Executive summary

When people think of the space industry, what often comes to mind are things unconnected to daily lives such as rocket ships and resupplying the space station. However, there is another side to the space industry – one that enables people to carry out their daily lives – such as putting satellites into orbit that support our car navigation systems. The upstream part of the sector is undergoing a rapid transformation. As it does so, it is building new capabilities and unlocking new opportunities, as well as opening itself up to new risks.

This new Lloyd's report, published in association with London Economics, provides an overview of current and future developments in the space sector. It provides comprehensive analysis of the upstream sector so that risk managers in companies that are or will be involved in the industry, and all Lloyd's market stakeholders, can begin to understand the potential impacts on their businesses and how to benefit from new opportunities.

To build understanding we have also produced a guide to NewSpace insurance for customers to raise awareness about the complementary role of insurance to mission assurance.

Although the global space market is already worth an estimated $300bn (SIA, 2018), innovation in space looks to continue, further pushing the bounds of technology. Increasing interest in the sector and what the upstream sector has to offer have led to estimates that the value of the global space industry could be worth $1tn by 2040 (Morgan Stanley, 2019).

NewSpace lifts off

A wave of innovation – known as NewSpace – has attracted private investors seeking to take advantage of technological advancements in other terrestrial sectors. As a result, an alternative approach to overcoming the challenges of spaceflight has emerged, with focus moving towards low-cost, easy access routes to space.

This space sector is rapidly opening up to private enterprise, wealthy entrepreneurs, innovative start-ups, and even school projects and amateur hobbyists.

Space connectivity

Everything from watching the financial markets open on the other side of the world, checking the arrival of a customer's flight on your laptop, booking a taxi pick-up because a weather app showed it was going to rain to paying for the taxi using your smart phone, is satellite-enabled. As an example:

- Farmers are increasingly using satellite data to help them with crop management and determine the best time to harvest. News services transmit their coverage from field teams to your screen via space. Financial systems use global positioning satellite (GPS)-based timeclocks for their transactions. While financial markets have back-ups, many of these also depend on GPS.
- Planes receive signals for precise positioning and transmit the position via satellite, so aircraft controllers can safely direct traffic. Apps on smart phones also use this technology to allow people to track flights – and share documents while flying at 30,000 feet.
- Weather services around the world gather and share data derived from satellites, among other sources, that is used by national weather services, and commercial organisations that use and augment that data to provide additional services. Insurers also use this data to model weather events, so they are ready to give customers up- to-date knowledge, and where necessary investigate and pay claims.
- These days taxis are likely to use an app that relies on GPS data to find your exact location to pick you up and determine the best route to get you to your destination. It is estimated that approximately 7% of European GDP depends on satellite navigation applications, including aviation, maritime, rail, road, energy, telecommunications and financial services (The Royal Academy of Engineering, 2011). The US Department of Homeland Security has designated 16 sectors of infrastructure as "critical," and 14 of them depend on GPS (Tullis, 2018).
- When bank cards are used a satellite link is established between banks and the business to validate and initiate payment.

NewSpace trajectory

Changes in upstream space activities mean that satellite touch-points are going to expand and play and increasing role in people's lives. These capabilities are now a reality or within touching distance because of four main trends:

- Democratisation of space: New technologies are lowering barriers to entry and could be further coupled with automation allowing ease of access into what has long been the domain of governments. The segment has also come to the attention of outside investors. As a result, the frontier of space is fast becoming accessible to private enterprise, wealthy entrepreneurs, innovative start-ups, and even the amateur hobbyist.

  The characteristics of NewSpace are comparable with emerging sectors where rapid iterations, a strong focus on research and development, and private capital, mean that NewSpace entities are taking the risk on themselves. However, as the market matures, and traditional sources of finance are sought, these institutions are highly likely to require risk transfer to be part of the equation.

- Rise of constellations[a] and the need for greater and more varied launch capabilities. More numerous and varied launch capabilities, reusable launch vehicles, and commercial spaceports are increasing launch frequency and therefore the risks associated with launches.

  This raises new and interesting challenges around the aggregation of risks, as the collective value of hundreds of identical, interconnected constellations of satellites can now run to billions of dollars. Ridesharing[b] also brings up the question of who is next to who on the launcher and how stringent has each company's testing and risk management been?

- Development of space as a resource: this includes space tourism and the potential for manufacturing in space. There are also long-term options such as commercial space stations and asteroid mining that are being discussed and planned today to meet the needs of tomorrow.

  Launcher reusability is going to be paramount for lift costs to come down enough to allow space tourism to take off. When it does the insurance industry already has well developed products for high risk environments and the infrastructure that will be needed, and could use existing skills and thinking to support development.

- Innovative mission concepts: New innovative mission designs and concepts in areas such as in-orbit servicing. As scale increases, liabilities and resource-demand are likely to trigger new services that support the space sector.

  The ability to service and build satellites in space could allow for more proactive risk mitigation. For example, if a damaged satellite could be repaired or upgraded in space, it could remove collision risks and prevent further debris from aggregating.

Opportunities on the horizon

In the future businesses might:

- Decide to establish their own constellation of satellites, or use a satellite subscription service to buy bandwidth, so their network is secure and always online *(see Section 3.1 for details)*.

  There are plans for over 7,000 new satellites that are going to change market dynamics and open a new frontier for telecommunications companies. For example, SpaceX has started launching the first of its planned 12,000 constellation, and Amazon announced its version – project Kuiper – which look to use 3,000 satellites to provide high-speed Internet to up to four billion new customers.

  These ventures will increase interconnectivity, and provide huge amounts of data that will require artificial intelligence to analyse it. Both artificial intelligence and big data come with their own set of threats and opportunities *(see the reports from Lloyd's Digitalisation series to learn more)*.

- Offer new services to customers by connecting their Internet of Things (IoT) networks to company systems, to give customised, instant feedback *(see Section 3.1 for more details)*.

  Additional capacity will be needed to offer global connectivity, enable the Internet of Things, and provide the 5G backbone needed to support this development. Constellations of satellites are going to enable devices to be connected in regions that have remained unconnected by cables. Satellite Machine to Machine (M2M)/IoT[c] is expected to be a $11.6bn market over the next decade (NSR, 2019), with the strongest growth in industries with existing heavy machinery partnerships, such as agriculture and construction, and growth in the energy and maritime sectors.

[a] A constellation of satellites are a networked group of satellites working in concert. While constellations of satellites are not new, the scale is significantly larger under NewSpace, with potentiall constellations of thousands of satellites in a network to provide global coverage.

[b] Buying a seat on someone else's launcher that has spare space. Commercial entities are increasingly providing this as a service offering., and offering dedicated packages.

[c] The transmission of data between devices or a relatively closed network that can be considered part of the IoT. The development of M2M and IoT applications relies on connectivity, and s has created a specific demand for low-cost satellite communications to provide global connectivity (London Economics, 2017).

For example, DHI Global Seas is already allowing customers to reduce fuel consumption and to improve vessel performance by utilising satellite data enriched with ocean current, wave and wind data. SatCBRN is exploring the use of satellite services for surveillance and hazard management of incidents involving the release of chemical, biological, radiological or nuclear threat agents. New companies are lining up to provide new data, while traditional markets are increasingly offering new services that use their existing expertise to augment data.

- Launch a dedicated small satellite. Options for getting into space are becoming more varied and accessible through pooling resources with others, or booking a dedicated smallsat launcher for a mission *(see Section 3.2 for more details on how to achieve lift-off)*.

  The ability to service and build satellites in space is also on the horizon with the potential for services stations. This could allow the lifespans of assets to be increased, prevent breakdowns or recover damaged satellites *(see Section 3.4 for more details)*.

- Be able to develop new innovative products and services to meet customers' needs with access to new sources of materials and low gravity manufacturing environments.

  Scientific research that has occurred over decades has already been cataloguing potential asteroids and lunar excursions have revealed the presence of metals and minerals buried at or beneath the Moon's surface that could be used *(see Section 3.3 and 3.4 for more details)*.

- Take a suborbital flight to get to a meeting in record time or deliver essential components to where they are needed most just in time *((see Section 3.3 for more details)*.

  If suborbital point-to-point space liners can transport 5% of the passengers that currently take 10+ hour long-haul flights, UBS estimate this could be a $20bn a year market (Sheetz, 2019). To get to this point there are outstanding questions around regulations, profitability, infrastructure investments needed, and weather. Per kg lift costs, environmental impacts, and competing transport options may make commercial space tourism a more realistic growth segment over point-to-point in the short term.

- Travel to Mars *(see Section 3.3 to learn how this could be possible and which companies are involved)*.

  Some estimates put the date Mars travel will be possible to around 2037 (IDA, 2019), so there is still some way to go. However, plans are already underway and even if closer targets like the moon are first in line, companies operating in the space will require robust risk management frameworks and processes that adopt best practice and contain worst case scenarios, crisis response plans and full-scale exercises. There are many practical steps businesses can take to manage risks effectively, including investing in space technologies and transferring some of the risks to specialist insurers.

Risks and challenges

As these trends and opportunities become more widely adopted, risks and challenges are emerging. Insurers already offer products and services that meet these, and are developing new propositions to help customers manage these risks.

However, some challenges remain that will require all stakeholders to work together to ensure the sector develops in a responsible and considered way.

Traditional space risks include:

- Design/manufacturing defects and random failures: When multiple spacecraft feature the same or similar components, there is an inherent risk that previously unidentified issues can emerge that can cause loss of capability to multiple space missions, or even lead to the failure of satellites.
- Space weather events: Although we have evidence of space weather and solar storms existing for centuries, it poses a greater threat today because of the uncertainty of how NewSpace technology will respond to extreme events. An exponential increase in the number of satellites, identical designs and common components, mean any vulnerabilities could have severe consequences.
- Collisions and debris: Exponential rises in the number of forecasted satellites and stakeholders, alongside a patchwork of global systems, could see a rise in collisions. Some small satellites are being launched without propulsive systems, which means that they will be not be able to act on any warnings to avoid collisions. Space is big, but it is getting smaller. As the sector becomes further commercialised, a civil aviation style management model is going to become increasingly important to assess risks and establish mitigation efforts, standards, and monitor compliance.
- Cyber attacks: The exponential growth in satellite applications is creating a systemic risk. As a large, and increasing, number of globally interconnected services on the ground come to rely more extensively on satellite communications, certain signal disruptions or interruption to these services could have catastrophic consequences.

Lloyd's and space

The first space satellite insurance was placed with Lloyd's in 1965. Today, Lloyd's underwriters continue to play a crucial role in enabling satellite launches globally; each year, specialist space underwriters provide satellite owners and users – from national governments to telecommunications firms and research institutes – with protection worth more than US$7bn.

The Lloyd's market are developing innovative products to meet the needs of the NewSpace community with products such as Llift. The innovative product builds on the strong history of the Lloyd's market in supporting space endeavours, bringing together 18 syndicates to write NewSpace risks via a dedicated Lloyd's platform to meet the needs of the small satellite community. See the case study for more details.

Conclusions

NewSpace is growing rapidly, and will create an increasingly interconnected world. To grow safely and thoughtfully it needs to be underpinned by insurance, and all classes will need to collaborate to offer customers the products and services that will secure their futures.

NewSpace activities are going to enable affordable coverage to emerging markets where billions of people and internet of things devices are waiting to be connected where they are most wanted.

As increasingly ambitious concepts evolve, understanding the risks involved has never been more important. To take advantage of the opportunities on offer, insurers must:

- Talk to customers to establish where product gaps exist
- Ramp up innovation to increase product development for NewSpace
- Collaborate across classes to harness existing expertise to meet this growing sector

To build understanding we have also produced series of takeaways for risk managers and insurers, and a guide to NewSpace insurance for customers to raise awareness about the complementary role of insurance to mission assurance. For example, insurers are willing to be part of conversations from the beginning of ideation, and can help in the identification of coverage needs.

The Lloyd's insurance market has well developed tools such as scenarios, expert knowledge, and decades of experience at being at the front of the market helping customers to be brave. These skills will be needed to support the sustainable development of the new frontier.