Satellite Evolution Sparks a Service Revolution

SES White Paper
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The changing DNA of satellites prompts a landslide of new products and services

Technology changes lives. That statement, as banal as it sounds, implies two major elements of fundamental importance. The first is the observation that technological shifts create markets, and not the other way round. The second is that faster technological evolution sparks a revolution in the services and products that are available. Markets, and the individual consumers that define them, do not presage and pronounce demands, technological breakthroughs do. Unforeseen and unforeseeable products are created by translating new technology into applications that rapidly transform entire industries, sectors, behaviors and business models. Technologies ferment the markets. And this is exactly what is happening with satellite technology today.

THE OLD AND NEW SCHOOL OF THINKING

For a long time the satellite business was framed by the stable and reliable coordinates of orbital positions, satellite fleets, and their spectrum and capacity. All of this was viewed, of course, in the perspective of rate cards and price points. Admittedly, in this old school of thought the orbiting real estate of satellite operators delivered fantastic results, transmitting thousands of TV programs reliably and in the highest quality to millions of households and billions of people. In turn this created mass audience solutions downstream, as well as instant and remote connectivity over continents and deserted areas. Yet the optics were always focused on a small slice of a larger sector.

The new school of thinking has overthrown that approach. Now technology is the launching pad for new products and markets, as new capabilities in the sky are immediately applied on the ground in tailor made ways for each market. As satellites change their DNA rapidly to become fluid and flexible, they grow their already key role in the connected and rapidly evolving world. The new approach positions satellite to deliver on the demands for the new age of connectivity. High performance satellite constellations are being put in place with a strategic mix of spectrum types, and wide and spot beams. Reusable and re-deployable beams boost capacity and bandwidth efficiencies. Roaming capabilities enable seamless maritime and aeronautical connectivity experiences. And the terabit per second satellite is on the horizon, pushing the boundaries of global connectivity to infinity.

SES is perfectly positioned to drive this technological revolution, and knows that it is not about one big idea or one big satellite. Technologies such as High Throughput and terabits are not the exclusive elements of the winning formula, but are part of the tools SES will use to chart a new course beyond frontiers, and not just for itself, but for the entire industry. By breaking with ideology, and reconsidering the entire business with a precise, market-focused, and insightful view, SES will take the most advantage of the fundamental changes underway. The optimal formula will be a precise balance between a differentiated focus on four market verticals and a global scalability of all solutions across the globe. The sheer size of the SES operations and fleet, the importance of its spacecraft investment, and the high pace of its satellite launch manifest, will allow SES to develop solutions with a worldwide scale and deploy these with an accelerated approach in all four verticals that each have different maturity levels. The four verticals SES focuses its business on are: Video, Enterprise, Mobility and Government.

Technological innovation in the sky is already changing communications on the ground

ENERGISING GLOBAL VIDEO AND DATA MARKETS

The new dynamic is energizing all segments of the global connectivity market and its four main wings.

In **Video**, cutting-edge Ultra High Definition (UHD) is pushing picture quality to new heights and fuels the launch of even larger and more powerful screens. Satellite is the ideal delivery method for such high quality video, and broadcasting UHD to homes across the globe is possible thanks to advances in compression technology. UHD is delivered to viewers in High Efficiency Video Coding (HEVC) instead of the previous compression standard H.264 that is used for HD. HEVC reduces bandwidth requirements and therefore makes broadcasting UHD affordable for customers. The global success of non-linear video platforms is changing the way consumers watch video. The new generation's preference for streaming and Over-the-Top content is pushing video to every screen on every device. In this new landscape of video, seamless hybrid networks that integrate satellite into terrestrial infrastructure will lead the way by delivering high quality video that is both linear and on demand to viewers anywhere in the world.

In **Data** and on land, organisations also need reliable high speed broadband and cellular coverage on a global scale regardless of terrestrial infrastructure. Telecommunications providers, mobile phone operators, energy suppliers, mining companies, car manufacturers, banks, and retail chains all seek to elevate their communications capabilities using new technology. The Internet of Things is a big part of this step change in communications, allowing machine to machine connection and data exchange. This kind of connectivity needs reliable, real-time, and scalable communications support, service that satellites are tailor made to provide. SES is already empowering the connected world – from smart cities to smart operations and smart spaces, and is ready to expand globally by working actively with partners to create new solutions prepared for the arrival of HTS.

In **Mobility** new technologies that deliver connectivity regardless of location are fundamentally changing the travel experience both in the air and at sea, delivering airline and cruise ship passengers a connected living room experience during their trip. The possibilities offered by the technology have set expectations high and cause a boom in demand that is unprecedented.

Finally, the **Government** segment is increasingly demanding global connectivity on land, sea, and in the air. These services are vital to governments worldwide who share the daunting mission of protecting their people in increasingly turbulent times. Satellite technology meets those needs, providing protected connectivity for defence and security solutions, surveillance, disaster recovery and e-inclusion (initiatives such as SES's e-health, e-learning, and e-elections).

MICROPROCESSED PAYLOADS FURTHER REVOLUTIONISE PERFORMANCE

Technological progress drives markets and pushes them several steps further to create dramatic changes in customer experiences, and more progress is coming.

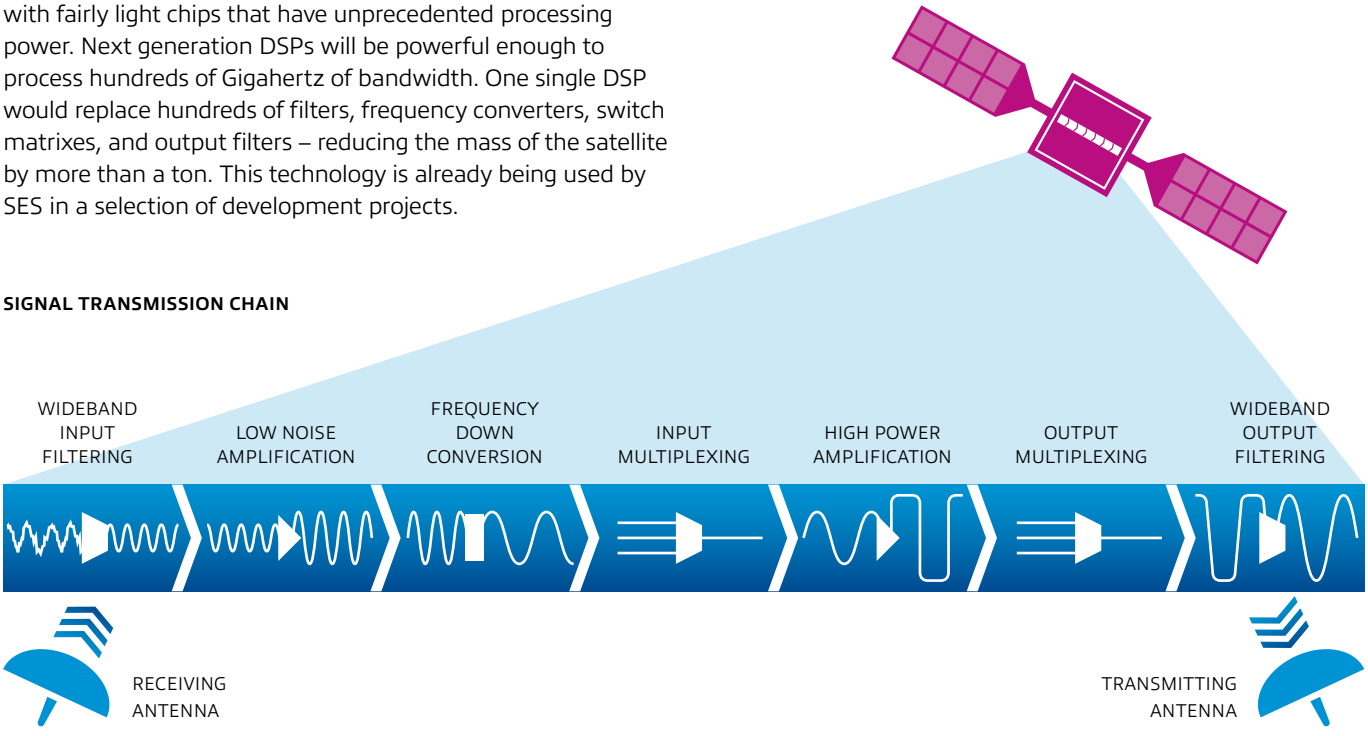
The satellites that orbit the Earth are marvels of engineering. Each is made of building blocks that enable it to receive and redistribute signals from Earth. The key element is the transponder, a physical unit that allows the satellite to fulfil its role in transmitting video and data to large audiences and geographies extremely efficiently. The transponder receives the signal from the ground in a specific frequency band – typically C-band, Ku-band or Ka-band, which have been used for data and video transmission for decades. The payload then filters the signal, converts it to another frequency (since the upstream traffic cannot collide with the downstream signal), amplifies it, multiplexes it to combine it with other signals into a package, and finally sends it back to Earth to be received by the dishes of those using the service. The inside of a satellite thus contains hundreds of filters, switches, converters, multiplexers and amplifiers to do that.

Now there is an on-board revolution underway.

The inclusion of extremely powerful digital signal processors (DSPs) will revolutionise the way satellites operate, perform, interact, connect and serve customers. This will significantly change the satellite's design and increase its capabilities by replacing a large portion of traditional on-board hardware with DSPs. The uplink signal will no longer flow through external filters, switches and frequency converters, but rather be fed into DSPs for conversion, transformation, digital amplification, and re-conversion to the downstream frequency for transmission. This will allow engineers to dramatically reduce a satellite's hardware, replacing major parts of the transponder with fairly light chips that have unprecedented processing power. Next generation DSPs will be powerful enough to process hundreds of Gigahertz of bandwidth. One single DSP would replace hundreds of filters, frequency converters, switch matrixes, and output filters – reducing the mass of the satellite by more than a ton. This technology is already being used by SES in a selection of development projects.

The satellites that orbit the earth are marvels of engineering

SIGNAL TRANSMISSION CHAIN



TECHNOLOGY YIELDS VALUE FOR CUSTOMERS

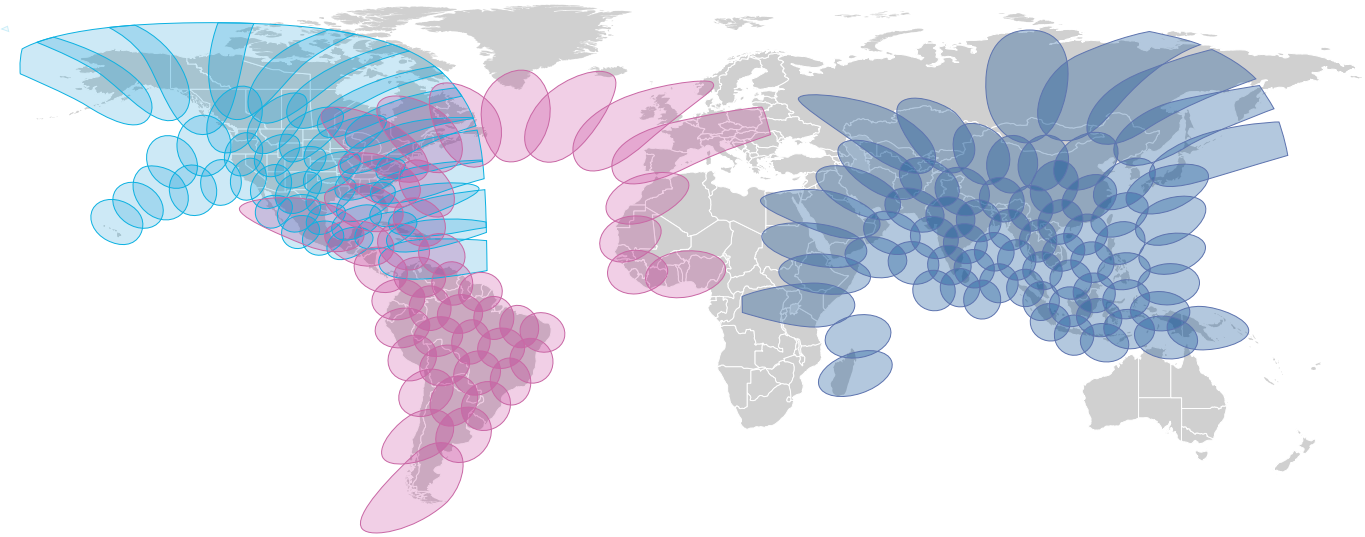
The digitalisation of satellites is dramatically changing SES's capabilities in the sky. The next generation of satellites will be flexible and adaptive, providing an improved customer experience. Complex multiplexing of channels, a feature of digital signal processing, allows a satellite to continuously form and shape beams or hop from one beam to another. This enables the satellites to use resources according to demand by seamlessly switching frequencies and allocating spectrum with the maximum efficiency. The new satellites will be able to transmit thousands of Gigabits per second, multiplying on-board traffic by one or more orders of magnitude. Even further, the new satellites will operate simultaneously in broadcast and unicast mode, allowing data and video service to converge.

This technology will result in a number of benefits for SES customers. With the new technology, resources can be customised so that they are available when and where they are needed, also allowing for video content differentiation that is based on location. Thanks to the adaptive nature of digital signal processing SES will also be able to adjust the signal strength to a customer's antenna size, and avoid frequencies that have been interfered with. Customers will also get the added benefit of cost savings. Because the technology is homogenous SES will have the flexibility to use available spectrum without the requirement to customize filters and receivers, and therefore can pass on the associated cost savings. Even further, these features will be available in GEO and MEO architectures, allowing for synergies across these two orbits, and significant volume discounts.

Digital processing will enable satellites to seamlessly blend into telecommunications and terrestrial infrastructure, creating hybrid systems that allow the systematic offload of traffic from innovative global video platforms, and delivering linear and non-linear signals in Internet Protocol to multiple screens. It will form the backbone for new trunking and backhaul models for mobile phone operators by feeding signals from satellites into terrestrial head ends and towers that transmit enormous quantities of data (and often video) to more and more demanding mobile phone networks. And it will be the key enabler for powerful and innovative hosted payloads, serving the specific needs of a variety of governments and institutions. Providing high-powered coverage, thanks to the technological improvements in satellites, will transform the security environment globally. Future Intelligence Surveillance and Recognition (ISR) platforms will monitor borders, events and municipalities, while HD surveillance platforms on unmanned air vehicles (UAVs) will develop even further alongside this new satellite technology.

Depiction of SES-15, a HTS satellite launching in Q7 2017

SES-12, SES-14, SES-15 HTS COVERAGE



A STEP FURTHER: MODULAR SYSTEMS

The fast metamorphosis of satellites will not stop at digital processing. They will also accelerate their production time and, on the other side, extend their lifetime.

The current product lifecycle of a geostationary satellite is linear. Five years in advance of a satellite's launch, SES predicts the service capabilities for its nominal lifespan of 15 years. The service payload satellites carry define their capabilities for the entire lifetime of service.

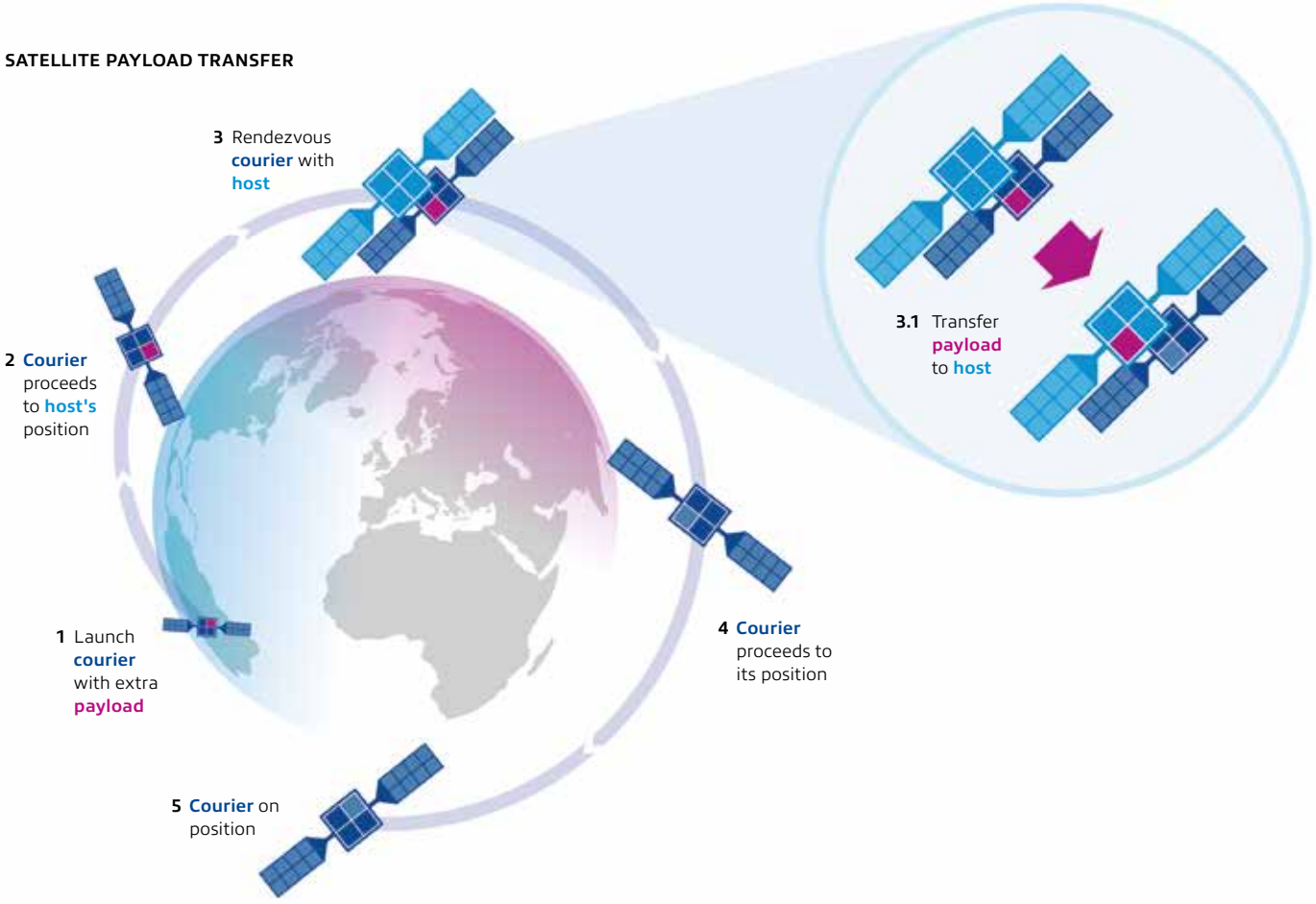
Now, advances in satellite engineering have the potential to break this dynamic. Due to the launch mass saved by electric propulsion and digital processing, satellite engineers have more real estate with which they can consider modular designs. This will allow operators to add pieces to an existing satellite in orbit that were unknown and unheard of at the time of its procurement and launch: modular satellite designs will disrupt the static nature of the satellites in service today.

To make modular design possible, satellites need to have a connector and docking mechanism installed. New satellites will be launched and used as delivery vehicles. Once a new service payload is ready for a host satellite in orbit, it will be attached to the next satellite being prepared for launch.

Once that satellite is launched, it will make a stop at the host satellite to drop off the service payload before continuing on to its intended orbital position.

These multi-purpose missions will eliminate the need to launch additional or replacement payloads individually and therefore maximise the value of each launch. As the industry accelerates the development of innovations, satellites and payloads will be put into operation in much shorter time frames: as little as two years. These flexible payloads will generate new service offerings for customers, further driving down the cost per bit. The technology for this connecting and docking equipment in space already exists, and has been used successfully on the International Space Station and other government projects. While the equipment is not yet commercially viable, SES innovators intend to adapt the technology for commercial applications.

SATELLITE PAYLOAD TRANSFER



ANOTHER STEP: EXTENDING SERVICE LIFE

Extending the commercial life of a spacecraft is another primary focus for operators like SES, postponing the sizeable investment needed to completely replace a satellite in orbit.

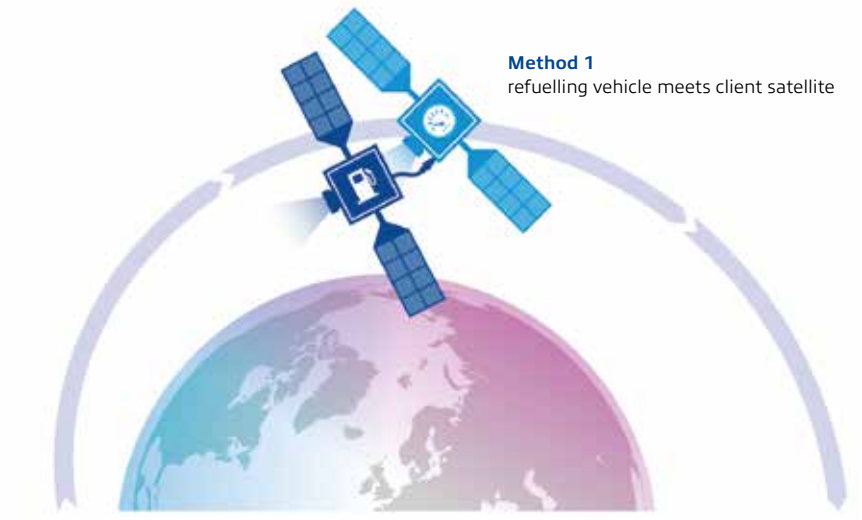
Satellites currently launch with enough fuel to last for a nominal service lifetime of 15 years. Fuel is required to keep the satellite in its orbital position and ensure that its signal is properly received on the ground.

SES now encourages the development of technologies that will extend the service life of satellites in orbit. The industry is currently focused on two methods to extend satellite life. The first method consists of refueling a satellite with something akin to a mobile gas station in space. When launched, the gas station would carry enough propellant to refuel multiple satellites. Once in orbit, it will travel to meet each individual satellite and refuel it in space, extending its lifetime. This can be accomplished with the use of a robotic arm capable of very exact movements in space, enabling the refueling station to move the blanket, unscrew the cap to the fueling pipes, fill up the tank, replace the cap and re-enclose the system.

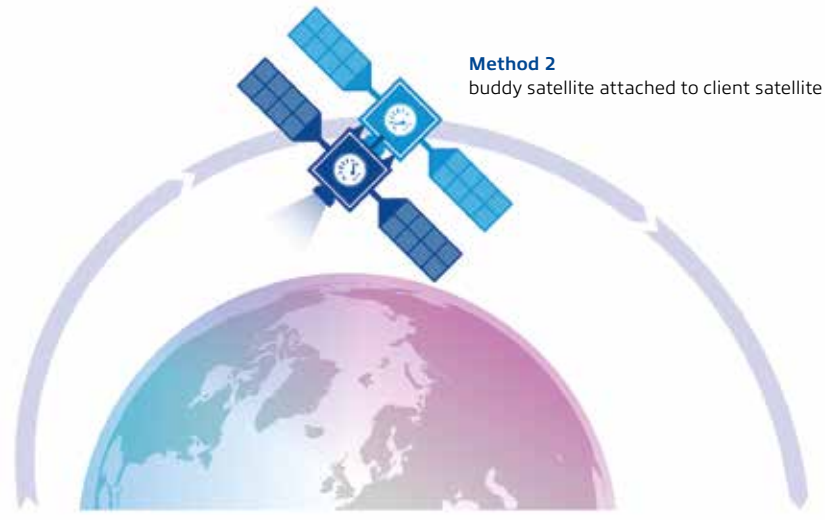
The second method can be described as a buddy system. A new satellite is launched from Earth to meet a satellite in orbit. It becomes the "buddy" by attaching itself to the orbiting satellite and actively controlling it for the duration of the service contract. At the end of the contract, the buddy satellite will detach itself from the satellite and move on to the next client. The buddy satellite would service multiple satellites during its lifetime, extending the lifetime of a number of satellites in space.

Both of these methods have a number of technical and commercial challenges to overcome in order to be successful. Yet positive results will provide SES with a new tool to defer major investments with sizeable cost reductions compared with commissioning a new satellite.

SATELLITE REFUELLING



Method 1
refuelling vehicle meets client satellite



Method 2
buddy satellite attached to client satellite

CONCLUSION: A NEW CENTURY OF CONNECTIVITY

The potential of new satellite and space technologies is exciting and places these developments at the heart of meeting the dramatic surge in connectivity demand that SES expects with the coming technological supernova. Exponentially more powerful satellites, startling efficiencies in production and operation, and new architecture in space will together generate the widest array of services and customer solutions, to leverage the enormous potential of space for the new century of connectivity.

The vertical focus and the global size of SES are the key traits that allow it to look at distinct and dynamic markets through the future lens of technical innovation. In all areas SES tunes its approach to focus on creating solutions that meet specific needs and have a global scalability. Applied with intelligence and precision space innovations transcend market boundaries, push product developments, unleash unknown business possibilities, and ferment new markets. This is how SES is able to project products and solutions that have not existed before, and provide services many have not even dared to dream of.

Satellite innovation creates attractive products and services

SES headquarters
Château de Betzdorf
L-6815 Betzdorf
Luxembourg

Regional offices
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Addis Ababa | *Ethiopia*
Bucharest | *Romania*
Dubai | *UAE*
The Hague | *The Netherlands*
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For more information about SES, visit **www.ses.com** or email **info@ses.com**