 2018

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