Sky High Connectivity

SES White Paper
September 2016

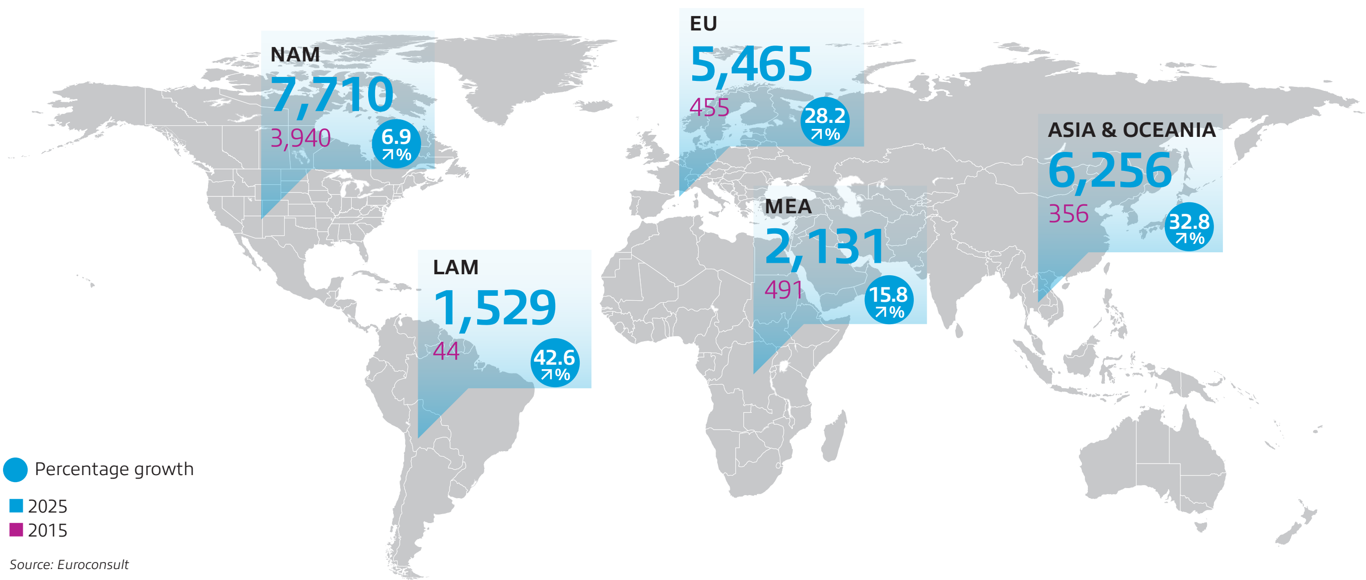
Global coverage and innovative satellites propel SES into a new age of air travel

Satellites are shaping a new age of inflight connectivity. New satellite technologies are covering the globe in layers of high-powered, ubiquitous bandwidth, capable of connecting devices on both commercial and business aircraft carrying millions of passengers. From real-time turbulence-avoidance capabilities at the pilot's fingertips, to a curated and personalised inflight passenger experience – global satellite ubiquity is on the verge of unveiling a new realm of possibilities.

SES innovation is boosting demand by investing billions in fortifying its global, robust, reliable, and secure satellite network to accelerate the exciting new growth and cost-saving opportunities in one of the most dynamic industries on earth – aviation. Now airline passengers travelling at 500 miles per hour and 30,000 feet in the sky enjoy high-speed broadband thanks to satellite-enabled connectivity. SES's ubiquitous global coverage, with high throughput beams placed over the busiest of 50,000 air travel routes in the world[1], has resulted in a compelling inflight connectivity (IFC) offering ideal for delivering connectivity to all airlines across the world.

The procurement of SES-17 is SES's next strategic step in serving the aviation market. SES's first and next generation Ka-band high throughput (HTS) satellite is yet another differentiator enabling SES to provide varied connectivity solutions to customers seeking mobility connectivity. This new addition to the SES fleet will significantly augment SES's global coverage and ability to deliver a band-agnostic seamless network, meeting the exponential connectivity needs of the airline passengers of tomorrow.

GLOBAL TERMINALS
BUSINESS AVIATION AND COMMERCIAL AIRLINES



Source: Euroconsult

1. *Air Transport Action Group, Aviation Benefits Beyond Borders (2014)*

SOARING DEMAND FOR INFLIGHT CONNECTIVITY

Global IP traffic will nearly triple over the next five years, and by 2020 smartphones are expected to generate 30% of the total IP traffic.[2] In this new age of connectivity a record 3.6 billion airline passengers will board over 40 million commercial flights worldwide in 2016[3] and 65% of today's travellers would choose to access entertainment services on their own device.[4]

The majority of these passengers will expect to connect to high-speed Wi-Fi, stream video entertainment, text, and catch up on email and social media just like they do on the ground. In fact, more than half of the world's airline passengers say the availability and quality of inflight Wi-Fi is increasingly a factor in their airline choice when booking a flight.[5]

Passenger demand for IFC is soaring, with aviation growing to one of the largest ever market users of satellite capacity.

Responding to this demand, the number of connected commercial aircraft is expected to grow from 5,300 in 2015 to 23,100 in 2025.[6] Airlines in Latin America, Europe, the Middle East and North America are connecting aircraft at staggering rates.[7] Inflight connectivity is more available today in North America than anywhere else, where 80% of the world's connected aircraft are currently flying.[8] In the next decade the largest growth, however, is expected across the Latin America region, where the number of connected aircraft is projected to balloon from 44 in 2015 to 1529 by 2025.[9]

MORE THAN 50% of airline passengers say the availability and quality of inflight Wi-Fi is increasingly a factor in their airline choice

In this climate of booming capacity demand SES is growing its fleet to deliver top quality service. SES already serves three major inflight connectivity providers: Global Eagle Entertainment (GEE), Gogo, and Panasonic Avionics. The most recent agreements with these customers secured dedicated HTS capacity aboard three advanced hybrid satellites (SES-12, SES-14, SES-15) set to launch in 2017. SES-14 in particular will serve the increased demand expected in Latin America, mentioned above.

Recognising the complexity of addressing the fixed/mobile broadband market, SES has taken a multi-band, multi-orbit, multi-system architecture approach which provides inherent flexibility and advantages. With the announcement of the procurement of SES-17 – SES's first fully HTS Ka-band Geostationary Orbit (GEO) satellite – SES revealed that the fourth major inflight connectivity provider, Thales, will be the key anchor customer and utilise the capacity to deliver high-speed broadband throughout the Americas. SES-17 is a step-change ushering in a new era of connectivity in the skies. By being band-agnostic SES is leading the way to ubiquitous coverage that can serve the unique requirements of aeronautical demand.

2. *IATA 2015 Global Passenger Survey*
3. *Air Transport Action Group, Aviation Benefits Beyond Borders, 2014*
4. *SITA 2016 Passenger IT Survey*
5. *Gogo 2016 Global Airline Passenger Study*

6-9. *Euroconsult Prospects for Inflight Entertainment and Connectivity, 2016*

THE PERSONALISED PASSENGER EXPERIENCE

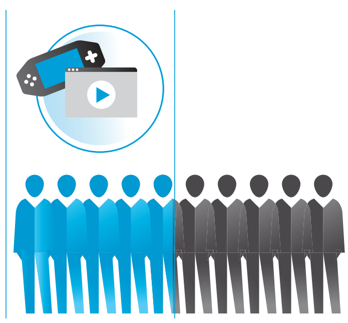
More than 80% of airlines today are focused on, and investing in, a personalised passenger experience.[10] Most airlines and airports are already serving their passengers in ways that were not possible just a few years ago. While still on the ground passengers can conveniently check in, board the plane, track their baggage, and monitor connecting flights. Now, thanks to satellite connectivity, this kind of service fed by connectivity is moving to the sky. Airlines looking to differentiate themselves are providing an array of connectivity services after take-off.

MORE THAN 80% airlines today are investing in a personalised passenger experience

Today's Inflight connectivity packages are as varied as the airlines offering them. There are free Wi-Fi offerings, pay per use, and package services. Some carriers opt for fully-curated bouquets of cached movies, TV shows, music and games, coupled with live television, OTT video streaming and social media delivered via satellite.

Beyond entertainment, each passenger's inflight preferences are being securely transmitted and stored, allowing airlines to offer up a far more personalised travel experience. Flight attendants can now provide passengers with up-to-the-minute connecting flight information, real-time credit card processing, and even inflight meal choices based on passenger profiles. Cabin crews can also send inflight reports of a broken passenger seat or cabin cargo bin latch in need of repair, in order to schedule a timely maintenance fix upon landing.

Airlines are extending the connected journey seamlessly inflight, with a full course of satellite-delivered Wi-Fi offerings and cached content, including bite-sized news and sports updates periodically refreshed via satellite. Passengers are so enamoured with inflight entertainment (IFE) that seven out of ten would like to order their meals through the IFE system.[11] Nearly half are willing to pay for internet and entertainment services, and 72% prefer watching movies and TV over sleeping on long-haul flights.[12]



NEARLY half of passengers are willing to pay for internet and entertainment services

10. *SITA 2016 The Future is Connected Report*
11,12. *IATA 2015 Global Passenger Survey*

THE CONNECTED AIRCRAFT

Airlines are implementing inflight connectivity systems primarily to provide a better passenger experience. However, carriers are increasingly intent on leveraging their inflight connectivity to drive cost savings, safety, and operational efficiencies across their fleets. Airlines realise that the connected pipes they have installed on their planes are now capable of delivering data communications between flight, cabin, and ground crews, in addition to real-time analytics that can optimise flight operations like never before.

The connected aircraft concept may still be in its infancy, but the technological leap forward is already playing a key role in getting the smart plane down the runway. Powerful HTS systems, smaller next-gen IFC aircraft antennas, sophisticated on-board modems, the global deployments of electronic flight bag (EFB), and cockpit integration solutions, have all worked together to land the plane of the future in the present.

Electronic Flight Bags (EFBs) and the Connected Pilot

Airline pilots used to carry heavy briefcases (average of 25kg) loaded with cumbersome stacks of freshly printed flight documents covering everything from aircraft manuals to weather conditions, many of which were outdated the moment the plane left the gate. This weight and space are now being saved. About 90% of commercial airlines plan to transition to an electronic flight bag (EFB) and built-in cockpit integration capabilities that will put mission-critical flight and weather data at the fingertips of their pilots.[13]

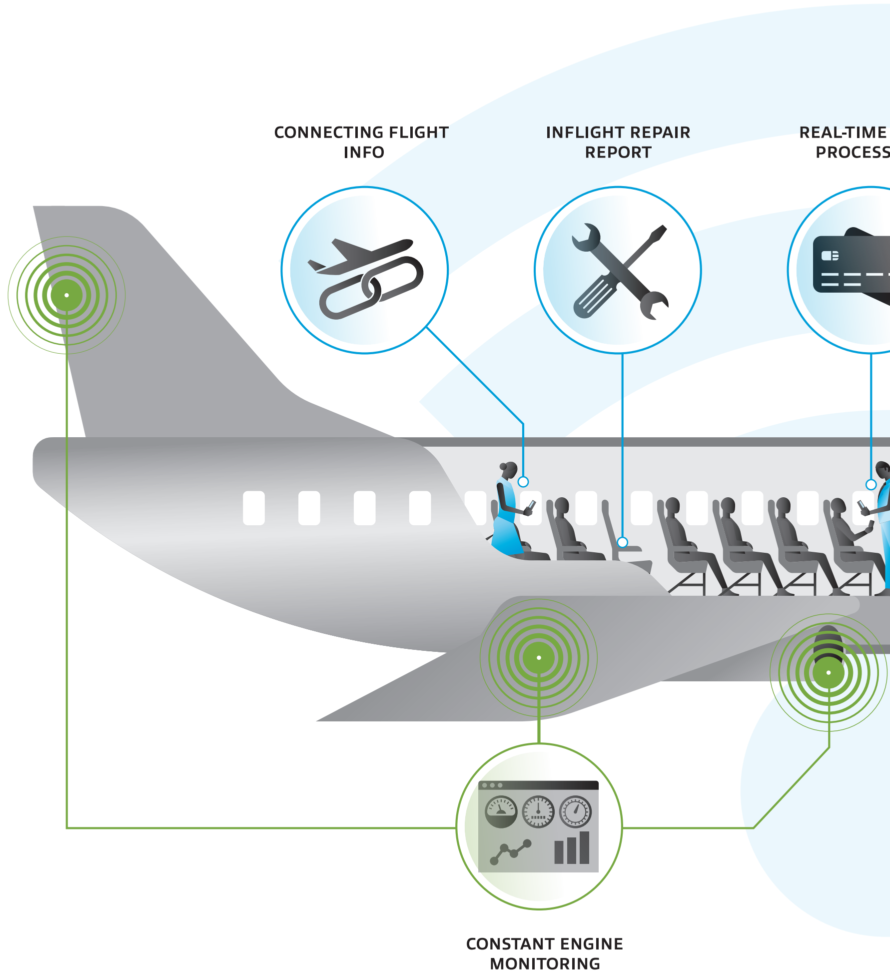
Global satellite capacity and the emergence of the connected aircraft are the key developments that enable pilots to use their EFBs fully. With only an off-the-shelf, lightweight, and portable tablet pilots can now receive a wealth of critical real-time flight data, including regularly updated flight-path

Security

Many worry about aircraft avionics being vulnerable to security threats, especially if inflight connectivity systems were shared across operational and passenger applications. Two-way communications between pilots and ground crews elevate the need for firewalls between cockpit data platforms and passenger internet access points. And while today's legacy avionics networks separate the airline's operational data transmissions and cache from passenger internet activities aboard the flight, tomorrow's digital aircraft will completely isolate them.

The EFB, aircraft interfaces, and inflight connectivity systems will operate on isolated networks, featuring firewalls and advanced encryption technologies to maximise the security of operational data. ACARS systems depend on ground-based radio networks, leaving the messages and information they deliver susceptible to interception, while satellite-based IFC platforms feature global coverage and end-to-end encryption and data security.

Security requirements can be managed through discrete networks and firewalls and end-to-end data encryption. Once the information reaches the ground, data transmissions can be made through virtual private networks (VPNs) and encrypted tunnels to optimise security.



13. SITA 2016 Passenger IT Survey
14. The Future of Aeronautical Connectivity Report, Valour Consultancy, 2014
15. Connected Aircraft: Impact on Operations (Global Eagle Entertainment), 2015
16. Data Science Central, Bernard Marr, 2015
17. The Future of Aeronautical Connectivity Report, Valour Consultancy, 2014
18. Euroconsult Prospects for Inflight Entertainment and Connectivity, 2016

weather and turbulence reports. Agile flight plans that avoid major storms and turbulence can save airlines millions of dollars annually in fuel-hungry reroutes and delays, and ultimately provide passengers with a smoother, safer and more enjoyable journey.

On top of all these benefits, the move to pilot EFBs and cabin crew tablets can also have a dramatic impact on the environment. The transition to electronic flight bags from paper reports is already saving hundreds of thousands of pages of daily inflight documentation, maps, charts and manuals (average of 12,000 pages per pilot), which dramatically cuts the weight aboard planes and saves airlines more than 83 million litres of fuel each year.[14]

A mid-size airline burns more than USD 1 billion of fuel each year. Implementing real-time optimisation of aircraft flight profiles to reduce fuel burn by 2% would drive more than USD 20 million in annual savings.[15]

Legacy Fleets to the Internet of Things

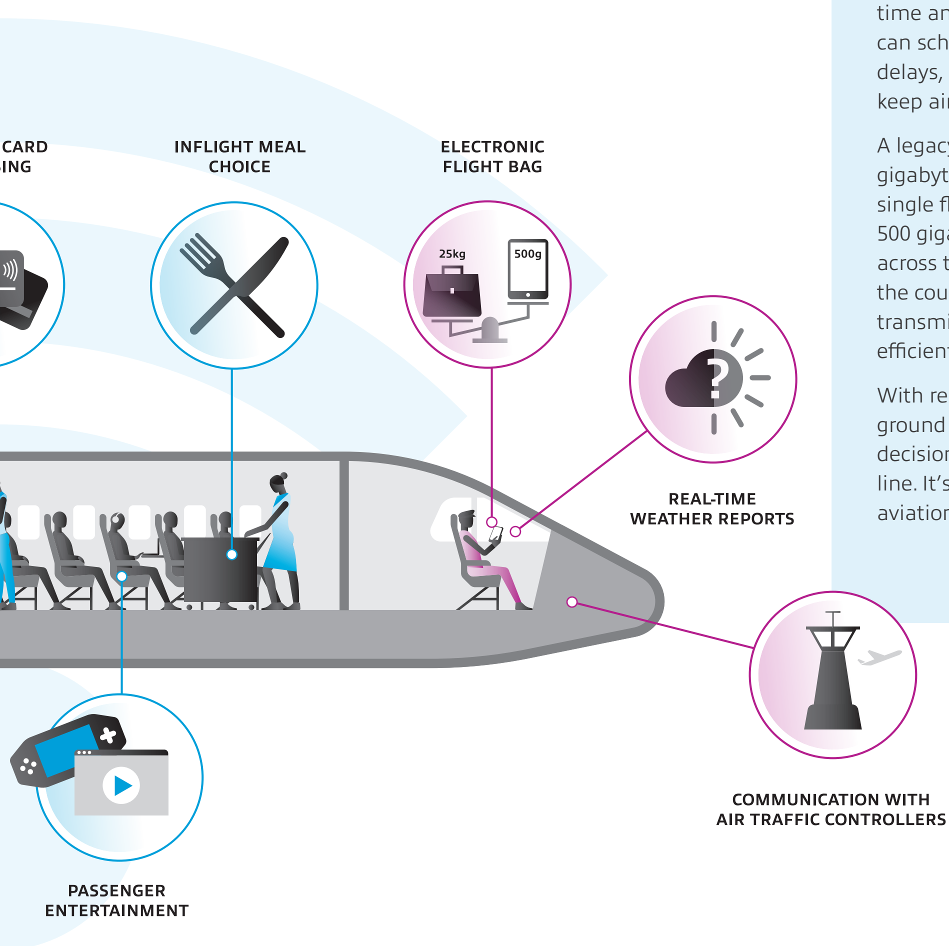
Airlines have used air-to-ground connectivity for operational purposes for decades, relying on the Aircraft Communications Addressing and Reporting System (ACARS) to transmit brief messages between aircraft and ground crews. ACARS was revolutionary in the 1980s and continues to play an integral role in the connected aircraft. ACARS, however, is expensive and limited in its ability to meet the airlines' fast-growing demands for in-depth avionics reports from legacy fleets, not to mention the enormous amounts of data produced by the next-generation of connected aircraft.

The advent of the Internet of Things (IoT), and the connected aircraft itself part of the IoT ecosystem, will open the door to completely new passenger services and provide airlines with a holistic, real-time view of their operations.

New age commercial aircraft engines feature thousands of sensors, constantly monitoring engine wear, oil pressure, and fuel consumption to enable predictive and preventative maintenance programs that can save time and money. By pinpointing engine issues, airlines can schedule maintenance, avoid aircraft downtime and delays, improve turn times, reduce maintenance costs, and keep aircrafts running and passengers travelling on time.

A legacy Boeing 737, for example, generates a mere 3 gigabytes of data from a month of operations, while a single flight by a new Boeing 787 generates more than 500 gigabytes of information from thousands of sensors across the plane, resulting in more than 30 terabytes over the course of a month in flight.[16] Part of this data will be transmitted real-time over high-speed satellite, to ensure efficient and smooth operations.

With real-time information at their fingertips, pilots and ground crews are able to make better, more informed decisions that can have a significant impact on the bottom line. It's estimated the connected aircraft could save the aviation industry more than USD 1 billion annually.[17]



Sky High ROI

Airlines investing in connecting their next-generation aircraft fleets are on the verge of major multifaceted returns – ranging from environmental and operational savings to new revenue-driving services based on the high-performance HTS connectivity.

In fact, the average annual revenue per commercial aircraft (ARPA) is expected to more than double from 2015 levels ranging from USD 125,000 to USD 135,000 to at least USD 300,000 per plane in the next three to five years. The projected growth is expected to be driven largely by increased take rates of high performance global satellite connectivity.[18]

UBIQUITOUS COVERAGE - PRIME AIM OF SES'S SATELLITE SOLUTION

Setting the Pace with Time to Space

Game-changing developments in satellite architectures are enabling demand for aero connectivity to evolve at a velocity unimaginable just a few short years ago. Satellite operators, IFC service providers and airlines are well positioned to meet unforeseen market shifts with the availability and adaptability of high-speed capacity. The global breakout of HTS capacity, with 20 times the bandwidth of conventional satellites, is accelerating the global delivery of enhanced inflight Wi-Fi services, creating a lower total cost and driving up adoption rates in established and developing markets. Delivered across multiple bands, from multiple orbits, the high octane capacity is a big step toward the ubiquitous coverage necessary to facilitate connectivity anywhere. SES goes further by augmenting this capacity with end-to-end solutions that are tailored to the specific needs of customers.

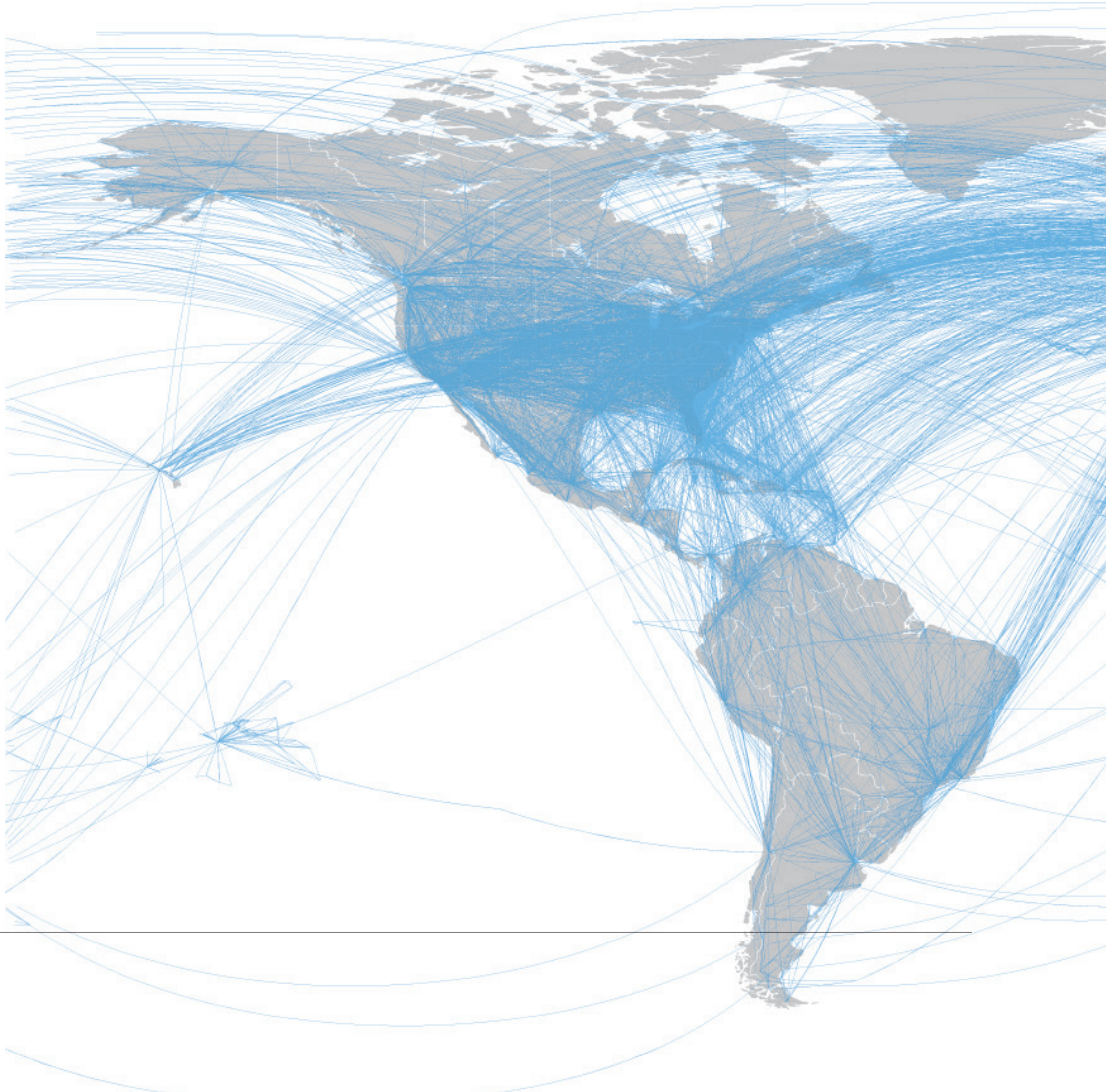
SES is actively involved in the development of revolutionary Ku and Ka-band HTS satellite architectures, providing massive gigabit and terabit capacity levels when and where needed. Expected to debut in 2017, the real power of this new breed of electric, software-defined spacecraft is not only speed to market, but flexibility.

SES is investing billions in expanding its already robust, scalable network of 50+ GEO satellites. The future SES fleet will be made up of C, Ku, and Ka-band, and HTS satellites, which feature high-powered spot beam and wide beam coverage capable of delivering fast, reliable, and secure mobile broadband.

The procurement of SES-17 represents the next dramatic step toward this goal for SES. SES's first GEO HTS satellite in Ka-band is a next-generation satellite that will be interoperable with O3b satellites, and enable SES the flexibility to track the peak usage of airplanes on different routes and at different times of the day. This brand new satellite will characterise SES's organic growth to incrementally serve the connectivity needs of airlines passengers travelling across the Americas and Atlantic Ocean routes.

Another vital aspect of the HTS network that SES is investing millions in is the ground infrastructure architecture. SES already operates a diverse base of ground terminals as well as an extensive network of teleports and hub assets around the world. All of which are interconnected by MPLS and fibre. HTS satellites require a complementary ground segment though, and so half the investment in HTS capability in space actually happens on the ground. In preparation for the first HTS satellite launch in 2017 multiple gateways and antennas have to be built in order to efficiently serve the enterprise, government and mobility sectors with new levels of flexibility in everything

WORLD AERO ROUTES



Source: ICAO projections for 2020

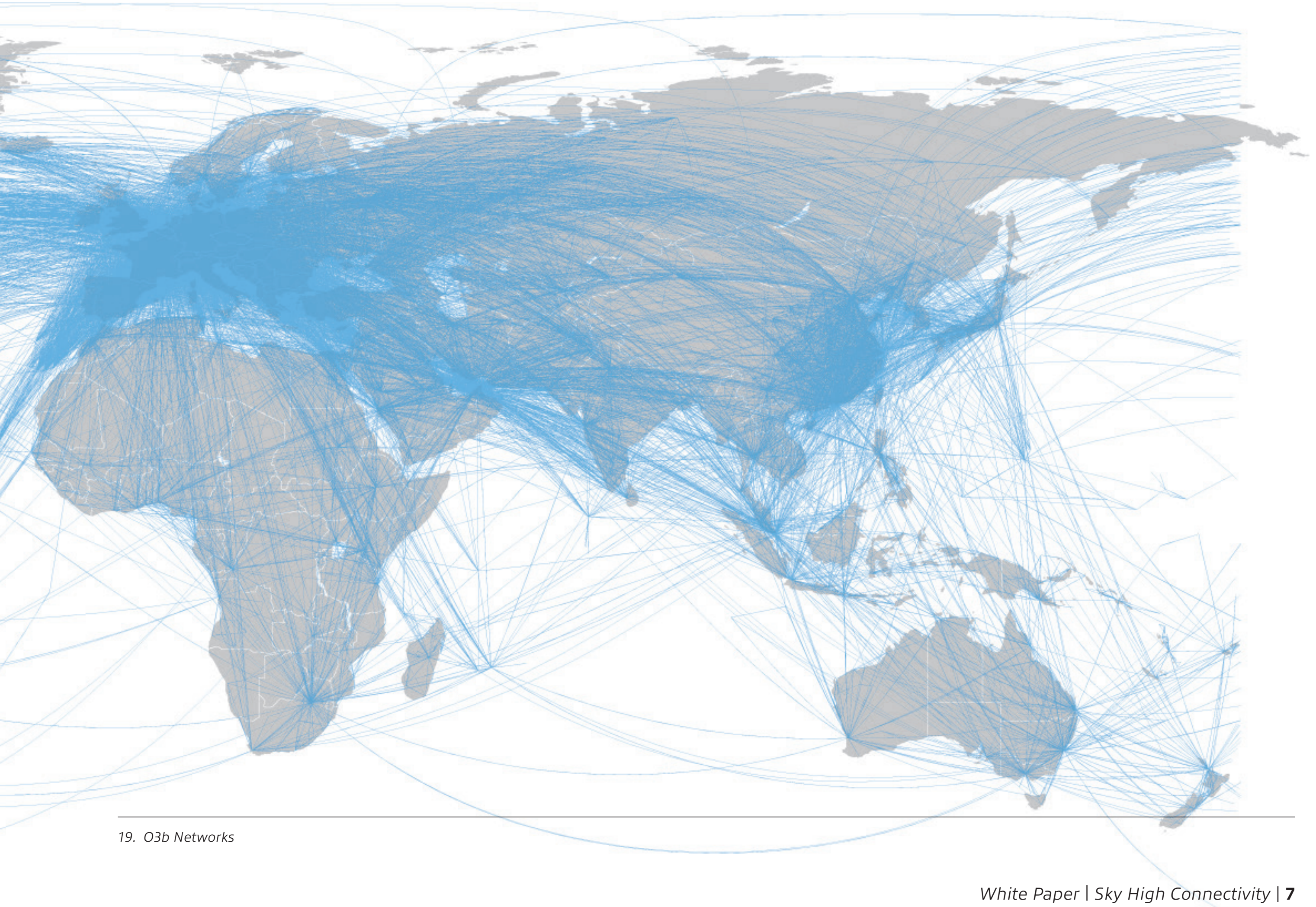
from payload design to capacity reuse. New super nodes and teleports are the brains behind the intelligent and automated routing of data and HTS capacity, which enables connected aircraft worldwide. This enables the distinctive customised solutions SES provides that meet the exact specifications of each different situation and customer.

SES's acquisition of O3b Networks and its growing complementary fleet of Medium Earth Orbit (MEO) Ka-band HTS satellites is expected to further transform inflight connectivity with a unique GEO/MEO solution. O3b has already revolutionised the connected cruise ship passenger experience, with its fibre-in-the-sky offering that delivers up to 1.6 Gbps of throughput per beam at a low latency (tiny delay) of less than 150 milliseconds.[19] Another eight satellites are scheduled to join the scalable O3b constellation in 2018/2019. Successful O3b aero connectivity demonstrations for the US Government have quickly attracted the interest of airlines and inflight connectivity service providers.

SES and O3b are also collaborating closely on the development of a new flat, electronically steerable ground-based antenna optimised for O3b's MEO Ka-band HTS satellites and ultimately SES's GEO fleet. The innovative antenna solution could allow enterprises, governments, and airlines to tap the unprecedented benefits of a combined GEO-MEO HTS offering in the near future. As a complete ecosystem the SES fleet in GEO, O3b's in MEO, and the infrastructure on the ground will come together to lead the way in connectivity for mobility solutions.

CONCLUSION

The future of connectivity is not about one big idea or one big satellite. It requires open minds, systems designed to adapt to new possibilities and a clear focus on very specific market needs. Delivering successful inflight solutions is not about GEO or MEO satellites, but the definition of the value chain and the application at the customer and user's end. Connecting people in the air is not just about what satellites are invisible in the sky above them, but also about the infrastructure on the ground. The interplay between these elements is the key to success, and that is why SES is investing equally in the infrastructure it is building both in space and on the ground, in order to deliver uncompromising quality in the air. By developing technologies, and applying them with precision, new markets ferment and grow into powerful economic drivers. By applying a global approach that is customer focused and scalable SES distinguishes itself in this competitive new market place, fuelling the new phenomenon of connected passenger, aircraft and ship.



19. O3b Networks

With SES, sky high connectivity is ready for take-off.

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