EUROPEAN SPECTRUM MONITORING SERVICE MISSION: ENABLING APPLICATIONS SCALABILITY WITH PLATFORM POWER AND ON-BOARD PROCESSING

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ABSTRACT

The European Spectrum Monitoring System (ESMS) will be an integrated end-to-end solution comprising both Space and Ground Products and providing persistent space-based monitoring of the wireless spectrum environment in the EU. While not limited to 5G, the ESMS will, in particular, provide insights into the deployment of 5G/6G networks across the European continent as a commercial service to telecom operators, regulatory agencies, to European institutions such as primarily EU (and potentially ESA on ad-hoc basis), as well as to governmental and commercial entities. ESMS will be realised by a consortium of companies, including RHEA Luxembourg, Aurora Insight, EBRC Luxembourg and LuxSpace.

The ESMS will be based on LuxSpace Triton-X microsatellite platform, a cutting-edge modular satellite platform divided into three classes to optimally meet the needs of customers: Light (40kg), Medium (75kg) and Heavy (150-250kg). The three classes are based on a common core, ensuring non-recurring engineering costs associated to adaptation to different missions are minimized. The experience gained by LuxSpace in building satellites for AIS that were required to comply with very demanding EMC requirements flows into the design of Triton-X, making it well suited to the RF monitoring application.

This paper presents the impact of the Triton-X next-generation on-board processing and power characteristics that are enabling the deployment of the ESMS commercial service, including: capability to process on-board data complementary to Spectrum in order to enable downlink of useful information, full and scalable ability to deploy additional assets based on the same core architecture but adapted to different payload requirements, and on-board computer architecture redundancy to ensure mission reliability.

1 INTRODUCTION

The 5G cellular networking standard is expected to bring a wealth of new opportunities to the telecom terrestrial and satellites sectors. These opportunities will be associated with low latency, faster data speeds, and the ability to cost effectively connect many Internet-of-Things (IoT)-type devices. While the use cases for 5G are compelling, implementing such a ground-breaking technology presents challenges. With the promise of faster data rates, 5G requires wider bandwidths and thus more spectrum. However, the spectrum that is needed for, and indeed ideal at this point in 5G technology, is already in use for other applications. While there is a strong political push and promises of societal benefits, issues such as cross-country interference, white zones, minimum coverage, and security concerns at the communication and infrastructure levels remain concerns and can impede 5G progress.

Current methods of spectrum monitoring and wireless network optimization are highly manual, inefficient, and limited in geographical reach. A new approach, one that has wide area coverage, inherently monitors all frequencies of interest, and has a high revisit/update rate is needed to enable Europe to:

- Efficiently deploy optimized 5G and future networks
- Measure wireless network coverage and quality of service across EU
- Understand and improve divergences in spectrum use across European countries
- Create and lead a pathway for next generation wireless technologies in EU

Space-based monitoring of the RF spectrum will provide coverage of the entirety of Europe with updates every few days, improving upon driving or airborne methods that take days or weeks to cover a metro area or rural region, respectively. ESMS is agnostic of how the spectrum is being used and will capture spectral activity across all bands of interest without being tied to any particular network and without being dependent upon network settings.

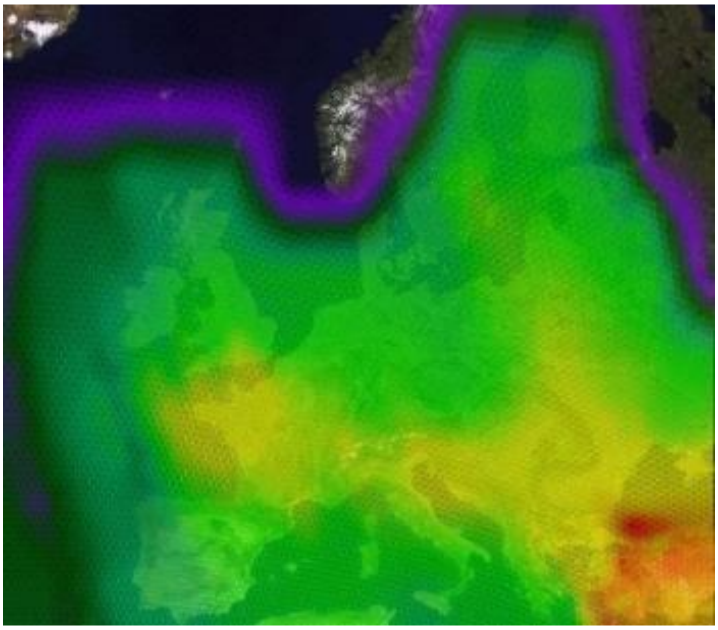

Figure 1: early stages of 5G deployment in Europe as detected by Aurora Alpha satellite in 2020

2 HERITAGE

Aurora has pioneered commercial space-based mapping of the RF spectrum for commercial and civil government use cases. Aurora's three on-orbit satellites, one launched in late 2018 and two launched in 2021, have proven the viability and benefits of this approach, while greatly reducing the risk of the ambitious technology developments of the ESMS. Further, Aurora aggregates all of its data in the cloud for storage and processing, enabling high-performance processing and combination of spectrum data with other data sets to produce new, innovative solutions. This space-and-cloud architecture serves as a point of departure for the new and enhanced technology for ESMS.

Aurora uniquely utilizes a "multi-regime" approach to monitoring the RF spectrum by deploying our sensors not only on satellites, but also in aircraft, in vehicles, and at stationary locations. This allowed Aurora to develop algorithms, processing, and sensor technology very rapidly, even before the first satellite was launched, and it enables Aurora to continue to enhance our technology beyond the pace of space developments. Aurora has applied this terrestrial data to its vast, cloud-based repository of spectrum data, enabling new artificial intelligence/machine learning approaches to processing and algorithm development for data collected from space.

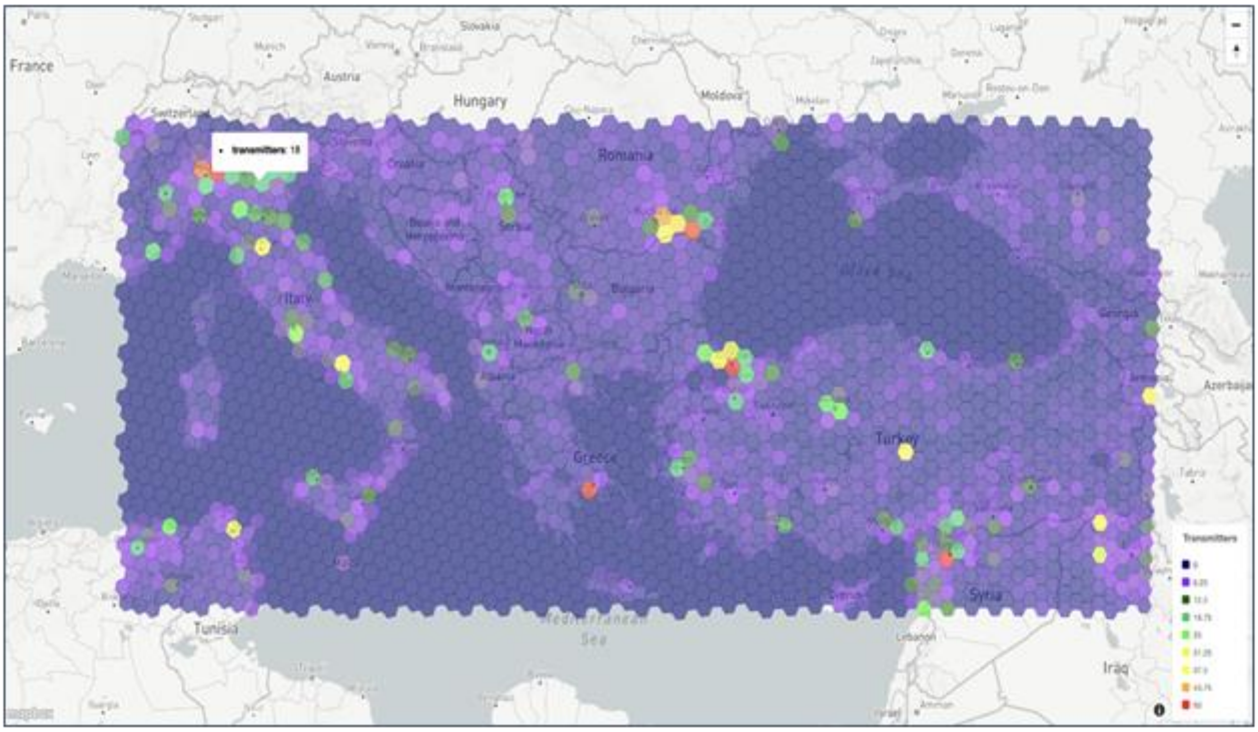

Figure 2: example of product from current Aurora assets

LuxSpace has heritage in a different kind of RF monitoring missions, having built satellites for AIS vessel detection in the form of Vesselsat-1 and -2 and ESAIL. Currently, LuxSpace is developing the next generation platform, explicitly also targeting the RF monitoring market and including necessary requirements for EMC performance, based on the experience of the previous missions.

3 ESMS MISSION CONCEPT

Aurora has already successfully proven a modern architecture for space-based measurements and cloud-based processing and solution generation. Our second generation of satellite payload is already on-orbit, with each generation building in new technology advances and addressing lessons learned from previous on-orbit measurement activities. ESMS will leverage and build upon this experience to provide an advanced space-based, commercial RF measurement system. Data storage on the cloud has many benefits, including being able to retrieve historical information for change detection and trending and for new algorithm development. Processing data on the cloud enables high-performance algorithms to operate on massive data sets and fusion of spectrum data with other data sources.

The satellite platform proposed for the ESMS mission is LuxSpace’s Triton-X, a new developed multi-mission modular platform concept. It uses at its core a modular avionics concept that allows for scalability and tailored redundancy, and its main ´Digital Main Board´ is a high -performance computer that can be configured alternatively as On-Board Computer with integrated Low-Speed (S-band) Communications, Payload Management unit, or High-Speed (X-band) Downlink. The high performance of the Payload Management and High-Speed downlink are particularly well suited to RF monitoring missions, allowing to deal with large volumes of data either on board, transmitted to ground or both. The mission will leverage LuxSpace´s experience in highly sensitive RF missions from the Vesselsat and ESAIL heritage where EMC performance was a key mission driver.

The objective of this initiative is to develop, validate, and demonstrate the **European** Spectrum Monitoring System (ESMS), based on Aurora’s existing spectrum monitoring service, which will be adapted to meet the unique requirements of a European system and service. While not limited to 5G, the ESMS will, in particular, provide insights into the deployment of 5G networks (and later 6G) across the European continent as a service, to be provided as a commercial service to telecom operators, regulatory agencies, to European institutions such as primarily EU (and potentially ESA on ad-hoc basis), as well as to governmental and commercial entities. Over time, the service may expand to provide global commercial services.

Key elements for innovation and project outcomes are:

- An expanded frequency range
- Increased spatial resolution
- Customized data service, and bespoke user interface
- Enhanced satellite payload and related platform
- Fully European cloud operations
- End-to-end European labelled and compliant service for 5G spectrum monitoring

4 PAYLOAD DESCRIPTION

The ESMS spectrum monitoring payload makes direct measurements of the radio frequency spectrum. The payload consists of an electronics assembly and a suite of antennas. The first ESMS payload will measure spectrum across all frequencies for modern and near-term planned communication systems. The modular design is readily extensible to other frequency ranges, and Aurora has proven this approach on its second and third satellites, which added certain high-band frequencies to its low-band capabilities.

The electronics assembly is based on a modern software defined radio (SDR) approach that first conditions the RF signal from a selected antenna, and then digitally samples the analog RF signal. The SDR is fully on-orbit reprogrammable to enable mission flexibility and updates over time to accommodate new algorithms and wireless technology standards. On-board storage and processing resources enable scalable processing based on the mission parameters. A key advantage of the Triton-X modular platform is the scalability of capabilities. For the payload electronics the critical capabilities include available payload power and downlink data capacity. Spectral measurements can create significant amounts of data. Processing the data in real-time, on-orbit can drive payload on-orbit power requirements. Conversely, downlinking raw data without processing can drive satellite telecom subsystem requirements for high-speed downlink.

Another advantage of the Triton-X platform for spectrum monitoring is its scalability. The ESMS payload antenna suite consists of multiple antennas that are sized for different frequency ranges, gain, and directivity. Each antenna, ideally, is nadir-pointing and thus requires nadir deck volume and/or antenna deployment capabilities, both of which are enabled by the Triton-X platform.

5 TRITON-X PLATFORM CONCEPT

Triton-X is a new modular platform developed by LuxSpace with partners in an ESA ARTES programme. The core of the concept is a common avionics architecture that is modular and can be scaled in terms of redundancy and mission scope. This core covers the On-Board Computer, S-band and X-band communications, Payload Management Unit and Remote Terminal Units. It is completed with off-the-shelf equipment for ADCS, propulsion, and power.

The Triton-X version being developed is aimed at high-performance Earth Observation, because of market demands, and because it envelopes smaller versions of the platform for missions like ESMS.

A rough breakdown in classes of satellite is shown below, and consists of:

- Light: no high-speed downlink, limited pointing, no redundancy
- Medium: high-speed downlink, medium pointing, medium resources (power) for payload
- Heavy: for large payloads with significant power demand, very accurate pointing and high stability

For ESMS, the Medium version of Triton-X is targeted, fitting the power needs of the payload and providing the required amount of data handling, pointing accuracy and downlink volume.

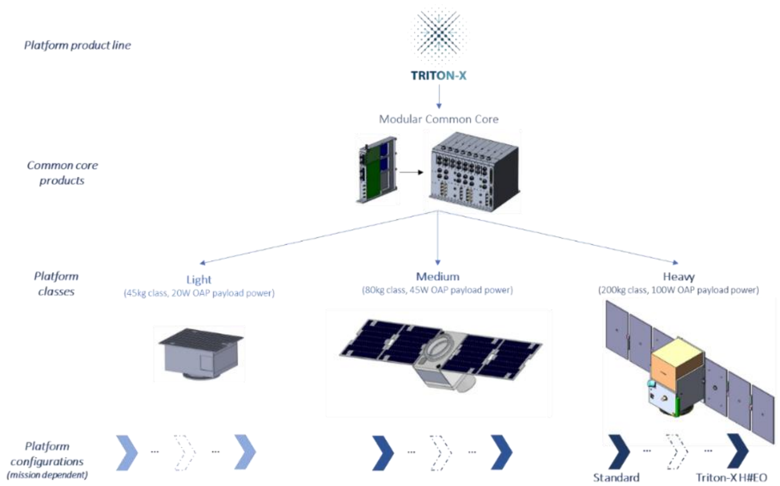

Figure 3: Triton-X modularity concept

The key characteristics of the ESMS spacecraft using the Triton-X platform are given in Table 1.

Table 1: ESMS spacraft platform characteristics

Equipment	Features	Remark
Downlink Antenna Operational Frequency	X-Band	
Downlink Antenna polarization	Single	
Downlink data rate delivery	400Mb/s	
Data downlink per satellite pass	24GB/pass	Assuming 8 min effective downlink
Satellite altitude	500 KM (LEO)	
Number of payloads	1	
Satellite Mass	40-50Kg	indicative
Satellite size	50×60cm	indicative
On-board available power	45W (average) – 83W (peak)	
Pointing accuracy	<< 1° achievable	1-2° required by mission
Satellite lifetime	5 years	
TMTC connectivity	S-band	
Total high downlink data per day (X-band)	240GB/day	Ground segment located in polar area and 10 satellite passes per day
Total low downlink data per day (X-band)	72GB/day	3-4 satellite passes per day, can be reached with low latitude ground station

6 TRITON-X AVIONICS AND PAYLOAD PROCESSING

The Triton-X core avionics unit consists of the following core elements:

- Digital Main Board, which can be configured as either
  - On-Board Computer
  - Payload Computer / Payload Management Unit including data storage
  - High-Speed Downlink
- Remote Terminal Element – Digital
  - To provide power and data connectivity to spacecraft units (e.g. ADCS elements) and small payloads
- Remote Terminal Element – Analog/Driver
  - To drive mechanisms, magnetorquers, heaters, and acquire analog sensor data (thermistors, sun sensors)

The Digital Main Board will be expanded by Mezzanine boards for the following tailored applications:

- Low Speed Communications: S-band TMTC to be mounted on the OBC boards
- High Speed Communications: X (or other) band downlink to be mounted on the High Speed downlink DMB
- Small Payload Interface: mezzanine with one high-speed interface to payload(s), can be mounted on Payload Computer or On-Board Computer
- Large Payload Interface: mezzanine with multiple high-speed interfaces to payload(s), can be mounted on Payload Computer

Apart from the core System on Chip and memories that support the main function of the DMB, each board also carries a ´supervisor´ module that independently checks the operational health of the DMB and that communicates with the supervisors of the other boards to control possible reconfiguration in case of failure of the main board.

The main function of the DMB is controlled by its Software and Firmware and can be adapted without change of the hardware. The core of the DMB is a System on Chip used consisting of processor and Programmable Logic (FPGA). The specific device used provides a large amount of FPGA resources.

A combination of these boards is used to build the Integration Avionics Unit and the Remote Terminal Unit. The level of redundancy can be selected by adding more boards as required.

The S-band TMTC system uses a combined LNA-SSPA-Diplexer unit developed by LuxSpace, while the X-band downlink uses an upconverter/SSPA unit developed by the program partner Emtronix.

Key parameters of the Integrated Avionics:

- Mass memory: 64 GByte / DMB
- Low speed data link between boards: CAN bus
- High speed data link between DMBs: 500 Mbps – 4 links per DMB
- Payload data rate to DMB: up to XX Gbps
- Low speed downlink (S-band) datarate: up to 2 Mbps
- High-speed downlink (X-band) datarate: up to 400 Mbps with single unit and polarity, 800 Mbps with units and dual polarity (for ground station G/T 26.5 dB/K, average over pass)

The FPGA of the SoC of the DMB is available for payload data processing if the DMB is dedicated to the Payload Management function.

Raw measurements of the RF spectrum can create hundreds of millions of bits per second of digital data. There exists a trade-off in on-board processing versus downlinking data. Ideally, all raw digitized data would be downlinked to the cloud. Once on the cloud, the raw data would be stored and archived to create a vast and expanding data repository that can be used for historical analysis and for enabling new machine learning models. Cloud-based processing can be expanded to encompass high-performance processing on large data sets. However, the costs associated with downlinking large amounts of data can be prohibitive, and the storage costs on the cloud over time would require enormous memory resource and similarly would drive cost.

Conversely, the raw data can be processed on-orbit. Real-time, or near-real-time processing of such fast sample rates requires high-performance processing which drives payload power requirements. The solution is a flexible approach that takes advantage of on-board processing and related payload power requirements, plus high-rate downlink options that the Triton-X platform provides. The SDR architecture allows for flexibility in payload modes of operation. In some cases, raw data samples are stored in on-board memory and downlinked. In other cases, on-board processing reduces the data quantity that is stored and downlinked. The flexibility of the SDR-based payload architecture ensure that the best trade-offs can be made that take into account satellite power, data downlink rates, and data downlink and storage costs.

7 ESMS MISSION CONCEPT

A single demonstration satellite is planned, built in a framework with ESA, followed by several further satellites to form a small constellation with the required coverage and timeliness characteristics to answer the market needs. These follow-on satellites will be built under a commercial framework by the consortium.

The ESMS system will be procured and implemented according to the ESA Security Directives (ESA/ADMIN/IPOL-SECU(2020)1) with the support of the ESA Security Office and the TIA Security Office. Security certification of the system will be granted by the ESA Security Authority.

The ESMS system design will include a detailed system security analysis resulting in the definition of dedicated security concepts and security requirements for the individual components of the System.

The Security Engineering of the industrial consortium will design the system targeting the needs of early adopters.

The Triton-X platform is designed for small constellations specifically. A propulsion system with a Hall effect thruster (redundant if required) is foreseen that can provide significant ΔV for initial orbit adjustment, phasing, orbit maintenance, avoidance manoeuvres, and end-of-life de-orbiting.

The ground segment is composed of the following elements:

- A secure satellite operation center for commanding controlling the full satellite network,
- An RF chain for receiving the data downlink from the satellite,
- The cloud-based data storage and processing systems,
- Telecommunications links to transport the processed data to the users,
- The user interface.

The RF chain needs to support X-band downlink suitable for the high volumes of data. The cloud-based data storage and processing systems require adaptation to European-specific requirements for security, and data fusion. Further, the raw data is highly scientific and does not address specific questions and interests of the European user community. In this regard, critical inputs will be gathered that will drive requirements for data processing that will produce actionable information and that will address specific European concerns about spectrum use and wireless networks. Data transportation will be an engineering effort that is likely based on existing methodologies. There does not yet exist a definition for the European user interface that will meet the needs of regulators, governments, and commercial entities, and the needs of these end-user groups will be determined by conducting customer interviews. The need for fused data, however, is needed as part of the design move to a European environment. The entire user interface effort will require innovations in reducing the complex, scientific dataset of the measured wireless spectrum environment through processing stages and data fusion to create actionable information that is easily understood and which enables informed decision making. The main characteristics of ESMS ground segment data link are listed in the table below:

Table 2. ESMS ground segment data link list of characteristics

Equipment	Features	Remark
Antenna Operational Frequency	X-Band	
Antenna polarization	Single	
data rate	400Mb/s	
Data download capacity per satellite pass	24GB/pass	Assuming 8 min effective downlink
Total high download data per day	240GB/day	Ground segment locates in polar area and 10 satellite pass per day could be reached
Total low download data per day	72GB/day	3-4 satellite pass for ground segment is feasible/day

Data from the ground stations will be stored in EBRC cloud-based storage resources. Ground processing consists of two steps: ingest and ESMS processing. The ingest process is common among all Aurora satellites and consists of retrieving data from cloud storage, applying calibration algorithms to the data, and storing the data in a geospatial database. This geospatial data base is the launching point for all down-stream processing associated with ESMS.

ESMS processing accesses the geospatial database of ingested spectrum samples. A number of sophisticated processing steps occur to render spectrum and technology in use into geospatially referenced data products. The data products identify the types of signals "on-air", quantifies spectrum use and spectral activity, and projects characteristics of the signals, such as power levels, geospatially. European-centric product outputs are available to subscribers via a cloud-based interface. A critical element, addressed by the cloud architecture and service provider, is security of the data and the users of the data.

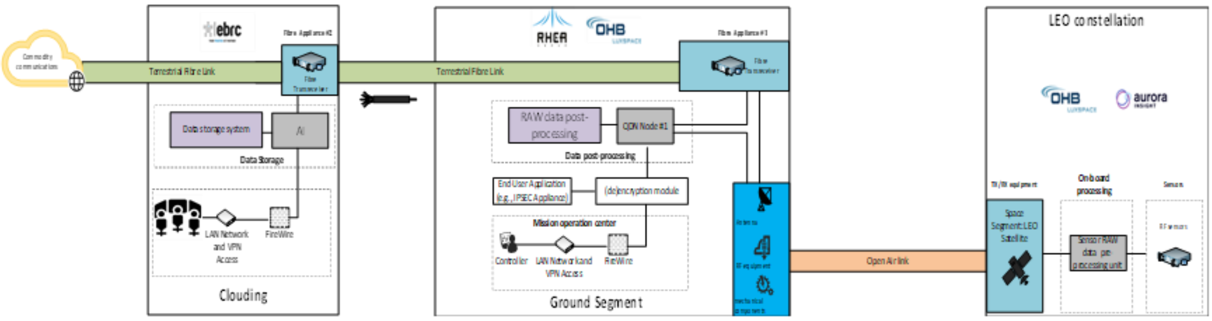

Figure 4: ESMS Block Diagram

8 MARKET(ING)

As reported by Market&Market [1], the global **5G Services Market** size is expected to grow from USD 53.0 billion in 2020 to USD 249.2 billion by 2026, at a Compound Annual Growth Rate (CAGR) of 29.4% during the forecast period. The transformation to the 5G ecosystem is expected to be 3–4 times faster than other connectivity transformations. This is mainly due to the rapid innovation in virtualization in the networking domain, coupled with the growing numbers of applications, which require a latent-free connection. The above factors have led to an additional drive for rapid adoption of 5G services, followed by a quick roll out of 5G services by other developing economies. Countries with a strong 4G infrastructure are currently delivering agile connectivity platforms for IoT 5G. Figure 5 indicates the number of projects run by different players into 5G standards up to 2020 [2] and Figure 6 shows the countries where 5G networks are deployed.

Figure 5. The number of projects run by different players into 5G standards up to 2020 (STATISTICA 2020)

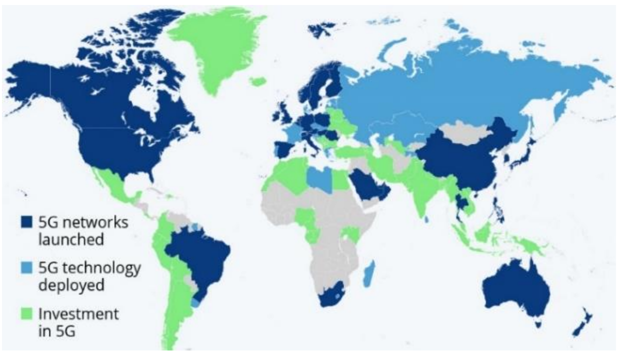

Figure 6. Countries where 5G networks deployed

The European Commission identified 5G opportunities early, establishing a public-private partnership on 5G (5G-PPP) in 2013 to accelerate research and innovation in 5G technology. The European Commission has committed public funding of more than €700 million through the Horizon 2020 programme to support this activity. These activities are accompanied by an international plan to ensure global consensus building on 5G. EU investment in 5G research and standards is necessary to support the traffic volume expected by 2025. EU investment will also boost networks and Internet architectures in emerging areas such as machine-to-machine (M2M) communication and the Internet of Things (IoT). The Commission adopted a 5G action plan for Europe in 2016 to ensure the early deployment of 5G infrastructure across Europe. The objective of the action plan was to start launching 5G services in all EU Member States by end 2020 at the latest. Following this, it suggests a rapid build-up to ensure uninterrupted 5G coverage in urban areas and along main transport paths by 2025. The Digital Compass: The European way for the digital decade adopted in 2021 sets the additional target to cover all populated areas with 5G by 2030.

The deployment of 5G networks depends closely upon access to the broader radio spectrum. 5G networks deliver an enhanced broadband experience of up to 1 Gbps and latency <10ms and provide the platform for cloud and AI-based services. Various data-intensive applications, both individual as well as Business 2 Business (B2B), are emerging, such as video applications. Industries, such as IT and telecom, have different types of service requirements, including high bandwidth, low power, ultra-low latency, and high speed. To cope with the increasing demand for mobile broadband services, the network capacity needs to be increased by using wider portions of the RF spectrum. Further, as the rate of connected devices and their use increases, spectrum resources and their uses need to be harmonised across Europe to allow for interoperability of infrastructure across borders. This is the basis for a broad range of services delivered with 5G for consumers, such as new smartphone apps, and professional services for various industrial sectors.

Considering the remarks mentioned above concerning the 5G market size and requirements, market size for the spectrum monitoring system offered by ESMS is big as the solutions can be applied to commercial heterogeneous and non-heterogeneous 5G networks. Concretely, the ESMS consortium will provide services to different types of customers:

- Public sector customers, providing ESMS solutions for governments and public sectors missions which are active in providing 5G services.
- Private sector customers, TELECOM 5G service providers which are selling services for vertical applications.

Several services have been identified and are expected to be provided.

We expect the following markets:

- **Short-Term Market:** 5G TELECOM Operators with IT infrastructure located within EU.
- **Medium-Term Market**: 5G TELECOM Operators with IT infrastructure located within US.
- **Long-Term Market**: providing ESMS service globally to the 5G TELECOM Operators with IT infrastructure located within everywhere.

In addition, it is expected that revenue acquisition can be done through,

- *Joint Revenue Acquisition*, revenue achieved based on planned abovementioned ESMS IP share where each partner benefits.
- *Individual Revenue Acquisition*, each partner of programme can directly sell the solution to its customers. For this, the consortium will prepare a Memorandum of Understanding (MOU)

among whole partners to fulfil the benefits of all partners from end-product of ESMS.

ESMS Short-Term Market: Luxembourg

As mentioned above, we will consider EU market to be served through ESMS solution. Therefore, we will focus on a two-step for building-up market for ESMS:

- Step 1: ESMS Trial market
- Step 2: ESMS EU territory market penetration

ESMS Trial market: in this step, we initially will focus on Luxembourg 5G market. Just in Luxembourg, and as assessed by the SMC LU report on 5G Ecosystem, the field is of high interest, revenues-generation, and impact, due to the high number of businesses at risk in the Luxembourg ecosystem (esp. in Finance, Banking and Telecom). In Luxembourg, TELECOM companies POST and PROXIMUS collectively expect to make a revenue of 5G services of 45 MEUR per year. It is commonly known that this constitutes only a fraction of the global spending of commercial companies. Reported by POST Luxembourg annual report on 5G context during 2020 [3], it is expected that due to increasing the number of TELECOM operators:

- Inter-network interference management between different networks is going to be critical issue in Luxembourg.
- Spectrum resources are scarce, and management and monitoring spectrum is key for increasing market revenue and provide acceptable service quality to customers.

POST Luxembourg in 2020 estimated that a loss of revenue up 2MEUR starting from 2023 will be suffered in case of not properly managing available spectrum in TELECOM network. This value for current TELECOM services in POST Luxembourg is around 12MEUR. Our estimate is that market size in Luxembourg, for only ESMS 5G-NMS and 5G-IMS service will be of 2 MEUR/year in 2025 and gradually increasing every year with 1%-2% overhead. Note that there is no clear market revenue acquisition plan in Luxembourg concerning 5G-HMS.

ESMS EU territory market penetration: in this step, the EMSA consortium will focus on mimicking and scaling up the solution applied for Luxembourg and iterate to provide services similar services within EU territory to EU state members. The potential 5G market revenue in EU is reported by Market&Market in 2020. This analysis shows also that EU 5G driven market represents "the 0.3% starting from 2025 and gradually increasing up to 0.9% in 2029 of the market lost due to poor spectrum management and inter-network interference. Our initial estimation is ESMS can capture 1% of 0.3% (i.e., 1% of 100,000,000) of this market starting from 2025 and progressively penetrate further market targeting 1.1% out of 0.9% by 2029 (i.e., 1.1% of 586,000,000). This can be done by selling the ESMS 5G-IMS solution in the market".

We consider revenue acquisition from 2025 due to fact that during 2022-2024 ESMS will be developed so that

- Years 2022-2023: developing the technology and launching the satellite.
- Year: 2024: Satellite LEOP and commercializing ESMS solution

9 FUTURE POTENTIAL

The need for wireless connectivity is ever-increasing and will drive new wireless technologies and expanded use of the spectrum. ESMS is designed to grow as wireless systems grow due to its highly capable Triton-X platform, its modular and high-performance payload, and its unique cloud-based storage and processing architecture.While the first market addressed is focused on the near-term needs associated with the 5G market, ESMS technology will immediately be able to serve other markets. This is because all aspects of ESMS technology are agnostic to the use of the spectrum. ESMS measures all signals and technologies in its frequency range to capture all types of wireless activity, including mobile networks, IoT, satellite communications, radars and more. This means that additional markets exist for ESMS beyond 5G.

Additional markets include satellite operators, telecom equipment manufacturers, IoT networks, and national defence.

The payload of Aurora Insight is small in terms of mass and size. The power demand and pointing requirements are driving the size of the platform, opening the possibility of carrying additional payloads that are compatible with the ESMS payload in terms of duty cycle and pointing needs.

One candidate category of payloads is Maritime surveillance, where LuxSpace has significant heritage. An AIS receiver or the new LuxSpace designed passive radar detector/locator payload can be considered for a combined mission.

10 CONCLUSIONS

The currently on-going deployment of 5G networks is a given. The 5G market grows at a very rapid pace. The means to monitor and control the RF spectrum used by these new networks are only starting to be available, and in Europe there is a clear perceived need to have an independent European system for this purpose.

The combination of the experience and heritage of the partners in the ESMS consortium ensures that this European service can be developed and brought into operation. Combining the spectrum monitoring payload and experience of Aurora, with the RF monitoring satellite experience of LuxSpace, the high performance of Triton-X, the market experience of RHEA and the cloud services experience of EBRC will ensure a system with high performance is going to be provided to serve the European market and institutions.

11 REFERENCES

[1] https://www.marketsandmarkets.com/Market-Reports/5g-services-market-226908556.html

[2] https://www.statista.com/chart/17536/mobile-network-standards/

[3] https://business.post.lu/en/particuliers/mobile/5g