Routes to Market Report

18 - Satellite Technologies for Insurance Services

Innovate UK

CATAPULT Satellite Applications

Contents

1. Introduction and Scope

Insurance is a risk transfer mechanism that protects people and businesses against the risk of unforeseeable events. It ensures full or partial financial compensation for loss or damage caused by event(s) beyond the control of the insured party, by pooling funds enabling the losses of a few to be paid for by the many.

There are up to five parties (policyholder, insurance broker, primary insurer, reinsurance broker and reinsurer) and two principle transactions involved in the risk transfer process.

Underwriters are employed by insurance companies to evaluate risks. They use algorithms and actuarial data to determine the likelihood and magnitude of claims made over the life of each potential policy to help decide the price of premiums. Risks vary between **idiosyncratic risk,** where an individual's exposure does not concur with that of its neighbours and covariate or **systemic risk** where a single shock affects neighbouring individuals at the same time[1].

For complicated risks that could lead to a large exposure, elaborate risk models are used which include many sources of data including space-derived data such as Earth Observation imagery and vehicle telematics. Reinsurance, known as 'Insurance for insurers,' is often used by insurance companies to cover themselves against these large, mostly systemic risks. When an insurance company takes up a reinsurance policy, it becomes known as the 'prime insurer'.

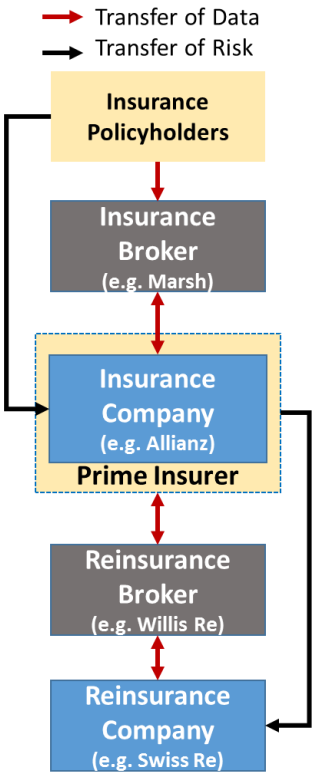

Figure 1: Generalised flow of data and Risk in PC insurance

The activities of insurers and reinsurers are largely the same, differing only in their customer base. Reinsurance policyholders are insurance companies, and insurance policyholders can be either individuals or enterprises. The two will be collectively referred to as **(re)insurers** for the remainder of this briefing.

The activities of (re)insurers can be segmented into **Life & Health (LH)** and **Property & Casualty (PC)** insurance. Although some companies have operations in both, most specialize in one of them.

(Re)insurance brokerage services are mostly associated with PC insurance. **Brokers** negotiate, and sell insurance policies, acting as intermediary between (re)insurers and their policyholders. However, **an important role of brokers is to help insurers to assess the types of risks they face** e.g. natural hazards such as bad weather, hurricanes, tornadoes, fires, and floods. Many brokers also offer related services to their customers such as Marsh who offers risk management, risk consulting & alternative risk financing services.

[1] MDPI, The Potential and Uptake of Remote Sensing in Insurance: A Review, 2014

To help with the evaluation of risks and the assessment of damage after an accident, insurers use a variety of data and services, including many derived from space. Space services to the insurance industry come under three applications:

1. Earth Observation Data
2. GNSS Data
3. Satellite Communications

This briefing will analyse the global opportunities around the application of the above space services to the insurance sector and therefore will **only be considering specific business lines within PC insurance**. Life insurance is not considered in this report, although may be relevant in the future for personal tracking.

The PC insurance value chain below shows the key activities undertaken by PC insurers. Those outlined in red can be directly impacted by the satellite-based applications described above. PC insurance is officially segmented (in order of size by premium revenue) into **motor, property,** general liability, accident and 'other'. The 'other' category consists of many specialist insurance products such as **Inland Marine, Ocean Marine, Crop & livestock**.

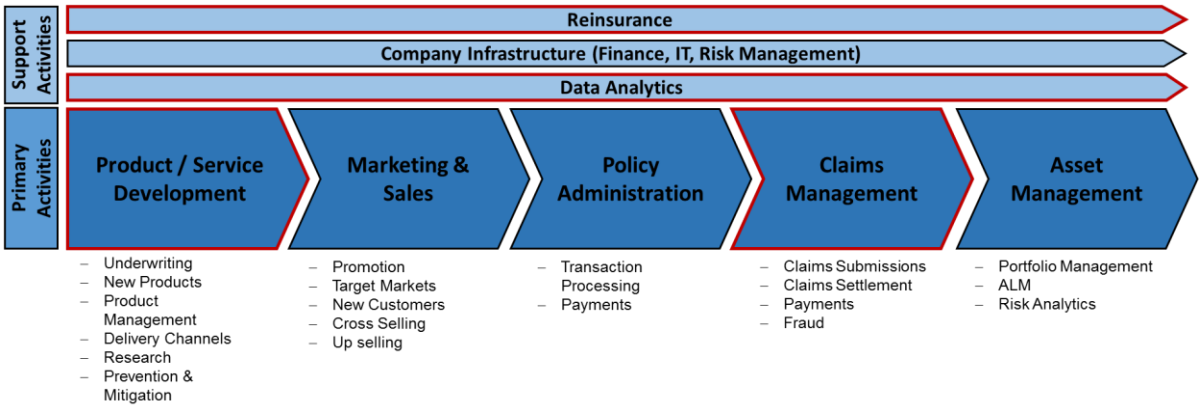

Figure 2: PC Insurance Value Chain

2. Market Overview and Opportunities

2.1. Overview of Earth Observation in Insurance

Depending on the companies, up to 20% of the (re)insurers activity is directly related to observing the environment of the insured products[2], and so links directly to Earth Observation. The use of EO in the industry is mostly related to catastrophe, where imagery analytics can provide valuable information to help evaluate potential risks, assess damage after a catastrophic event and develop specific products that allow monitoring of insured areas.

Its use can therefore be segmented into 3 categories, mostly used in **property** (which includes private and commercial property) and **agricultural insurance**:

1) Catastrophe/Risk Modelling
2) Event Loss Assessment
3) Index/Parametric insurance products.

Catastrophe/Risk Modelling

Risk modelling (or catastrophe modelling) is the process of building a probabilistic model estimating the likelihood and severity of a loss. It is an upstream process in the insurance value chain, used by insurers in support of underwriting, premium pricing and portfolio management.

The key element is the determination of the probable maximum loss (PML) that could arise from a natural catastrophe. The insured, the insurer and the reinsurer use tools to determine accurately their accumulated PML combining hazard, exposure, vulnerability and financial models. Today, models of varying sophistication are available to estimate PMLs[3]. These include:

1) Deterministic PML – a 'what if' loss estimate designed to analyse what loss an insured or insurer could incur should a specific historic event occur again today.
2) Probabilistic PML - an estimation of the accumulated losses from events that potentially may occur.

Modelling is either managed internally, through professional associations such as the Oasis Loss Modelling Framework (UK), or outsourced to specialized third-party companies[2]. Three prominent risk modellers used in the industry today are R**isk Management Solutions (RMS), AIR Worldwide (a Verisk Analytics company) and CoreLogic**. All model a large variety of risks such as Agriculture, Flood, Earthquake, Terrorism, Wildfire, Marine and Energy & Windstorm.

(Re)insurers use many different types and sources of data within the risk models, depending on the risk and information required. These can be:

- Weather history and forecasts from metrological agencies (e.g. MET Office)
- Seismographic Data from Geological agencies (e.g. US Geological Survey)
- Wind Data (for storms and hurricanes) from relevant agencies such as NOAA

[2] The Copernicus Downstream Sector and User Benefits, PwC, October 2016 (SatApps Contributed)
[3] Earth Observation Responses to Geo-information Market Drivers – Insurance Sector Summary Report

The current use of satellite imagery in risk models is limited to those caused by natural hazards, and even with these risks there is much variation on the amount of EO data used. For some companies, such as Willis Re, EO is commonly used to build the models and it represents a major source of data for this activity (70% of the data used by Willis Re is satellite data). AXA only uses EO as a complimentary source to traditional data sources, while other companies do not exploit satellite images at all[2].

Event Loss Assessment

In the traditional claim-based insurance model, Event loss assessment involves comparing the loss claimed by the policyholder with the actual damages that have occurred to determine the value of indemnities to be paid. EO imagery is used in two ways:

1) Damages can be assessed remotely in the case where a loss is visible from space and does not need in-field verification. This is only in the case of large-scale, covariate risks being realized such as natural hazards / catastrophes e.g. large flooded areas or areas effected by fire.
2) Resources for in-field assessment can be optimised (with respect to where to assess first etc.) using low-resolution imagery.

However, for both use cases for EO imagery in event loss assessment (total or partial loss assessment), getting access to the imagery very soon after the catastrophe has occurred is critical. For a reinsurance company, its often about having an overall loss estimate, and in that situation, it is necessary to be very quick. For the example of a flood, a footprint needs to be available ideally within a few hours but no more than one or two days after an event.

For both Loss assessment and risk modelling, the extent to which EO is used varies greatly between companies. This is mostly due to:

1) The cost of EO data
2) The availability of EO data
3) The specialist skills required to analyse EO data.
4) Lack of understanding of the benefits of EO imagery and what is available

Parametric Insurance

Parametric insurance is a relatively new but innovative approach to insurance provision that pays out indemnities based on a predetermined index for losses resulting from measurable events e.g. storms, earthquakes, crop damage, low production levels, too much/little rain and extreme temperatures. It is most commonly used in emerging markets or vulnerable regions where traditional claims-based insurance is unfeasible.

Parametric insurance products rely on models which compute an index containing variables that relate to specific possible losses to the policyholder. Policyholders receive payments once the index has surpassed a threshold value, which is **calculated to correlate as accurately as possible with the actual loss suffered by the policyholder.** In this way, the need for individual claims and in-field vent loss

assessment is eliminated, allowing the settlement processes to be quicker and more objective, but more importantly allowing previously uninsurable risks to be insured[4,5].

Most parametric products use a combination of:

- Weather data from in-situ sensors,
- Crop-yield data,
- Satellite data products such as NDVI & soil moisture
- Seismic data.

Although a relatively recent instrument (<15 years old), parametric insurance products are used by both insurance companies and government entities (as part of a disaster resilience framework for infrastructure and agriculture) in a large variety of insurance sectors including both commercial and private **property** and **agriculture** in areas with high exposure to extreme events. For example:

Property

- Used for large corporations that are subject to complex business interruption exposures. E.g. Swiss Re has developed a commercial property earthquake cover based on the measured seismic intensity. Pay-out is ensured within 30 days of the earthquake and there is a step-up payment scale (from 0% for magnitude 5.5 or less to 100% for 6.1 or greater).
- The **Caribbean Catastrophe Risk Insurance Facility (CCRIF)** paid out $29.2M to member countries[6] on their parametric policies for claims arising from hurricane Matthew. These claims were paid out within 14 days of the hurricane.

Agriculture:

- The **African Risk Capacity (ARC)** is a continental sovereign insurance pool jointly developed by the African Union Commission and UN World Food Programme utilising three satellite-based rainfall datasets to insure crops against losses caused by drought.

Satellite data is imperative to agricultural insurance products in developing countries because of the lack of geo-climatic information in the region and historical datasets. Therefore, building a model to estimate crop growth/loss due to weather isn't possible using only ground sensors and crop-yield data, and requires expansive EO datasets of environmental information[7]. Hybrid index products are proving the best designs and rely on a combination of all datasets available. Swiss Re is the leader in commercial parametric products – with 2% of its European revenues derived from parametric products and march larger percentages in emerging markets - 80% in India which is a high growth market.

[4] Index Insurance – FAQs – International Finance Corporation, World Bank Group (http://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/industries/financial+markets/retail+finance/insurance/index+insurance+-+frequently+asked+questions)

[5] Weather Index-based Insurance in Agricultural Development - A Technical Guide, International Fund for Agricultural Development (IFAD), November *2011*

[6] Barbados, Haiti, Saint Lucia & St. Vincent and the Grenadines)

[7] Insurance Data Providers - International Finance Corporation (http://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/industries/financial+markets/retail+finance/insurance/data+providers)

2.2. Overview of GNSS and Satcoms in Insurance

The Internet of Things is forecasted to be pervasive by 2025, with connected "things" driving a data explosion with sensors embedded in industry, cars, buildings, and wearable devices[8]. IoT will change what businesses and consumers know about their environment and activities, and how they interact with insurers, leading to a **data-driven insurance market**. This is forecasted to have a significant impact on PC insurers by 2025. The most impactful data streams and sources from IoT are likely to include[9]:

1) Wearable or Personal Technology
2) **Sensors on objects -** Personal and commercial vehicles and shipping containers, measuring distance travelled, speed and frequency and level of braking
3) **Location-based sensors –** In factories, warehouses, offices and homes – smart thermostats, alarms and cameras, and industrial control systems
4) **Other GIS -** Providing geophysical, topographical, climatological and hydrological data

The most common current use of GNSS and IoT in insurance is **usage-based insurance** (UBI) and pay-as-you-go models. These are mostly related to **insurance telematics** - products based on telematics devices ('black boxes') relying on GNSS data to tell insurers how often, where and how people drive to enable them to offer customised car insurance premiums. EY estimates that UBI policies will reach 15% market penetration by 2020 in Europe, Asia and the Americas. As embedded car connectivity become more common, black boxes will no longer need to be installed, but UBI can be enabled through sharing data the car is already collecting with your insurance providers. This information could be streamed in real-time to a central location.

Advanced Driver Assistance Systems (ADAS) technologies such as assisted and automated driving are growing and this move toward autonomy is creating questions regarding the continued relevance of current insurance products and value chains. Current thinking is that future policies are likely to hold vehicles and manufacturers liable for accidents, which suggests the suppliers of the underlying technology will also come under scrutiny in the event of a technology failure leading to a claim. In June 2016, specialist car insurance provider Adrian Flux became the first UK company to offer a dedicated policy for autonomous cars.

Regarding **property insurance**, the connected home or the connected office could enable insurers to warn policyholders in the case of a fault before it becomes too damaging. For example, wall-mounted flood sensors in the home connected via the internet of things will enable floods to be detected early and policyholders informed if they are not at home.

Most of the specific IoT insurance initiatives discussed today are consumer focused, looking at personal risk (telematics, home insurance, health insurance etc.). These IoT applications are expected to be mostly brought to market through terrestrial M2M/IoT services, primarily due to cost. However, devices generally need to operate both indoors and outdoors, and without both the value added from adding IoT capabilities is significantly reduced. A dual-mode IoT service could be employed, but this

[8] The Internet of Things: Opportunity for Insurers, AT Kearney 2014
[9] The Internet of Things in Insurance, EY 2016

would increase the cost of devices potentially above what the target customers would be willing to pay.

Consequently, satellite based IoT services are expected to only be offered in areas where terrestrial network coverage is lacking or for services where a drop in connectivity would greatly reduce its value. This applies to some home appliance type products such as smart TVs, thermostats and risk sensors.

However, the most value can be derived from commercial and industrial insurance applications, where premiums are largest due to complicated risks and IoT data would provide the most value to insurers. According to Frost and Sullivan, maritime and land-based shipping and logistics as well as Oil and Gas are key high-medium growth markets for satellite-based IoT. Applications are standard across these markets, with IoT solutions used for asset tracking, fleet management and asset/equipment monitoring. These applications would provide useful information to the insurance sector.

2.3. Market Opportunity 1 – Shared Risk & Exposure Data Platform

With competition across the industry high, insurance companies who utilise EO data currently work in isolation to procure and process the data themselves, often from different sources to create incremental improvements to their products and services.

However, the cost and availability of relevant data is often prohibitive to its use. Both Aon and Willis agree that Cooperation between insurance firms is needed to lower these barriers. The sector has indicated they would support a pre-competitive data platform in return for lower costs and easier access to EO. 'marketplace' for EO imagery and sensor data products accessible across the industry. This would include multiple types of imagery (Optical, Radar, Satellite-Derived Bathymetry) aggregated from various commercial and public providers, giving access to standardised base-line imagery products tailored for the sector.

1) Raw data would be acquired and undergo a first level of processing, providing access to imagery in a more usable format for non EO-experts.
2) There are a number of standardised products such as Normalised Difference Vegetation Index (NDVI) & flood extent which could immediately provide value across the industry for common applications such as flood and fire. These would be developed on the platform for direct use by (re)insurance companies.
3) Value-added datasets would also be included such as **weather** (rainfall, hail and frost), **environmental** (soil moisture, pollution levels) and **population location** data (from census information). This would encourage the use of this platform by VAS companies who can develop more specialised products for specific insurance applications.

Examples of specific use-cases of this platform:

1) **Urban flood extent –** Access to imagery from a variety of sources quicker and more efficiently for regional scale loss assessment after urban floods. Could be merged with ground-sensor data to better characterise peak flood.
2) **Parametric Insurance products –** Parametric insurance products are only feasible if there is a strong correlation between reality (actual loss experienced by the policyholders), and the models that calculate the thresholds. Long history of archive data needed for models and

current data (e.g. Copernicus and other data as it becomes available) used in combination with in-situ sensors for near real-time monitoring.

3) **Large Scale Coastal Infrastructure Development Risk –** utilising satellite-based bathymetry, and change detection of coastal areas using SAR and optical imagery to better understand the risks around large coastal infrastructure developments.
4) Location and number of infrastructure assets – Machine learning and Artificial Intelligence using EO data.
5) **Forest fire risk models –** to better understand the environment that leads to a forest fire and more accurately predict the risk to the forest industry and their assets.
6) **Ground subsidence related to mining and climate change–** There have been many claims that UK mining activities have caused damage to local communities' buildings via subsidence.

2.4. Market Opportunity 2 – Insured Asset IoT Data Platform

IoT sensor networks will produce streams of data which could be made available in near real-time directly to insurers allowing them to understand their risks better. Although personal risks have received much attention (health, motor & home), the largest opportunities over the next 10 years for insurance will lie in industrial & commercial risks, where IoT is being quickly exploited, risks are complex and premiums are high. The key industrial/commercial applications identified for Satellite-based IoT applicable to the insurance sector are related to asset and Infrastructure Monitoring:

- Shipping & **Logistics** – (Maritime and Land-based)
- Monitoring **Pipelines** - Oil and Gas Industry
- Monitoring **Reservoir dams** – Water Industry
- Monitoring **Tailing dams** – Mining Industry

For these applications, sensors can be used to monitor things such as movement of pipelines and dams, temperature, flow and quality of water, movement of ships and trucks as well as changes in the flow of gas in pipelines. They are also particularly relevant to Satellite-based IoT as the assets are often in remote locations with less access to adequate terrestrial-based networks. There are companies developing these sensors to monitor specific variables. However, insurance companies do not want to interact with many different platforms but instead require a complete overview of the system requiring large amounts of data produced in a way that is standardised and can be easily understood.

The opportunity would be to develop an IoT platform for use by (re)insurers that fuses data from their insured assets above in near real time and develops tailored products in a form that can be integrated with (re)insurers' current activities. This would be an end-to-end system (if necessary, sensors developed that work in conjunction with the platform), but would be sensor agnostic and so compatible with the many sensors currently offered (or in development) by remote monitoring companies.

2.5. Market Opportunity 3 – Property Monitoring with IoT Sensors

Insurance companies want improved situational awareness of the health and status of their assets. Smart sensors in the home/property connected to insurers via the internet will provide quicker, more granular information about the state of insurers' exposure in near real-time, e.g. the number of houses

in an area flooded due to an extreme weather event, or the exact moment when a home develops a leak. Following the trend right across the insurance industry, these smart home devices will allow insurers to warn policyholders of impending dangers, causing a shift toward loss prevention services rather than risk assessment services.

According to Frost and Sullivan, connectivity remains a low-value component of the IoT value chain on a per-connection basis. Profitability, therefore, depends on network service providers' ability to **drive volume deployments, and deliver vertical-specific and end-to-end solutions[10].** There is an opportunity for the space community to develop **low power, low cost, easily deployable sensors** for property/home use outside urban areas (homes, farms, commercial properties). Sensors offering 'protective' services such as those sensing gas, humidity, termites, structural movements/deformation and rodents would be particularly suited to satellite solutions. These would then be integrated into an end to end IoT system tailored for insurers' needs.

Many smart-home sensors do exist; however, they are often expensive and are not tailored to the needs of the insurance sector. For wide spread use scalability is key and so cost, power and size are important factors. The ability to use these sensors in all locations will require seamless integration of satcoms with WIFI/LoRaWAN technologies.

[10] European IoT Operator Profiles Part 1, Frost and Sullivan November 2016

Table 1: Summary of Key Insurance Market Opportunities

ID	Sector	Need	Opportunity	Potential Users	Market Size (Global, 2020)
1	All	**Shared Risk & Exposure Data Platform:** Centralised access to EO imagery and associated information products tailored for the insurance industry. Datasets to be included: - Optical Imagery - Radar Imagery (SAR) - Satellite-Derived bathymetry	- Development of a platform giving access to standardised base-line imagery and insurance specific formation products	- (Re)insurers - Risk Modellers - Geospatial companies - UK VAS Companies - Environmental consultancies - Universities (Parametric Products)	TAM: EO Data=$88M VAS&IP=$352M ➔ $440M SAM: Data=$12.5M VAS&IP=$31.5M ➔ $44M
2	Property, Marine, Infrastructure	**Insured Asset IoT Data Platform** - Asset/infrastructure monitoring solutions for insurance related to Oil & Gas, Mining and logistics industry.	- Development of a platform aggregating IoT data from multiple sources in real time into a tailored dashboard for use by insurance companies.	- (Re)insurers - Risk Modellers - UK VAS Companies	TAM: IoT Sat.Tech = $160M IoT insurance Platform=$640M ➔ $800M SAM: IoT Sat. Tech=$100M IoT Platform=$30M ➔ $130M
3	Property	**IoT Sensors for Flood, Fire & Intrusion** - Low power, low cost, easy deployment sensor network providing situational awareness of damage to their policyholders' property.	- Develop end to end IoT demonstration service including space-enabled IoT sensors for flood, fire, gas or intrusion detection in and around remote personal and commercial property.	- Consumers - (Re)insurers	TAM: ➔ IoT Sat.Tech = $160M SAM: ➔ IoT Sat.Tech = $8M

3. Customer and value proposition to the customer and end user

3.1. EO Customer and Value Proposition

There are many customers of EO data feeding into the insurance sector:

1) Catastrophe risk modellers - RMS, AIR worldwide and CoreLogic (EQECAT)
2) Value-added Resellers and Consultants developing specialist products such as vulnerability maps etc. – JBA, HR Wallingford
3) (Re)insurance companies
4) (Re)insurance brokers

EO is used by these actors to varying degrees. If a neutral service providing tailored, standardised base-line imagery products existed, the entire insurance industry would be a potential customer, but this would depend on the products offered. **Both VAR companies and reinsurers represent the larger customer base compared with insurers as the activities of reinsurance companies are more focused on catastrophe risks than those of prime insurers.**

- For risk modelling purposes, better access to archive EO imagery in risk models will enable more tailored pricing of premiums. Although an incremental rather than a disruptive application, insurers are asking for this capability. In a highly competitive industry incremental improvements lead to competitive advantages particularly then it comes to premium pricing. The challenge here is to 'discover' relevant archive data and this is where analytics such as machine vision can be applied.
- For event loss assessment, the value of EO imagery is greater than in risk modelling. A quick, efficient and accurate loss assessment phase speeds up the claims process, improving customer relations and ensuring policyholders are not over or underpaid. It also reduces the large costs associated with fraudulent claims. **(Re)insurers are very interested in better access to imagery for loss assessment, particularly in relation to flood extent and peak flooding in urban areas. RMS are also increasingly concerned about drought.**
- The invention of parametric insurance in the last decade has allowed previously uninsurable risks to be insured, giving insurers access to new markets. This is particularly true for emerging markets. There are very specific needs from insurers for the creation of parametric products and they rely on the availability of continuously monitored parameters which are often space-derived such as weather, biomass and soil-moisture. In addition, new indexes are continuously being developed allowing more accurate and realistic products to be offered to existing and new markets.

Figure 3 shows the value chain of EO data products within the industry. Imagery is currently sold either to Value-Added Service providers or directly to (re)insurers and/or (re)insurance brokers.

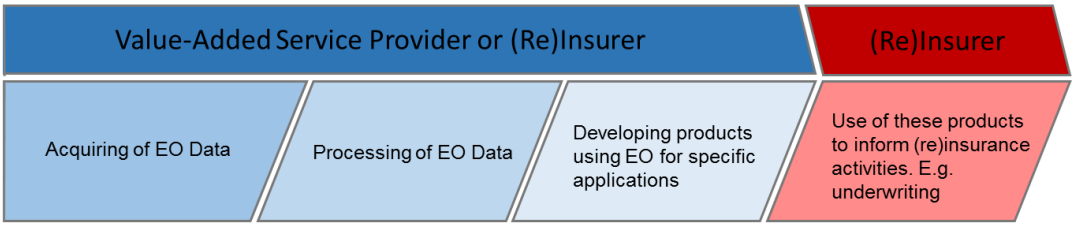

Figure 3: EO data value chain in the insurance industry. Source: PwC and Satellite Applications Catapult

The manipulation and processing of EO data requires technical expertise and training which are often only available in-house in larger (re)insurance companies[2] (Munich Re, Swiss Re, Willis Re, AXA…). **Even though larger (re)insurers do have in-house EO capabilities, this is only due to the lack of alternatives and they would much rather buy dedicated software tools allowing them to exploit the analysis of EO data as an input to their core activities rather than manipulate the data themselves.**
Often, VAS companies such as (name) either buy the data and make it available to (re)insurers for a fee on data processing platforms, or they compute specific insurance products using the data such as indexes and risk models, and sell these to (re)insurers and their brokers. Therefore, although larger (re)insurance companies represent a strong customer base for EO products, VAS companies, particularly catastrophe modellers represent an easier customer as they already have the strong expertise in processing multiple datasets for (re)insurance customers.

3.2. GNSS and Satcoms Value Proposition and Customer

The value of the 'connected world' for insurers is in the creation of new information and insights that were previously unattainable. Insurance is about the use of information to price customer risk and so the more knowledge known about a customer, the better the risk of loss is understood leading to more tailored and accurately priced premiums. There a two main value propositions of satcoms compared with terrestrial solutions when used for connectivity related services: **The global, ubiquitous nature of satellite connectivity and the increased security of satellite solutions**.
UBI models and the connected vehicle are currently connected via terrestrial systems (2G, 3G, 4G), which face issues in terms of speed, coverage, and security. 5G is predicted to be commercialized by 2021 to combat this, however it will need to be integrated with satellite communications to enable seamless communications independent of location. Satellite connectivity also offers a consolidated distribution opportunity that reduces cyber-attack vectors by eight or nine orders of magnitude when compared to terrestrial systems in terms of entry and exit points, demonstrating the security benefits that satellite delivers - a major requirement for the future of the connected car[11]. In February 2016, Toyota partnered with Kymeta (antenna company) and showcased a research vehicle prototype that toured America for a month across cities, towns, and rural areas, covering about 15,000 miles using satellite communication,[12] specifically showcasing the increased security compared to cellular solutions.

[11] Interview with Mohammad Marashi, VP Innovation and Service Architecture at Intelsat – wireless Design Mag
[12] Frost & Sullivan – Disruptive Satcoms in the automotive industry, 2016

4. Market Competition

4.1. EO and GIS Platforms

Data from airborne sensors (UAS, Aircraft & Helicopters) can be competition to very high-resolution satellite imagery, providing very useful data for small area surveys (very local applications). However, these systems do not provide the revisit time and consistency of acquisition of satellite systems. This source of data is also complementary to medium and high-resolution satellite data for large areas and is often used to calibrate the imagery.

The EO downstream market is more and more dependent on the Geographic Information System (GIS) market, which enables users to create dynamic relations between spatial geo-referenced data and situational/relational data based on the specific need of the users such as internal statistic or in-situ data. The combination of these types of data brings a large value-added, linking imagery to a multitude of complementary other sources of data[13].

The companies mentioned below are offering an intelligence platform to develop specific satellite imagery applications or maps. Ready to use APIs are often available as well. Some of the key differentiating properties are listed for each platform.

DigitalGlobe – GBDX platform

- Vast & historic imagery database feed into technical developer platform
- Options to import own algorithms or use built in algorithms, developed both in-house and by 3rd party developers
- Partnership with Esri to connect with ArcGIS user base
- Platform used by Orbital insights and SpaceKnow

Airbus - OneAtlas

- Worldwide layer resolution down to 1.5m, refreshed once a year. Accessible via API and GoogleCloud.
- 3000 cities in THR (50cm)
- OneStack product available in 2017 with temporal time-series.

Hexagon – Smartm.Apps

- Cloud based geospatial platform
- Developers can design, build, and publish their own Hexagon Smart M.Apps
- 'Smart M.Apps exchange' acts as app store where developers offer their products under subscription based payment model
- Content partnership with Airbus DS

Esri – ArcGIS

- Open GIS platform, open data, open source software, etc.
- Platform available on different devices
- Ready to use apps and maps
- Partnership with DigitalGlobe on content + connect ArcGIS with GBDX to allow ArcGIS users to perform deeper analysis

Pitney Bowes (MapInfo)

[13] The Copernicus Downstream Sector and User Benefits, PwC, October 2016 (Satellite Applications Catapult Contributed)

- Desktop GIS mapping application
- Easily combine data, analytics and base maps
- UI like well-established applications for ease of use.
- Compatible with most PC data formats for ease of integration with existing IT systems

Mapbox

- Open source mapping platform to develop own maps on different operating systems
- User friendly platform with monthly subscription models
- Ready to use maps and API's
- Partnership with DigitalGlobe, providing its 'Maps API' section

Urthecast

- Earth-imaging system (APIs and developer tools) for geospatial analysis
- Own constellation with future SAR-optical constellation providing cloud-free image products every day, multiple times a day
- Full colour, 60 sec. video from space

Planet

- Platform with APIs and browser-based tools to quickly find and extract information
- Own constellation providing near-real-time data
- Openly licensed commercial datasets for analysts, scientists, developers and researchers to analyse and develop applications

TerraBella (acquired by Planet)

- Growing, own constellation of rapid response, high resolution colour and near-infrared satellites
- Searching for patterns to extract information using deep learning, geospatial and web information streams
- Continuous, real-time videos from space in the future

Sentinel Hub

- Overall winner of Copernicus Masters and T-Systems Open Telekom Cloud Challenge
- Sentinel data available for GIS applications and value adding services in an easy and cost-efficient way, using Amazon Web Services (AWS) cloud technology
- Use of open data sources (commercial imagery will be included in the future)

A shared risk and exposure platform for the insurance industry would be a GIS platform, not only hosting satellite imagery but would combine this with available airborne imagery and eventually data from in-situ sensors.

4.2. IoT Platforms

There are several standardised IoT platforms built as a 'one size fits all' from large enterprises. The IoT parts of Amazon Web Service, IBM Watson and Microsoft Azure fall into this category. There are several UK companies that have developed more comprehensive, end-to-end market-specific platforms to help IoT application developers and service providers quickly get to market. Examples include[14]:

[14] An Introduction to IoT Platforms, IoT UK, March 2017

1. **Nquiringminds -** Open City Data Platform (formerly UbiApps)
2. **AlertMe** - Interoperability platform for connected home energy devices acquired by British Gas in 2015 for £44m. This underpins British Gas's emerging IoT services, which include its smart meter programme and the Hive intelligent thermostat business
3. **BrainDrain Solutions** - Alfred Smart Home platform and service
4. **EVRYTHNG** - Focuses on retail, logistics and manufacturing
5. **Sensye** – Focuses on the power and manufacturing sectors
6. **Nuwe** – Focuses on the wellness and healthcare market
7. **Intellisense** – Focuses on industrial wireless sensor networks, aiming to enable retrofitting of IoT connectivity and data platform capabilities to existing installations.
8. **Vodafone** – Also provides platforms for industry specific IoT deployments as well as horizontal solutions. It offers mobile asset tracking, energy data management, integrated terminals with embedded connectivity, smart grid and metering, monitoring and control of assets, usage-based insurance, and several other solutions. It uses these internally to provide its customers with a service.

As of today, there are no insurance-specific IoT platforms known to exist within the UK. However, US based company **ROC-Connect** is an IoT Smart Home as a Service (SHaaS) solutions and includes the insurance sector as a major market. They recently won the Insurance Nexus IoT Innovation Award at the IoT Insurance Europe Summit in London for their SHaaS (smart homes as a service) IoT platform and associated services. This shows that there is appetite amongst insurers for this kind of service.

5. Role of UK Companies

5.1. Role of UK Space Sector: Market Opportunity 1 – Shared Risk & Exposure Data Platform

Commercial and Public data sources would be used for data aggregation. This would include providers such as Digital Globe, Airbus, Copernicus and Landsat for optical and SAR data. Companies such as UK-Based **Proteus GEO** have a global shallow water satellite derived bathymetric (SDB) database, which could be made available through or easily integrated into the platform. (German company **EO Map** also develops an extensive SDB dataset). UK company **Bird.i** is also focused on curating raw satellite, airborne and drone imagery, which could be integrated into the platform.

Insurance companies are not EO experts and would rather buy products that enable them to draw insights for their risk models directly, without the need for involvement in processing any data themselves. Currently, UK space SMEs, geospatial companies and consultants such as **Geospatial Insights, Terrabotics, Flock, JBA and ERM** among others have difficulty providing these products due to the prohibitive cost and availability of the data. The platform would require partnership with these types of VAS companies who could develop products and machine-learning algorithms within the platform to provide a full integrated service (one-stop-shop) for risk modellers and (re)insurers to access information they require.

A neutral body representing the space sector would be required for initial development of this platform in collaboration with a neutral body also representing the insurance sector.

5.2. Role of UK Space Sector: Market Opportunity 2 – Insured Asset IoT Data Platform

IoT Platforms for insurance developed either by large enterprises (Verisk Analytics, Cisco, IBM, Accenture) or specialist companies (e.g. **Zonoff & ROC Connect**) have started to emerge but sensors are mainly from outside the UK. However, these are mostly optimised for consumer and smart-home solutions rather than industrial/commercial IoT and there is not yet an insurance-specific platform developed in the UK.

UK start-up companies such as **Dashboard Ltd** and **DexDyne** are providing IoT solutions including dashboards and platforms for remote monitoring in a variety of industries such as **Oil & Gas, Mining and Energy.** These services could feed into the platform developed and be made available directly to insurers.

5.3. Role of UK Space Sector: Market Opportunity 3 – Property Monitoring with IoT Sensors

The implementation of satcoms into IoT Sensors for insurance will require a partnership between satellite communication providers (Inmarsat, Intelsat, Viasat etc), equipment manufacturers, smart antenna technology providers and insurance companies.

The UK has key capabilities across the IoT value chain and the government has invested £32M in accelerating these capabilities[15]. In 2015 **Inmarsat** had a 12.8% share of the satellite-based IoT market[16], and in October 2016 they announced a roaming agreement with Vodafone, with the ambition to enable international satellite and cellular roaming connectivity for IoT. In February 2017, they also announced that their LoRaWAN-based network developed in partnership with **Actility** is 'delivering on its strategy to bring the IoT to every corner of the globe.'

At the moment, there is only one UK insurance provider tailored specifically to smart tech in property- **Neos[17],** who have recently announced a £1M seed funding round for their smart-home policies. Neos provides each policyholder with 8 smart sensors plus a camera and these are connected to a mobile app which alerts the user in the case of a problem. UK insurance company Aviva is partnering with many UK IoT start-ups rather than developing the technology itself, such as a partnership with leak-detection sensor **Leakbot** developed by HomeServe Labs. There are many other non-UK insurance companies integrating smart home solutions into their policies. As with Aviva, these are often in partnership with tech companies and therefore linked to current ownership of a specific device (e.g. **Statefarm** and ADT pulse, **American Family Insurance** and Ring, **AXA** and Philips hue bulbs, AXA's La Maison Connectée policy in France).

The UK has started a service called **flood.network**, providing the public with low cost sensors to put in to their local rivers and waterways, connected to the IoT via LoRaWAN networks. Work like this can be further developed and integrated with satellite communications.

[15] https://iotuk.org.uk/about-us/
[16] Global Satellite Internet of Things (IoT) Market, Forecast to 2022 – Frost & Sullivan, December 2016
[17] https://neos.co.uk/

6. Revenue Projections

Table 2: Market Opportunity Revenue Projections

	2016	2020	2030
Shared Risk & Exposure Data Platform ($M)	19.5	44	186
Insured Asset IoT Data Platform ($M)	68	130	5,341
Property Monitoring with IoT Sensors ($M)	4	8	50

6.1. How are these figures calculated?

Logic of revenue estimate, based on comparison with complimentary market, turnover of leading players, published reports etc.

6.2. Market Opportunity 1 – Shared Risk & Exposure Data Platform

Technavio predicts that the overall satellite-based EO market for insurance will grow at a CAGR of 17.5% over 2015 – 2020, reaching about USD 88 million for Europe in 2020[18]. According to NSR[19], the regional Satellite-based EO market share is NAM: 40%, LAM: 8%, Europe: 26%, MEA: 5% Asia: 21%.

Therefore, the global satellite-based EO market for insurance can be estimated as approximately worth $338M in 2020.
Assuming 30% added for the inclusion of value-added datasets into the platform.

➔ **Total Addressable Market = ~$440M**

Assuming:

1. 20% of this value is for data ($88M) and 80% for VAS & IP ($352M)[19]
2. Europe holds 26% of the market
3. Serving 40% of Europe's data needs, 5% elsewhere
4. Serving 20% of European VAS & IP market and 5% elsewhere

➔ **Serviceable Addressable Market for data (2020) = $12.5M, for VAS and IP = $31.5M – Total = $44M**

If the platform becomes an enabler of parametric insurance products, the size of the market would be much higher. Parametric Insurance products enable previously uninsured losses to be insured. According to Munich Re Geo Risks Research, uninsured losses due to natural catastrophes represent approximately 70% of overall losses each year, representing a **potential EO market of $677M** for uninsured losses (This is likely larger in developing countries). However parametric products have specific data requirements and so could be a spin-out product enabled by this platform.

CAGR 2020 – 2030 = 17.5%

6.3. Market Opportunity 2 – Insured Asset IoT Data Platform

There are a wide range of estimates for the size of the IoT market. According to General Electric, total market for IoT tech products and services (spent by corporates) will be $218bn in 2020. Market and Markets predict that the total market for IoT products and services in insurance will be approximately $16Bn[20] by 2020, therefore representing roughly 7.5% of the total IoT products and services market (from GE).

[18] Note: This only covers Optical and SAR data. Including SDB would increase the potential revenue, but these figures are currently unknown.

[19] Satellite-Based Earth Observation (EO), 7th Edition, NSR

[20] IoT insurance market by type, application and geography – global forecast to 2022' Market and Markets

Mach Nation, an IoT insight services company predicts that the IoT platform market will be worth $8.5B in 2020[21], with a CAGR of 62% in the period 2017-2025. Taking 7.5% leads to an estimated Total addressable market for IoT insurance platforms of $640M in 2020.

NSR forecasts that the total M2M/IoT via satellite market will be $2Bn in 2020. Taking 7.5% leads to an approximate market for satellite M2M/IoT technology in insurance of $160M.

- **Total Addressable Market (2020) →**
  - **IoT platforms for insurance ~ £640M**
  - **IoT via satellite technology for insurance ~ $160M**

For a sensor and platform solution specifically targeted at industrial & commercial insurance, the market will be smaller. NSR predicts that of the $2bn satellite IoT market, mining, Oil & Gas, utilities, cargo, transportation and construction represents approximately 65% equating to $1.3Bn. 7.5% of this is ~$100M globally to the space industry.

Assumptions:

1. Industrial & commercial insurance solutions represent 20% of the total IoT platform for insurance market ($128M).
2. This opportunity can capture only the European insurers market (~30%, although assets will be global).

These assumptions lead to a market value of ~ $30M in 2020.

- **Serviceable Addressable Market (2020) →**
  - **IoT via satellite tech for insurance ~ $100M**
  - **IoT platforms for insurance ~ £30M**

CAGR 2020 – 2030 = 45%

6.4. Market Opportunity 3 – Property Monitoring with IoT Sensors

NSR forecasts that the total M2M/IoT via satellite market will be $2Bn in 2020. Taking 7.5% of this figure (representing insurance share, calculated in opportunity #2) leads to a to an approximate

→ **Total Addressable Market for satellite M2M/IoT technology in insurance of $160M in 2020**.

Assuming property monitoring in remote locations is 10% of total market, and we can serve 80% of Europe's needs and 20% elsewhere:

→ **Serviceable Addressable Market (2020) = ~$6.1M**

CAGR 2020 – 2030 = 30%

[21] https://www.i-scoop.eu/internet-of-things-guide/iot-platform-market-2017-2025/

7. SWOT Analyses

7.1. Market Opportunity 1 – Shared Risk & Exposure Data Platform

Strengths	- Strong UK Insurance sector in London - Expertise in building platforms within the UK - UK has strong reputation in selling services globally - Good access to Satellite imagery through the Catapult - Good academic expertise in geospatial data analysis - Good relationships with potential export countries - Proximity to global multi-disciplinary engineering/consultancy/ professional services companies in London - Good access to Machine Learning and Artificial Intelligence expertise
Weaknesses	- World-leading risk modelling companies are non-UK (US company RMS) - UK Space sector has limited skilled resources
Opportunities	- Development of a multi-data platform giving access to standardised base-line imagery and insurance specific information products to the industry. - To unite the insurance industry and promote the use of earth observation data which is currently seen as too costly and difficult to access. - To lead the way in fostering links between the space and the insurance sector, which is a burgeoning space end-user. (Many SMEs beginning to consider insurance as a key target market).
Threats	- Global cloud computing / data companies outside the UK could develop a similar product (Google, Amazon etc.)

7.2. Market Opportunity 2 – Insured Asset IoT Data Platform

Strengths	- Strong UK Insurance sector in London - Expertise in building platforms within the UK - UK has strong reputation in selling services globally - Inmarsat (largest satellite - IoT Market Share) based in the UK - Existence of some UK SMEs with expertise in remote monitoring.
Weaknesses	- UK Space sector has limited skilled resources - Majority of global large-asset base is outside the UK
Opportunities	- Development of a platform aggregating IoT data from multiple remote assets in real time into a tailored dashboard for use by insurance companies. - Develop stronger UK expertise in insurance IoT platform market, predicted to grow at CAGR of 62% until 2025.
Threats	- Who owns the licenses for the sensor-platform interface? - Prevalence of generic IoT platforms → Global cloud computing / data companies outside the UK could develop a similar product (Google, Amazon etc.)

7.3. Market Opportunity 3 – Property Monitoring with IoT Sensors

Strengths	- Strong UK Insurance sector in London - UK has strong reputation in selling services globally
Weaknesses	- UK Space sector has limited skilled resources - Leading sensor manufactures are international, end to end services required for insurers. - Still a lack of standardisation
Opportunities	- Develop end to end IoT demonstration service including space-enabled IoT sensors for flood, fire, gas or intrusion detection in and around remote personal and commercial property. - Facilitate improved situational awareness. - Technology developed can easily be transferred (will enable) other IoT sensor types.
Threats	- High potential costs of devices compared with terrestrial sensors. - Market potential is reliant on very large CAGR forecasts which may not deliver.

8. Opportunity Blockers

Market Opportunity 1 – Shared Risk & Exposure Data Platform
- High level of capital investment required to develop the platform and purchase data
- Difficulty uniting the insurance industry to understand common needs and requirements in terms of data, software, or use-case.
- Data ownership, formats and use of algorithms.
Market Opportunity 2 – Insured Asset IoT Data Platform
- Specialist IoT solutions for remote monitoring are currently provided by several small companies. Data fusion will likely be a source of difficulty.
- Providing the data in a form that can be integrated into insurers existing models and processes
- Cost may be an issue, who pays for sensors – need cost benefit analysis
Market Opportunity 3 – Property Monitoring with IoT Sensors
- Relative cost of satellite-based solutions could make sensors unaffordable for consumers. (but with new LEO constellations, costs may reduce.)
- Sensor standards are not yet pervasive.
- Insurers may be slow to adopt.

9. Market Dynamics

The insurance market is a fragmented mature market composed of both very large (re)insurers and many smaller companies. In the UK, the industry is dominated by Aviva & AXA in the insurance domain and Lloyds of London in the reinsurance domain. The UK is particularly strong globally in (re)insurance brokerage, with 3/5 top global insurance brokers and 4/5 top global reinsurance brokers being headquartered in London.

Table 3: Top Global Insurance Industry Players

Insurers Brokers	Insurers	Reinsurance Brokers	Reinsurers
- Marsh & McLennan Cos. Inc. (US) - **Aon P.L.C. (UK)** - **Willis Towers Watson (UK)** - **Arthur J. Gallagher & Co. (UK)** - **Jardine Lloyd Thompson Group (UK)** - Wells Fargo Insurance Services (US)	- Berkshire Hathaway (US) - Allianz (DE) - Munich Re (DE) - People's Insurance Company of China (CHN) - Zurich Insurance (CH) - AIG(US) - **Aviva (UK)**	- **Aon Benfield (UK)** - Guy Carpenter (US) - **Willis Re (UK)** - **JLT Reinsurance Brokers (UK)** - **Cooper Gay Swett & Crawford (UK)** - **Miller Insurance Services (UK)**	- Munich Re (DE) - Swiss Re (CH) - Hannover Re (DE) - SCOR SE (FR) - Berkshire Hathaway (US) - **Lloyds of London (UK)**

The UK insurance and Long-Term savings provider industry is the largest in Europe and fourth largest in the world. It plays an essential part in the UK's economic strength, managing investments of £1.6tn and paying nearly £12bn in taxes to the government in 2014[22].

10. Market Trends

Worldwide, US and European insurers, which once ruled the global ranks, have been steadily losing ground to Asian companies as **emerging markets grow and mature markets slow down**. In 2015, worldwide premium growth rates for non-life insurance in emerging markets grew three times faster than those in advanced markets, at 7.8% and 2.6% respectively[23]. This growth rate in emerging markets was primarily driven by China. Munich Re predicts that by 2025 more than one quarter of global primary insurance premiums will come from emerging economies.

Local insurers in emerging markets are becoming more competitive and have the advantage of the trust and loyalty of local populations. Although both US and European companies have expanded into emerging markets, they have faced many challenges and still depend on the mature markets for most of their business[24]. As of 2013, the only European or US company in the Top 5 list of PC insurance companies present in 'Emerging Asia[25]' (by premiums) is Allianz General Insurance Company in Malaysia and Prudential in The Philippines.

[22] Association of British Insurers
[23] World Insurance in 2015, Swiss Re Sigma, 2016
[24] Global Insurance Insights: A detailed analysis of trends that shape the industry – McKinsey, July 2015
[25] China, India, Indonesia, Malaysia, The Philippines, Thailand, Vietnam

In general, the insurance industry is undergoing a period of change and the challenges faced by traditional insurers fall in to two categories:

Global Economy

There has been low growth in most developed countries. PC insurance generally grows and declines with GDP. Excess capital (Almost $250 billion of extra capital has poured into the global reinsurance industry since 2008 due to its double-digit returns,[26]) has led to a pricing collapse.

Technology

Insurance has traditionally been a slow-moving industry with only incremental innovation. However, the adoption of **digital** and new customer technologies across all industries has led to changing customer needs and expectations of insurance solutions and interaction channels. Recent research from London business accelerator 'Startupbootcamp InsurTech' and PwC based on more than 1,300 start-ups across the world, shows that 75 percent of traditional insurers "believe the biggest impact to the industry will come from building new products to address the changing needs of the customer"

Aiming to capitalise on these changing needs, there has been a recent explosion of start-ups, with investments into InsurTech tripling from 2015 levels and reaching £16.5 million by Mid-2016[27]. With easy access to open source frameworks, scaled cloud computing and development on-demand, technology barriers to entry into the market have been lowered[28]. New companies who are able to innovate quickly have begun to enter the market, adapting quickly and disrupting the traditional value chain. These start-ups have been combining new technologies such as Machine Learning (**Digital Fine Print, UK**), new models such as peer to peer insurance for cars (**Guevara, UK**) and property (**Lemonade, US**), pay-as-you-go cover (**Cuvva, UK**), and simplified subscription processes (**Back Me Up, UK**).

Traditional insurers have been partnering with these start-ups in some cases (Ageas and Back Me Up) but have also begun to innovate themselves. Traditionally, information from historical claims has been the main data source for the insurance industry. However, with these changing dynamics, and the explosion of data sources available, there has been significant growth in the use of external data from traditional insurers. Earth Observation and GNSS data are some of the key sources used in **catastrophe risk models for property insurance and vehicle telematics**, along with other sources such as **customer credit reports, driver records, traffic violation history and social media data**. The **benefits** being realized by insurers by using these external sources of data include **better pricing, risk selections and fraud detection**. The key data interests of the main industry stakeholders are summarised in Table 4:

[26] Morgan Stanley – Global Reinsurance: Outlook Cloudy, with Some Silver Linings (Sep 15th 2016)
[27] City AM – Insurtech investment in the UK has tripled
[28] Top Issues Facing the insurance industry volume 8, PwC 2016

Table 4: Key data Interests of Insurance Industry

Policyholders	Insurers	Reinsurers
- **Understand size of their risk and risk appetite** - **Determine amount and cost benefit of risk transfer** - **Determine balance sheet impact of retained risk.**	- Determine pure premium risk in transaction - Support new product design - Monitor liabilities - Claims management - Monitor risk aggregation within and across lines - Manage compliance on solvency requirements.	- Determine pure premium in pricing reinsurance - Modelling and pricing catastrophe risk reinsurance - Monitor risk aggregation within and across lines - Manage compliance on solvency requirements.

Table 5: Key Insurance Definitions

Insurance	Insurance protects people and businesses against the risk of unforeseeable events. It is a risk transfer mechanism that ensures full or partial financial compensation for loss or damage caused by event(s) beyond the control of the insured party[29], by pooling funds enabling the losses of a few to be paid for by the many.
Insurance Premium	The (often monthly) sum of money paid by the insured (policyholder) to the insurer to protect them against the risks identified as part of the insurance policy.
Indemnity	The sum of money paid by the insurer to the insured (policyholder) in the case of the insured risk being realized (damage or loss of property etc.).
Insurer / Underwriter	Under an insurance contract, the insurer indemnifies the insured against a specified amount of loss, occurring from specified eventualities within a specified period. Underwriters are employed by insurance companies to evaluate the risk and exposures of potential clients to help decide the price of premiums. Underwriters use algorithms and actuarial data to determine the likelihood and magnitude of indemnities claimed over the life of the policy[30].
Reinsurer	Insurers may use reinsurance to make sure they can pay a large number of claims if a big disaster such as a cyclone or flood, happens. This is usually called catastrophe cover to cover the big volumes of claims that may occur if there is a natural disaster[31]
Property & Casualty (PC) Insurance	P - Provides financial reimbursement to the owner or renter of a structure and its contents, in the event of damage or theft. Property insurance can include homeowners' insurance, renters' insurance, flood insurance and earthquake insurance.[32] C - Coverage against loss of property, damage or other liabilities. Casualty insurance includes vehicle insurance, liability insurance, theft insurance and elevator insurance.[33] *Link to Catastrophe Insurance?*
Life & Health (LH) Insurance	LH - contracts that pay off in lump sums or annuities upon the insured's death, disability, or retirement.
Insurance Broker	Professional/Company who offers, negotiates, and sells policies. He acts as intermediary between insurers and customers and receives compensation. An important role of brokers is to help insurers to assess the types of risks they face. Risks include natural hazards. At the same time, brokers act on behalf of and in the interest of customers. They do comparison shopping to find the best deals and offer policies from more than one insurance company. Brokers also help their clients to outline risk management strategies, which are suitable for their profile.
Geographic Information System (GIS)	System designed to capture, store, manipulate, analyse, manage, and present spatial or geographic data.

[29] Business Dictionary - Insurance
[30] Investopedia – Insurance Underwriter
[31] What do Insurers do? - http://understandinsurance.com.au/what-do-insurers-do, accessed Jan 2017
[32] Investopedia – Property Insurance
[33] Investopedia – Casualty Insurance