



D7.3

Updated plan and initial report on Exploitation, Dissemination & Communication activities

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Abstract:	This report includes updates on the exploitation, dissemination and communication plans as well as initial reports on the executed activities. It furthermore includes a first view on the market, its opportunities and on the target audiences.
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Executive Summary

This deliverable includes information on the exploitation, dissemination and communication activities of the SERENA project. It is the first update on the exploitation activities as well as on the communication and dissemination ones. It thus contains relevant information about the executed activities for up to the delivery date – M18 (June 2019) as well as an updated plan of future activities. It further includes a first view on the market, its opportunities and on the target audiences.

The deliverable will be updated and finalized within “D7.4 Final plan and report on Exploitation, Standardisation, Dissemination & Communication activities” at the project end in M36.

However, being this a public deliverable, sensitive information has not been disclosed in order to safeguard the possibility to apply for patents.

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Chapter 1 Introduction

This deliverable provides an updated plan and initial report on the partners' **exploitation**, as well as on their **dissemination** and **communication** activities, as listed in Annex I. It will be finalized until the project end within D7.4 “Final plan and report on Exploitation, Dissemination & Communication activities”.

Dissemination & communication activities ensure the visibility and awareness of the project and support the widest adoption of its results among potential users. The SERENA dissemination & communication plan prepares the way for successful exploitation by facilitating internal communication within the project from the outset. Dissemination & communication activities are actively pursued from the beginning to the end of the project – engaging continuously with both internal and external audiences. The activities have been clustered into three main phases, which is shown in the Figure 1.

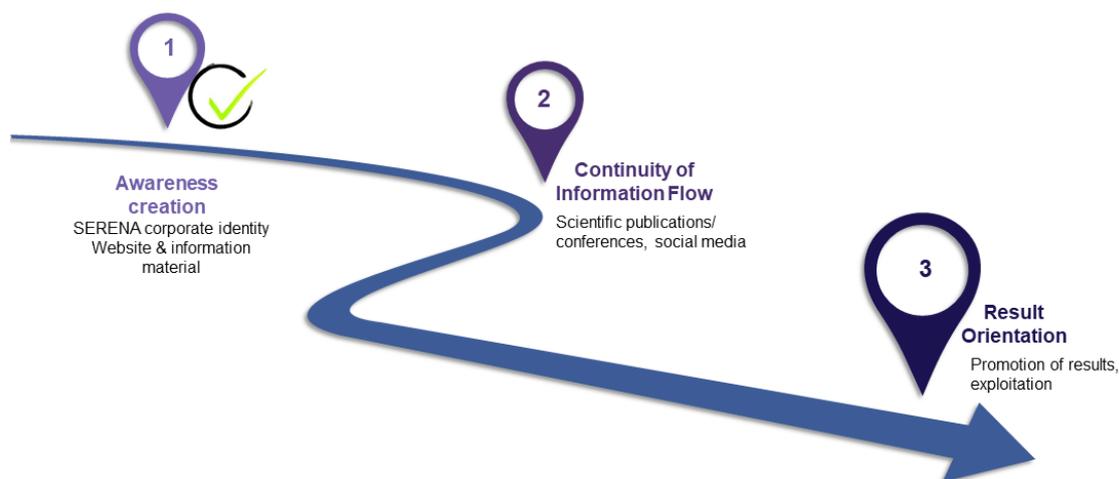


Figure 1: SERENA Dissemination and communication phases

The first phase is called “***awareness creation***” and consists of building up the SERENA branding and corporate identity, as well as establishing the SERENA website and additional project information material, like templates for documents as well as presentations. The SERENA has successfully passed this first phase.

In the second phase called “***continuity of information flow***”, in which the project is now, scientific papers are written and submitted to conferences and journals as well as presentations at conferences and workshops will be given in order to further raise awareness among the scientific and industrial stakeholders. Furthermore, publications, whitepapers and certain deliverables will be published on the project website in order to keep interested parties informed about the latest progress. In addition, engaging posts on Twitter & LinkedIn and on the Blog constitute an important part of keeping the information flow upright and increase the interest of multiple audiences. Besides that, newsletters, press releases, poster, information about workshops and conferences, etc. are an integral part of this dissemination phase, allowing more interactive communication within and outside the consortium. There will be additional press releases/newsletters when significant milestones are reached or for specific project events.

In the third phase “***Result orientation***”, dissemination will feed into exploitation and standardisation, which means using the results for commercial purposes or in public policymaking. There will be some ongoing dissemination activities after the project end in order to promote the project results

(e.g. website will stay alive for 5 years, social media, cooperation activities with other projects, talks at conferences and follow-up projects). The main focus will be to exploit those project results and attract the target audience group.

At the beginning of the project, the consortium established an initial dissemination and exploitation plan, which will be stated and explained in more detail in the following chapters, where we report on communication & dissemination activities as well as exploitation activities.

Chapter 2 Dissemination and communication

Strategy

A clear communication and dissemination strategy is essential and a forerunner for the execution of a dissemination and communication plan. Therefore, the SERENA project has set out a clear strategy for dissemination and communication, Figure 2. The strategy defines the audiences the project aims to target, and defining why such audiences should be targeted and by which means.

While talking about communication the goal is to highlight the benefits of the SERENA project for society, e.g. by showing the public society and media the impact of our project on everyday lives. When it comes to dissemination the goal is to transfer knowledge and make project results available to an audience that may take an interest.

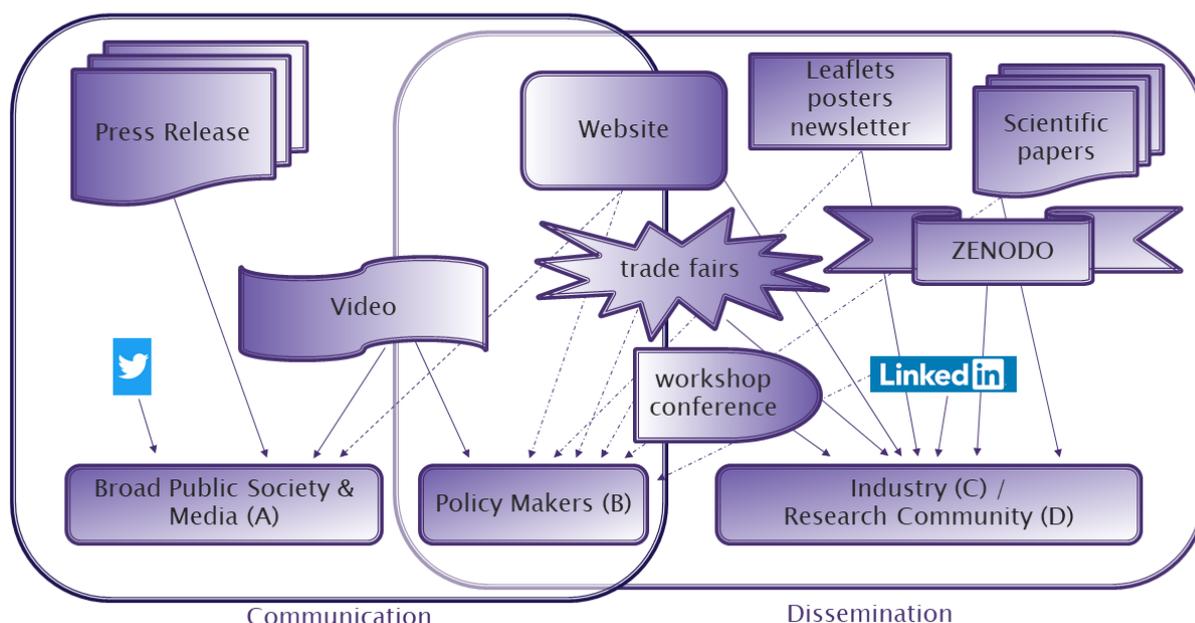


Figure 2: SERENA dissemination and communication strategy

Within the SERENA project, four main audience groups can be defined:

For communication:

- **Broad Public Society & Media (A),**
- **Policy Makers (B),**

For dissemination:

- **Policy Makers (B),**
- **Industry (C), and**
- **Research Community (D).**

The project results can be used specifically to reach different audiences, by using various channels from Figure 3. The channels and forms of their application are described in the following.

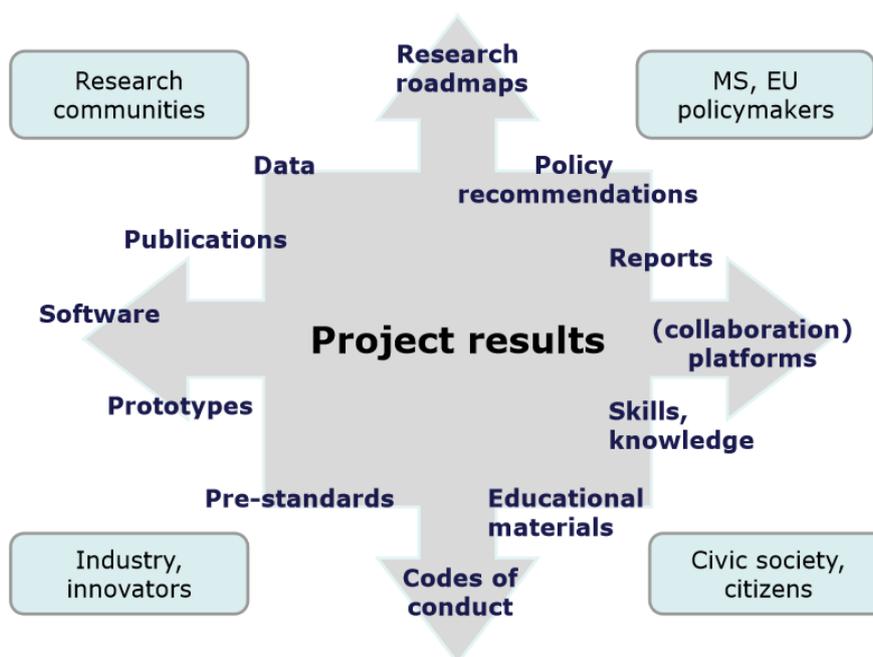


Figure 3: SERENA targeted audiences and measures

2.1 Broad Public Society & Media

Citizens are taxpayers and pay large amounts to the European Commission yearly. It is only fair that they expect to see that the resources they commit serve a meaningful purpose. Without funding from taxpayers, there would be no funding for H2020 projects. With different communication activities we show to the society the impact and benefits of the SERENA project, and how they could profit from the project results in their everyday life.

Within the SERENA project, there are many means defined to reach the public. One of the main is the [project website](#), on which it is possible to find an [announcement letter](#), a [project leaflet](#) as well as a [general presentation](#). Further channels that are emerging are introductory video interviews, which are available on the project website. Also, the [SERENA Twitter account](#) gives an overview of the EU funded R&I activities.

2.2 Policy Makers

It is important to bring the research and its outcome to policymakers in order to support them while fostering collaboration and innovation. There are several benefits in presenting the work and the results of the SERENA project to policymakers.

First, it increases the visibility of our research and enhances the project partner’s reputation. Further, it helps to gain understanding and support, also financially. Additionally, we attract potential end-users of the project results and by outlining the broader socio-economic and policy context of our project. Future policymaking will be positively influenced. The scientific evidence of SERENA additionally supports the grounds for European policymaking.

2.3 Industry

In order for the innovation developed within the SERENA project to have any value, it is essential to show it and its applicability to industry needs. Within the industry, a large potential of stakeholders can be found which will eventually enhance the general exploitation of the innovation, thus also benefitting the global European economy.

The SERENA project foresees several ways to reach the industry. Whereas the main channel is the attendance of trade fairs, the industry is also reached by attending conferences, workshops and further by publishing newsletters and keeping the website up to date.

2.4 Research and standardisation communities

Reaching the research and standardisation communities is crucial to innovation within the European Union: in order for the SERENA project to have a real impact in further research, and to help the standardisation path, it is essential to reach and gain the interest of the said communities.

There are many channels through which the research community can be reached and results of the project can be made available. First of all, it is necessary to publish in open access. SERENA provides open access to all published articles, on the ZENODO platform, and all publications are made accessible on the project website, where they are linked to their DOIs.

Standardisation is an important aspect of the SERENA project. A strategic objective of SERENA is to contribute to standardization efforts. Partner EAB is the leading members and contributor to 3GPP, ETSI and IEEE standardization processes for telecommunication and the next generation wireless access (5G) systems. The project partner IFAT is involved in multiple existing and emerging wireless and mobile communication standardization initiatives on a European as well as on an international level with regularly contributing to 3GPP and 3GPP-LTE partnership projects and being a member of the IEEE standards association. Hardware related achievements coming from the SERENA project will be promoted by IFAT in the 5G New Radio Access Technology (NR) standardization effort.

In order to connect with the scientific community, the SERENA project aims to be active on social media (LinkedIn). Partners are also encouraged to share the project results with their peers and followers. The regular project newsletter, with the information on the project progresses, is made available on the project website, as well as on social media.

Moreover, the SERENA project attends conferences, where the project's posters are presented and leaflets handed out. The main aim should be dissemination at conferences of European significance at least. However, lectures can be further disseminated at national levels in national languages for border scope of impacts.

Chapter 3 Dissemination & communication in SERENA

3.1 Phase 1: Awareness creation

The goal of the “awareness creation” phase was to build up the SERENA branding and corporate identity, as well as to establish the website and other useful information material. The SERENA consortium successfully finished this first phase. The planned activities for the first phase can be found in section 2.2.1 of the DoA part B document and the executed activities are described in the following sub-chapters.

3.1.1 Project information material (past communication activities)

Within the first phase of the project, several communication activities were planned. First, the project was announced by an [official announcement](#) letter, which was published on the coordinator’s (TEC) website at first, and then later on the project website. It was made available for all project partners, in order to encourage partners to make their own internal announcements.

Further, the **project logo and a colour scheme** were agreed upon, which are used for all communication and dissemination activities in order to ensure a recognisable visual identity.

Also, a project [leaflet](#) has been established: It is a four-page informative and graphically appealing A4 flyer, highlighting the objectives and the work programme of SERENA.

The [project website](#) was built-up, which is constantly updated by the coordinator. In addition, the project uses the advantages of social media in order to distribute information of the project to a large audience. As a consequence, they are valuable means to disseminate project ideas and results and have been actively used during the third project period.

- *Twitter* is an online social networking service and micro blogging service that enables its users to send and read text-based messages of up to 280 characters, known as "tweets". The SERENA project is available on https://twitter.com/SERENA_H2020
- *LinkedIn* is a social networking site for people in professional occupations or simply a social network for business. The SERENA group is a closed group. This ensures that only people who have been approved by the manager or administrator can see the content of the group. It can be accessed via: <https://www.linkedin.com/in/serena-project-a0ab60157/>

Direct links to the SERENA Twitter Account and the LinkedIn page can be found on the SERENA website.

As [Newsletters](#) are an efficient communication channel in order to provide news on the progress of the project, as well as to discuss ongoing topics relevant to SERENA for internal and external project partners, stakeholders and other interested bodies, the SERENA consortium published already three newsletters, informing about the main outcome and results of the project. As they are published on a half-yearly basis the next newsletter will be presented in September 2019.

Additionally, TEC produced a short [interview video](#) with the the technical leader of the SERENA project, Kristoffer Andersson (EAB). The video is available on the [project website](#), and were circulated via social media channels and the newsletter. During the second project period further interviews with key personal from the project are planned.

3.1.2 Project website (with statistics)

The SERENA project website is available on the following link:

<http://www.serena-h2020.eu/>

At each page of the SERENA website the disclaimer, the legal notice, the privacy policy and the feedback form are accessible (located at the bottom).

The homepage provides an overview of the project, including information about the project's *mission and motivation*, about the planned *results*, the *technical approach* (work packages). Furthermore, the *consortium* is presented and each partner website is linked. The page also presents an overview of other related projects that are complemented and strengthened by the research activities that are carried out in the scope of the SERENA project.

The website is kept up to date with latest information on past and upcoming events. Regular blog entries are also posted on the website, allowing to monitor the work performed by the different project partners. In addition to that submitted public RTD deliverables are made available as well as publications related to the project.

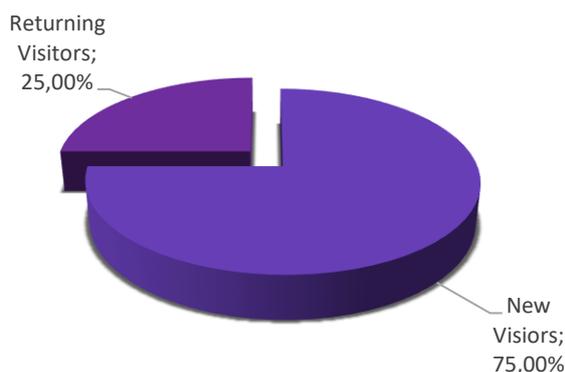


Figure 4: Website statistics: New vs. Returning Visitors

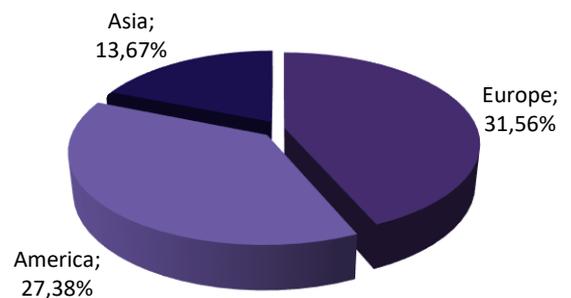


Figure 5: Website statistics: visitors' geo location

To summarize, and according to Google Analytics, the SERENA website was looked in approximately 420 times (visits) from its launch until end of May 2019 by 215 visitors, including 200 new guests (75%) and 25% returning guests (Figure 4). Most of the visitors come from Europe, the others from America or Asia, and a few from Africa (Figure 5). Approximately, half of the visitors are female. In addition to that, we would like to point out that the average session duration is 14:41 minutes.

3.1.3 Overview of past dissemination activities – Phase 1

Dissemination & communication are ongoing tasks within SERENA. Past activities which were already completed in the first awareness phase are summarised in Table 1. As most of the activities were needed for communication and dissemination, we have combined them in one table:

Type of activities	Partner	Title	Day	Month	Year	Type and goal of the event / website	Place
Press release	TEC	German Announcement Letter	10	01	2018	A German Press release has been published on: https://www.presstext.com/news/20180110028 The title of the letter is: "Forschungsprojekt SERENA kratzt an den Grenzen der klassischen Halbleiterindustrie"	Online
Other	TEC	Project Logo	17	01	2018	The logo will be used for SERENA deliverables, publications, etc.	Online
Press release	TEC	Announcement Letter	19	01	2018	The SERENA Announcement Letter is available on https://serena-h2020.eu/downloads/SERENA-announcement-letter-Jan2018.pdf It summarizes the project and lists the partners.	Online
Social Media	TEC	SERENA Twitter Account	23	01	2018	SERENA twitter account: https://twitter.com/SERENA_H2020	Online
Social Media	TEC	SERENA LinkedIn Account	23	01	2018	SERENA LinkedIn Account: https://www.linkedin.com/in/serena-project-a0ab60157/	Online
Flyer	TEC	Project Leaflet	28	02	2018	The SERENA leaflet gives an overview of the project and describes the mission, motivation and concept of the project, as well as the included work packages. It is available on the project website (https://serena-h2020.eu/downloads/SERENA_Folder_Web.pdf).	Online
Website	TEC	SERENA website	09	03	2018	The official website was launched in March 2018. https://serena-h2020.eu/	Online
Other	TEC	General Project Presentation	26	03	2018	This general presentation can be used for basic/ general presentations on various events. It is available on the SERENA website as well as the coordinators website (TEC).	Online
Press release	TEC	Newsletter Issue 1	14	05	2018	The first Newsletter includes some general project information, reports about the kick-off meeting as well as the WP5 workshop and a short overview of the technical approach. It also promotes the first publication, and lists	Online

Type of activities	Partner	Title	Day	Month	Year	Type and goal of the event / website	Place
						some ongoing activities and upcoming conferences/meetings. https://serena-h2020.eu/downloads/SERENA-Newsletter-Issue1-May2018.pdf	
Press release	TEC	Newsletter Issue 2	01	11	2018	The second Newsletter includes a message from the coordinator and describes the main achievements of the work packages. It also summarizes the technical meeting of the SERENA consortium which was held in Gothenburg, lists highlights of the dissemination activities and introduces upcoming conferences and meetings. Furthermore, it mentions the submitted- and upcoming public deliverables. https://serena-h2020.eu/downloads/SERENA-Newsletter-Issue2-November2018.pdf	Online
Press release	TEC	Newsletter Issue 3	01	03	2019	The newsletter includes a message from the coordinator and lists upcoming conferences and meetings. Further, it summarizes the technical and general assembly meeting in Villach and also the review meeting in Brussels. It also highlights the Interview Video with the technical leader which was produced by TEC and promoted on the website and social media platforms and lists the project achievements and highlights. https://serena-h2020.eu/downloads/SERENA-Newsletter-Issue3-March2019.pdf	Online
Video/Film	TEC	SERENA Interview Video	01	03	2019	Kristoffer Andersson (Ericsson, Sweden) is the technical lead of the SERENA project. He is talking about the vision and mission of the project. The video is available here: https://serena-h2020.eu/index.php/news/press-news	Online

Table 1: Dissemination activities - Phase 1

3.2 Phase 2: Continuity of information flow

The goal of the Continuity of information flow phase, which started approximately after the first year of the project, is to raise further awareness among our different target groups.

3.2.1 Overview of past communication activities – Phase 2

The goal towards the *Broad Public Society & Media (A)* as well as towards the *Policy Makers (B) and Industry (C)* is to communicate the benefits of our SERENA project for the society for example by explaining the impact of our project on everyday lives.

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Press release	TEC	German Announcement Letter	10	1	2018	N/A	A German Press release has been published on: https://www.presse-text.com/news/20180110028 The title of the letter is: "Forschungsprojekt SERENA kratzt an den Grenzen der klassischen Halbleiterindustrie"	Online
Other	TEC	Project Logo	17	1	2018	N/A	The logo will be used for SERENA deliverables, publications, etc.	Online
Press release	TEC	Announcement Letter	19	1	2018	N/A	The SERENA Announcement Letter is available on https://serena-h2020.eu/downloads/SERENA-announcement-letter-Jan2018.pdf It summarizes the project and lists the partners.	Online

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Social Media	TEC	SERENA Twitter Account	recurrent			31	regular tweets on the SERENA twitter account: https://twitter.com/SERENA_H2020	Online
Social Media	TEC	SERENA LinkedIn Account	recurrent			72	SERENA LinkedIn Account: https://www.linkedin.com/in/serena-project-a0ab60157/	Online
Flyer	TEC	Project Leaflet	28	2	2018	N/A	The SERENA leaflet gives an overview of the project and describes the mission, motivation and concept of the project, as well as the included work packages. It is available on the project website (https://serena-h2020.eu/downloads/SERENA_Folder_Web.pdf).	Online
Website	TEC	SERENA website	recurrent			420	The official website was launched in March 2018 and gets updated on a regular basis with interesting information on the project progress (blog entries, update on use cases, workshops, videos etc.). https://serena-h2020.eu/	Online
Other	TEC	General Project Presentation	26	3	2018	N/A	This general presentation can be used for basic/ general presentations on various events. It is available on the SERENA website as well as the coordinators website (TEC).	Online
Press release	TEC	Newsletter Issue 1	14	5	2018	N/A	The first Newsletter includes some general project information, reports about the kick-off meeting as well as the WP5 workshop and a short overview of the technical approach. It also promotes the first publication, and lists some ongoing activities and upcoming conferences/meetings. https://serena-h2020.eu/downloads/SERENA-Newsletter-Issue1-May2018.pdf	Online

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Press release	TEC	Newsletter Issue 2	1	11	2018	N/A	The second Newsletter includes a message from the coordinator and describes the main achievements of the work packages. It also summarizes the technical meeting of the SERENA consortium which was held in Gothenburg, lists highlights of the dissemination activities and introduces upcoming conferences and meetings. Furthermore, it mentions the submitted- and upcoming public deliverables. https://serena-h2020.eu/downloads/SERENA-Newsletter-Issue2-November2018.pdf	Online
Press release	TEC	Newsletter Issue 3	1	03	2019	N/A	The newsletter includes a message from the coordinator and lists upcoming conferences and meetings. Further, it summarizes the technical and general assembly meeting in Villach and also the review meeting in Brussels. It also highlights the Interview Video with the technical leader which was produced by TEC and promoted on the website and social media platforms and lists the project achievements and highlights. https://serena-h2020.eu/downloads/SERENA-Newsletter-Issue3-March2019.pdf	Online

Table 2: Past communication activities – Phase 2

3.2.2 Overview of past dissemination activities – Phase 2

Furthermore, we foster to disseminate knowledge and results with the Research Community (D) as well as with Policy Makers (B) and the Industry (C). Therefore, scientific papers and articles are written and submitted to conferences and journals, presentations at workshops and conferences are given. Project partners were attending several conferences and workshops to spread information about the SERENA project. Publications and certain public deliverables are published on the project website and on zendod.org. In addition to that frequent posts on social media channels (LinkedIn) are an important dissemination instrument to keep the information flow upright.

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Participation to a Conference	TUB	WSA - Workshop on Smart Antennas	14-16	03	2018	N/A	Partner TUB presented a conference paper with partly prior work, demonstration of a testbed (prior work, much lower frequency 2.4GHz) using algorithms which will be used in the SERENA demo platform https://wsa2018.dks.ruhr-uni-bochum.de/en/	Bochum, Germany
Participation to a Conference	EpiGaN	GaN material solutions for 5G	10	04	2018	N/A	There was an oral presentation in the Compound Semiconductor International Conference 2018, as part of the session "5G: where are we and what's next?" https://www.cs-international.net/home	Brussels, Belgium
Participation to a Conference	EpiGaN	Epitaxial processes of GaN-on-Si (and SiC) for RF applications	15	06	2018	N/A	Invited presentation in IMS 2018 (International Microwave Symposium). https://ims2018.org/	Philadelphia, USA
Participation to a Conference	FRAUNHOFER	FUTURE INDUSTRIAL COMMUNICATION	11-13	09	2018	N/A	Partner Fraunhofer participated in the conference: https://www.applied-5g.de/wp-content/uploads/2018/08/5G_Programm_f.pdf	Berlin, Germany
Participation to a Workshop	EAB	EU - South Korea workshop on Nanoelectronics	13	09	2018	N/A	Closed EU-Korea workshop. Oral presentation of SERENA-project. Abstract book available from Kristoffer Andersson. https://eeas.europa.eu/delegations/south-korea/49826/2018-korea-eu-research-and-innovation-day_bs	Seoul, South Korea

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Organisation of a Workshop	OMMIC	ESA 9th Wide Bandgap Semiconductors and Components Workshop.	02	10	2018	N/A	As proceedings of 9th Wide Bandgap Semiconductors and Components Workshop ESA/ECSAT the partner presented at Section 7: Demonstrators and future Perspectives. https://artes.esa.int/news/9th-wide-band-gap-semiconductor-and-components-workshop	Harwell, UK
Participation to a Workshop	EpiGaN	ESA 9th Wide Bandgap Semiconductors and Components Workshop.	08	10	2018	N/A	A presentation and an abstract booklet "GaN-on-SiC and GaN-on-Si material solutions for RF and mm-wave Power applications" was given. https://artes.esa.int/news/9th-wide-band-gap-semiconductor-and-components-workshop	Didcot, UK
Participation to a Conference	EpiGaN / IFAT	48th EMW week	23-28	09	2018	N/A	Partner Epigan presented GaN products for 5G and partner IFAT attended the conference. http://www.eumweek.com	Madrid, Spain
Participation to other events	TUB	BIMos Day 2018: "The Mathematics of Multiple Antenna Communications "	19	11	2018	100	TUB gave a talk at a BIMos day which is a regular event of a graduate school of the TUB where researchers present work related to the BIMos graduate school www.bimos.tu-berlin.de	Berlin, Germany
Participation to a Conference	Fraunhofer	Measurements and Verification (European Microwave Week 2019)	23-28	09	2018	N/A	Partner Fraunhofer gave a presentation on measurement and verification techniques for 5G. https://www.eumweek.com/	Madrid, Spain

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Participation to a Workshop	IFAT	Scientific Colloquium at the Ferdinand Braun Institut für Höchstfrequenztechnik, Berlin	03	12	2018	N/A	Infineon held a presentation with the title “Towards 5G Wireless: Radio Architectures and Circuits” by DR. Franz Dielacher. Moreover, IFAT discussed the trends in communications and RF frontend architectures and provided examples for 5G technology. https://www.fbh-berlin.de/	Berlin, Germany
Participation to a Workshop	IFAT	ICT-2018 conference	04-06	12	2018	N/A	Infineon contribution to session “ICT-What will be required in 2030? “and „Rump Session “ https://ec.europa.eu/digital-single-market/en/events/ict-2018-imagine-digital-connect-europe	Vienna, Austria
Participation to a Conference	IFAT	ISSCC-International Solid-State Circuits Conference 2019	17-21	02	2019	N/A	Forum organizer (committee) for: "Sub-6GHz 5G Radio Circuits and Systems: from concepts to silicon". http://isscc.org/	San Francisco, USA
Participation to a Conference	CHALMERS	ISSCC-International Solid-State Circuits Conference 2019	17-21	02	2019	100	Partner Chalmers gave a forum talk on "Power Amplifier Linearity and Efficiency Challenges for sub-6GHz 5G Systems". http://isscc.org/	San Francisco, USA
Organisation of a Conference	EpiGaN	CS International Conference	26-27	03	2019	N/A	Partner EpiGaN was invited for a talk: “GaN on Si – A Key enabling technology for 5G” by Dr. Markus Behet. https://10times.com/profile/markus-behet-15302194	Brussels, Belgium

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Participation to a Conference	TUB	IEEE International Conference on Communications	20-24	05	2019	N/A	Partner TUB presented a paper “A Joint Evaluation of Fully-/Sub-Connected Hybrid Precoding Architectures for mmWave MIMO Systems”. https://icc2019.ieee-icc.org/	Shanghai, China
Participation to a Conference	EAB	IEEE International Microwave Symposim	02-07	06	2019	N/A	EAB gave talks at a workshop “Exploratory Semiconductor Devices for 5G mm-Wave Era and Beyond” and “Integration challenges for 5G mm-wave radios” https://ims-ieee.org/	Boston, MA, USA
Participation to a Conference	IFAT	IEEE International Microwave Symposium	02-07	06	2019	N/A	IFAT participated at: IMS technical sessions, IMS Plenary Session, RFIC technical sessions, RFIC Plenary Session and Industry Showcase, ARFTG technical sessions, 5G Summit and Panel. https://ims-ieee.org/	Boston, MA, USA
Organisation of a Workshop	IFAT	IEEE International Microwave Symposium	02-07	06	2019	N/A	IFAT was organizer of the workshop WFH “Challenges for mm-Wave Remote Radio Units in 5G Infrastructure”	Boston, MA, USA
Participation to a Workshop	IFAT	IEEE International Microwave Symposium	02-07	06	2019	N/A	IFAT participated at a workshop with the title “The Analog vs. Digital Battle - A Fight of Paradigms to Optimize Systems & PA Solutions for Wireless Infrastructure in 5G and Beyond” Franz Dielacher held presentations with the title “Overview about RF and PA Requirements for 5G NR and Challenges for Hardware Implementation” and “RTu2E-3: A 24.2-30.5GHz Quad-Channel RFIC for 5G	Boston, MA, USA

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
							Communications Including Built-in Test Equipment". Another presentation in the session Rmo3C-3 with the title "A 18.2–29.3GHz Colpitts VCOs Bank with -119.5dBc/Hz Phase Noise at 1MHz Offset for 5G Communications" was given by IFAT https://ims-ieee.org/	
Participation to a Workshop	Fraunhofer	Roadmap 5G-Technologien für das massive Internet der Dinge	22	2	2018	N/A	Presentation on Roadmap for 5G technologies	Freiburg, Germany

Table 3: Past dissemination activities

3.2.3 Highlights of Phase 2

3.2.3.1 Social Media

Social media is a very powerful tool to communicate and disseminate information and to effectively let people know about the activities we carry out in our SERENA project, this is the reason we created in January 2018, a SERENA Twitter, as well as a LinkedIn account. Both accounts are updated on a regular basis, to schedule the postings and tweets, we have created a posting plan, which helps us to plan and organize upcoming content.

3.2.3.2 Twitter

Twitter is an online social networking service and micro blogging service that enables its users to send and read text-based messages of up to 280 characters, known as "tweets". The SERENA project is available on https://twitter.com/SERENA_H2020.

Since the beginning of the project, SERENA published 19 tweets and is mainly used for communication activities, including the announcement of the project website, press releases, newsletter publications and different meetings. The account has currently 25 followers (status 17.06.2019). In the second period of the project, there will be more activities to be published and posted and therefore we are confident to get more followers.

3.2.3.3 LinkedIn

LinkedIn is a social networking site for people in professional occupations or simply a social network for business. The SERENA project has a public account, which can be accessed via: <https://www.linkedin.com/in/serena-project-a0ab60157/>.

Until the mid of June 2018, the SERENA team has established a good network on the social media platform and gathered 75 interesting and professional contacts. Information (publications, deliverables, conferences, workshops) on the project is posted on a regular basis. We can report that the engagement rate (9,13%) at our LinkedIn profile is quite good, and that our followers are interested in the posted content. (Engagement measures the number of likes, shares, and comments our social updates receive. In our opinion a good engagement rate is more important than just the number of followers.) At the moment we are satisfied with the number of contacts, as we can say that all are interesting contacts for the project and work in related fields. The goal is to triple the number of contacts by the end of the project and build a network interested in the results of SERENA.

Open Access to Scientific Publications

The mentioned publications in Table 4 are publicly available. As soon as a paper is published, the Consortium is committed to provide open access *via* the EU compliant repository Zenodo (<https://zenodo.org>), where also a SERENA community has been established. Zenodo is convenient to access and also easy to use. This repository allows to easily share the long tail of small research results in a wide variety of formats including text, spreadsheets, audio, video, and images across all fields of science. Further, each uploaded publication and dataset receives a persistent identifier (DOI), which ensures long term preservation. If relevant, also underlying research data will be made publicly available and linked to the specific publication. In total one scientific publication including a dataset was published. In total three further publications are planned whereas one is in the pipeline. Hence also four public deliverables are accessible.

The SERENA Consortium published 2 peer-reviewed scientific papers during the first 18 month of the project.

The publication “An Analog Module for Hybrid Massive MIMO Testbeds Demonstrating Beam Alignment Algorithms” which was published in February 2018 was viewed 90 times and downloaded 104 times. For the other uploads it is too early to give a statistic.

In addition to that public deliverables of the project were made available also on zenodo.org:

Title	Authors	Journal/Conference	DOI (publisher)
Beam Alignment Measurements using a Hybrid Massive MIMO Testbed	Kühne, Thomas	International ITG Workshop on Smart Antennas (WSA 2018)	https://doi.org/10.5281/zenodo.1217533
An Analog Module for Hybrid Massive MIMO Testbeds Demonstrating Beam Alignment Algorithms	Kühne, Thomas; Caire, Giuseppe	International ITG Workshop on Smart Antennas (WSA 2018)	https://doi.org/10.5281/zenodo.1175891
Deliverables on Zenodo			
Proof of concept platform and front-end specifications	Andersson, Kristoffer	N/A	10.5281/zenodo.3240304
E-/W-band multifunctional sub-system specifications	Andersson, Kristoffer	N/A	10.5281/zenodo.3240449
Integration specifications	Ndip, Ivan	N/A	10.5281/zenodo.3240451
Signal processing algorithms and specifications	Kühne, Thomas; Caire, Giuseppe; Song, Xiaoshen	N/A	10.5281/zenodo.3240455

Table 4: Scientific Publications

Related Projects

In order to create information flow with external parties, a “Related Project List” has been created. Those projects were integrated in the SERENA website by following this link: <https://serena-h2020.eu/index.php/related-projects>. In addition, the coordinators of the projects which are still running have been contacted via email. We provided them with some basic information about the project, the link to the SERENA leaflet and ask for permission to link their website to the SERENA homepage.

- [InRel-Npower](#)
- [M3TERA](#)

- [TWEETHER](#)
- [Flex5Gware](#)
- [mmMAGIC](#)
- [Car2TERA](#)
- [GaNonCMOS](#)

3.2.4 Planned activities – Phase 2

The following section presents the planned dissemination and communication activities planned until the project end identified by the project partners. The lists are regularly monitored and updated, so all the partners are aware of possible opportunities to disseminate, and each activity is aligned with the others.

All consortium partners are involved in the planning of newsletters and press releases and participate in the creation and dissemination of these materials. The coordinator TEC manages and continuously updates the SERENA LinkedIn and Twitter accounts to raise awareness about the project among the general public and to its own stakeholders. Project partners are also encouraging external persons to follow the project on Twitter and LinkedIn, and those having a social media account also promote the project with frequent activities.

The consortium has planned a series of dissemination activities which will target the general public, and that will be carried out until the end of the SERENA project:

Dissemination and Communication through SERENA Social Media

SERENA Twitter and LinkedIn accounts will be frequently updated with news about the project. In addition to that the project website will be updated with all the relevant news and announcements, conferences, workshops, publications, meetings, etc.

Newsletters

Several further issues of the newsletter are planned until the project end. The newsletters will be created and published in correlation with the entire team after the achievement of certain results and milestones. At least three more issues are foreseen. All [newsletters](#) can be downloaded on the project-website.

In order to get a better overview of upcoming events, where participation is envisaged by one or more partners, the consortium a list for upcoming events and other dissemination activities. This list complements the already existing list, where we collect past dissemination activities. Upcoming as well as past conferences are also listed on the [project website](#). Table 5 shows the planned events. Please note that this is a living document and will be updated on a quarterly basis.

Activity	Partner	Title	Day	Month	Year	Size of audience / KPI	Description	Place
Participation to a Conference	IFAT	15th ConTEL-International Conference on Telecommunications	3-5	07	2019	N/A	Franz Dielacher (IFAT) will give a Presentation about "RF-Frontend design in SiGe-BiCMOS technology" http://www.contel.hr/2019/	Graz, Austria
Participation to a Workshop	EAB/CHALMERS	European Microwave week 2019	29-04	09/10	2019	N/A	EAB together with Chalmers planned a workshop on Multiphysics and 5G mm-wave systems. The planned workshop has been submitted to the European Microwave week in 2019. The proposed workshop has now been accepted for inclusion in the technical program of European Microwave week 2019. https://www.eumweek.com/	Paris, France
Participation to other events	EAB/CHALMERS	SERENA Winter School	TBD			N/A	The current proposal is to have a joint Winter school in 2020 with two related H2020 projects (CAR2TERA and GRACE).	TBD
Scientific publications	Fraunhofer	2019 IMAPS International Symposium	30	10	2019	N/A	At this Symposium the partner will present a paper: "Is Packaging Relevant for 5G?" http://www.imaps.org/imaps2019/index.htm	Boston, MA, USA
Scientific publications	Fraunhofer	2019 International Conference on Microwave, Communications, Antennas and Electronic Systems	04-06	11	2019	N/A	Another scientific publication is planned for 2019 with respect to the Role of Packaging in 5G. https://www.comcas.org/	Tel Aviv

Table 5: Planned dissemination activities

3.2.5 Resume Dissemination and Communication activities Phase 1& 2

Communication activities to promote the project itself and its success, as well as the dissemination of results are key areas of our H2020 SERENA project. Our goal is, to bring research and its outcomes to the attention of non-scientific audiences, scientific community, potential business partners or policymakers. To achieve this, we have created our SERENA dissemination and communication strategy described in Chapter 2

The SERENA project has successfully passed the first phase “awareness creation” and the project team has prepared the necessary communication and dissemination material (corporate design, leaflets, website social media channels, etc.) We would like to point out, that this work was carried out jointly and all project partners, especially the technical and the WP leaders were involved.

The project is now in the second phase called “*continuity of information flow*”. In the past months the partners submitted 2 papers to conferences and journals and presented the project at different conferences and workshops in order to further raise awareness among stakeholders. The project website and the social media channels (LinkedIn and Twitter) are updated on a regular basis with news from the project. The consortium is committed to boost the communication and dissemination activities more in the upcoming months / period 2 of the project.

In addition, SERENA uses [EUVATION](#), as a dissemination channel. EUVATION is a multi-channel platform to spotlight European technical innovation on a broad public level. EUVATION promotes public material of any sort. The EUVATION website features animated videos and podcast series focusing on European research, innovation projects and their stakeholders. Content can be searched by topic and subject matter. Moreover, interviews and profiles from key European players can be found together with dissemination material and publications. Content is created and collected from a variety of sources which are selected based on novelty, quality and common interest.

3.3 Phase 3: Result Orientation

The SERENA project will enter this third phase towards the end of the project. The result orientation phase consists of three main goals:

1. Promotion of project results
2. Exploitation activities
3. Attraction of the target group

The SERENA consortium has currently the following plans for phase 3.

Activity	Audience	Time frame	Objectives	Partners
Training by research of the existing personnel	Young researchers, PhD students, technical personnel	Throughout and after the project	A considerable effort of the SERENA consortium will be directed towards the inter-disciplinary training of young researchers in the field of RF system integration based on GaN and silicon technologies. The consortium acknowledges its responsibility to improve training activities helping to provide a skilled pool of researchers and engineers. It is expected that a significant portion of the knowledge created within the framework of this project will serve as valuable material for PhD theses and publications co-authored by PhD students.	CHALMERS, TUB and the other research partners together with contributions from academic partners.
Organization of a SERENA Winter School	Young researchers, PhD students	This is planned between M22-M24	Summer school in design and simulation of Multiphysics mm-wave communication and sensing systems.	CHALMERS, EAB, FHG, TUB
Keynote talks in leading conferences and events (e.g.5G summits)	R&D community in the field of wireless communications, mm-wave microsystems packaging and GaN technology	Worldwide, towards the end of the project as opportunity to presents itself	Raising attention towards the SERENA project results especially towards high-level technical staff of large companies involved in 5G standardization and development.	EAB, IFAT, OMMIC, EPIGAN, FOI, FHG, CHALMERS, TUB
Submission of an IEEE Communication Magazine project review paper	Scientific community, industry, policy makers especially in the field of communications	Towards the end of the project	Providing a general overview of the outcomes of the SERENA project in a tutorial and accessible form, (Comm-Mag. has the highest impact factor among all IEEE publications in the area of communications and	TUB with the help of the other partners

Activity	Audience	Time frame	Objectives	Partners
			the IEEE Communications Society is the largest and most important professional society in the area of communication technology (40,000 members).	
Organisation of SERENA workshops as training activities	Young researchers, PhD students, technical personnel	Throughout and after the project	These workshops will contribute to raise awareness of the scientific work being undertaken both inside and outside of the project. During and after the project, material that was identified by the consortium as being able for public dissemination will be elaborated for education of a broader public.	Research partners together with contributions from other academic institutions, addressing the training aspects of all involved partners

Table 6: Table 6: Dissemination Plan Phase 3

Internal and external training

As stated in Table 6, the consortium acknowledges its responsibility to improve training activities helping to provide a skilled pool of researchers and engineers. Partner EAB quarterly organizes internal workshops with dissemination of SERENA activities. Typically, 25-30 participants from the fields research managers, product development leaders, standardization delegates and RnD engineers are taking part in these workshops. Partner Fraunhofer is giving the lab course “EMV in elektronischen Systemen” at the “Technische Universität Berlin” in the summer term 2019. Additionally, they attended two workshops in 2018 and will also be present at on workshop in 2019 (Table 3 and Table 5). From partner IFAT, Franz Dielacher attended as Forum organizer for "Sub-6GHz 5G Radio Circuits and Systems: from concepts to silicon" at the [ISSCC-International Solid-State Circuits Conference 2019](#) in San Francisco. Also, at this conference partner Chalmers with Prof. Christian Fager gave an invited forum talk "Power Amplifier Linearity and Efficiency Challenges for sub-6GHz 5G Systems", which included a part on electro-thermal effects where analysis techniques related to SERENA were presented.

Further, the senior researchers (Prof. Christian Fager and Dr. Koen Buisman) exploit the knowledge about multi-physics analysis of 5G systems through supervision of a PhD student in a Marie Curie Innovative Training Network (SILIKA).

Partner TUB has engaged two PhD students into the SERENA project. Thomas Kühne works directly on the project and his research will be used in SERENA and for his thesis. He profits from the collaboration with the other partners through getting feedback on the signal processing. The second PhD student Xiaoshen Song indirectly benefits by SERENA in gaining insights on the application and hardware limitations for her research on the theoretical basics of hybrid MU-MIMO. Additionally, Prof. Giuseppe Caire gave a three hour talk to graduate students at the BIMos Day 19 at TUB with the topic "The Mathematics of Multiple Antenna Communications". The BIMos day is a regularly event of the BIMos graduate school where researchers present their related work.

Chapter 4 Exploitation

This Chapter presents the Exploitation Strategy for the SERENA project, as well as the individual partners' exploitation plans.

However, being this a public deliverable, and desiring the partners to protect their rights, only a general overview is disclosed, not to compromise future patent applications.

4.1 Exploitation Strategy

The main objective of an efficient exploitation strategy is to ensure that the results and benefits of the developed project outputs are attractive and get well-known in the industry. The objectives of the SERENA exploitation plan are:

- to establish and maintain mechanisms for effective exploitation
- to inform stakeholders of the project development and encourage interactions/ networking
- to coordinate all levels and types of exploitation of the knowledge produced by the project
- to ensure that information is shared with appropriate audiences on a timely basis and by the most effective means and medium.

Besides the dissemination of the project results exploitation of the achievements of SERENA is of crucial importance and is recognized as one of the key elements for the success of SERENA as underpinned by its significant industrial participation. Our common goal is to create knowledge, research new solutions and pave the way for successful commercial product innovation. Individual exploitation plans, which define a preliminary strategy for the development and exploitation of the project results, are listed in the tables below. Table 1 lists the initial exploitation plans per partner, whereas Table 2 describes the updates on the individual exploitation plans.

4.2 Market Expectations

The final SERENA technology platform will be exploited in different ways for different markets. The major potential markets for the SERENA platform are the wireless infrastructure, radar sensors, and imaging.

An economic impact analysis from ABI classifies 5G as one of the next General Purpose Technologies that will act as a catalyst for transformative changes of work processes and will establish a new set of rules of competitive economic advantages at the same time. ABI expects 5G to enable \$12.3 trillion of global economic output in 2035 – nearly equivalent to the US consumer spending in 2016.

5G will employ massive MIMO beamforming. This will require multiple transmit and receive chains for each antenna element in a phased-array configuration of the transceiver system. As the power per antenna element is reduced compared to the single omni-directional antenna case, the amplifier size per antenna can be reduced. MIMO requires all antenna elements to emit signals with a well-defined phase relationship to one another, which will be facilitated if the chosen RF amplifier technology is suitable for close integration with the driving digital controllers which is much convenient when working on Si substrates rather than on their SiC counterparts. Consequently, compactness, low cost, high power density, linearity at mmWave frequencies and integratability with CMOS technology are mandatory attributes for the power amplifier technology to meet objectives for both 5G infrastructure and handset architectures.

Here GaN-on-Si technology comes to the rescue. As a fundamentally superior RF semiconductor technology GaN is best suited to achieve these demanding performance targets. According to Yole 2019¹, the market for GaN RF device will reach \$2B by 2024 (see Figure 6)

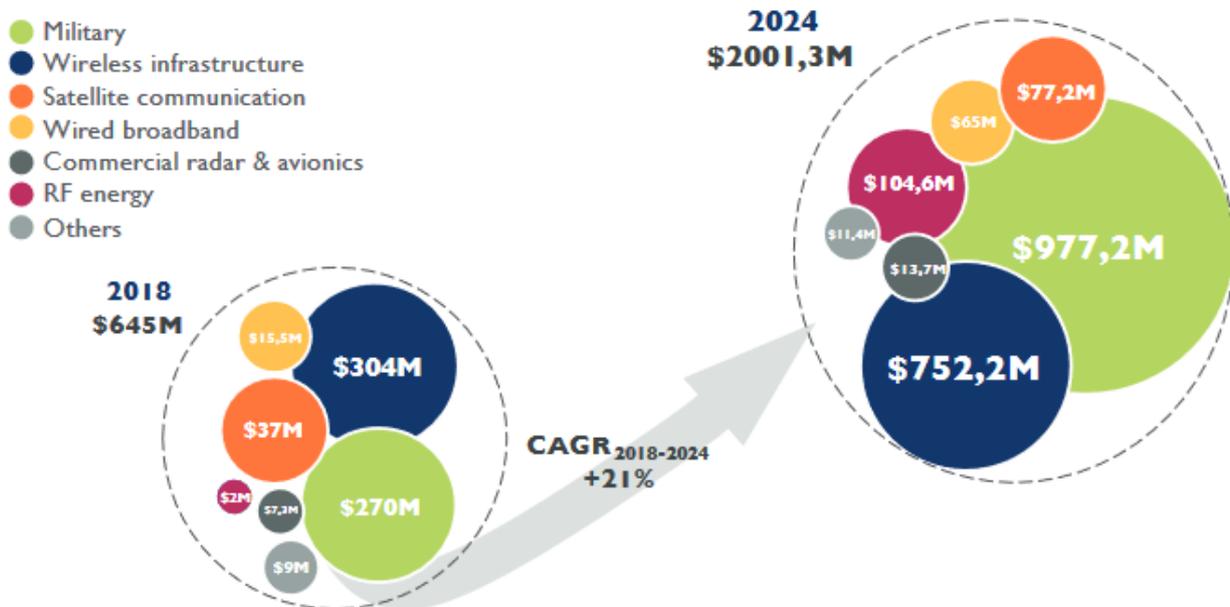


Figure 6: GaN RF device market size forecast 2019-2024 [Yole Development, May 2019]

In the latest edition of the Ericsson Mobility Report 2019², Fedrik Jejdling (Ericsson Executive Vice President and Head of Business Area Networks) gives the following statement:

“As market after market switches on 5G, we are at a truly momentous point in time. No previous generation of mobile technology has had the potential to drive economic growth to the extent that 5G promises. It goes beyond connecting people to fully realizing the Internet of Things (IoT) and the Fourth Industrial Revolution. Digital infrastructure can make distance less relevant than ever. 5G is the key to making it all work – driving economic value from enhanced mobile broadband to industry digitalization. That, in turn, will require an ecosystem of technology, regulatory, security and industry partners to deliver on the potential. Smart cities, Industrial IoT, augmented reality, autonomous transport and digital health are just some of the exciting prospects that can be made real with the support of the 5G ecosystem.”

5G deployments are gaining momentum worldwide. During 2018, a few 5G launches took place, mainly in North America. In North America and North East Asia significant 5G subscription volumes are expected early. 5G coverage build-out can be divided into three broad categories:

1. Radio deployments in new bands in the sub-6GHz range,
2. Deployments in millimeter wave frequency bands,
3. Deployments in existing LTE bands.

¹ [Emerging Semiconductor Substrates: Market & Technology Trends 2019](#)

² The Ericsson Mobility Report 2019 (<https://www.ericsson.com/assets/local/mobility-report/documents/2019/ericsson-mobility-report-june-2019.pdf>)

Looking at the first two categories combined, 5G population coverage is forecast to reach 45 percent in 2024. The 5G adoption is projected to be significantly faster than for 4G (LTE) when that was introduced 2009.

Device (terminal) availability is imperative to motivate network roll-outs. Figure 7 below shows available devices, listed by frequency and type, available during 2019 and 2020. Relevant for the SERENA project is the 39 GHz devices that will be available as either pocket routers or Smartphones by mid-2019 and then also fixed wireless terminals (FWT) in early 2020.

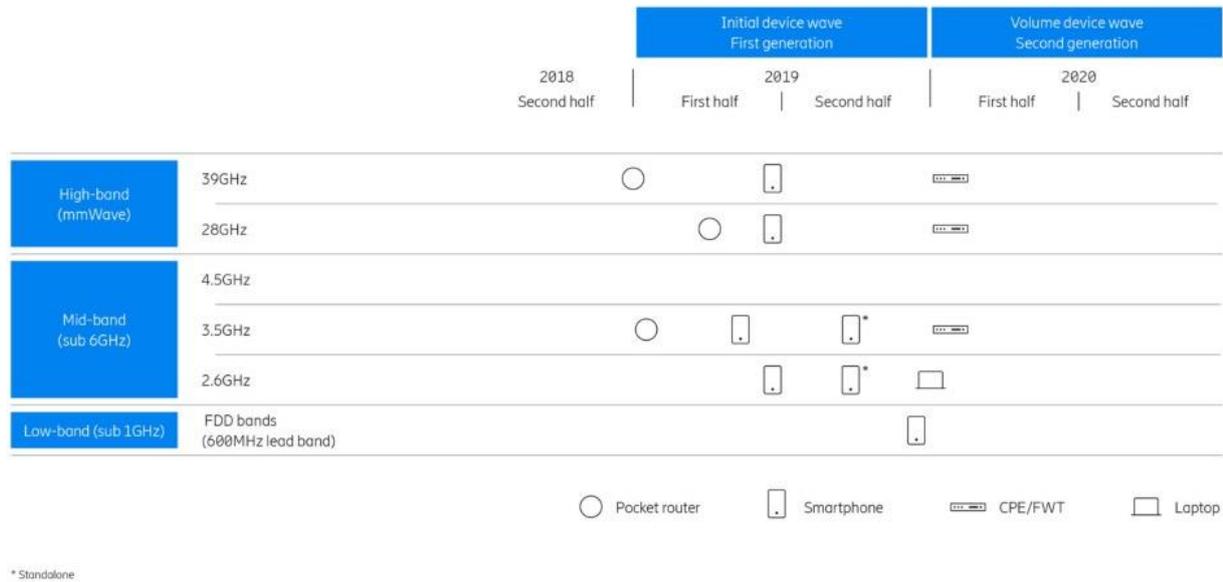


Figure 7: 5G device availability [ERRICSSON, 2019]

The uptake of 5G technology will vary across regions. The main growth will be in US followed by North East Asia and Western Europe. Figure 8 shows the projected evolution of mobile subscription technology from 2018 to 2024. According to current estimates more than 60% of all US subscribers

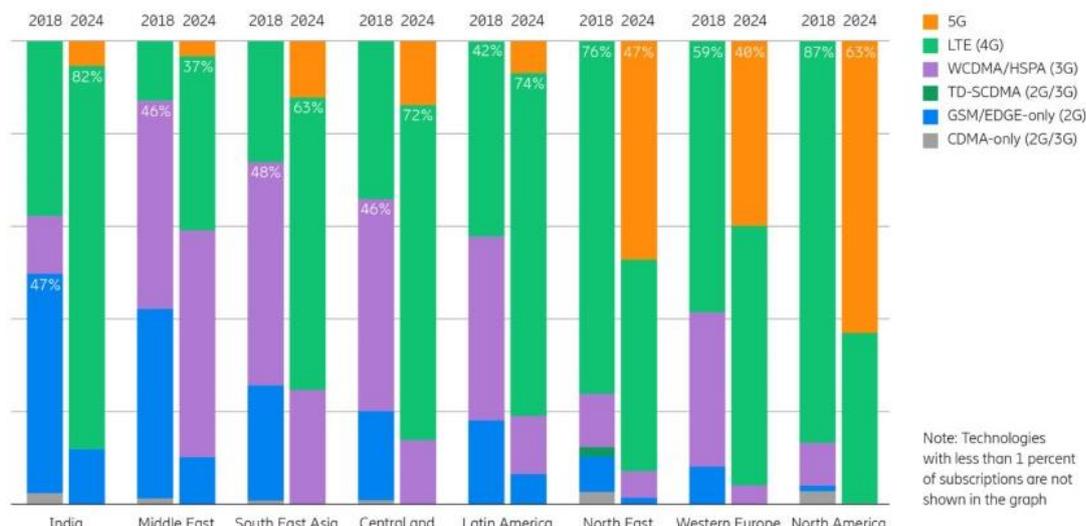


Figure 8: Mobile subscriptions by region and technology [ERRICSSON, 2019]

will use 5G technology by 2024 (Figure 8). This will of course drive demand for 5G infrastructure in the coming years.

4.3 Initial exploitation plans per partner

The following table provides an overview of the partners' initial exploitation plans.

TEC
<p>Exploitation plan: TEC is offering Engineering Services to industrial customers in Europe. Our prime services are requirement engineering, system optimization and hardware security solutions for resource constrained systems. TEC will make use of the SERENA project to drive further the exploitation of their requirements services for novel system solutions. We will support the gathering of requirements for system integration and plans to use the outcomes of the project to foster the relationship to future customers in the telecommunication domain. Further, as an emerging SME, the reputation gained from the project will positively influence TEC's ambition to land new contracts and win long-term business partners in order to expand our professional services with customer-oriented solutions. Further, TEC will highly profit from the project approach of solving complex problems, deriving system solutions for industrial driven use cases, applying projections and developing roadmaps for emerging technologies and future products.</p>
<p>Target group/audience/stakeholder: TEC will use the know-how gained in the project within collaborations with existing and new customers of our engineering services. Those customers are mainly large industry companies or research centres.</p>
<p>Expected results/expected impact: Extended portfolio of security engineering services. Positive influence on new contracts and partnerships.</p>
EAB
<p>Exploitation plan: To meet the requirements of future mobile networks, EAB must seek for technologies that are cost effective, energy efficient and with the right performance. The proposed integration technology platform offers an opportunity for 5G radio access systems and point-to-point systems with high-performance, small footprint and high energy efficiency. Therefore, the knowledge obtained from SERENA will provide essential guidance for roadmaps and product decisions. The results from SERENA will be transferred to product development for future radio products. The supply chain focus, with a strong volume manufacturer IFAT, paves the way for developing and launching future generation products which will secure the leading market position of EAB in the wireless infrastructure market.</p>
<p>Target group/audience/stakeholder: Telecom operators (customers), supply chain (e.g. component manufacturers and sub-system vendors).</p>
<p>Expected results/expected impact: Future 5G radio access products will employ active array antennas at a scale never seen before. Manufacturing these systems at a commercially viable price point is extremely challenging. By engaging with major suppliers (IFAT) and innovators (OMMIC, FHG) at an early stage enables EAB to steer and influence the supply chain to develop the right technologies at the right price point at the right time.</p>
IFAT
<p>Exploitation plan: Infineon Technologies Austria AG will exploit and make use of (sell, develop marketable applications) all the relevant results of the SERENA project through the mother company Infineon Technologies AG based in Munich/Germany. SiGe BiCMOS technology with 400 GHz fmax currently provided by IFAT is already utilized in car radar applications, point to point communication links and imaging applications in frequency range up to 122 GHz. Infineon also offers an extensive component portfolio for radio-base-stations and wireless infrastructure equipment. SERENA will provide a low-cost hardware platform for active antenna arrays for applications like radio base-stations, security, radar and scanning. This platform will answer the challenges our customers are facing regarding the stringent RF-hardware requirements for the next generation wireless access (5G), wireless backhaul (point-to-point), automotive radar, and for</p>

<p>many other RF-applications. All integrated circuits developed at IFAT will be brought to market by Infineon’s worldwide marketing and sales organization.</p>
<p>Target group/audience/stakeholder: System providers, telecom infrastructure equipment companies, OEMS (Open Equipment Manufacturers) for areas like security, avionics, radar, scanning, test-and measurement, industrial, automotive radar, biomedical.</p>
<p>Expected results/expected impact: The smart RF-system solutions resulting from SERENA will be directly used to answer challenges our customers are facing. Due to the close customer contact IFAT is keeping we are at the pulse of their needs and expect the results to be directly marketed within the Infineon product portfolio. The impact is significant as IFAT being an industry partner depends on having the best solutions in a perfect time frame (time to market) to keep the market share and production in Europe competitive.</p>
<p>EPIGAN</p>
<p>Exploitation plan: EpiGaN, as the sole supplier of GaN epitaxy in Europe, will exploit the results achieved in SERENA by validating its GaN-on-Si substrate technology for mm-wave applications, in particular for 5G. SERENA will offer a good platform for high visibility of the unique capabilities of EpiGaN’s substrate for mm-wave. EpiGaN aims at consolidating its position as (sole) European provider of GaN-on-Si technology including its unique technology differentiators for device passivation and very low channel resistivity, to address European and also serving a global market. EpiGaN plans to expand its product portfolio offer by developing material with reduced RF losses up to 100GHz including on large Si wafer diameters, as required for better cost efficiency.</p>
<p>Target group/audience/stakeholder: RF Foundries (both for compound semiconductors and for Si devices), Integrated Device Manufacturers, Fabless RF Design Houses.</p>
<p>Expected results/expected impact: Extended portfolio products’ offer. The demonstration of EpiGaN’s GaN-on-Si epiwafer capabilities in proof-of-concept systems is considered as mandatory and a key trigger for GaN wafer market growth. Enhanced adoption of GaN technology for mm-wave wireless applications is a major market segment targeted by EpiGaN for its future expansion.</p>
<p>OMMIC</p>
<p>Exploitation plan: OMMIC is a foundry services provider, through its state of the art GaN processes. OMMIC will have the possibility to demonstrate the high frequency capabilities of its GaN/Si processes in the frame of a telecom use case. OMMIC would like to take the opportunity of such project to communicate on the performances of products designed and produced using this process.</p>
<p>Target group/audience/stakeholder: Scientific community, OEM, Telecom companies.</p>
<p>Expected results/expected impact: OMMIC hopes this project will have an important impact on the role and possibilities of European foundries since most of worldwide foundries are now in the USA or in Asia. There are still some high-end foundries that can provide state of the art solution here in Europe.</p>
<p>FOI</p>
<p>Exploitation plan: The Swedish Defence Research Agency (FOI) is an independent public authority and research institute, created to serve the Ministry of Defence and now also serving an increasing number of civilian clients. Core activities are applied research and development for defence, safety and security, in a wide range of specialist fields including sensor and information technologies. FOI is today participating in a large number of EU security and ICT related projects (such as e.g. CONSORTIS and INACHUS involving research and development at the RF front-end and system technology levels). The exploitation at FOI will be through information seminars on the ongoing activities within the SERENA project, which will contribute to increasing the dissemination of the results in a wider scope. Outside FOI the SERENA results will be disseminated by our activities within the scientific community (e.g. journal and conference publications) and dialogues with our customers. The exploitation plan will aim at exploiting the generated knowledge through the creation of further advanced research projects (also at a higher system and scenario level) and also in collaboration with relevant industry and academic partners.</p>

<p>Target group/audience/stakeholder: Scientific community, system end-users and relevant industry partners. A main objective of FOI in this research program is to take active part in the realisation, validation and assessment of the enabling key technologies and proof-of-concept hardware prototypes developed within SERENA. Furthermore, the know-how that FOI will gain from participating in the project will be for the benefit of its main costumers during procurement and investments in future robust RF sensor equipment with improved functionalities and cost-effectiveness (e.g. short-range radar systems used for obstacle warning/collision-avoidance and high-speed wireless communication systems).</p>
<p>Expected results/expected impact: A main objective of FOI in this research program is to take active part in the realisation, validation and assessment of the enabling key technologies and proof-of-concept hardware prototypes developed within SERENA. Furthermore, the know-how that FOI will gain from participating in the project will be for the benefit of its main costumers during procurement and investments in future robust RF sensor equipment with improved functionalities and cost-effectiveness (e.g. short-range radar systems used for obstacle warning/collision-avoidance and high-speed wireless communication systems).</p>
<p>Fraunhofer</p>
<p>Exploitation plan: Fraunhofer is focusing on applied research supporting research and development of European companies with state-of-the-art scientific knowledge and facilities. The results will be used for further research into mm-wave packaging solutions with academia in publicly funded projects as well as development projects and consulting especially for SMEs. The technical results will be published in scientific publications complementing the expertise. In addition, the results will be used in lectures and lab courses for masters' students.</p>
<p>Target group/audience/stakeholder: Scientific community, European industry, students of microsystems engineering.</p>
<p>Expected results/expected impact: Fraunhofer expects to broaden its knowledge of mm-wave packaging both in terms of design and technological realization. The scientific findings will contribute to the academic training of Ph. D and masters' students. Based on the technical expertise additional research projects targeting the mm-wave frequency range will be initiated.</p>
<p>CHALMERS</p>
<p>Exploitation plan: CHALMERS will greatly benefit from the knowledge acquired and the results achieved by participating in the SERENA project. It will enable CHALMERS to explore new areas and scenarios in key 5G technologies. The know-how generated will be shared among related projects concerning mm-wave transmitters and receivers, as well as projects on system solutions for future communication systems. Furthermore, some of the results and findings will be directly translated to our 'active microwave course' as well as on-line measurement laboratories. E.g. http://dpdcompetition.com/rfweblab/</p>
<p>Target group/audience/stakeholder: Students (PhD and MSc), academic researchers. Industry</p>
<p>Expected results/expected impact: The results will directly influence the education of our students about future mm-wave communication system from both hardware and software perspective.</p>
<p>TUB</p>
<p>Exploitation plan: TUB is a public academic research and teaching institution, whose primary mission is to contribute to the advancement of knowledge and prepare future generations of engineers and researchers. Therefore, the results of SERENA shall be exploited by TUB in the framework of its primary mission along the following lines: 1) expanding research expertise, increasing visibility on key 5G technologies related to hybrid beam forming and mm-wave use in wireless networks; 2) strengthening the collaboration and partnership with industry; 3) direct knowledge transfer to SMEs, especially in the area of Berlin (start-up incubator); 4) patenting and IPR transfer. SERENA will establish new competences and open new directions to provide opportunities for PhD and MSc student training. As far as technology transfer is concerned, TUB will leverage its excellent track record of technology transfer to industry and assist the industrial partners in the project to incorporate the project results into their products and technology. Finally,</p>

<p>possible architectures/algorithms with commercial potential will be protected through patenting. TUB has a start-up spinoff program for which patented IP can be transferred to spinoff companies with royalty-free exploitation rights. TUB hosts also an institutional start-up incubator funded by the government of the State of Berlin. These schemes shall be exploited for technology transfer of patented IP.</p>
<p>Target group/audience/stakeholder: Students (PhD and MS) and academic researchers, Industry, and SME (Start-up Tech Industry with particular emphasis on the Berlin start-up incubator area).</p>
<p>Expected results/expected impact: New Lab-based courses including mm-wave experimentation and implementation based on the SERENA platform, leveraging TUB SDR massive MIMO platform; support toward industry for IP development, own IP patent filing and transfer towards SMEs.</p>

4.4 Update on the individual exploitation plans

The following table provides an overview of the partners' updated exploitation plans. The updates of the initial plans were performed before the end of the first project period in M18.

TEC
<p>Exploitation plan: For the last 20 years, TEC offered research services and business expertise for technology-related challenges. TECs' engineering services are towards system modelling and optimization whereas business services focus on feasibility studies, the creation of technology-based business plans and the planning and management of industrial research activities. The core customers are early adopters of new ICT technologies. TEC is using the knowledge created within the project to foster its image as technology scout and spearhead. Participation in this project has led to the early identification of novel technology, which is a prime asset for TECs' business success. The requirement engineers took a leap in their expertise while working together with some of the world's leading scientists in this project. TEC will make use of the SERENA project to drive further the exploitation of their requirements services for novel system solutions. We will support the gathering of requirements for system integration and plans to use the outcomes of the project to foster the relationship to future customers in the telecommunication domain. Further, as an emerging SME, the reputation gained from the project will positively influence TEC's ambition to land new contracts and win long-term business partners in order to expand our professional services with customer-oriented solutions. Further, TEC will highly profit from the project approach of solving complex problems, deriving system solutions for industrial driven use cases, applying projections and developing roadmaps for emerging technologies and future products.</p>
<p>Target group/audience/stakeholder: TEC will use the know-how gained in the project within collaborations with existing and new customers of its engineering services. Those customers are mainly large industry companies or research centres.</p>
<p>Expected results/expected impact: Extended portfolio of security engineering services. Positive influence on new contracts and partnerships.</p>
EAB
<p>Exploitation plan: As new frequency bands are being standardized it is important to understand the limits of current and soon to be available technologies. Active participation in SERENA provides important information on the current state-of-the-art in GaN-on-Si and packaging technology.</p>
<p>Target group/audience/stakeholder: Besides the target groups which were mentioned in Table 2 also standardization bodies (IEEE/3GPP) are considered.</p>
<p>Expected results/expected impact: The expected results and impacts are still valid for EAB. Future 5G radio access products will employ active array antennas at a scale never seen before. Manufacturing these systems at a commercially viable price point is extremely challenging. By engaging with major suppliers (IFAT) and innovators (OMMIC, FHG) at an early stage enables</p>

<p>EAB to steer and influence the supply chain to develop the right technologies at the right price point at the right time.</p>
<p>IFAT</p>
<p>Exploitation plan: Energy efficiency, mobility and security and IoT and big data are the central global challenges that Infineon Technologies Austria AG addresses with its semiconductor and system solutions. Whether in the car, in the smartphones, industrial electronics or with debit cards and ID cards - know-how from Infineon Austria is found in many everyday applications. The results of the SERENA project will be used, to get closer to customer needs and to fit the RF-hardware requirements in reference to 5G in the future. It is proposed, that Infineon Technologies AG in Munich makes use of the results and all integrated circuits developed at IFAT will be brought to market by Infineon's worldwide marketing and sales organization.</p>
<p>Target group/audience/stakeholder: With System providers, telecom infrastructure equipment companies, OEMS (Open Equipment Manufacturers) for areas like security, avionics, radar, scanning, test-and measurement, industrial, automotive radar, biomedical the target group, reached audiences and stakeholders are still valid.</p>
<p>Expected results/expected impact: The results from SERENA will help IFAT to be prepared for the future and be on the pulse of innovation. Integrating the smart RF-systems solution from SERENA into the Infineon product portfolio will make it possible for IFAT to fit the customer needs in a perfect time frame and to keep the position as a competitive market player.</p>
<p>EPIGAN</p>
<p>Exploitation plan: EpiGaN is a leading European provider of GaN-on-Si epitaxy for electronics and telecommunications. In May 2019, EpiGaN was acquired by SOITEC, a listed French company, world leader in semiconductor materials. Based on the broadly recognised strong expertise of EpiGaN expertise in the field of nitride growth, SOITEC is fully committed to support EpiGaN in its industrial production ramping. As part of the exploitation plan of results achieved in SERENA, EpiGaN aims indeed at consolidating its position as European industrial provider of large diameter (6"; 8") low loss GaN-on-Si epiwafer technology, including its unique technology differentiators for device passivation (in-situ SiN) and very low channel resistivity ($R_s < 300$ Ohm/sq.). In particular, the very low RF losses of EpiGaN GaN-on-Si products up to 100GHz offer a unique selling advantage over competing technologies. We have developed and optimized a robust technology on resistive Si substrates up to 200mm diameter, reducing RF signal loss on GaN-on-Si material to below 0.3dB/mm up to 20GHz. Even for future 5G frequencies in E-band up to 100GHz the RF signal loss stays well below 0.8 dB/mm. EpiGaN has also partnered with Ommic, leading European GaN foundry, and demonstrated the capability of our RF GaN on Si technology in a 100 nm gate-length, open foundry MMIC process with a complete design kit. The SERENA project provides to EpiGaN a strong validation of its GaN-on-Si substrate technology for mm-wave applications for 5G. EpiGaN is currently taking multiple steps towards enhancing its manufacturing capabilities: in particular, EpiGaN nv is currently increasing its production capacity, by qualifying a fully-automated multi-wafer reactor for GaN-on-Si epiwafer production.</p>
<p>Target group/audience/stakeholder: The above-mentioned groups of RF Foundries (both for compound semiconductors and for Si devices), Integrated Device Manufacturers, Fabless RF Design Houses are still targeted by EpiGaN.</p>
<p>Expected results/expected impact: Extended portfolio products' offer to include large diameter low RF losses suitable for 5G mm-wave application. Enhanced adoption of GaN technology for mm-wave 5G MIMO is a major market segment targeted by EpiGaN. GaN-on-Si technology is further now being considered by different players for utilization in 5G handsets.</p>
<p>OMMIC</p>
<p>Exploitation plan: The plan is still valid in its original form. OMMIC is a foundry services provider, through its state of the art GaN processes. OMMIC will have the possibility to demonstrate the high frequency capabilities of its GaN/Si processes in the frame of a telecom use case. OMMIC would like to take the opportunity of such project to communicate on the performances of products designed and produced using this process.</p>

<p>Target group/audience/stakeholder: With the Scientific community, OEMs, and Telecom companies there is no update regarding the target groups/audiences or stakeholders.</p>
<p>Expected results/expected impact: OMMIC hopes this project will have an important impact on the role and possibilities of European foundries since most of worldwide foundries are now in the USA or in Asia. There are still some high-end foundries that can provide state of the art solution here in Europe. Run 1 of the T/R chip have been successfully completed and tested, results obtained are allowing to go to the next step. Shipping of parts to IZM partner for integration is ongoing. This step demonstrate which kind of performance can be obtained regarding Power Amplifier output power, Noise figure and switch realized with OMMIC GaN on Si process. This is a very encouraging point for the remaining steps of the project.</p>
<p>FOI</p>
<p>Exploitation plan: The exploitation plan for FOI is still valid in its original form which is given in Table 2.</p>
<p>Target group/audience/stakeholder: Also, the initially defined target groups, audiences and stakeholders remain the same and are mentioned in Table 2.</p>
<p>Expected results/expected impact: Additionally, to the expected results and impacts mentioned in Table 2 above, FOI has during the first 12 months of the SERENA project designed different types of GaN-Si designs for the targeted E/W-band proof-of-concept subsystem (e.g. LNA, PA and driver). It is anticipated that assuming that the experimental data of those designs (to be tested in Q3 2019) are in line with the simulation results it should be possible then to publish those results in some scientific journals and conference proceedings (e.g. IEEE MTT Trans., IEEE International Microwave Symposium., EuMW etc.). Some additional publications are also foreseen in relation with the E/W-band proof-of-concept GaN-Si MMIC based antenna module which is to be characterised during 2020.</p>
<p>Fraunhofer</p>
<p>Exploitation plan: The mentioned exploitation plan of Fraunhofer, mentioned in Table 2 is still valid in its initial form.</p>
<p>Target group/audience/stakeholder: With the Scientific community, the European industry and students of microsystems engineering, Fraunhofer is still targeting the groups mentioned in Table 2.</p>
<p>Expected results/expected impact: Fraunhofer still expects the results and impacts which are mentioned in Table 2 above.</p>
<p>CHALMERS</p>
<p>Exploitation plan: The exploitation plan for Chalmers is still applicable in its initial form. Chalmers is exploiting the knowledge gained in SERENA, directly in other ongoing and new projects. This includes knowledge both about emerging packaging technology at mm-wave frequencies, in GaN technology, and multi-physical effects in 5G applications. The researchers active in SERENA (Prof. Fager, Dr. Buisman, Dr. Rasilainen) exploit the knowledge in a national industrial collaboration project on emerging mm-wave heterogeneous packaging solutions for 5G and radar. Overall, the collaboration with partners in the project has increased Chalmers knowlede about the trends and requirements for hardware and signal processing for high power mm-wave integrated antenna systems. Chalmers applies this knowledge in training of MSc and PhD students as described below.</p>
<p>Target group/audience/stakeholder: With students (PhD and MSc), academic researchers. And industry partners the target groups/audiences and stakeholders (Table 2) remain.</p>
<p>Expected results/expected impact: Like already mentioned in Table 2 above, the results will directly influence the education of our students about future mm-wave communication system from both hardware and software perspective.</p>
<p>TUB</p>

Exploitation plan: The exploitation plan for TUB is still valid in the initial form. TUB started exploiting SERENA results mainly through expanding its research expertise and gaining visibility in the research community. TUB published two papers related to SERENA and presented them on conferences. A third journal publication is currently in progress. Through the collaboration with the partners TUB gained insights in the application of the theoretical work it is researching. The collaboration lead to stronger connections with industry and other research institutes. This enables TUB to continue its research as for example proposals on new topics are the result of stronger connections to other partners. Furthermore, TUB exploits SERENA results for its PhD training as described above in Phase 3.

Target group/audience/stakeholder: The target groups, audiences and stakeholders are presented in Table 2 and are still valid.

Expected results/expected impact: The outcoming results, as well as the impact are still expected like quoted in the Table 2 above.

Chapter 5 Summary and Conclusion

Dissemination, communication and exploitation are besides the technical and R&D work key areas of activity for the members of the consortium and for the success of the whole project.

This document provides an overview of dissemination and communication activities, both past and planned. The activities were assigned to different phases: “awareness creation”, “continuity of information flow” and “result orientation”. As reported, several targeted dissemination activities have been performed both jointly and individually by all partners. Beside a summary of past activities an outlook for future activities was given, it is a summary of planned activities which gives an outlook (it is not completed, it is a living document).

Furthermore, the SERENA Consortium saw already one scientific publications which was published via the EU compliant repository Zenodo (<https://zenodo.org/communities/serena-h2020/>). In order to raise the awareness of the project’s goal and to target potential stakeholders and the general public, the consortium’s common dissemination strategy was further developed and defined.

In addition to that the deliverable includes a first view on the market, the partners’ updated exploitation plans and a table of main project results that the project intends to exploit. For each of these results its exploitation intentions or the means to ensure their sustainability were described.

In D7.4 “Final plan and report on Exploitation, Dissemination and Communication activities”, due in M36, the dissemination and communication activities undertaken during the second project period will be presented. Furthermore, the exploitation plans will be updated once again, and a rough insight on the target market opportunities and exploitation beyond the project will be presented.

Chapter 6 List of Abbreviations

Abbreviation	Translation
3GPP	3rd Generation Partnership Project
CMOS	Complementary metal-oxide-semiconductor
DoA	Description of Action
DOI	Digital Object Identifier
ETSI	European Telecommunications Standards Institute
EuMW	European Microwave Week
GaN	Gallium nitride
IEEE	Institute of Electrical and Electronics Engineers
IP	Intellectual Property
MIMO	Multiple Input Multiple Output
SME	Small to Medium-sized Enterprise
RF	Radio-Frequency