2023

Report on Insurance and Finance

User Needs and Requirements

#EUSpace

EUSPA European Union Agency for the Space Programme

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION AND CONTEXT OF THE REPORT

The User Consultation Platform (UCP) is a periodic forum organised by the European Union Agency for the Space Programme (EUSPA), where users from different market segments meet to discuss their needs and application level requirements relevant for Position, Navigation and Timing (PNT), Earth Observation (EO) and secure telecommunications. The event is involving end users, user associations and representatives of the value chain, such as receiver and chipset manufacturers and application developers. It also gathers organisations and institutions dealing, directly and indirectly, with the two European satellite navigation systems, Galileo and EGNOS and newly since 2020, also with the EU Earth Observation system, Copernicus, and with GOVSATCOM, the upcoming system for secure governmental satellite communications. The UCP event is a part of the process developed at EUSPA to collect user needs and requirements and take them as inputs for the provision of user driven space data-based services by the European Space Programme.

In this context, the objective of this document is to provide a reference for the European Space Programme and for the Insurance and Finance community, reporting periodically the most up-to-date user needs and requirements in the Insurance and Finance market segment. This report is a living and evolving document that will periodically be updated by EUSPA. It serves as a key input to the UCP, where it will be reviewed and subsequently updated and expanded in order to reflect the evolutions in the user needs, market and technology captured during the event.

The report aims to provide EUSPA with a clear and up-to-date view of the current and potential future user needs and requirements in order to serve as an input to the continuous improvement of the development of the space downstream applications and services provided by the European Space Programme components. In line with the extended mandate of EUSPA, the Report on User needs and Requirements (RURs) previously focused on GNSS, have been revamped in order to also encompass the needs of Earth Observation (EO) commercial users and is now organised according to the market segmentation of the EUSPA EO and GNSS Market Report.

Finally, as the report is publicly available, it also serves as a reference for users and industry, supporting planning and decision-making activities for those concerned with the use of PNT and of Earth observation technologies.

It must be noted that the listed user needs and requirements cannot usually be addressed by a single technological solution but rather by space downstream applications which combine several signals and sensors. Therefore, the report does not represent any commitment of the European Space Programme to address or satisfy the listed needs and requirements in the current or future versions of the services and/or data delivered by its different components.

1.1 Methodology

Following the methodology section of the previous RURs, an updated text and figure (see below) will be provided to explain the methodology as well as elaborate on both EO and GNSS activities (where needed/took place).

The following figure details the methodology adopted for the analysis of the Insurance and Finance user requirements at application level.

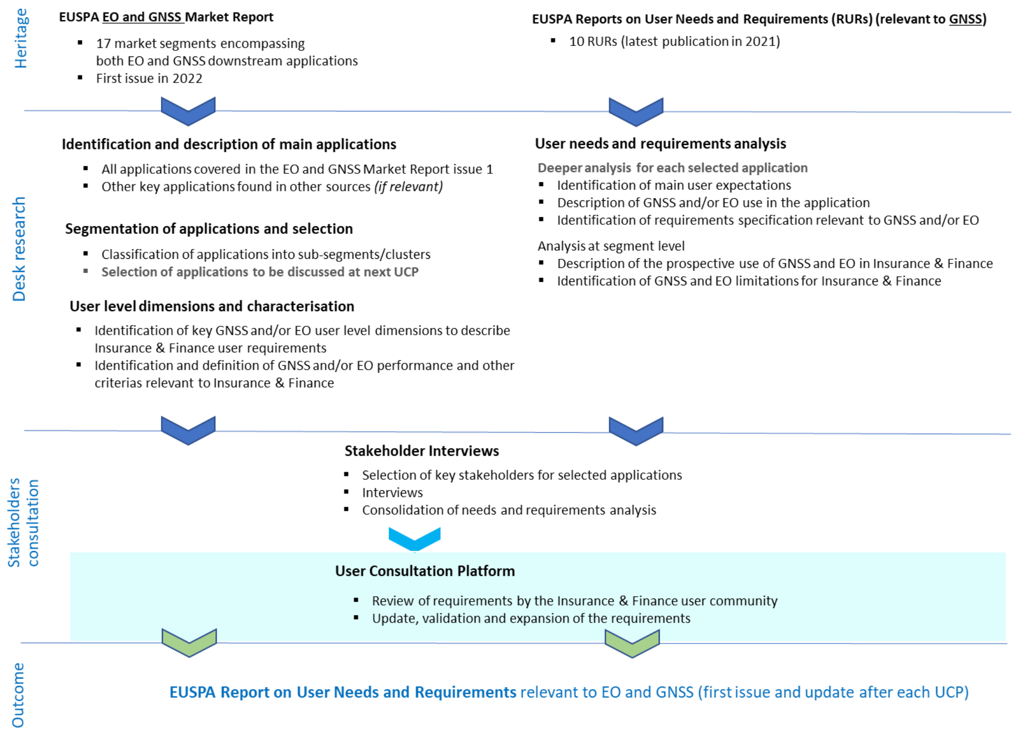

Figure 1: Insurance & Finance user requirements analysis methodology

As presented in the figure 1, the work leverages on the latest EUSPA EO and GNSS Market Report, adopting as starting point the market segmentation for EO and GNSS downstream applications and takes on board the baseline of user needs and requirements relevant to GNSS compiled in the previous RURs published by the agency.

The analysis is split into two main steps, including a "desk research", aiming at refining and extending the heritage inputs and at gathering main insights, and a "stakeholders' consultation" to validate main outcomes.

More in details, the "desk research" was carried out to consolidate when required the list of applications and their classification, to identify the key parameters driving their performances or other relevant requirements together with the main requirements specification, etc. A deeper analysis was conducted for a set of applications prioritised for discussion at the last UCP event. The outcomes of this preliminary analysis were shared and consolidated prior to the UCP with a small group of key stakeholders, operating in the field of the selected applications.

These requirements analysis results were then presented and debated at the UCP with the Insurance and Finance user community. The outcomes of the Insurance and Finance forum discussions were finally examined in order to validate and fine-tune the study findings.

The steps described above have resulted in the outcomes that are presented in detail hereafter.

1.2 Scope

This document is part of the User Requirements documents issued by the European Union Agency for the Space Programme for the Market Segments where Position Navigation and Time (PNT) and Earth Observation (EO) data play a key role. Its scope is to cover requirements on PNT and Earth Observation-based solutions from the strict user perspective and considering the market conditions, regulations, and standards that drive them.

The document starts with a market overview for Insurance and Finance (section 3), focusing on the market evolution and key trends applicable to the whole segment or more specific ones relevant to a group of applications or to the use of GNSS or EO. This section also presents the main market players and user communities. The report then provides a panorama of the applicable policies, regulations and standards (section 4). It then moves to the detailed analysis of user requirements (section 5). This section first presents an overview of the market segment downstream applications, and indicates for each application, the depth of information available in the current version of the report: i.e. broad specification of needs and requirements relevant to GNSS and EO, partial specification limited at this stage to needs and requirements relevant to GNSS, or limited to an introduction to the application and its main use cases at operational level. The content of this section will be expanded and completed in the next releases of the RUR.

Following its introduction, section 5 is organised as follows:

- Section 5.1 aims to present current GNSS and/or EO use and requirements per application, starting with a description of the application, presenting main user expectations and describing the current use of GNSS and/or EO space services and data for the application and providing a detailed overview of the related requirements at application level.
- Section 5.2 describes the main limitations of GNSS and EO to fulfil user needs in the market segment.
- Prospective use of GNSS and EO in Insurance and Finance is addressed in section 5.3.
- Section 5.4 concludes the section with a synthesis of the main drivers for the user requirements in Insurance and Finance.

Finally, section 6 summarises the main User Requirements for Insurance and Finance in the applications domains analysed in this report.

The current version of the report will be expanded and completed through its future releases.

The RUR is intended to serve as an input to more technical discussions on systems engineering and to shape the evolution of the European Union's satellite navigation systems, Galileo and EGNOS and the Earth Observation system, Copernicus.

2 EXECUTIVE SUMMARY

This report aims to enhance the understanding of market evolution, strongpoints, limitations, key technological trends, and main drivers related to the uptake of GNSS and EO data and services across the different insurance and finance application domains. These elements are essential to frame the appropriate technology and service offering development against the requirements of the respective users.

Key trends and market evolution

- ***Insurers keep integrating satellite data into their product portfolios for increased granularity in risk selection, pricing as well as adding to the upcoming parametric Insurance instruments.***
- ***Risk models (Catastrophe models) are becoming increasingly climate change adapted.***
- ***As more financial institutions are publicly committing to net zero and other nature related targets as well as being pushed by policymakers and regulators to report on their Environmental, Social and Governance (ESG), EO data will become increasingly valuable.***
- ***In parallel, synchronisation services based on GNSS time continue to support the financial markets***

The use of EO for insurance is not new, but ever present as insurance products keep asking for more data in order to better assess risk and lower insurance premiums to increase competitiveness. Recent developments in insurance products include parametric insurance, which does not, in contrary to claims-based insurance, triggers pay outs based on post-event damage assessment but on the measured incident itself. This new way of insuring, enabled by measured indexes often supplied data by analysing EO imagery, paves the way for rapid payments and a larger customer base.

Climate change is requiring existing risk models to evolve and adapt to the increasing level of uncertainty it brings. Risk models will rely ever more on current and historic EO data to improve the accuracy of their outcomes.

Financial institutions are becoming more interested in EO data as it provides economic incentive by supplying better information on investments and predict market reactions. Additionally, they are facing a push by an evolving environment of customers, policymakers and regulators that demand more reporting and transparency on the climate impact of their investments.

Current and prospective use of GNSS and EO in Insurance and Finance

As per market report, the use of GNSS in the insurance and finance segment is limited to the timing and synchronization for finance application. EO however, supports five applications of which three focus on the insurance industry and two others in finance. EO is used to assess natural hazards and the damages they cause to insured assets in the application **event footprint.** Triggering pay outs based on thresholds calculated for **index production** is the most recent product development in the insurance industry. EO aids in both insurance and finance by adding an extra layer **to risk assessment** models that predict natural hazards and affect payouts and invested assets. Finally, c**ommodity trading** is helped by EO by providing information on assets supply chains across the globe previously impossible to analyse.

The prospective use of EO in insurance and finance is challenged by the conservative nature of the insurance industry that will need to be convinced by economic investment and technological capability. The finance industry faces the lack of existing data needed to successfully track assets and investments and poor adaptation of climate and environmental data.

Drivers for users' requirements

This document provides an overview of the user needs for each one of five insurance and finance applications and a summary of the drivers for user requirements. For GNSS, Resilience and reliability, security, traceability, high availability, GNSS Authentication, Low (1ms) /Medium (10 µs) Accuracy for T&S are part of the identified drivers.

For EO, drivers include spatial resolution, the availability and accessibility to EO data, the increasing climate change effects and availability of historical data and the regulatory push for financial institutions demanding more transparency.

3 MARKET OVERVIEW & TRENDS

3.1 Market Evolution and Key Trends

3.1.1 Introduction to Insurance & Finance

The Insurance and Finance market segment contains services and products provided and consumed by institutions and organisations in the insurance and financial service domains. Stakeholders are insurers (and re-insurers) and international and local financial institutions (e.g. private and commercial banks, stock exchanges or traders). Many different applications within these segments are currently making use of EO. After an introduction, how these applications can make use of EO will be expanded on in section 5.

In the insurance segment, the applications can be defined as follows:

1. ***Event footprint: involves comparing the claims received from insured clients with the actual material damages that occurred in the field in order to determine the amount of compensation that should be paid.***
2. ***Parametric (or index based) insurance: insurance against the occurrence of specific events based on the magnitude of the event. EO data is used for the computation of numerical indexes for crops and livestock insurance based on images analysis.***
3. ***Risk modelling: the insurance industry relies on risk models that predict potential losses due to natural disasters.***

For the finance segment, applications include:

1. ***Commodity trading: commodity trading refers to the trading of futures contracts of basic goods like oil or grain that are exchanged across traders. Investors bet on the expected future value of such a commodity which is affected by future supply and events impacting producers.***
2. ***Risk assessments: the process of analysing potential events that may result in the loss of (financial) value of an asset, loan, or investment and is one element of risk management. It usually includes an analysis of the history and assessment of the current physical situation.***
3. ***Environmental, Social and governmental (ESG) reporting: the data disclosure on the operations of organisations that are related to environmental, social and governance aspects.***

3.1.2 Key Market Trends

- **Insurers keep integrating satellite data into their product portfolios for increased granularity in risk selection, pricing as well as adding to the upcoming parametric Insurance instruments.**
- **Risk models (Catastrophe models) and their bonds are becoming increasingly climate change adapted**
- **As more financial institutions are publicly committing to net zero and other nature related targets as well as being pushed by policymakers and regulators to report on their sustainability risks (ESG), EO data will become increasingly valuable.**
- **In parallel, synchronisation services based on GNSS time continue to support the financial markets**

The use of EO data by insurers is not new, the past decades EO became a crucial input for many insurance products and more particularly **catastrophe modelling**. These models have been evolving and finetuned over the years but with 2021 providing more evidence that climate change is unpredictable, the need arises for more climate adapted models. Artificial intelligence and Machine Learning techniques will be enabling these models to take into account past natural catastrophes better and improve their outcomes. These better outcomes on the hazard intensity will enable Insurers to better estimate exposure risks. Out of these models come **catastrophe bonds** that are insurance linked securities where the risk resulting from the catastrophe occurrence is transferred from re-insurers to investors.

Index production insurance or parametric insurance which is a relatively new innovative approach to insurance provision whereby pay-outs are based on a predetermined index for loss of assets and investments as a consequence of weather and/or catastrophic events. Parametric insurance allows for faster settlements and reduced costs of claims adjustments and reducing the margin added by the insurers for uncertainties in outcomes.[RD37] In order to prevent adverse selection and set premiums at a level consistent with the levels of risk, insurers are including hazard modelling techniques into parametric insurance. This would enable insurers to write previously unprofitable business while still giving policyholders fair and transparent pricing for the coverage they require.

Based on a recent survey conducted by Agroinsurance, the main innovations introduced for underwriting needs in 2020 due to COVID-19 included a more extensive use of digital solutions for crop monitoring, mobile applications for online premium payments and electronic communication with the insurance buyers. The use of satellite technology for loss assessment remains limited in the global market, although more initiatives emerge to showcase its advantages. For instance, Swiss Reinsurance are working with start-up GreenTriangle's remote monitoring software to improve the loss adjustment processes. The platform integrating satellite data helps settle claims in a more transparent and efficient way – from detection of erroneous insurance claims to differentiating impacts of adverse weather events as opposed to diseases on the crop's yield – benefiting both insured and insurers.

At the same time, financial institutions (FIs) face a similar, increasing need to consider climate risks in their assessments. EO constitutes a major source of data to feed FI's screening processes. Combined with other relevant data, EO data help investors and asset managers to better understand current and future risks to their investments (e.g. inland flood risk, coastal erosion, etc.). With accessible satellite data, existing insurance programmes can potentially be extended to cover a range of natural hazards, (e.g. encompassing cyclones, droughts and coastal inundation), while for FIs, EO can translate into more responsible investment decisions (e.g. by providing an impartial assessment of the environmental impacts, such as deforestation, that investment projects have).

In general, FI's interest in EO data is being pushed threefold:

1. FIs are publicly committing to net zero and nature related targets which affects their risks assessment and their trading in general;

2. Financial policymakers and regulators are pushing FI's to report on their sustainability risks in which EO will play a crucial role; and
3. Financial regulators are cracking downs on misreporting and greenwashing.

Apart from Financial institutions, there is a clear trend and opportunity for companies to make use of EO data for their Environmental Social and Governance (ESG) reporting. EO data makes it increasingly easier to track transported commodities and identify their origin across the globe as well as monitor changes in land cover identifying, for example, illegal deforestation and assess land use in general. On top of that it allows to measure greenhouse gasses emitted during transportation extending the reach EO has in the measuring of the environmental impact of a company's operations. As investors, shareholders and governments are increasingly demanding more transparency on a company's operations through ESG reporting, the rising availability of EO data and products provide a solution and will make sure the importance of EO in ESG will keep rising.

This push will drive the demand for EO products increasingly as they will demand more verifiable insights on the companies and assets they have insured, financed or invested in. More often than not, they have no direct reported data from their clients and investees and alternative datasets such as EO and other satellite derived data will become increasingly valuable.

Since 2018, the European Securities and Markets Authority (ESMA) has imposed on EU member states a series of technical requirements on business clock synchronization in the Commission Delegated Regulation (EU) 2017/574, which complements the MiFiD II Directive 2014/65/ EU in markets of financial instruments In trading especially, time lags as small as 10 microseconds can be a deadly disadvantage. In the meantime, financial institutions are increasingly concerned by the potential impact of GNSS disruption or outage. A host of GNSS receiver vendors offer services to implement, operate and maintain their networks according to the MiFID II regulation requirements, but also to protect timekeeping from any GNSS issues. Synchronization service for business clocks offers are therefore growing accordingly.

3.1.3 GNSS Market evolution

When it comes to the GNSS market evolution, the main measurement is the shipments of GNSS devices by application. The graph below depicts its evolution of the past decade:

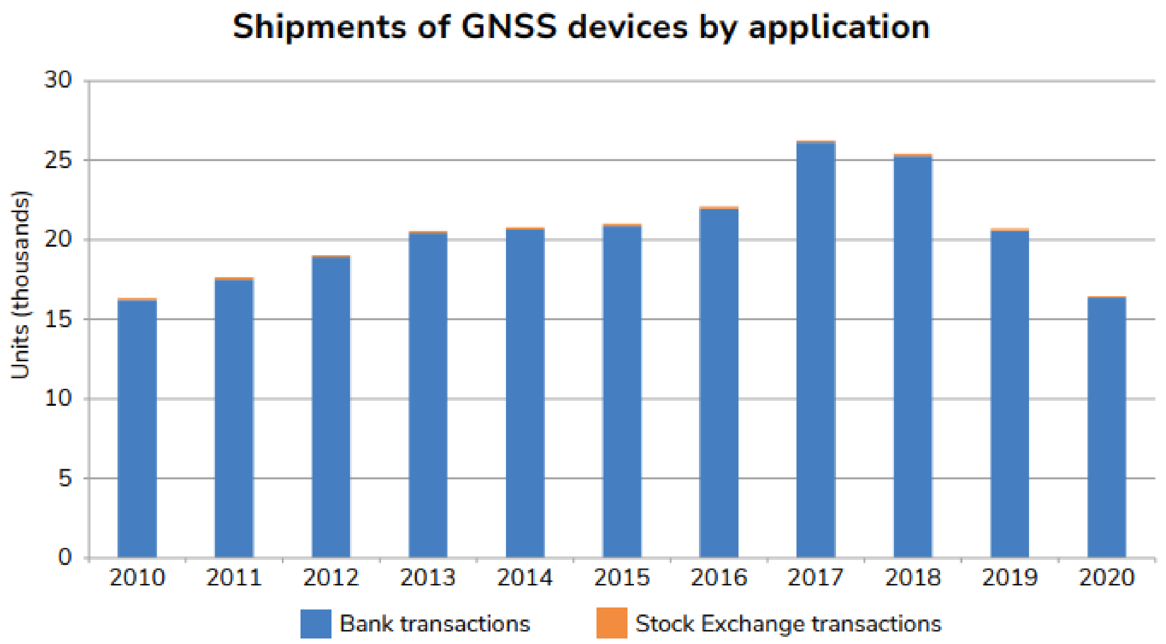

Figure 2: Shipments of GNSS devices by application

GNSS equipment is used for Time Stamping functions, to log events in a chronologic manner and therefore be able to recreate causal links. All stock exchanges are equipped with large data centres holding the exchanges' matching engines in racks of interconnected servers using GNSS receivers as timing and synchronisation sensors. The MiFID II (in EU) and FINRA (US) regulations had a distinct, positive impact on sales of GNSS receivers peak of shipments in 2017: over 33,000 units of new equipment were acquired by financial institutions. With the average device lifetime of about 5 years and the volume of funds at stake, financial markets are more likely to keep up the pace with latest technological developments.

3.1.4 EO market evolution

As EO is expected to rise sharply in the coming decade for insurance and finance, its revenues from data and service sales are expected to follow. The graph below predicts its evolution per application:

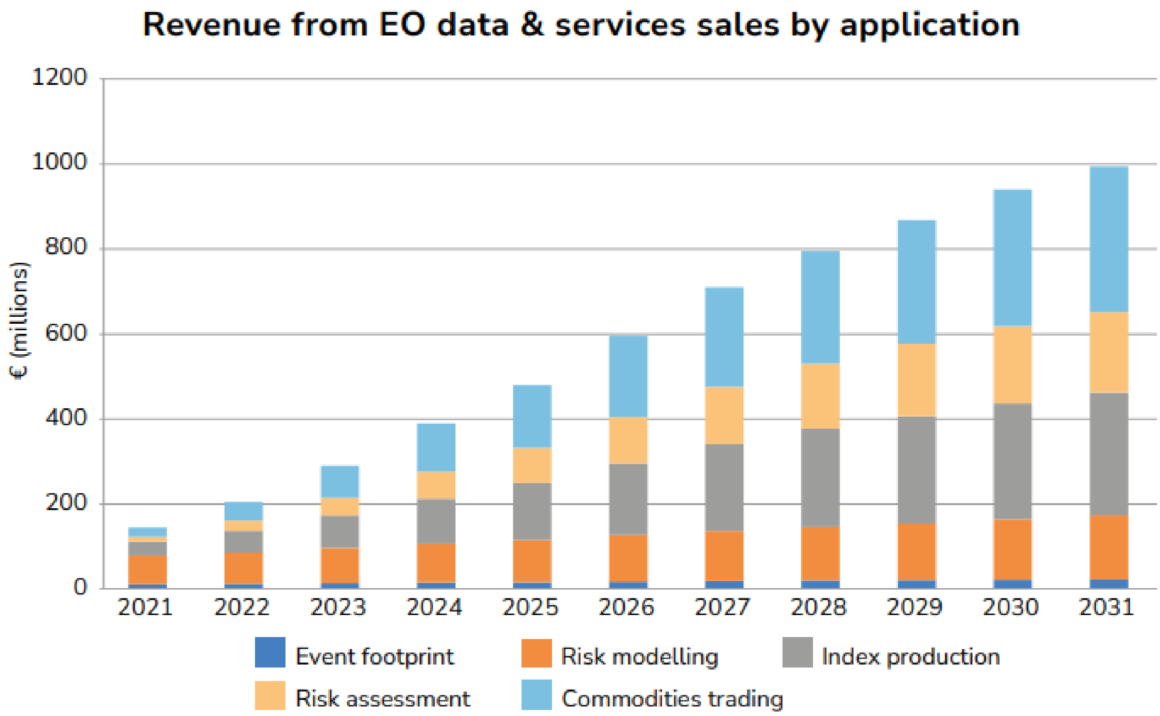

Figure 3: Revenue from EO data & services sales by application in the finance and insurance subsegment

The total amount of EO data and services for 2021 accumulates to €145 m across the five categories of applications (event footprint, risk modelling, index production, risk assessment and commodities trading) considered in the EO and GNSS market report. [1]From 2021, the EO data and services for the insurance and financial market segment will see a CAGR of 20% by 2031, resulting in almost €1 bn total revenues. The massive boost which will accelerate the uptake of both EO data and value-added services across the industry is related to the use of parametric insurance products in the context of disaster resilience frameworks as well as by commercial entities in areas with high exposure to extreme events at global level. In 2021, around 46% of the total revenues come from risk modelling, presenting the largest customer base for EO data and services. However due to its slower future growth, which is below the average of the whole market segment in terms of CAGR (8%), the revenues from this application will represent only 15% of the total revenues in 2031, even if the revenue generated will amount for €151 m, compared to €67 m in 2021. Risk assessment and commodities trading are the two applications with the biggest growth rate (32%) between 2021 and 2031. The revenues from risk assessment go from €12 m in 2021 up to €189 m in 2031. In its turn, the revenues from commodities trading goes from almost €22 m up to more than €343 m in 2031.

[1] EUSPA

3.2 Main User Communities

3.2.1 Insurance

For the Insurance segment the main user groups are:

- **Insurers**: there are different types of insurers:
  - **Insurance companies** either offer many different types of insurance products (e.g. Allianz, Royal & Sun Alliance, AIG) or specialists that offer one or two products (e.g. Westminster, Catlin). These companies have a range of activities such as risk surveying, underwriting, claims handling and investment management.
  - **Mutual indemnity associations**, (e.g. OIL Insurance Ltd. Bermuda, EMANI, the NFU), and numerous other agricultural mutual insurance societies, are owned by their policyholders, who typically have some common exposure. Profits are returned to members (policy holders) through lower future premiums and/or increased policy benefits.
  - **Captive insurers** are "in-house" insurance firms that big businesses create and own to cover a few of their risks. Captives maintain premiums within the organisation, preventing the loss of funds to the insurance market, in addition to gaining certain tax advantages.
  - In addition to purchasing insurance, the **state or government** can also serve as an insurer (or reinsurer), particularly in situations when there is a need for protection and the insurance market is unable to provide coverage.
- **Reinsurers** are similar to insurers, however they provide financial protection to the aforementioned insurers. In effect, they insure the insurers. The main insurer sells portfolios or books of business to reinsurers. In order to do this, reinsurers are interested in the risk aggregation from both the book of business being transferred and across other books.
- **Insured people**: the person or organisations whose property is covered by an insurance they buy from insurers. They can be comprised of governments, public entities (municipalities), corporations or voluntary associations as well as private individuals.
- **Catastrophe modelling companies** allow insurers, reinsurers, financial institutions, to evaluate and manage natural catastrophe risks**,**

Insurance companies often partner up directly with remote sensing companies to get EO data daily.

3.2.2 Finance

In the Finance segment, EO and GNSS end user groups are the **Financial institutions** that comprise:

- **Exchanges** are marketplaces where securities, commodities, derivatives and other financial instruments are traded**;**
- **Banks** are financial institutions that deals in money and its substitutes and provides other money-related services**; and**
- **Other users such as general investors, market makers or hedge funds**.

Commodity brokers are the other large user group in the EO for Finance segment. They are buying satellite data from EO imagery service providers and us it as an extra layer in their forecasting models. Otherwise, information service providers can do the analysis of the EO data and provide a more advanced layer of information for commodity brokers to forecast supply and demand from crops and their yields towards oil supply.[RD23]

When it comes to environmental and other ESG risks, **regulatory bodies** will play an increasing role as they are creating regulatory frameworks and laws that require compliance and disclosure applied to investors and institutions alike. The European banking Authority (EBA) for example, included in its prudential framework a pillar focusing on enhancing data collection by collecting relevant and reliable information on their environmental risks and their impacts on financial losses. EO could potentially play a big role by bridging current existing data gaps when assessing environmental and climate-related risks.

System integrators do typically not play a major role in the selection of the synchronisation solution as this is very often driven by specific operational requirements of the end users (banks, exchanges, traders, …) and, of course, by compliance requirements. Moreover, in Europe, the **European Securities and Markets Authority (ESMA**) plays an important role as part of their standardisation activities.

3.3 Main Market Players

For timing and synchronisation purposes, GNSS receivers are utilised in the insurance and financial sectors. The industry that supports this area also provides support for infrastructure, energy, and raw materials. With a slightly smaller focus on Insurance and Finance applications than its top worldwide competitors, European firms like Orolia, u-Blox, and Meinberg hold 36% of the timing and synchronisation industry, giving the continent an estimated 25% of the Insurance and Finance market.

With a sector value of €0.17 billion and over 58% of the market share overall, the EU market dominates in EO.
The main players involved in Earth Observation and GNSS are depicted the value chains[2] below. The role of the key players is as follows:

Figure 4: Value chain for EO in insurance and finance segment

EO Value chain

Infrastructure providers offer various types of computing infrastructure upon which EO data can be accessed, stored, distributed or manipulated, such as cloud infrastructure, servers, databases, and storage systems. The increasing volumes of EO and geospatial data needs the capabilities and possibilities offered by cloud environments to store, process and exchange data. The infrastructure providers make up the backbone by providing data centres and computing resources thus they cater many different market segments so currently, Insurance and finance just presents a small market. Besides the main global leading IT companies such as Google cloud platform, IBM cloud, there are a few European infrastructure providers across Europe such as CODE-DE, COLLGS, and Cloudeo that offer entry points to data products of the Copernicus Sentinel constellation and others.

Data providers offer un- or pre-processed EO data. Earth Observation data services can be provided by public agencies, or commercial actors. European commercial actors include Airbus SE, Copernicus DIAS and e-GEOS.

Platform providers offer online platforms and/or digital services on which users can benefit from tools and capabilities to analyse EO data, develop algorithms and build applications. Platform providers generally offer everything needed to develop new software in a virtual environment.

EO products and Service Providers are providers of products or services (e.g. land cover classifications or ground motion monitoring) that make full use of EO data and processing capabilities offered by data and platform providers. For example, in crop insurance, a provider can process soil moisture data of specific areas to support in crop-growth analysis which in turn can be used by insurers to calculate the premium. In Europe, the market is mostly made up of micro-sized companies, followed by smaller companies and much less large and medium companies.

Information Providers offer sector-specific information that incorporates EO data along with non-EO data, such as aerial imagery, IoT or other sensors, tailored to sector specific clients. They use the geospatial data and use spatial analytical techniques to offer crucial information services for the end user. In the insurance field, companies offer tools fully integrated with processed EO data and claim management application to fully automate the process between insurers and the insured.

Both the service providers and information providers defined above, are the ones tailoring the EO data specifically to the needs of the Insurance and Finance end-users. They do so by developing services and

[2] Please consult the EUSPA EO and GNSS Market Report (issue 1, 2022) for a more detailed value chain.

products tailored to. The following table provides a sample of companies actively developing and offering these products:

Table 3-1: Service providers for EO in Insurance and Finance (non-exhaustive list)

Segment	Applications	Example organisation
Insurance	Event footprint	- Geospatial Insight - Vandersat - McKenzie Intelligence Services - Skytek
	Index production	- Swiss Re - Global Parametrics - Carribean Catastrophe Risk Insurance Facility - African Risk Capacity
	Risk modelling	- Earthblox - Fathom - Vandersat - Mantle Labs
Finance	Commodity trading	- Kayrros - Geospatial Insight - Earth-I - OilX - ChAI
	Risk assessment	- Planet and Moody's - GHGSat and Bloomberg - Kayrros - RSMetrics - TransitionZero - Sust Global - Climate X
	ESG	- Planet - Satellogic - Picterra - Terrabotics - RSmetrics

End users are the final users of the applications and services offered by the providers. As elaborated on in the previous section, these users comprise of financial institutions, insurance companies, commodity brokers and farmers.

Figure 5: Value chain for GNSS in insurance and finance segment

GNSS Value chain

The above figure depicts the overall value chain of the GNSS timing and synchronisation market, together with the main industrial actors and corresponding roles. This value chain is extracted from the market report. Companies mentioned in each block are not intended to be exhaustive and are mentioned as illustrations. This value chain is voluntarily high level and is further detailed for Finance.

The first block is the GNSS chip producers which are not pure players of the T&S market. These actors are selling their GNSS chips to many applications including mass market. Considering the volumes, the T&S market represents a small part of their revenues.

The added value and market specificities are added by the GNSS Time product manufacturers. GNSS Time equipment usually takes the form of rackmount equipment with specific interfaces supporting Time protocols such as PTP or NTP or synchronisation specific electrical or optical interfaces, for example IRIG B, which are often industry specific. However, there exist also Timing modules, particularly interesting for small cell synchronisation applications. The market is dominated by a small number of actors (most players are US companies), as depicted in the value chain.

Additional revenues can also be generated in the value chain through the provision of:

- Synchronisation infrastructure design consultancy;
- Maintenance, calibration and testing services.

These services are typically provided by equipment resellers. System integrators are used to integrate GNSS T&S equipment in complex system (network) depending on the target market segment (i.e. PMU manufacturers, PMR base station manufacturer) which is then used by the network operator (finance).

4 POLICY, REGULATION AND STANDARDS

4.1 Policy and regulatory stakeholders

In Insurance, the European Commission is the main regulatory and policy stakeholder in Europe.
In Finance, the European Banking Authority (EBA) is the regulatory agency of the EU responsible for supervising the banking sector by setting regulatory standards and guidelines and monitoring compliance. The European Securities and Markets Authority (ESMA) is the agency responsible for supervising the securities and market industries and the European Commission is the main regulatory and policy stakeholders in Europe. Moreover, the European Commission plays an increasingly important transversal role with respect to Critical Infrastructure protection.

4.2 Regulations towards EO user requirements

The insurance and finance industry is increasingly faced with control and regulation. Data identification, collection, and aggregation are given a lot of attention. These data include balance sheet position and market exposure data, internal loss history, pertinent risk indicator data, subjective assessments of exposure, and consideration of long tail liabilities (long lag for liability emergence or claims settlement). Additionally, there are legislation that allow governments to compel insurers to assume risk, such as environmental risk, terrorist risk, etc. While there is no legislating directly addressing EO user requirements in Insurance and Finance, the privacy concerns play a role. With the emergence of high-resolution commercial remote sensing and improving data enrichment and dissemination methods, worries about data privacy and potential reputation danger may rise. International laws governing the use of data gathered by remote sensing technologies, however, are still being developed and may differ by market. This may increase uncertainties about the ability of insurance solutions to scale across markets.

When it comes to environmental risks and other ESG related risks, there are no regulations directly mandating the use of EO, however there are instances where EO can prove to be a crucial tool to make sure there is compliance. For example the European Banking Authority is integrating environmental and other ESG risks into their supervision activities and regulations. Assuming environmental risks and their associated losses will increase in the future, the EBA's view on their own future regulatory capital requirements for assets and activities will address this increased risk. This means that Financial investors and institutions will have to enhance their data collection, their tools to quantify their environmental risks and their disclosure of the ESG risks of their investments. Here EO could play an important role. [RD36].

4.2.1 Principles relating to remote sensing of the earth from outer space

According to the United Nations guidelines on the resolution "Principles Relating to Remote Sensing of the Earth from Outer Space" recommend that remote sensing by one country should not be conducted in a manner detrimental to the legitimate rights of another country. Albeit, not legally binding and countries do not have any veto power to stop themselves from being monitored, it can pose issues for foreign insurers using locally generated images of insured assets.

4.2.2 GDPR

It is currently not possible to spy on people or monitor their movements on a large scale, using satellite resolutions. However, putting this data in a geographical context may help identify insured assets in some cases. The General Data Protection Regulation (GDPR) in Europe has clauses that may expose a remote sensing enterprise to data protection and privacy legislation. However, there is currently no international law governing the regulation of personal data collected through remote sensing.

4.3 Regulations towards GNSS user requirements

4.3.1 EC Directive on critical infrastructure protection

In the context of Timing and Synchronization for financial transactions, the European Commission issued in December 2008 the 2008/114/EC Directive on the “identification and designation of European critical infrastructures and the assessment of the need to improve their protection” [RD9]. The 2008/114/EC Directive distinguishes the “critical infrastructure” from “European critical infrastructure”. Indeed, the Directive mentions that “There are a certain number of critical infrastructures in the Community, the disruption or destruction of which would have significant cross-border impacts [...]. The evaluation of security requirements for such infrastructures should be done under a common minimum approach.”

Interestingly, the Directive does not explicitly refer to the Finance and Communication domains when Energy and Transport are mentioned (contrary to US initiatives): “The sectors to be used for the purposes of implementing this Directive shall be the energy and transport sectors.” However, the Directive mentions that “if deemed appropriate, subsequent sectors to be used for the purpose of implementing the Directive may be identified. Priority shall be given to the ICT sector”.

4.3.2 MIFID II - RTS25

On 20 October 2011, the European Commission adopted formal proposals for a “Directive on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council” (MiFID II Directive), and for a “Regulation on markets in financial instruments” (MiFIR). The MiFID 2 took effect from 3 January 2018.

The European Securities and Markets Authority (ESMA) received a mandate from the European Commission on 23 April 2014 to provide technical advice to assist the Commission on the possible content of the delegated acts required by several provisions of MiFID II and MiFIR.

ESMA has published a set of Regulatory Technical Standards (RTS) – including one on the level of accuracy of the business clock that has been endorsed by the European Commission as a delegated act applying from 3 January 2018 [RD18]. Proof of compliance to RTS25 is by documentation only [RD15]. There has been a real concern of finance stakeholders to cope with the regulation. Timing architectures have been revisited to mandate the certification of compliance. For HFT it was much more conservative than the best practice, but for common data traceability the accuracy should be improved to fit the confidence level necessary to protect operator against regulation authority claim [RD14]. The underlying requirement of 100% availability has been a design driver for the T&S network architecture [RD15]. MIFID2/RTS25 specifies the level of accuracy required for a business clock depending on the trading activity. The most stringent application is related to high-speed trading with a maximum of 100 μs accuracy from UTC and a granularity of the timestamp of 1 μs. The requirement for GNSS is therefore between 100ns and 200ns depending on the IT system architecture (the network itself and data processing are wider contribution to the error budget).

Moreover, Article 4 of [RD18] states that:

Article 4 Compliance with the maximum divergence requirements

Operators of trading venues and their members or participants shall establish a system of traceability to UTC. They shall be able to demonstrate traceability to UTC by documenting the system design, functioning and specifications. They shall be able to identify the exact point at which a timestamp is applied and demonstrate that the point within the system where the timestamp is applied remains *consistent. Reviews of the compliance with this Regulation of the traceability system shall be conducted at least once a year.*

From this article, the issue of liability appears particularly important for Finance operators as they have to demonstrate that their system complies with the timing and synchronisation requirements of RTS25.

There is a need to justify how UTC is generated, which has implications for a financial operator to be able to prove how the time stamp has been created. The question of how to achieve UTC traceability is a key question. Laboratories call for having certified UTC sources from network connectivity. Regarding GNSS, a 3rd party receiver certification for UTC certification (traceability) would be important to reassure regulators (see also below requirements from FINRA Consolidated Audit Trail in the US). Financial operators implement different architectures solutions but the use of multiple timing sources (e.g. GNSS, network based and local oscillator) is an option to meet this requirement.

4.4 Conclusions

The Timing capability offered by satellite navigation systems is at the core of most vital infrastructures: such as financial transactions. GNSS provides a unique offering to the Timing and Synchronisation user communities by delivering a free and highly accurate time and synchronisation capability available worldwide. This explains why GNSS has been rapidly adopted by the T&S user communities, in particular for Critical Infrastructure operations.

In the meantime, cyberattacks on Critical Infrastructure are an increasing issue. GNSS is obviously subjected to these cybersecurity threats. As such, despite a long experience in GNSS, the T&S community is facing many challenges linked to an increased need for reliability and security, supported by an evolution of the regulation. With the advent of new threats to GNSS (jamming and spoofing) and the increased importance of protecting critical infrastructure, resilience has become mandatory. Moreover, impacts of the recent GPS timing anomaly (January 26th 2016) reinforced the need for integrity and independence of GNSS Timing. Finally, there has been an increasing demand for calibration of hardware equipment delays for both scientific and industrial applications.

The GNSS vulnerability topic was thoroughly discussed at the latest three ITSF 8 conferences organised in 2016, 2017 and 2018. Dependence on GNSS of the timing and sync communities was highlighted several times. With its authentication functions and improved performance EGNSS (European GNSS) could contribute to mitigate cybersecurity threats in critical infrastructure. The following table summarises the T&S user requirements taking into account all the information presented in the previous sections of this document focusing on the most stringent ones.

The insurance and finance industry is increasingly faced with control and regulation. As presented in this report, EO is supporting many insurance and finance applications however no real legislation is addressing any EO user requirements yet. Nonetheless, EO can play an important role in assessing financial risks in the case of compliance (e.g. EBA's prudential framework). Finally, the use of EO data in Insurance and Finance can however raise privacy concerns and could be subjected to privacy laws and regulations, possibly creating the uncertainty that it could be scaled across markets.

5 USER REQUIREMENT ANALYSIS

This chapter aims at providing a detailed analysis of user needs and requirements pertaining to Insurance and Finance applications introduced before, describing the different roles and needs covered by GNSS and EO and, ultimately, identifying the corresponding requirements from a user perspective.

Table 5-1 below depicts the main applications making use of GNSS and/or EO technologies in Insurance and Finance. The list of applications is non-exhaustive and is expected to potentially grow and adapt according to the expected adoption of space technologies in the coming years and the innovations that should come with it. The current report being the first version of the Insurance and Finance report on User Needs and Requirements relevant to EO in addition to GNSS, it is a living and evolving document that will periodically be updated and expanded by EUSPA in its next releases.

While each one of the applications addressed in this document can benefit from GNSS and/or EO, the current issue of this report does not cover in detail the needs and requirements for all of these applications. A categorisation was performed prioritising some applications based on their maturity level and relevance to the market trends and drivers. Other applications are foreseen to be covered in more detail in future versions of this RUR.

The following applications categorisation reflects the depth of information available in section 5:

● **Application Type A:** these applications correspond to those for which an in-depth investigation is presented, and for which needs and requirements relevant to GNSS and EO have been identified and validated with Insurance and Finance user community at the UCP.

◑ **Application Type B:** these applications correspond to those not selected for in-depth investigation in the current version of the RUR, for which a partial specification of needs and requirements is provided, limited at this stage to the ones relevant to GNSS if apply.

○ **Application Type C:** these applications correspond to EO-based applications, not selected for in-depth investigation in the current version of the document. A high-level description of the application is included considering that they will be further analysed and developed in next versions of the RURs.

Currently, no type C application is part of the analysis. The table below maps the **6** Insurance and Finance related applications to the three above-mentioned types. **The following** list of **applications and their** categorisation are **expected to evolve in the next versions of the document.**

Legend

EO only application

GNSS only application

The table for consumer solutions, giving an overview of its subsegments, their applications and categorisations is presented below:

Table 5-1: Applications and level of investigation

Sub-segments	Applications	Types of Application/ Level of Investigation	
Insurance	Event footprint	A	
	Parametric (or index based) insurance	A	
	Risk modelling	A	
Finance	Commodities trading	A	
	Risk assessment	A	
	ESG reporting	B	
	Timing and synchronisation for finance	B	

The following section 5.1 first addresses "type A" applications, followed by "type B" applications and finally "type C" applications, for which the level of provided information is currently the less developed. Further investigations will be carried out and the section expanded and completed in the next releases of the RUR.

Each EO-based "Type A" application will cover the needs and requirements for potentially several operational scenarios. For each scenario, a table summarises the EO related needs and requirements.

The table template is illustrated in Table 5-2 and explains the various inputs.

Table 5-2: Description of needs and requirements relevant to EO table[3]

ID	Identifier
Application	Application covered.
Users	Common users of the product/service.
User Needs	
Operational scenario	**Describes the operational scenario faced by the user, which requires a solution.**
Size of area of interest	Describes the area of interest. The values or ranges provided are "typically" the case.
Scale	Describes the scale of interest The values or ranges provided are "typically" the case.
Frequency of information	How often the user requires the information. The values or ranges provided are "typically" the case.
Other (if applicable)	Other user needs such as contextual information (weather data) or file formatting requirements.
Service Provider Offer	
What the service does	Description of the service that satisfies the user's needs.
How does the service work	(Technical) description of how the service works.
Service Provider Satellite EO Requirements	
Spatial resolution	Spatial resolution of the satellite imagery/data required by the service provider to realise the service. The values or ranges provided are "typically" the case.
Temporal resolution	Frequency of satellite data (revisit time) over the area of interest. The values or ranges provided are "typically" the case.
Data type / Spectral range	Type of data (e.g. RGB, SAR) and spectral range (if relevant).
Other (if applicable)	Other data requirements.
Service Inputs	
Satellite data sources	Type of required data and examples of operational satellites that can provide these data.
Other data sources	Other sources of data that the service provider uses to realise the service.

Disclaimer: The EO-related requirements presented in the next section should be considered as "work-in-progress". They must be seen as a first attempt to specify requirements relevant to EO and are likely to evolve throughout the UCP process. Current GNSS/EO use and requirements per application.

5.1.1 Event footprint

What is Event Footprint?

In case of insured assets that were damaged, event footprint involves comparing the claims received from insured clients with the actual material damages that occurred in the field in order to determine the amount of compensation that should be paid. Event footprint provides a correct and rapid visualisation of the extent of the damage including an assessment of the asset prior to the damage event.

[3] See key EO performance parameters (detailed) definition in annex A1.2.

Claim management starts with a formal request by the insured person or organisation to the insurance to be reimbursed for money, goods, or services after incurring a loss. A claims examiner checks that they have complete information and compares it to the policy to verify the loss is actually covered. This usually involves also persons in the field visiting the occurred damage (e.g. taking pictures, talking to the persons). Then, a claims adjuster digs deeper into the specifics of the claim to determine whether or not the insurance company will pay. Overall, it is a time/effort consuming and costly process.

There are two types of observations of relevance:

1. The first one is a periodical monitoring service that allows for continuous change detection of the relevant assets and/or geographical locations (e.g. changes in forest areas). This usually serves to set the baseline for comparing the situation before an event happens.
2. The second one is the ad-hoc and in-depth analysis after an event (man-made or natural) that allows for the comparison of the situation before and after the event. This involves information (imagery) during/after the event, preferably at the point of time of maximum impact/damage.

For example, forest areas can be insured against forest fires and storm breaks (e.g. wind, ice, storm). As forests usually cover large areas and are uninhabited, the happening of such events can go by unnoticed. Therefore, continuous / regular monitoring of the insured areas is necessary. As soon as a relevant event is detected, the extent of the damage needs to be assessed.

Other events (e.g. flooding, landslides, avalanches, hurricanes, earthquakes) and their impact occurring in populated areas can be usually clearly identified at the time of occurrence, as concerned people will report the damage. In such cases, images collected before and during/after an event are required to support the claim management process. Such information may be already sufficient to conclude the claim management process, not requiring evidence collected in the field. E.g. the geographical location of a house in a flooded area may be already sufficient proof. Related processes can be automated increasing the speed and efficiency of the process.

The use of EO in Event Footprint

When a loss is observable from space and does not need in-field verification, **EO allows for an immediate and remote impact assessment.** This only applies when large-scale, covariate risks such as natural disasters or hazards and extensive flooding or fire damage, materialise. **Resources for in-field assessment can be optimised** as it can, for example, help to determine which area to examine first. Eventually, **using EO can lower the chances of insurance fraud** and wrong assessment by adding an additional layer in the damage assessment improving the accuracy of the assessment.[RD38]

Table 5-3: EO requirements - Event footprint

ID	EUSPA-EO-UR-IAF-0001
Application	**Event footprint**
Users	Reinsurers, insurers, brokers, insured people and organisations, local authorities, disaster relief organisations, humanitarian organisations
User needs	
Operational scenarios	• Forests insured against forest fire events and storm breaks • Personal assets insured against damaged by natural events such as flooding, landslides, avalanches, hurricanes and earthquakes). • Agricultural crops insured against damaged by natural events.
Size of Area of Interest	Typically 1 km^2 to > 100 km^2
Scale	• Monitoring forest areas: typically 1:10.000 to 20.000 • Personal assets: typically 1:1.000 to 5.000
Frequency of information	There are two frequencies for data capture: 1. **Periodically**: An updated view of the baseline situation may be required periodically. Most likely annually when insurance contracts are renewed. (a few times a year) 2. **Ad hoc trigger**: Once the natural disaster occurs, information needs to be captured and made available as soon as possible. Multiple captures over time will be required to get a sense of both the maximum damage extent and how/when the situation might improve (e.g. flood waters retreating).
Other (if applicable)	Data are usually provided in form of web services.
Service Provider Offering	
What the Service does	Provide damage assessment in conformity with the type of insurance, based on EO data are collected from the area of relevance in regular time intervals before during and after an event.
How the Service works	When an event strikes, geographical delineation maps based on EO are created indicating the impact zone of the event. This information is fed into the insurance claims management process either with direct interface or via web based services.
Service Provider Satellite EO Requirements	
Spatial Resolution	• Typically in the sub-meter range for residential properties; • Typically in the meter range for the. assessment of infrastructure; • Typically between 10-100 m to assess larger events.
Temporal resolution	Typically daily to weekly.
Data type / Spectral range	Different data types or spectral ranges relevant for different types of disasters. E.g. SAR imagery for flooding extent; optical imagery for storm or wind damage; near-infrared (NIR) imagery for damage to vegetation or natural assets
Other (if applicable)	• Reliability of information • Historical imagery before the event to compare the situation with the present
Service inputs	
Satellite data sources	• Public: Sentinel-1, Sentinel-2, Sentinel-3, MSG/METOP

	• Commercial optical imagery coming from Very High (VHR) and High (HR) resolution optical satellites. Hyperspectral satellites. SAR satellites • GNSS supported ground-based information to confirm the space-based observations complements the data.
Other data sources	• Weather data for the monitoring of weather effects (e.g. storms, rainfall) • In-situ measurements (e.g. flood depth), • imagery collected from UAVs

NOTE: *In the case of event footprint, no GNSS requirements will be presented since this is an EO-only application.*

5.1.2 Parametric (or index based) insurance

What is parametric (or index based) insurance?

The application refers to index-based insurance products that are a type of insurance that covers the probability of a predefined event happening instead of indemnifying actual losses incurred. The principle is to use satellite images to measure observable and quantifiable parameters and to compute an index from these parameters.

Used mainly in agriculture, it serves to pay out indemnities based on indexes for potential losses resulting from natural events such as storms, earthquakes, draughts, floods and other events causing crop damage. Thus, index products can be sold by insurers as a protection against various natural disasters.

The insurance then provides pre-specified pay-outs based upon a trigger event where the calculated index reaches the threshold value and “triggers” a pay-out. Typical representatives of such insurances are floods and crop production. Related services are based either on event triggered monitoring (e.g. floods) or on continuous change detection (e.g. agriculture). In case of flooding, an insured person whose estate is flooded, files a claim to his/her insurance company. In case of agricultural insurances, a continuous monitoring of the relevant area/region is done. If certain environmental conditions are met (e.g. drought, flood, other events), then the pay-out is triggered. As this type of insurances reduces significantly the cost of claim management and the overhead cost of insurances (insurance transaction cost), such insurances become also an attractive means for micro-insurances to smallholders in developing countries.

The use of EO in parametric (or index based) insurance

EO contributes to calculate indexes for crops such as **soil moisture** and **vegetation growth** used in insurance products covering potential damage coming from mainly **natural disasters** such as floods and droughts and other weather events. Other indexes can be calculated for livestock insurance as well. Additionally, EO helps to understand past evolutions of the insured assets. The assessment of the satellite images and the determination of the trigger event are usually supported either by AI and ML or by in field assessments however it can help to reduce the need for on-site visits for verifying claims.

Table 5-4: EO requirements - Parametric (or index based) insurance

ID	EUSPA-EO-UR-IAF-0002
Application	**Parametric (or index based) insurance**
Users	Reinsurers, insurers, brokers, insured people and organisations, local authorities, disaster relief organisations, humanitarian organisations
User needs	
Operational scenario	• Farmers insuring their crops against potential damage caused by weather events • Companies insuring against business interruption exposures stemming from earthquakes. • Private properties insured against damage from hurricanes ensuring fast pay-outs
Size of Area of Interest	Typically > 100 km²
Scale	Typically 1:25.000 to 1:100.000
Frequency of information	Typically daily to weekly.
Other (if applicable)	*N/A*
Service Provider Offering	
What the Service does	Index production insurance covers potential losses incurred by natural disasters and pay-outs are quick after a trigger. Compared to traditional insurance products, there is no loss assessment.
How the Service works	EO data are then translated e.g. into geographical demarcation of an event, or directly into a calculated index/parameter. The policy pays out a lump sum if an event occurs within a predefined geographic area surrounding/affecting the insured asset and the trigger threshold is met.
Service Provider Satellite EO Requirements	
Spatial Resolution	Typically 10 m
Temporal resolution	Typically daily to weekly
Data type / Spectral range	SAR imagery for flooding extent; multispectral imagery for damage to vegetation or vegetation stresses (e.g. droughts)
Other (if applicable)	• Reliability of information • Historical data is also valuable to understand past trends of the insured event. Particularly in areas where no/limited other historical data is available (e.g. from weather stations).
Service inputs	
Satellite data sources	• Sentinel-1, Sentinel-2, MSG/METOP • GNSS based ground-based information to confirm the space-based observations
Other data sources	*N/A*

NOTE: *In the case of index production, no GNSS requirements will be presented since this is an EO-only application.*

5.1.3 Risk modelling

What is risk modelling?

Risk modelling is the process of building a probabilistic model estimating the likelihood and severity of a momentary loss of an insured asset. The insurance industry relies heavily on **models for risk assessment**, capital allocation or projecting financial market trends. These models have been built generally relying mostly on historical data. If an asset was insured or what the related insurance premium was, was decided on the location of such an asset and the probability of certain events to hit this asset.

In view of present- and future-day uncertainties introduced by factors such as climate change, interest rates and inflation, among many others, insurers need to debias their risk assessment models and make them also forward looking. Modelled risks need to reflect both past experience, and present and likely future developments. The range of forward-looking variables to consider for insured risks is wide, and different by line of business. E.g. climate change is impacting insurers' assets and liabilities. Rising global temperatures are leading to increased intensity of severe storms and increasing losses when an extreme weather strikes areas of high population and economic value. By far the biggest risk driver remains the rapid increase of assets in exposed areas, mainly through urbanisation. As an example, systematic indices and heatmaps for local, industry and sector situations are enabling improved risk scenario analysis.

The type of events that affect more people around the world than any other is flooding, and it is a rising threat. Urbanisation, economic growth, and changing precipitation patterns are all contributing to increased flood losses. Fast-growing cities are often located on coastlines or near rivers that are increasingly prone to flooding. On top of that, development of flood infrastructures, such as sea walls, dams and levees, often lags the expansion of cities and is not keeping pace with the climate trend. Flood is also a complex peril to model. The influence and interplay of various factors such as 'soil sealing,' ageing infrastructure, and climate change create additional challenges compared to other natural catastrophes.

The use of EO for risk modelling

Earth Observation is able to contribute to many of aspects of risk modelling, by including historical data providing imagery of natural events and damages hitting certain geographical areas in the past and supporting the creation and calibration of risk maps. These time series of imagery and data on parameters influencing the future risks, allow to make predictions of future trends introduced by climate change.

The EO requirements for Risk modelling are presented in the following table.

Table 5-5: EO requirements - Risk modelling

ID	EUSPA-EO-UR-IAF-0003
Application	**Risk modelling**
Users	Reinsurers, insurers, brokers, catastrophe modelling companies,
User needs	
Operational scenario	Predict environmental risks affecting assets
Size of Area of Interest	Typically > 100 km²
Scale	Typically 1:50.000 to 1:1.000.000
Frequency of information	**Continuous / regular monitoring** will be required to be able to predict occurring risks as soon as possible as some models only predict for a limited time in the future. However, most insurance products are re-evaluated and re-priced **annually**.
Other (if applicable)	Ancillary data from local databases are required to complete the analyses.
Service Provider Offering	
What the Service does	The service provides either the most recent information on the current status of the aspects of interest to the insurer (e.g. infrastructure), or time series of historical imagery and data on relevant aspects (e.g. location, extension and impact of an event). Where available, foresight into future trends can be provided, e.g. extension of arid zones, increased drought/flooding risk, rise of ocean water levels, expansion of cities, change of land cover and characteristics.
How the Service works	Risk modelling companies develop their models that rely on large volumes of data, including EO, to model and predict natural catastrophes. These models are then purchased by insurers and underwriters to develop their insurance products to sell.
Service Provider Satellite EO Requirements	
Spatial Resolution	Typically 1 m to 1 km
Temporal resolution	Typically a few days to a few weeks
Data type / Spectral range	Optical/SAR
Other (if applicable)	There are no specific requirements under this category when it comes to time series of data (either they exist or not). When it comes to foresight of impact of climate change, it should be clear that such foresight is tainted with uncertainty (e.g. with respect to the timeline, intensity, geographical coverage, etc.).
Service inputs	
Satellite data sources	Sentinel-1, Sentinel-2, Sentinel-3, Sentinel-5P, GNSS/Galileo, MSG/METOP
Other data sources	Depending on the type of risk subject to modelling, a variety of data sources are relevant, especially archived data: • SAR imagery data for infrastructure determination, flooding extensions, subsidence, water level; • Optical imagery for aspects like heatmaps, vegetation, soil and plant parameters, affects and impact of weather events and

	natural disasters (e.g. cyclones, landslides, earthquakes, volcano eruptions) • Meteorological information for weather related aspects (e.g. floods, droughts, extreme weather events. • Where available and relevant, GNSS supported ground based historic data to complement the space-based data. • Drone based remote sensing data that provides high resolution imagery • Vulnerability data is required (which is asset specific information about its ability to withstand shocks, financial value, rebuilding value, etc.) which can typically not be derived from satellite data and would have to be provided by the insurer or the insured. • Asset specific data such as information on buildings, utilities, transport network,...)

NOTE: *In the case of risk modelling, no GNSS requirements will be presented since this is an EO-only application.*

5.1.4 Commodities trading

What is commodities trading?

Commodity trading relates to the buying and selling of raw materials like oil, coal, metals, agricultural products among others. Oil and metal products (such as ore and petroleum) are examples of hard commodities, whereas agricultural products are typically considered soft commodities (e.g. potatoes, wheat, cotton, coffee, sugar, soybeans). To make better and quicker decisions and to have an advantage over their competition in trading on the trading market, users in any commodity market are interested in increasing transparency and knowledge about the current and future availability versus the current and future demand. This is expected to lead to financial gains.

Regarding hard commodities, the users are usually interested in information covering the whole process from production to sale to identify supply demand balance changes. On the example of oil trading, information is required how much oil is stored in storage tanks at the production sites, ports and other large distribution infrastructure and how much oil is extracted (representing the potential supply), how much oil is stored in storage tanks at the buyer sites, how much oil is in the shipping process towards these sites (e.g. with oil tankers), and what is the rate of consumption (representing the potential demand). Such information is then fed into trading models.

Regarding soft commodities (agricultural products), the users are usually interested to get predictions on the yield rates of the next harvest as early as possible in the growing cycle. Knowing as early as possible if there is a crop shortfall in one region will allow them to secure crop orders in another region.. The consequences of climate change with varying impact in different regions worldwide are especially noticeable in soft commodities (e.g. regions with more droughts, regions with more floods) leading in the future to a stronger imbalance between offering (reduced yields) and demand (growing world population).

While there is an increasing understanding of sustainability impacts (e.g. deforestation, pollution of air, soil, water) of various internationally traded commodities. information on these issues is generally more relevant to longer term investment, financing or purchasing decision making. (e.g. risk management in equity investment, reputation risk management linked to loans, selecting suppliers). And less relevant for short term commodity trading decisions based on derivative financial instruments. Where sustainability issues become pertinent for commodity traders is when one off event cause disruption of supply (e.g. hurricanes, oil spills causing seize of operations). The broader financial and reputational impacts from one off (pollution) events will be priced in a (polluting) company's stock price rather than the price of the commodity being produced.

The use of EO for commodities trading

Earth Observation is able to provide information on a number of the above-mentioned aspects, e.g. with high resolution SAR imagery the filling status of storage tanks can be observed, with optical imagery the activities at the production sites can be monitored and the rate of oil extraction assessed, transport activities (e.g. truck traffic, loading of ships) can be monitored, with AIS data ship transports can be monitored (e.g. ETA). Other data to complete the modelling process (e.g. oil consumption) are usually available to the traders. For soft commodities, information inputs such as EO, help generate predictions on yield rates and crop shortfalls in certain regions or include information during the sowing period (which type of crop, the total area of a specific crop) and a few times during the growing phase (status of the crops, what is the level of irrigation or fertilisation, are there droughts or floods) ahead of the harvest. Information inputs can be created from optical EO imagery (e.g. NDVI, irrigation). Other commodities like renewable energy requires information on environmental parameters (e.g. solar radiation for PV plants, wind speed and direction for wind power parks, water availability for hydro power). Nowadays more and more information on green/sustainable behaviour is required as the image and reputation of the finance industry is becoming more and more susceptible to damages.

EO can provide investors with reliable and accurate information to inform their decision-making before markets are impacted. EO proves to be an important tool in verifying market data with physical evidence, helping to detect anomalies or trends which can help to identify important investment opportunities and mitigate risks. It comes down to EO being another value-adding layer of information to forecasting models helping traders make better decisions.

Table 5-6: User requirements Commodities trading

ID	EUSPA-EO-UR-IAF-0004
Application	**Commodities trading**
Users	Traders, banks, hedge funds, commodity producers, commodity buyers, commodity speculators
User needs	
Operational scenarios	Traders are aided by EO by providing critical information production, inventories and supply chains. A few examples are: • Traders can predict annual yield estimations and price projections of certain crops; • Estimations of crude oil in storage tanks; • Estimations of amounts of raw material extracted by measuring the size of stacks at mining sites.
Size of Area of Interest	• **Hard commodities**: Typically 1 to 100 km^2 • **Soft commodities**: Typically 100 to 10,000 km^2
Scale	• **Hard commodities**: Typically 1:1.000-10.000 • **Soft commodities**: Typically 1:50.000-1.000.000
Frequency of information	For **hard commodities**, typically daily to weekly updates are sufficient (depending on the type of commodity). For **soft commodities** only, typically few updates (monthly / 2-monthly updates) during the crop growth period are required at specific points of the growth cycle (depending on the crop). If there are significant events (e.g. weather-related events such as flood, drought, storms) influencing the expected harvest result, these have to be reported immediately / as soon as possible.

Other (if applicable)	Pure production and consumption insights will typically be combined with other socio-economic data points that could indicate future demand/supply issues (e.g. policy, economic growth and consumer spending, crises in upstream markets) Information has to be provided in a format that is capable of being integrated easily in existing models of the users.
Service Provider Offering	
What the Service does	For **hard commodities** the service provides the monitoring of ongoing production activities (e.g. oil production, mining), the amount of produced goods, transport activities, of pollutions (green/sustainable misbehaviour). For **soft commodities** observations during the growing cycle are provided and fed into growing models to allow predictions regarding the potential harvest yields.
How the Service works	Service providers extract business intelligence insights from EO data using basic algorithms such as object counting, vegetation indexes, change detection and volumetric measurements. These are then often combined with more advanced image analytics algorithms and Deep Learning models. Some traders might develop their own algorithms and ingest raw EO data and other traders rely on derived ready to use products.
Service Provider Satellite EO Requirements	
Spatial Resolution	• **Hard commodities**: typically < 1 m to 100 m. • **Soft commodities:** typically 10 m to 1 km
Temporal resolution	Typically Daily (e.g. renewable energy) to weekly (yield predictions).
Data type / Spectral range	Multispectral, optical and radar.
Other (if applicable)	Information has to be available in time and reliable. If the EO data used or the system used is not reliable, this can result in immediately in financial losses, and are detrimental to any service.
Service inputs	
Satellite data sources	Sentinel-1, Sentinel-2, Sentinel-3 and Sentinel-5p, GNSS/Galileo, MSG/METOP as well as commercial satellite data.
Other data sources	Depending on the type of commodity observed, a variety of data sources are relevant: • Where available, in-situ data to confirm/verify the space-based observations. • Non-geospatial information would include pricing and transaction data, regional/national economic output or consumption statistics etc.

NOTE: *In the case of commodities trading, no GNSS requirements will be presented since this is an EO-only application*

5.1.5 Risk assessment

What is risk assessment?

Risk assessment for finance is the process of analysing potential events that may result in the loss of (financial) value of an asset, loan, or investment and is one element of risk management. It usually includes an analysis of the history and assessment of the current physical situation. Some examples of operational scenario are:

- Offshore wind parks: assessing the location and complexity to build and operate the park (influences e.g. CAPEX/OPEX), the environmental threats (e.g. regular storms, high waves) and the expected wind yield (influences profit);
- Infrastructure such as airports, power plants, bridges, mines or housing: assessing the situation of the ground (stable vs. subsidence), the risk of natural disasters (e.g. earthquake, flood, landslide) and whether the ground is polluted. As well as the effect to the environment/people, in case of pollutions caused by the infrastructure (e.g. air, water, ground);
- Agriculture/forestry operational risk analysis: assessing the past crop yields and the weather-related risks (e.g. flood, drought) Assessing the risk of infestations/diseases or pollutions affecting the quality of the harvest (e.g. ground, water, air); and
- Biodiversity risk analysis: to assess the clients/investee company's current or proposed activities in high biodiversity areas. Assess the risk to cause land use changes or pollution impacts in these areas as well as assessing the risk of breaching the bank/investor's policies on biodiversity.
- Assessments on country level of natural events like flooding, fire, earthquake, volcano, etc. in order to define counteracting measures or implement rescue plans on regional/country level.

While historically physical risks were of the main interest, there is now a broader set of risks that mainstream financial institutions are interested in understanding as their understanding of climate change and sustainability related issues increases (i.e. the exponential growth of green/sustainable finance). The four major types of sustainability related risks include:

a) **Transition risks**: e.g. Power station operational costs increasing as carbon prices go up and being outcompeted by cleaner technology power production
b) **Physical risks**: e.g. Heavy industry assets facing operational disruptions due to increased flooding or drought events, leading to loss of revenues
c) **Liability risks**: e.g. Extractives company paying millions or billions in fines for environmental damages caused by their operations such as BP's Gulf of Mexico oil spills, or Vale's Bruhmadinho disaster
d) **Reputational risks**: e.g. Bank's clients moving their savings after finding out the bank has been providing loans to companies responsible for deforestation in the Amazon

The use of EO for risk assessment

Earth Observation can contribute to the determination of physical various risks, such as floods and ground subsidence, associated with a current or future investment. It can help to compute the impact and probability of this risk materialising. This risk calculation is based on the processing of large data series of satellite images for the generation of images, statistics and indicators describing the past situation over a specific area. To ultimately understand trends and potential future evolutions.

If climatic aspects are of importance, such historic analyses may be complemented by climatic change analyses providing foresight on future climatic threats / increased risks. The following table provides an overview of the User Requirements:

Table 5-7: EO requirements - Risk Assessment

ID	EUSPA-EO-UR-IAF-0005
Application	**Risk Assessment**
Users	Investors (asset owners, asset managers), financiers (banks), companies, individual persons, authorities/governments

User needs	
Operational scenario	• Offshore wind parks • Infrastructure • Agriculture/forestry • Biodiversity risk analysis • Assessments on country level
Size of Area of Interest	1. For offshore wind parks: typically around 100 km². 2. Infrastructure: typically up to few km². 3. Agriculture/forestry: typically, from a few km² to 1000 km². 4. Assessment on country level: typically, from 100 to 10,000 km².
Scale	Individual buildings: 1:1000 Country level: 1:100.000
Frequency of information	Typically, two frequencies: 1. **Ad hoc** when taking an investment decision 2. **Annually** for updated risk management or reporting purposes
Other (if applicable)	Archived historical data. Ancillary data from local databases with information on assets are required to complete the analyses.
Service Provider Offering	
What the Service does	EO based data and insights can be provided directly to the financial institution. E.g. the service collects data from the various data sources and processes the data into easily understandable information. Usually simple maps presenting risk zones (green, yellow, red) are preferred by the users.
How the Service works	Data and processed information is made available often via web based platforms. EO based data and insights can also be provided indirectly to the financial institution through (financial data/news) intermediaries who combine it with ancillary (financial) datasets. The intermediary will combine geospatial datasets and EO derived indices or risk datasets, asset data and financial information to calculate risk scores (e.g. Value at risk, ESG ratings) at the company level. This allows investors to compare companies and their risk profiles against one another.
Service Provider Satellite EO Requirements	
Spatial Resolution	Typically 10 m to > 1 km
Temporal resolution	Typically weekly
Data type / Spectral range	Optical/SAR
Other (if applicable)	Historical data is a necessity for the risk models to be as accurate as possible.
Service inputs	
Satellite data sources	• Sentinel-1, Sentinel-2, Sentinel-3, Sentinel-5P • Commercial satellite data for high value assets or high impact risks or high-risk exposure.

	• GNSS based ground-based information to confirm the space-based observations.
Other data sources	*N/A*

NOTE: *In the case of risk assessment, no GNSS requirements will be presented since this is an EO-only application.*

5.1.6 ESG reporting

ESG reporting stands for Environmental, Social and Governance reporting. It refers to organisations reporting on their efforts to integrate sustainability in their business practices, process, product developments, operations and strategy. As an ultimate goal, reporting on these efforts will enhance their reputation and can be used as a tool to attract investors and financing.

Monitoring the whole supply chain from the first to the last mile becomes important for companies being serious about ESG reporting. As these companies are realising that they need to measure their impact on the climate, they also want to become aware what kind of impact the changing climate has on their operations, be it to their physical assets or rising production risks. Monitoring the **first mile** (e.g. transport between farms and mills and ports) proves to be the most difficult one as it often concerns tracking imports from regions far away [RD32]

Some examples what companies monitor, track and measure for their Environmental (E) **first mile** reporting are [RD30]:

- Identify crops
- Monitoring mining resources
- Discover illegal logging
- Monitoring deforestation and supporting certification programs

What happens after this first mile is often the transport of the goods to the last mile of the supply chain (e.g. from ports to warehouses in the destination country). During this **middle mile,** what can be monitored here is the GHG emissions that the transport vehicles emit or what other pollution it can cause (oil spills,...).

When it comes to measuring and reporting the Social (S) aspect, companies often try to identify labour violations. Checking working conditions of farmers or their access to sanitary facilities or educational facilities.

Finally, the Governance (G) aspect covers the reporting and materiality of information. Certain authorities and their jurisdictions demand ESG reporting and disclosure from companies to provide their investors with ESG related material [RD31].

The use of EO for ESG

For many organisations wanting to improving the transparency of their operations and enhancing their ESG reporting, **Earth Observation** can enable better measurement and compliance by bridging data gaps left open by conventional measuring methods. EO is already and will be the most important for the environmental side of ESG as it provides a scalable, low friction data source that can be used to quantify the risks of climate change on businesses. As businesses supply chains often start with importing goods originating from far away regions, **EO** will play an hugely important role. Some examples of how EO is currently used for the E (environmental) elements that could compromise the development of sustainable practices:

- EO enables to trace the relationships between palm oil farms, mills, refineries and ports to identify its origin and potential issues;
- Verifying the sustainable production of Cocoa and coffee and tracing both sustainable and unsustainable to make sure they don't get mixed [RD33]; and

- Calculating CO_2 emissions in the transportation of commodities that have a long value chain.

When it comes to the S (Social) element, EO can support in [RD35]

- Disaster response to earthquakes, fires and other natural disasters; and
- Help anti-human trafficking.

Finally for the (G) Governance part, examples on the use of EO are [RD35]:

- Supporting journalists by providing evidence;
- Tracking ships involved in illegal fishing; and
- Monitoring conflicts such as the Russo-Ukrainian war.

5.1.7 Timing and synchronisation for finance

Timing and synchronisation are two distinct functions that can be fulfilled using GNSS.

Timing: is the marking of an event with respect to a reference origin, usually UTC (Coordinated Universal Time), or more precisely a realization of UTC maintained by a time laboratory, named UTC(k), as UTC does not exist in real time. The precise time user requires the time tagging of events (also called Time stamping). Time stamping refers to the use of an electronic timestamp to provide a temporal order among a set of events.

Synchronisation: deals with understanding the temporal ordering of events produced by concurrent processes. Two clocks can be synchronised between them and/or with respect to an absolute time. Synchronisation is particularly important to ensure successful communication between nodes of a network. It is also required in applications in which two events have to be initiated within a specific time frame. In this document, the term “synchronisation” refers to both phase and frequency synchronisation (frequency synchronisation is actually called synchronization).

GNSS can be used to provide both services:

- **Timing**: GNSS provides a direct and accurate access to a prediction of UTC.
- **Synchronisation**: Either synchronisation between receivers at different locations can be established and maintained using GNSS reference time. Or, a master clock synchronized itself using the time provided by GNSS can redistribute this time to the slave clocks disseminated within the systems.

Financial services rely on very powerful IT systems and networks requiring a high level of availability, security and reliability. Due to their influential status within the financial system and upon national economies, banks are highly regulated in most countries. Nevertheless, the current regulation is obsolete and the current timing requirements are no more linked to regulation but to technical needs although this situation is currently evolving.

In the Finance sector, GNSS time is distributed throughout a network to up to several thousands of machines (client). Usually a GPS antenna is deployed on a roof and it is connected to a PTP or NTP server. It is highlighted that PTP is clearly the future (the whole industry works on it) as it provides sub μs accuracy (instead of millisecond for NTP). However, there is a significant issue with the current version of the PTP protocol which suffers from a single point of failure and is therefore not sufficiently reliable [RD15].

Availability of timing information is very important for banks and stock exchanges.

The finance community is increasingly concerned by GNSS threats (interference but primarily spoofing). Up to recently, considering the currently required accuracy (1 ms) unavailability of GNSS timing/synchronisation information in case of open GNSS services denial was managed by alternate solutions (e.g. NTP, local oscillator) even during a long period of time. This situation should rapidly evolve with the increased requirement for more accuracy (towards μs) and resilience.

Moreover, GNSS as a single source with no authentication is not a service answering the requirement for such CIS as recommended by the Network and Information Security Directive and ENISA policy. A complement solution shall be available.

5.1.7.1 Banks

Banks rely on very powerful IT systems and networks requiring a high level of availability, security and reliability. Critical operations are performed in dedicated data centres.

GNSS equipment is used for Time Stamping functions, to log events in a chronologic manner and therefore be able to recreate causal links. Typical requirement in terms of accuracy is 1ms for most applications but there is an increased trend for more accuracy linked to regulation requirements.

Banks operate centralized networks with much more machines than Stock Exchanges. Current PTP adoption is directly linked to the accuracy requirement.

Within a particular Bank organisation, time distribution for synchronisation applications is obtained by the use of transfer protocols (e.g. NTP, PTP). Today almost all the main European Banks are already equipped with timing and synchronisation equipment using GNSS technology. The number of implemented GNSS equipment is not foreseen to increase for this segment [RD1][RD2].

5.1.7.2 *Stock* exchanges

The individual Stock Exchange servers apply time stamps to the trades they execute and to the quotes they establish (In the United States, the quotes are sent to the Consolidated Quotation System (CQS) which is an electronic service that provides quotation information for stock traded on the American Stock Exchange).

All stock exchanges are equipped with large data centres holding the exchanges' matching engines in racks of interconnected servers using GPS receivers as timing and synchronisation sensors. PTP adoption is underway in this sector.

It is assumed that today almost all of the main Exchanges are already equipped with the synchronisation equipment using GNSS technology. The number of implemented GNSS equipment is not foreseen to increase for this segment. The regulation requires implementing systems providing μs level accuracy.

As an illustration of GNSS use in Stock Exchanges, 10 000 NTP clients are operated by the New-York Stock Exchange (NYSE) fed by around 10 GPS receivers [RD1][RD2].

5.2 Limitations of EO and GNSS

5.2.1 EO limitations

Although EO imagery is undergoing massive improvements in terms of temporal and spatial resolutions with commercial providers expanding their offers quickly, certain technical limitations of EO are still present such as:

Accessibility of EO data

EO data might not be consistently available for all regions or countries. When specific regions may have only a limited amount or even no data available, Insurance and finance players will have to resort to more traditional methods for their assessment.

Complexity of EO language

The language and technical jargon used in Earth Observation (EO) can be complex and difficult for non-experts to understand. This can act as a barrier to the uptake of EO data by decision-makers, policymakers, and stakeholders who may not have a background in the field.

Temporal resolution

Low revisit rates (temporal resolution) means that for some applications not enough observations can be made. In the EO domain there has been a trend in recent years towards near real time (NRT)data, together with increased resolution and revisit rates. NRT refers to low latency and fast processing of workflows to deliver EO data and analysis rapidly. This serves the needs of certain users in need of fast responses. Latency will always exist between satellites and ground sensors, as an inherent quality of space communications, but it is in fast processing capabilities and pre-tasked orders, that the industry is becoming more agile in delivering products and services.

Spatial resolution and coverage

The spatial resolution of EO imagery refers to the size of the smallest feature that can be detected by a satellite sensor or displayed in a satellite image, usually expressed in kilometres, metres or centimetres for the highest resolution. The value indicates the size or length of each pixel in a given image. This varies greatly across satellites and has significantly improved in recent years. The spatial coverage is the swath or band that a circling satellite captures at any given moment in time, that is defined by its orbit, orbital plane and technical capabilities. For certain insurance products, insurers need detailed damage information on individual assets which needs high resolution images.

Cost of commercial data

The cost of commercial EO data can be high. Too high for some players, often with smaller budgets, creating a financial barrier for some. Additionally, the processing of EO data, even the open source and free data available, can be very expensive

Cloud coverage

One of the most common interferences that especially optical imagery faces when capturing images of the earth's surface is the abundance of clouds at different altitudes; This is also true for some of the sentinels that operate in the multispectral ranges. Insurers are concerned about the continuity and consistency issues cloud coverage can create by interrupting the service. To mitigate the information loss and this the continuity caused by cloud-coverage, complementary technologies such as Synthetic Aperture Radar (SAR), and a series of processing approaches can be used, increasingly ML and AI that extrapolate information and build on historical data.

Archive with homogenous historical data

The Sentinel Hub services supports various data collections, such as Envisat, ESA, Landsat and commercial collections, from the moment that this data became available. The availability of data is not homogeneous trough time and space and researchers might face data gaps in their investigations. For risk models and index insurance products, companies need consistent historical data to make accurate predictions.

Angles

The absolute accuracy of imagery is not normally given, and off-nadir imagery requires some adaptations and processing to convert it into truly accurate 2D maps. Images can be assembled from multiple angles to complete the gaps created by shadows of buildings in the case of urban settings. Although off-nadir imagery can lead to lower spatial resolution it leads to more ground coverage, which might be more important in emergency situations that require NRT information, where any information is better than none.

5.2.2 GNSS limitations

Even if GNSS is massively used for Timing & Synchronisation there are several constraints that limit its further growth:

- Spoofing threats and the possible remaining after strategies currently developed by the receiver manufacturers to improve the resilience to spoofing
- Low resistance against interference
- Availability issue for Indoor/Urban use
- Receiver power consumption

5.3 Prospective use of EO and GNSS

5.3.1 Prospective use of EO and GNSS

Prospective use of GNSS in Timing & Synchronisation

The Reports on User Needs and Requirements on surveying (see [RD29]) identifies prospective uses of GNSS in Finance. This is repeated below:

Future trends

GNSS spoofing is seen as an increased threat, in particular when high frequency trading is at stake [RD1] [RD2]. However, the Finance industry already put in place mitigation measures (e.g. architecture choice) [RD15]. Indeed, GNSS spoofing in an issue for GNSS source not connected with PTP or NTP technologies but network technologies can help identify and mitigate interference from the GNSS source [RD14]. Moreover, there is more awareness on the GNSS spoofing threat even though the Finance industry would welcome a resilient GNSS solution. Traceability is one of the most important requirements as it is now legally required – see section 5.5.2.3 and it is stressed that GPS is not fully traceable to UTC. Another major parameter is Trustability that requires three-time sources to be available [RD15]. Moreover, there is now a legal obligation [RD5] to be accurate at 100 µs (up to now the "legal" requirement was 1 s). This level of accuracy can be achieved with NTP but with a lot of difficulties whereas PTP provides easily this level of accuracy. However, PTP in its current version has an issue of single point of failure which 6 Links to products datasheets are available in [RD2]. 7 Analysis made in 2017 on 260+ GNSS Timing solutions from 30 manufacturers. can be overcome with some solution (which is therefore not the standard solution). A change of the PTP standard should be envisaged in PTPV3 to make it more robust [RD15]. Finally, even if the requirement for a robust GNSS is met, the Finance industry would always prefer to rely on multiple time sources [RD15].

Prospective use of Earth Observation

The benefits of using Earth observation for Insurance and finance-related applications are recognised and the operational use of EO products and services in the market is continuously increasing, there are still some barriers on why not all players are using EO yet. Listed below are a few key elements that limit the uptake of EO in the **insurance** industry[RD39]:

- **The conservative nature of the Insurance industry** makes insurers to stick to existing systems and techniques. They take caution adopting new ways as it imposes a risk.
- **Some information requirements are already existing and free of charge** such as daily forest fire hazard assessments that are available on the internet to everyone.
- **A lot of effort needed to incorporate EO analysis tools into insurance products** and insurers might there opt out due to high development costs in terms of resources and time.
- **The required skill set is lacking in the insurance industry** to adopt the new EO methods, as insurers are currently limited to just entering location information on risks.
- **Concerns over continuity and reliability are expressed by insurers** as any system adopted requires a low probability of interruption of service.
- **As the insurance industry structure and its systems are inflexible,** the methods of accessing and using EO data sources need to adapt.

In the **finance industry**, the uptake of EO is becoming increasingly important informing in decision making processes often before markets are impacted. However, the use of EO is held back by three data barriers:

- **The lack of reliable asset level data at required granularity and regularity;**
- **Lack of supply chain data at required granularity; and**
- **Poor adaptation of observational climate and environmental data in financial applications.**

Currently, only for a select few major sectors, **asset data**, including the location, ownership information, and other characteristics of particular assets, is commercially accessible. Asset data and the accompanying information on company trees must be significantly upgraded in order to provide insights with a broad enough coverage to satisfy the majority of use cases. Only then, financial assessment with the help of EO can be used efficiently.

Similarly to assets, **supply chains are also lacking granularity** which blocks the use of EO data to create understanding needed for finance.

Finally, **robust climate and environmental datasets are missing** crucial to finance and investment decisions. Up-to-date, high resolution environmental or climate observational datasets encompassing metrics over a large portfolio are required in order to evaluate asset data against in order to acquire superior environmental and climate spatial financial insights. Depending on the application, different datasets will need to be developed at different temporal frequencies. All will ideally need to maintain methodological consistency with other observational datasets utilised, as well as throughout time and using the same base datasets.

5.4 Summary of drivers for user requirements

The following table summarises the main drivers in the GNSS Timing & Synchronisation and EO for Insurance & Finance.

Table 5-8: Main drivers for GNSS in T&S and EO for Insurance and Finance

GNSS	EO	
T&S for Finance	Insurance	Finance
Resilience and reliability Security Traceability High availability GNSS Authentication Low (1ms) /Medium (10 µs) Accuracy for T&S Increasing demand for calibration of hardware equipment delays	High resolution imagery High availability Accessibility of end-users to EO data Cost effectiveness of insurance pay-out processes Increased climate change effects availability of historical data	High resolution imagery High availability Prevention of financial losses Increased climate change effects availability of historical data Regulation requiring transparency

6 USER REQUIREMENTS SPECIFICATION

The chapter provides a synthesis of the requirements described in section 5.1 respectively on GNSS in section 6.1 and on EO in section 6.2.

6.1 Synthesis of Requirements Relevant to GNSS

The table below presents the GNSS user requirements for the bank and stock exchange network applications as introduced under section 5.1.7. These requirements are the same ones as introduced in the previous Report on Time & Synchronisation User Needs and Requirements [RD45] for the Finance applications.

Table 6-1: Requirements for Finance– GNSS

Id	Description	Type	Source
EUSPA-GN-UR-TSC-0070	The Timing & Sync system shall provide continuity of service	Function (Continuity)	[RD1] [RD2] [RD13]
EUSPA-GN-UR-TSC-0080	The GNSS system shall provide a T&S function with 100ns to 200 ns accuracy for timestamping.	Performance (Accuracy)	RTS25 [RD14] [RD15] [RD16]
EUSPA-GN-UR-TSC-0100	The Timing & Sync system shall provide a high level of availability (99.9%)	Performance (Accuracy)	NPL [RD15]
EUSPA-GN-UR-TSC-0110	The Timing & Sync system shall be trustable	Function (Trust)	[RD1] [RD2] [RD10] [RD11] [RD12] [RD14]
EUSPA-GN-UR-TSC-0120	The Timing & Sync system shall be reliable	Function (reliable)	[RD1] [RD2] [RD15] [RD6]
EUSPA-GN-UR-TSC-0121	The Timing & Sync system shall allow certification to satisfy the synchronisation requirements of 50 ms of UTC as maximum requirement	Function (certification)	[RD8] [RD16]
EUSPA-GN-UR-TSC-0130	The Timing & Sync system shall be resilient	Function (resilience)	[RD1] [RD2] [RD10] [RD11]

Id	Description	Type	Source
			[RD12] [RD13]
EUSPA-GN-UR-TSC-0140	The Timing & Sync system shall be able to detect and characterization GNSS interference	Function (interference detection)	[RD1] [RD2]
EUSPA-GN-UR-TSC-0150	The Timing & Sync system shall provide service commitment	Function (service commitment)	[RD1] [RD2]
EUSPA-GN-UR-TSC-0160	The Timing & Sync system shall get access to integrity information with a certain level of confidence	Function (integrity)	[RD1] [RD2] [RD17]
EUSPA-GN-UR-TSC-0175	The Timing & Sync system shall provide robustness against "non-synchronised" GNSS spoofing attacks for Finance applications	Function (Authentication)	[RD1] [RD2] [RD10] [RD11] [RD17]
EUSPA-GN-UR-TSC-0180	The Timing & Sync system shall be secure	Function (Trust)	[RD1] [RD2] [RD10] [RD11] [RD12]
EUSPA-GN-UR-TSC-0190	The Timing & Sync system shall be preferably provided worldwide and regionally as a minimum	Performance (Coverage)	[RD19]
EUSPA-GN-UR-TSC-0200	The Timing & Sync system shall be able to demonstrate traceability to UTC	Function (Traceability)	[RD19]
EUSPA-GN-UR-TSC-0210	The Timing & Sync system shall be able to provide an authentication capability at User Equipment level	Function (Authentication)	[RD19]
EUSPA-GN-UR-TSC-0220	The Timing & Sync system shall be able to provide an authentication capability on a continuous basis	Function (Authentication)	[RD19]
EUSPA-GN-UR-TSC-0230	The Timing & Sync system shall be able to provide an authentication capability with a duration between successive authentications of 5 to 10 seconds	Function (Authentication)	[RD19]
EUSPA-GN-UR-TSC-0240	The Timing & Sync system shall be able to provide an authentication capability with no degradation of the time accuracy	Function (Authentication)	[RD19]

Id	Description	Type	Source
EUSPA-GN-UR-TSC-0250	The Timing & Sync system shall be able to provide an authentication capability with a key management procedure as transparent as possible	Function (Authentication)	[RD19]
EUSPA-GN-UR-TSC-0268	The Timing & Sync system shall provide an update rate of 1Hz to 10 Hz	Performance (Update rate)	[RD19]

6.2 Synthesis of Requirements Relevant to EO

Table 6-2: EO requirements for Event Footprint

ID	Application	User	User Needs					Service Provider Offer		Service Provider Satellite EO Requirements				Service Inputs	
			Operational Scenario	Size of Area of Interest	Scale	Frequency of Information	Other (if applicable)	What the service does	How does the service work	Spatial Resolution	Temporal Resolution	Data Type / Spectral Range	Other (if applicable)	Satellite data sources	Other Data Sources
EUSPA-EO-UR-IAF-0001	Event Footprint	Reinsurers, insurers, brokers, insured people and organisations, local authorities, disaster relief organisations, humanitarian organisations	• Forests insured against forest fire events and storm breaks • Personal assets insured against damaged by natural events such as flooding, landslides, avalanches, hurricanes and earthquakes). • Agricultural crops insured against damaged by natural events.	Typically 1 km2 to > 100 km2	•Monitoring forest areas: typically 1:10.000 to 20.000 •Personal assets: typically 1:1.000 to 5.000	There are two frequencies for data capture: 1. Periodically: An updated view of the baseline situation may be required periodically. Most likely annually when insurance contracts are renewed. (a few times a year) 2. Ad hoc trigger: Once the natural disaster occurs, information needs to be captured and made available as soon as possible. Multiple captures over time will be required to get a sense of both the maximum damage extent and how/when the situation might improve (e.g. flood waters retreating).	Data are usually provided in form of web services.	Provide damage assessment in conformity with the type of insurance, based on EO data are collected from the area of relevance in regular time intervals before during and after an event.	When an event strikes, geographical delineation maps based on EO are created indicating the impact zone of the event. This information is fed into the insurance claims management process either with direct interface or via web based services.	•Typically in the sub-meter range for residential properties; •Typically in the meter range for the. assessment of infrastructure; •Typically between 10-100 m to assess larger events.	Typically daily to weekly.	Different data types or spectral ranges relevant for different types of disasters. E.g. SAR imagery for flooding extent; optical imagery for storm or wind damage; near-infrared (NIR) imagery for damage to vegetation or natural assets	• Reliability of information • Historical imagery before the event to compare the situation with the present	• Public: Sentinel-1, Sentinel-2, Sentinel-3, MSG/METOP • Commercial imagery coming from Very High (VHR) and High (HR) resolution optical satellites. Hyperspectral satellites. SAR satellites • GNSS supported ground-based information to confirm the space-based observations complements the data.	• Weather data for the monitoring of weather effects (e.g. storms, rainfall) • In-situ measurements (e.g. flood depth), • imagery collected from UAVs

Table 6-3: EO requirements for Parametric (or index based) insurance

ID	Application	User	User Needs					Service Provider Offer		Service Provider Satellite EO Requirements				Service Inputs	
			Operational Scenario	Size of Area of Interest	Scale	Frequency of Information	Other (if applicable)	What the service does	How does the service work	Spatial Resolution	Temporal Resolution	Data Type / Spectral Range	Other (if applicable)	Satellite data sources	Other Data Sources
EUSPA-EO-UR-IAF-0002	Parametric (or index based) insurance	Reinsurers, insurers, brokers, insured people and organisations, local authorities, disaster relief organisations, humanitarian organisations	• Farmers insuring their crops against potential damage caused by weather events • Companies insuring against business interruption exposures stemming from earthquakes. • Private properties insured against damage from hurricanes ensuring fast pay-outs	Typically > 100 km²	Typically, 1:25.000 to 1:100.000	Typically daily to weekly	/	Index production insurance covers potential losses incurred by natural disasters and pay-outs are quick after a trigger. Compared to traditional insurance products, there is no loss assessment.	EO data are then translated e.g. into geographical demarcation of an event, or directly into a calculated index/parameter. The policy pays out a lump sum if an event occurs within a predefined geographic area surrounding/affecting the insured asset and the trigger threshold is met.	Typically 10 m	Typically , daily to weekly	SAR imagery for flooding extent; multispectral imagery for damage to vegetation or vegetation stresses (e.g. droughts)	•Reliability of information • Historical data is also valuable to understand past trends of the insured event. Particularly in areas where no/limited other historical data is available (e.g. from weather stations).	• Sentinel-1, Sentinel-2, MSG/METOP • GNSS based ground-based information to confirm the space-based observations	/

Table 6-4: EO requirements for Risk modelling

ID	Application	User	User Needs					Service Provider Offer		Service Provider Satellite EO Requirements				Service Inputs	
			Operational Scenario	Size of Area of Interest	Scale	Frequency of Information	Other (if applicable)	What the service does	How does the service work	Spatial Resolution	Temporal Resolution	Data Type / Spectral Range	Other (if applicable)	Satellite data sources	Other Data Sources
EUSPA-EO-UR-IAF-0003	Risk modelling	Reinsurers, insurers, brokers, catastrophe modelling companies,	"Predict environmental risks affecting assets	Typically > 100 km²	Typically 1:50.000 to 1:1.000.000	Continuous / regular monitoring will be required to be able to predict occurring risks as soon as possible as some models only predict for a limited time in the future. However, most insurance products are re-evaluated and re-priced annually.	Ancillary data from local databases are required to complete the analyses.	The service provides either the most recent information on the current status of the aspects of interest to the insurer (e.g. infrastructure), or time series of historical imagery and data on relevant aspects (e.g. location, extension and impact of an event). Where available, foresight into future trends can be provided, e.g. extension of arid zones, increased drought/flooding risk, rise of ocean water levels, expansion of cities, change of land cover and characteristics.	Risk modelling companies develop their models that rely on large volumes of data, including EO, to model and predict natural catastrophes. These models are then purchased by insurers and underwriters to develop their insurance products to sell.	Typically 1 m to 1 km	Typically a few days to a few weeks	Optical/SAR	"There are no specific requirements under this category when it comes to time series of data (either they exist or not).		•Optical/SAR •Meteorological •GNSS •Dones •Vulnerability data •Asset specific data

Table 6-5: EO requirements for Commodities trading

ID	Application	User	User Needs					Service Provider Offer		Service Provider Satellite EO Requirements				Service Inputs	
			Operational Scenario	Size of Area of Interest	Scale	Frequency of Information	Other (if applicable)	What the service does	How does the service work	Spatial Resolution	Temporal Resolution	Data Type / Spectral Range	Other (if applicable)	Satellite data sources	Other Data Sources
EUSPA-EO-UR-IAF-0004	Commodities trading	Traders, banks, hedge funds, commodity producers, commodity buyers, commodity speculators	Traders are aided by EO by providing critical information production, inventories and supply chains. A few examples are: • Traders can predict annual yield estimations and price projections of certain crops; • Estimations of crude oil in storage tanks; • Estimations of amounts of raw material extracted by measuring the size of stacks at mining sites.	•Hard commodities: Typically 1 to 100 km2 •Soft commodities: Typically 100 to 10,000 km2	•Hard commodities: Typically 1:1.000-10.000 •Soft commodities: Typically 1:50.000-1.000.000	For hard commodities, typically daily to weekly updates are sufficient (depending on the type of commodity). For soft commodities only, typically few updates (monthly / 2-monthly updates) during the crop growth period are required at specific points of the growth cycle (depending on the crop). If there are significant events (e.g. weather-related events such as flood, drought, storms) influencing the expected harvest result, these have to be reported immediately / as soon as possible.	Pure production and consumption insights will typically be combined with other socio-economic data points that could indicate future demand/supply issues (e.g. policy, economic growth and consumer spending, crises in upstream markets) Information has to be provided in a format that is capable of being integrated easily in existing models of the users.	For hard commodities the service provides the monitoring of ongoing production activities (e.g. oil production, mining), the amount of produced goods, transport activities, of pollutions (green/sustainable misbehaviour). For soft commodities observations during the growing cycle are provided and fed into growing models to allow predictions regarding the potential harvest yields.	Service providers extract business intelligence insights from EO data using basic algorithms such as object counting, vegetation indexes, change detection and volumetric measurements. These are then often combined with more advanced image analytics algorithms and Deep Learning models. Some traders might develop their own algorithms and ingest raw EO data and other traders rely on derived ready to use products.	•Hard commodities: typically < 1 m to 100 m. • Soft commodities: typically 10 m to 1 km	Typically Daily (e.g. renewable energy) to weekly (yield predictions).	Multispectral, optical and radar can all be relevant.	Information has to be available in time and reliable. If the EO data used or the system used is not reliable, this can result in immediately in financial losses, and are detrimental to any service.	Sentinel-1, Sentinel-2, Sentinel-3 and Sentinel-5p GNSS/Galileo, MSG/METOP as well as commercial satellite data.	Depending on the type of commodity observed, a variety of data sources are relevant: •Where available, in-situ data to confirm/verify the space-based observations. •Non-geospatial information would include pricing and transaction data, regional/national economic output or consumption statistics etc.

Table 6-6: EO requirements for Risk assessment

ID	Application	User	User Needs					Service Provider Offer		Service Provider Satellite EO Requirements				Service Inputs	
			Operational Scenario	Size of Area of Interest	Scale	Frequency of Information	Other (if applicable)	What the service does	How does the service work	Spatial Resolution	Temporal Resolution	Data Type / Spectral Range	Other (if applicable)	Satellite data sources	Other Data Sources
EUSPA-EO-UR-IAF-0005	Risk Assessment	Investors (asset owners, asset managers), financiers (banks), companies, individual persons, authorities/governments	• Offshore wind parks • Infrastructure •Agriculture/forestry • Biodiversity risk analysis • Assessments on country level	• For offshore wind parks: typically around 100 km². • Infrastructure: typically up to few km². • Agriculture/forestry: typically, from a few km² to 1000 km². • Assessment on country level: typically, from 100 to 10,000 km².	Individual buildings: 1:1000 Country level: 1:100.000	Typically two frequencies: 1. Ad hoc when taking an investment decision 2. Annually for updated risk management or reporting purposes	Archived historical data. Ancillary data from local databases with information on assets are required to complete the analysis.	EO based data and insights can be provided directly to the financial institution. E.g. the service collects data from the various data sources and processes the data into easily understandable information. Usually simple maps presenting risk zones (green, yellow, red) are preferred by the users.	Data and processed information is made available often via web based platforms. EO based data and insights can also be provided indirectly to the financial institution through (financial data/news) intermediaries who combine it with ancillary (financial) datasets. The intermediary will combine geospatial datasets and EO derived indices or risk datasets, asset data and financial information to calculate risk scores (e.g. Value at risk, ESG ratings) at the company level. This allows investors to compare companies and their risk profiles against one another.	Typically 10 m to > 1 km	Typically Weekly	Optical/SAR	Historical data is a necessity for the risk models to be as accurate as possible.	•Sentinel-1, Sentinel-2, Sentinel-3, Sentinel-5P •Commercial satellite data for high value assets or high impact risks or high-risk exposure. •GNSS based ground-based information to confirm the space-based observations.	N/A

7 ANNEXES

A1.1 Definition of key GNSS performance parameters

This Annex provides a definition of the most commonly used GNSS performance parameters, based on [RD4] and is not specifically focusing on the Insurance and Finance community.

Availability: the percentage of time the position, navigation or timing solution can be computed by the user. Values vary greatly according to the specific application and services used, but typically range from 95-99.9%. There are two classes of availability:

- System: the percentage of time the system allows the user to compute a position – this is what GNSS Interface Control Documents (ICDs) refer to
- Overall: takes into account the receiver performance and the user's environment (for example if they are subject to shadowing).

Accuracy: the difference between true and computed position (absolute positioning). This is expressed as the value within which a specified proportion of samples would fall if measured. Typical values for accuracy range from tens of metres to centimetres for 95% of samples. Accuracy is typically stated as 2D (horizontal), 3D (horizontal and height) or time.

Continuity: ability to provide the required performance during an operation without interruption once the operation has started. Continuity is usually expressed as the risk of a discontinuity and depends entirely on the timeframe of the application (e.g. an application that requires 10 minutes of uninterrupted service has a different continuity figure than one requiring two hours of uninterrupted service, even if using the same receiver and services). A typical value is 1x10-4 over the course of the procedure where the system is in use.

Integrity: the measure of trust that can be placed in the correctness of the position or time estimate provided by the receiver. This is usually expressed as the probability of a user being exposed to an error larger than alert limits without warning. The way integrity is ensured and assessed, and the means of delivering integrity related information to the user are highly application dependent. For safety-of-life-critical applications such as passenger transportation, the "integrity concept" is generally mature, and integrity can be described by a set of precisely defined and measurable parameters. This is particularly true for civil aviation. For less critical or emerging applications, however, the situation is different, with an acknowledged need of integrity but no unified way of quantifying or satisfying it. Throughout this report, "integrity" is to be understood at large, i.e. not restricted to safety-critical or civil aviation definitions but also encompassing concepts of quality assurance/quality control as used by other applications and sectors.

Robustness to spoofing and jamming: robustness is a qualitative, rather than quantitative, parameter that depends on the type of attack or interference the receiver is capable of mitigating. It can include authentication information to ensure users that the signal comes from a valid source (enabling sensitive applications).

In this document, characterisation of the robustness against GNSS spoofing is made as follows:

1. Identification of the different types of attacks using Humphrey's spoofing threat continuum
2. For each type of attack, assessment of:
    - The cost of attack
    - The time to put the attack in place
    - The capacity needed to implement the attack
    - Deduction form the information here above of the possible profile of attackers

Low, Medium, High, Very High susceptibility to spoofing are defined as follows:

Note: for some users, robustness may have a different meaning, such as the ability of the solution to respond following a severe shadowing event. For the purpose of this document, robustness is defined as the ability of the solution to mitigate interference or spoofing.

Table 7-1: Low, Medium, High and Very High susceptibility to spoofing definitions

Susceptibility to spoofing	*Types of attacks*	*Cost of attack*	*Time to put in place*	*Capacity*	*Profile of attackers*
Low	*Plug and play*	> €10	*A few hours*	*Very little*	*End user criminal*
Medium	*Record and replay (using SDR)*	Several €100s	*Weeks*	*Limited*	*End users criminal*
High	Non-synchronised attack (can be done with SDR)	Between €1000 and €100 000s	and €100 000s A few months	*Significant*	*Organised crime*
Very high	Synchronised attack	More than €1000 000	From 6 months to a year	*Formidable*	*Hostile nations*

Indoor penetration: ability of a signal to penetrate inside buildings (e.g. through windows). Indoor penetration does not have an agreed or typical means for expression. In GNSS, this parameter is dictated by the sensitivity of the receiver, whereas for other positioning technologies there are vastly different factors that determine performance (for example, availability of Wi-Fi base stations for Wi-Fi-based positioning).

Time To First Fix (TTFF): a measure of a receiver's performance covering the time between activation and output of a position within the required accuracy bounds. Activation means subtly different things depending on the status of the data the receiver has access to:

- Cold start: the receiver has no knowledge of the current situation and thus has to systematically search for and identify signals before processing them – a process that typically takes 15 minutes.
- Warm start: the receiver has estimates of the current situation – typically taking 45 seconds.
- Hot start: the receiver knows what the current situation is – typically taking 20 seconds.

Latency: the difference between the time the receiver estimates the position and the presentation of the position solution to the end user (i.e. the time taken to process a solution). Latency is usually not considered in positioning, as many applications operate in, effectively, real time. However, it is an important driver in the development of receivers. This is typically accounted for in a receiver, but is a potential problem for integration (fusion) of multiple positioning solutions or for high dynamics mobiles.

Power consumption: the amount of power a device uses to provide a position. The power consumption of the positioning technology will vary depending on the available signals and data. For example, GPS chips will use more power when scanning to identify signals (cold start) than when computing position. Typical values are in the order of tens of mW (for smartphone chipsets).

A1.2 Definition of key EO performance parameters

In line with the list of key parameters to be covered in section 6.2 (and definitions provided in particular in MR7 annex 3 when relevant).

This Annex provides a definition of the most commonly used GNSS performance parameters, based on [RD4] and is not specifically focusing on the Insurance and Finance community.

Spatial resolution relates to the level of detail that can be retrieved from a scene. In the case of a satellite image, which consists of an array of pixels, it corresponds to the smallest feature that can be detected on the image. A common way of characterising the spatial resolution is to use the Ground Sample Distance (GSD) which corresponds to the distance measured on the ground between the centres of two adjacent pixels. Thus, a spatial resolution of 1 meter means that each pixel corresponds to a 1 by 1-meter area on the ground.

Temporal resolution relates to the time elapsed between two consecutive observations of the same area on the ground. The higher the temporal resolution, the shorter the time between the acquisitions of two consecutive observations of the same area. In absolute terms, the temporal resolution of a remote sensing system corresponds to the time elapsed between two consecutive passes of the satellite over the exact same point on the ground (generally referred to as “revisit time” or “orbit cycle”). However, several parameters like the overlap between the swaths of adjacent passes, the agility of the satellites and in case of a constellation, the number of satellites mean that some areas of the Earth can be reimaged more frequently. For a given system, the temporal resolution can therefore be better than the revisit time of the satellite(s).

Spectral range refers to the wavelength range of a particular channel or band over in which remote sensing data must be collected.

Latency is the difference between the reference time of the satellite measurement and the time the final product is made available to the user (here the service provider).

A1.3 List of Acronyms

Acronym	Definition
ACER	European Agency for the Cooperation of Energy
BEREC	European Regulators of Electronic Communications
CAPEX	Capital Expenditures
CQS	Consolidated Quotation System
DHS	Department of Homeland Security
EC	European Commission
EGNOS	European Geostationary Navigation Overlay Service
EGNSS	European Global Navigation Satellite System
EO	Earth Observation
ESA	European Space Agency
ESG	Environmental Social Governmental
ESMA	European Securities and Markets Authority
EU	European Union
EUSPA	European Agency for the Space Programme
EUSPA	European Agency for the Space Programme
FINRA	Financial Industry Regulatory Authority
GAO	Government Accountability Office
GDPR	The General Data Protection Regulation
GNSS	Global Navigation Satellite System
HAS	High Accuracy Service
HR	High Resolution
ICD	Interface Control Document
IP	Infrastructure Protection
IRIG	Inter-range instrumentation group
IT	Information Technology
ITSF	International Timing & Sync Forum
MIFID	Markets in financial instruments Directive
MR	Market Report
NIR	Near-infrared
NIST	National Institute of Standards and Technology
NRA	National Regulatory Authorities
NRT	Near real time
NTP	Network Time Protocol

Acronym	Definition
NYSE	New York Stock Exchange
OPEX	Operational Expenditures
OSNMA	Open Service Navigation Message Authentication
PMR	Professional Mobile Radio
PMU	Phase Measurement Unit
PNT	Positioning, Navigation and Timing
PTP	Precision Time Protocol
R&D	Research and development
R&I	Research and Innovation
RTS	Regulatory Technical Standards
RUR	Report on User needs and Requirements
SAR	Synthetic Aperture Radar
SATCOM	Satellite communications
SEC	Securities and Exchange Commission
SME	Small and Medium-sized Enterprise
SoL	Safety of Life Service
T&S	Timing & Synchronisation
TTFF	Time To First Fix
UAV	Unmanned Aerial Vehicle
UCP	User Consultation Platform
UTC	Coordinated Universal Time
VHR	Very High Resolution

A1.4 Reference Documents

Id.	Reference	Title	Date
[RD1]	GSA Lot4 SC1, D1 V2.0	Market research and quantification of the timing and synchronisation	19 January 2014
[RD2]	GSA Lot4 SC1, D2.2 V2.0	Existing and Potential GNSS TS applications and produc	30 October 2014
[RD3]	Spoofing GNSS Timing Receivers	Spoofing GNSS Timing Receivers, Tim Frost (Calnex) and Guy Buesnel (Spirent), proceedings ITSF 2015	November 2015
[RD4]	Technology Report 1	GSA GNSS Technology Report Issue 1	October 2016
[RD5]	GNSS Security and Robustness	GNSS Security and Robustness, Shankar Achanta (Schweitzer Engineering Laboratories, Inc)	September 2015
[RD6]	UTC Traceable Time for the Financial Sector using PTP	UTC Traceable Time for the Financial Sector using PTP, NPL Elisabeth Laier, proceedings ITSF 2015	November 2015
[RD7]	RTS25 Draft regulatory technical standards on clock synchronisation	Annex I MiFID II / MiFIR / MiFID/MiFIR Draft Regulatory Technical Standards - RTS25 "Draft regulatory technical standards on clock synchronisation"	28 September 2015
[RD8]	] FINRA Regulatory Notice Consolidated Audit Trail (CAT)	National Securities Exchanges and FINRA Issue Joint Guidance on Clock Synchronisation and Certification Requirements Under the CAT NMS Plan	March 2017
[RD9]	2008/114/EC Directive	2008/114/EC Directive on the "identification and designation of European critical infrastructures and the assessment of the need to improve their protection"	December 2008
[RD10]	Homeland Security Researching GPS Disruptions, Solutions	Inside GNSS News, Homeland Security Researching GPS Disruptions, Solutions, Latest News, Dee Ann Divis http://insidegnss.com/homeland-security-researchinggps-disruptions-solutions/	June 10, 2014
[RD11]	Critical Infrastructure Vulnerabilities to GPS Disruptions	Critical Infrastructure Vulnerabilities to GPS Disruptions Sarah Mahmood, Program Manager, Resilient Systems Division Homeland Security Advanced Research Projects Agency Science & Technology Directorate	4 June 2014
[RD12]	GPS disruptions effort to assess risks to critical infrastructure and coordinate agency actions should be enhanced	"GPS disruptions effort to assess risks to critical infrastructure and coordinate agency actions should be enhanced", GAO-14-15	November 2013
[RD13]	Consultation with Mr Jiri Luhan	Consultation report with Mr Jiri Luhan	February 2012
[RD14]	Consultation with Mr Gilles Boime	Consultation report with Mr Gilles Boime (Spectracom)	February 2012
[RD15]	Consultation with Mr Pedro Estrela	Consultation report with Mr Pedro Estrela (IMC Financial Markets)	February 2012
[RD16]	GSA-MKD-TS-UREQ233690	Report on Time & Synchronisation User Needs and Requirements	November 2017

Id.	Reference	Title	Date
[RD17]	GSA-MKD-T-SMOM-246199	User Consultation Platform 2018 – Minutes of Meeting of the Timing and Synchronisation Pane	03.12.2018
[RD18]	MIFID2/RTS25	COMMISSION DELEGATED REGULATION supplementing Directive 2014/65/EU of the European Parliament and of the Council with regard to regulatory technical standards for the level of accuracy of business clocks	07.06.2016
[RD19]	Market report 7	EUSPA EO and GNSS Market Report 2022 issue 1	January 2022
[RD20]	Parametric Insurance: Shaping the Future of Public Sector Resilience with Data and Technology	Parametric Insurance: Shaping the Future of Public Sector Resilience with Data and Technology, Serena Sowers and Aaraon Michel, https://riskcenter.wharton.upenn.edu/lab-notes/parametricinsurance/	June 8 2022
[RD21]	Routes to Market Report: 18 - Satellite Technologies for Insurance Services	Routes to Market Report 18 - Satellite Technologies for Insurance Services, Innovate UK and Catapult Catellite Applicaoints. https://sa.catapult.org.uk/wp-content/uploads/2018/12/18-Insurance-Services1.pdf	
[RD22]	A new value chain with Parametric insurance	A new value chain with Parametric insurance, Parsec accelerator, https://parsec-accelerator.eu/insight/a-new-value-chain-with-parametric-insurance/	
[RD23]	How Satellite Data is Bringing Value to Commodity Trading	How Satellite Data is Bringing Value to Commodity Trading, Aleks Buczkowski, GeoAwsome, https://geoawesomeness.com/eo-hub/how-satellite-data-is-bringing-value-to-commodity-trading/	15 July, 2022
[RD24]	Financial Services Matures as a Market for Satellite Imagery	Financial Services Matures as a Market for Satellite Imagery, Shaun Waterman, Via Satellite, https://interactive.satellitetoday.com/via/may-2021/financial-services-matures-as-a-market-for-satellite-imagery/	May 2021
[RD25]	Climate Models in a Catastrophe Modelling Context: Opportunities and Challenges	Climate Models in a Catastrophe Modelling Context: Opportunities and Challenges, Dijkstra H., Dodov, B., Verisk, https://www.air-worldwide.com/publications/air-currents/2020/climate-models-in-a-catastrophe-modeling-context/	16 December 2020
[RD26]	Spatial Finance: Challenges and Opportunities in a Changing World	Spatial Finance: Challenges and Opportunities in a Changing World, Patterson David J. et al, International Bank for Reconstruction and Development / The World Bank,	2020
[RD27]	Earth Observation data: A new frontier	Earth Observation data: A new frontier, Global Reinsurance	15 June 2022
[RD28]	Parametric & climate-adapted cat models are trends for 2022: CoreLogic	Parametric & climate-adapted cat models are trends for 2022: CoreLogic, Matt Sheehan, Reinsurance News, https://www.reinsurancene.ws/parametrics-climate-adapted-cat-models-are-trends-for-2022-corelogic/	31 January 2022

Id.	Reference	Title	Date
[RD29]	Report on Time & Synchronisation user needs and requirements	Report on Time & Synchronisation user needs and requirements – Outcome of the EUSPA user consultation platform Issue 3.0	01/07/2019 (revised 01/09/2021)
[RD30]	Earth Observation to Mitigate Impacts of Climate Change and Support Sustainable Business Decisions	Earth Observation to Mitigate Impacts of Climate Change and Support Sustainable Business Decisions, Nicolai Holzer, L3Harris https://www.l3harrisgeospatial.com/Learn/Whitepapers/Whitepaper-Detail/ArtMID/17811/ArticleID/24134/Earth-Observation-to-Mitigate-Impacts-of-Climate-Change-and-Support-Sustainable-Business-Decisions	
[RD31]	Why ESG reporting & geospatial data go hand in hand	Why ESG reporting & geospatial data go hand in hand, Picterra, https://picterra.ch/blog/esg-reporting-with-geospatial-intelligence/	19th May 2022
[RD32]	Space and the new ESG business climate	Space and the new ESG business climate, Jason Rainbow, SpaceNews, https://spacenews.com/space-and-the-new-esg-business-climate/	April 28, 2021
[RD33]	Earth observation from space: Monitoring supply chains and deforestation	Earth observation from space: Monitoring supply chains and deforestation, Investmentmonitor, https://www.investmentmonitor.ai/sponsored/earth-observation-from-space-monitoring-supply-chains-and-deforestation/	29 November, 2022
[RD34]	NA	GSA Market Development internal analysis	2020
[RD35]	2021 ESG report	Environmental, social and governance (ESG) report, https://resources.maxar.com/corporate-reports/2021-esg-report	2021
[RD36]	Environmental risks in the prudential framework	Environmental risks in the prudential framework, KPMG, https://kpmg.com/be/en/home/insights/2022/07/ba-environmental-risks-in-the-prudential-framework.html	2022
[RD37]	Application of Earth Observation in Parametric Insurance instruments	Application of Earth Observation in Parametric Insurance Instruments for Risk Financing and Climate Resilience in Support of the 2030 Development Agenda, Young, S. R.	2018
[RD38]	EO against insurance fraud	Satellites versus scammers – modern ways to fight insurance fraud, Earth-I. https://earthi.space/blog/satellite-insurance-fraud/	/
[RD39]	Earth Observation Responses to Geo-information Market Drivers	Earth Observation Responses to Geo-information Mzarket Drivers, AON. https://www.indexinsuranceforum.org/sites/default/files/Earth%20Observation%20-%20Index%20Insurance%20Products.pdf	2012

EUSPA Mission Statement

The mission of the European Union Agency for the Space Programme (EUSPA) is defined by the EU Space Programme Regulation. EUSPA's mission is to be the user-oriented operational Agency of the EU Space Programme, contributing to sustainable growth, security and safety of the European Union.

Its goal is to:

- Provide long-term, state-of-the-art safe and secure Galileo and EGNOS positioning, navigation and timing services and cost-effective satellite communications services for GOVSATCOM, whilst ensuring service continuity and robustness;
- Communicate, promote, and develop the market for data, information and services offered by Galileo, EGNOS, Copernicus and GOVSATCOM;
- Provide space-based tools and services to enhance the safety of the Union and its Member States. In particular, to support PRS usage across the EU;
- Implement and monitor the security of the EU Space Programme and to assist in and be the reference for the use of the secured services, enhancing the security of the Union and its Member States;
- Contribute to fostering a competitive European industry for Galileo, EGNOS, and GOVSATCOM, reinforcing the autonomy, including technological autonomy, of the Union and its Member States;
- Contribute to maximising the socio-economic benefits of the EU Space Programme by fostering the development of a competitive and innovative downstream industry for Galileo, EGNOS, and Copernicus, leveraging also Horizon Europe, other EU funding mechanisms and innovative procurement mechanisms;
- Contribute to fostering the development of a wider European space ecosystem, with a particular focus on innovation, entrepreneurship and start-ups, and reinforcing know-how in Member States and Union regions.
- As of July 2023, EUSPA will take the responsibility for the Programme's Space Surveillance Tracking Front Desk operations service.

The European Union Agency for the Space Programme: linking space to user needs.

www.euspa.europa.eu

@EU4Space
EU4Space
EUSPA
@space4eu
EUSPA
@EUSPA@social.network.europa.eu

#EUSpace