inmarsat aviation

SB-S

Real-time visibility into global operations

The first and only global, secure, IP connection for operations and safety communications

April 2018

BRING IT ON

Contents

Figures

1. Introduction

Inmarsat has a long-standing commitment to aviation safety services: airlines the world over trust our range of market leading, secure and reliable global connectivity solutions that set the standard for flight deck communications. More than 90% of the world's oceanic fleet and over 12,000 aircraft use Inmarsat safety and operational services for communication and surveillance today. In fact, Inmarsat provided 35 million aircraft position reports last year (roughly 100,000 per day) thanks to its satellite network.

With our wholly owned and operated global satellite network powering international commerce, Inmarsat is working with international aviation organisations to make flying safer, faster and more predictable. We are constantly building capabilities that anticipate the diverse and changing requirements of today's customers.

Our newest service for operations and safety, SwiftBroadband-Safety (SB-S), enabled by high-speed, secure IP broadband delivers much faster communications and a host of new safety and operational applications that were never before available. This is a natural evolution of our Classic Aero services, which have served airlines for over 25 years.

Inmarsat Aviation's purpose is to enable the connected world by defining the connected aircraft. We are leading the digital revolution of the complete connected aircraft, provided through a single, wholly-owned network. Using our decades of experience in delivering connectivity to the aviation industry, we're helping airlines navigate the complex choices on this new frontier. We provide innovative solutions for the cabin and passenger connectivity through Inmarsat GX and the European Aviation Network, and for airline safety and operational services through SB-S. Together, these services deliver a unique total connected aircraft solution that meets the safety, regulatory, priority and performance standards demanded for the flight deck, along with the economical connectivity demands of today's airlines passengers.

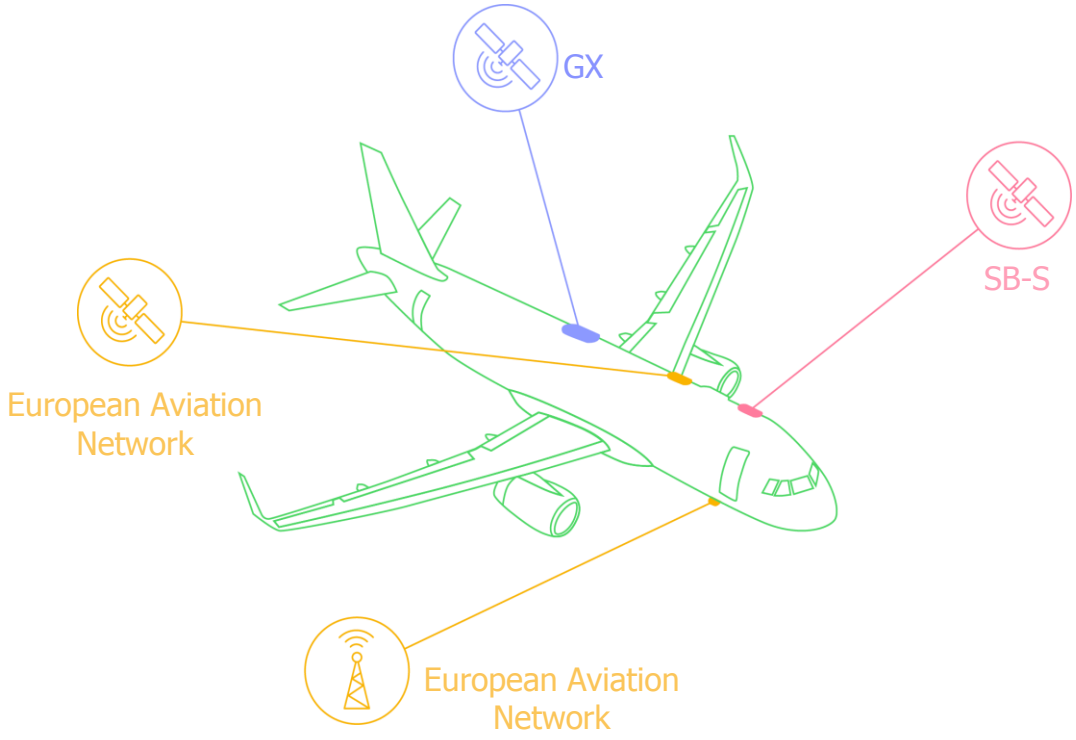

Figure 1: The Inmarsat Complete Connected Aircraft

2. Changing Technology Delivers Major Safety Benefits

To put the power of SB-S in perspective, we can look back through history at another technology that underwent an holistic evolution: the telephone. Long before smartphones put the world at our fingertips, calling someone by telephone could take a full twenty seconds. The telephone was the indispensable technology of the mid-20th century. As we dialled, we began driving the gears of the communications revolution that continues to unfold.

Older telephones were simple, reliable, and invaluable. They did their jobs, and nothing more. The phone continued to evolve incrementally over the decades, but its complete transformation did not occur until when we saw the reinvention of the telephone: the smartphone.

The smartphone's most important feature was not its touchscreen, onscreen keyboard, or its music features. Its greatest achievement was its online application marketplace with a vast selection of third-party applications that allowed us to interact with the world in nearly limitless ways. Infinitely more useful than a basic phone, the smartphone was a powerful small computer always by our side.

Like analogue phones, satellites have provided reliable communications for decades. Today, we are reinventing aviation connectivity the way the smartphone reinvented the telephone: by connecting satellites and airplanes the same way we connect our computers on the ground – with an internet connection provided by SB-S. The high data rates made possible by an IP-enabled cockpit will open multiple opportunities for cockpit safety applications. SB-S offers even better communications and surveillance than our previous offerings, but our IP connection introduces operational efficiency and safety applications that bring the age of digital transformation to aviation.

3. Why We Developed SB-S

Mobile data consumption has increased rapidly over the past decade, with its compound annual growth rate exceeding 100 percent between 2010 and 2014[1]. By 2019, global data consumption is expected to reach approximately 25 exabytes per month – a tenfold increase over 2014[2]. With this explosion of data usage changing how we live and work, it is no surprise that higher data speeds are coming to the cockpit.

> "We have over 50,000 data points now gathered from the performance of the system. And in fact, it's working better than other alternative satellite communication technologies."
>
> **- Dan Smith, Systems Engineering Manager, Hawaiian Airlines**

Modern aircraft generate huge quantities of data from their various systems on a second-by-second basis. The A350 has around 6,000 sensors[3] throughout the plane, capturing details of every aspect of their operation. This big data has immense value if airlines can process it efficiently and in a timely manner. When bigger and better data is refined, analysed, and linked to existing enterprise data, airlines can develop a more detailed and insightful understanding of their business, which can boost productivity and stimulate greater innovation – all of which can significantly influence the bottom line. Better data ultimately leads to better knowledge, allowing pilots to fly more safely and efficiently.

Broadband connectivity is fast becoming a catalyst for change in airline operations. Connectivity is revolutionising our lives at work and home, and airlines are seeking the same solution for the cockpit.

Figure 2: Data Volumes of Modern Aircraft[4]

[1] Ericsson Mobility Report, 2015 WRC Edition
[2] Cisco CNI: 2014-2019 Forecast
[3] https://www.datasciencecentral.com/profiles/blogs/that-s-data-science-airbus-puts-10-000-sensors-in-every-single
[4] http://www.aerospacemanufacturinganddesign.com/article/millions-of-data-points-flying-part2-121914, December 2014; Airline data

4. Inmarsat SB-S

SB-S is the first and only global, secure, IP connection for operations and safety communications, delivering incomparable amounts of protected data everywhere airlines fly. SB-S is a strategic asset that unlocks a new world of digital transformation, making airline operations more efficient and helping to assure safety, delivering game-changing visibility into global airline operations.

Figure 3: SB-S, the First and Only Global IP Service

SB-S builds on the capabilities of earlier cockpit satcom technologies, combining cutting-edge satellite technology with secure IP broadband connectivity. The result is vastly improved operational efficiency and enhanced safety. Always on and always secure, it delivers much faster communications along with a host of new applications that were never before available.

This unlocks operational advantages for airlines. Flight route optimisation and trajectory-based operations save time and fuel. Electronic Flight Bag (EFB) apps such as chart updates and real-time graphical weather assist efficient flight paths. Parts can be pre-positioned for better asset utilisation and improved turnaround through air to ground tech log notifications. Medical diversions can be reduced with the capability for real-time video for telemedicine. High-frequency positional reporting enables reduced separation minima, whilst VoIP and Aircraft Communications Addressing and Reporting System (ACARS) over IP bypass VHF congestion to improve Air Traffic Control (ATC) communications. Safety is enhanced over an encrypted, segregated network. Better than 99.9% L-band availability gate-to-gate worldwide coverage meets ICAO GOLD (Global Operational Data Link Document) standard. It also includes our aircraft position reporting service, which regularly reports latitude, longitude, altitude, speed and true heading.

Using our global L-band satellite network, SB-S delivers speeds several orders of magnitude faster than what is available today, providing airlines with communications fit for the digital age. SB-S uses spot beam technology over Inmarsat's I-4 constellation to dynamically allocate resources to the areas where it is most needed. This helps ensure that safety-critical information is available on-demand for the pilot, the airline, and air traffic controllers.

4.1. A virtual data fortress door

Using the proven and established Inmarsat L-band global network, the SB-S platform is completely isolated from any other systems accessible to passengers, thus creating a virtual data 'fortress door' between cockpit and cabin. Certified for exchange of safety-critical information by ICAO, SB-S supports the full suite of communication, navigation and surveillance capabilities to enable satcom-based air traffic management.

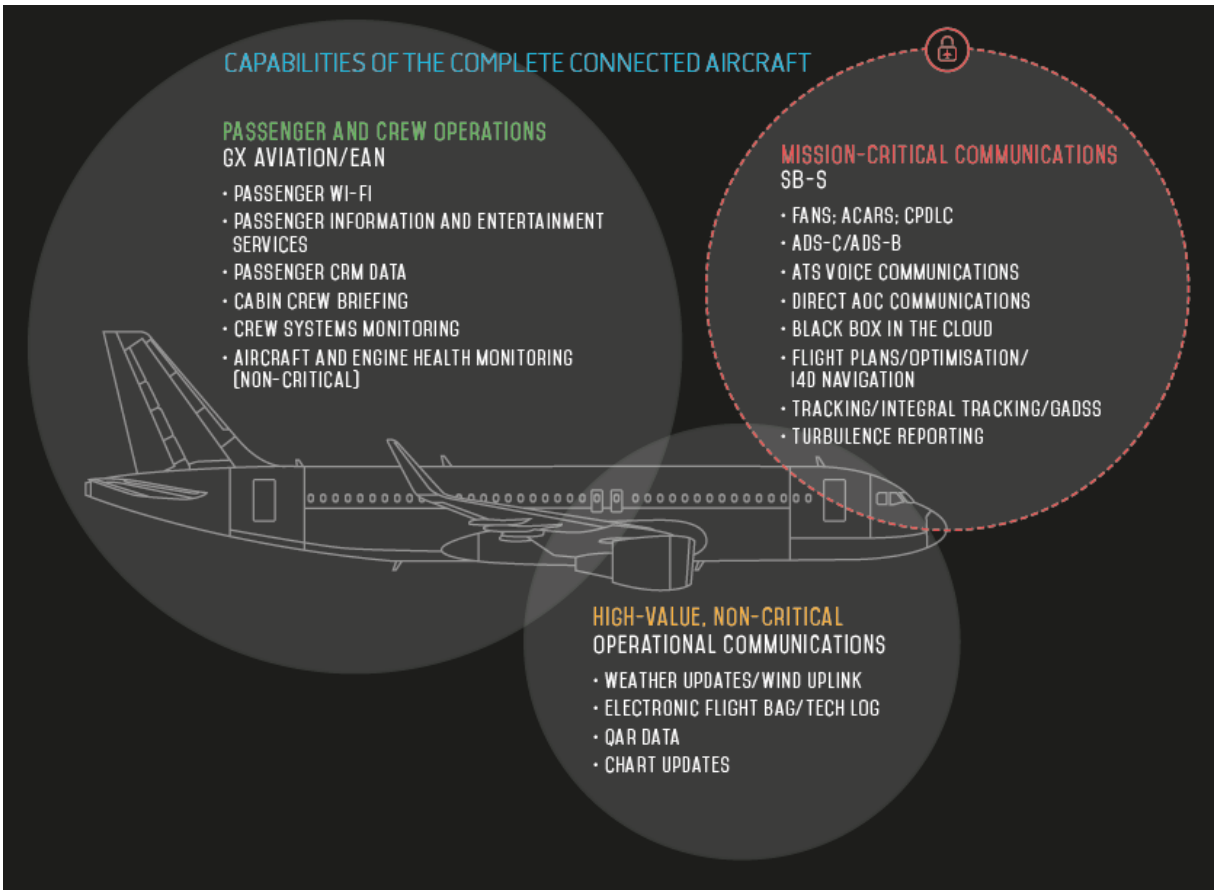

Figure 4: Virtual Fortress Door

Inmarsat's L-band allocation is also protected within the Aeronautical Mobile-Satellite (Radiocommunication) Service (AMS(R)S), a service reserved by the International Telecommunications Union (ITU) for communications relating to safety and regularity of flights on civil air routes.

4.2. Features and Applications

With the capability to increase connectivity in the cockpit comes a number of exciting new safety and operational features and applications, limited only by the speed at which they can be imagined and developed. This section illustrates the new features and applications made possible by SB-S.

> "The amount of information that we can provide to crew members in flight, to the pilot, crew in flight is vastly improved by having this installation on the aircraft."
>
> **- Ken Rewick, Vice President, Flight Operations, Hawaiian Airlines**

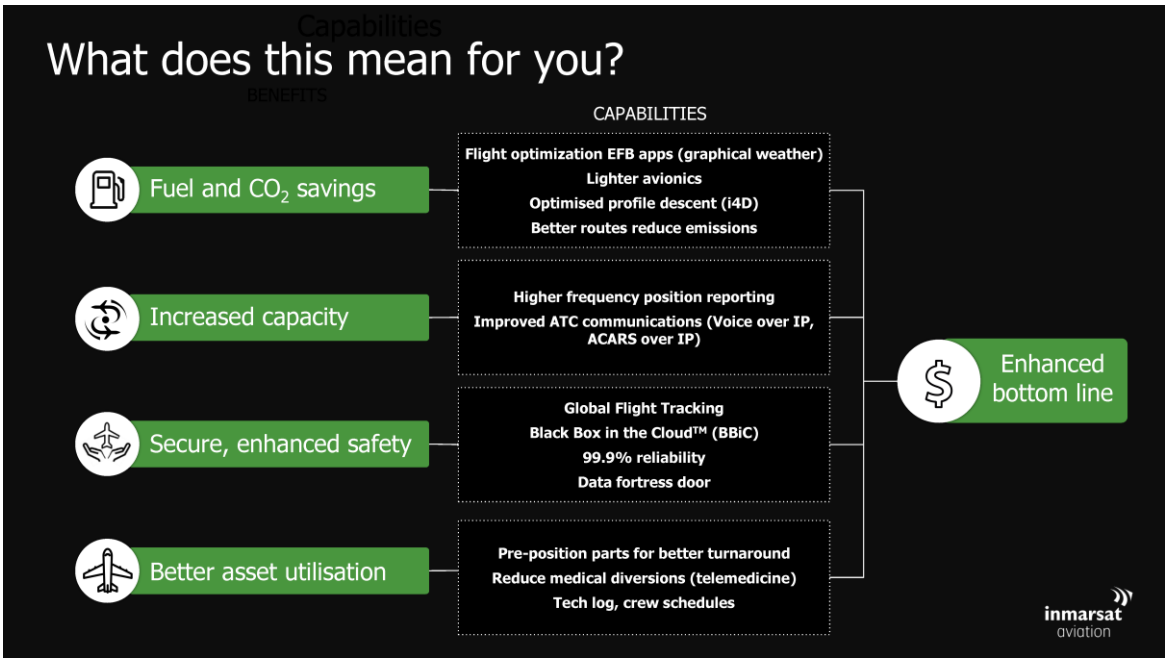

Figure 5: SB-S Benefits and Capabilities

4.2.1. Electronic Flight Bag (EFB)

SB-S delivers real-time, in-air updates to pilot EFBs instead of having to wait for downloads on the ground. Applications include graphical weather, telemedicine, passenger data and aircraft documentation, among others. Graphical weather is predicted to be one of the most popular applications, allowing the pilot to receive real-time updates that supports dynamic routing away from bad weather or strong winds, resulting in fuel savings – with enhanced safety and passenger comfort.

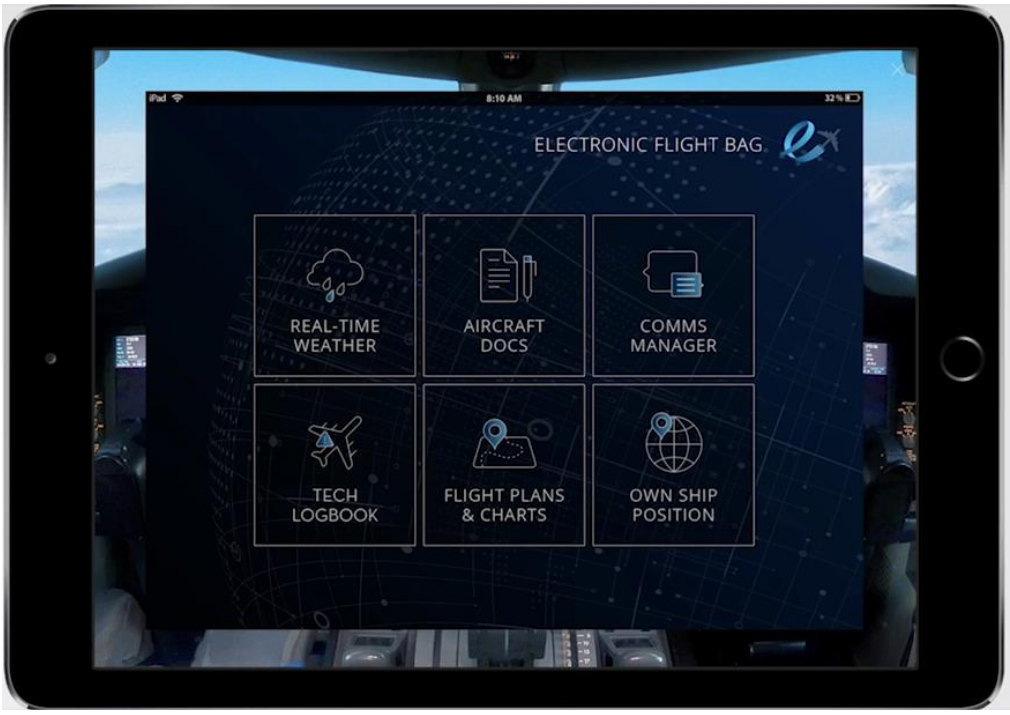

Figure 6: EFB Capabilities

The future of airline operational efficiency, safety, situational awareness and decision support will be enabled by the secure, robust broadband capabilities of Inmarsat's SB-S. Offering throughput hundreds of times greater than current competing services, SB-S will open the door to capabilities previously not considered possible.

4.2.2. Certified Application Partner (CAP) Programme

Inmarsat's new CAP programme is a cutting edge initiative that delivers real-time operational and safety benefits to airlines and air traffic management organisations and allows application developers to access SB-S. The CAP serves as a platform for those wanting to expand their business, increase application usage and open new revenue streams globally. The aim is to offer innovative products that bring operational efficiency, flexibility and benefits to all of Inmarsat's airline partners. By using Inmarsat's SB-S as a platform, new apps will gain exposure to areas otherwise unreachable on land, sea and air.

Below are some examples of SB-S applications that bring powerful benefits to airlines, such as fuel savings, better asset utilisation, increased capacity, and enhanced safety:

> **Charts:** With SB-S, there is no longer a need to collect countless PDFs on your EFB. The charts you need to fly can be calculated and rendered on demand, from various data sources. This will provide detailed and accurate charts which let you precisely fly the required departure, arrival, and approach procedures.

> **Flight optimisation and weather:** Applications use multiple data sources from the aircraft and from the ground to present continuous time or cost-saving opportunities to the flight crew, improving operational efficiency and decision-making.

"From a safety standpoint, if we can deviate around weather sooner or if we have an emergency situation where the aircraft needs to divert to an alternate airport, we get that information out to the air traffic control, to dispatch, other entities in a rapid manner, we get responses rapidly and we can operate safer that way."

- Captain David Valente, Boeing 767 Fleet Captain, Hawaiian Airlines

Real-time high-resolution weather can be reliably and cost-effectively received on the aircraft, whether over the continents or the vast oceans. Not only does such information improve the passenger experience and comfort level, better situational awareness and real-time data can help flight crews avoid unexpected weather and turbulence encounters which can lead to costly inspections, damage or personal injury.

> **Flight Brief/Notice to Airmen (NOTAMS):** SB-S gives you easy and fast access to NOTAMs worldwide. Download notifications for your departure, arrival and destination. Background refresh is also possible, so you know you have the latest information at all times.

> **Airline Operational Control (AOC) Communications:** Take-off and landing confirmation, weather information, fuel use monitoring, gate information, engine reports – SB-S can stream real-time data for quality assurance to help reduce delays and hence reduce compensation claims, unplanned maintenance and fuel bills. It even offers the potential for real-time intervention in developing safety or security situations. Applications and services which interface to aircraft, engine and other systems enable real-time diagnostics to take place on the ground, providing the ability to drill down into data and control the amount and type of information streamed to the ground. From this information, pre-positioning of the right parts, equipment and personnel at the gate can help keep turnaround times on schedule and asset utilisation up.

> **Telemedicine and disruption management:** Diversions due to weather, runway closure, ATC congestion, or in-flight medical emergencies can be costly and disruptive, increasing fuel use, leading to missed connections and incurring other costs. While many of these diversions are medically necessary, some are not. Telemedicine applications enable expert medical professionals to diagnose situations using real-time patient information transmitted from the aircraft to the ground, providing valuable decision support and risk management information to the flight crew.

> **E-tech Logs**: The aircraft technical logbook is the cumbersome maintenance status log that must be carried on board an aircraft whenever it flies. SB-S enables an electronic logbook application for the cockpit that increases the data quality of the log, eliminates the need for paper, and decreases time spent typing the collected defects from the paper book.

> **Airline enterprise mobility applications**: SB-S features document and safety management solutions for an industry with an increasing need for speed and accuracy of information. These applications, through the power of broadband, increase the speed of distributed delivery of graphical, visual and data elements to key airline personnel. These include applications to streamline workflows for flight and cabin crews, reduce paperwork through electronic forms and schedules, improve the availability of accurate, up to date information for the entire operation, and provide accurate records and logs.

These capabilities and accompanying benefits will define the future of airline efficiency and safety, and they are all enabled by the unique advantages of the next generation of broadband flight deck connectivity – SB-S. There has never been a better time to invest in technologies that will drive operational cost savings and efficiencies for the long term.

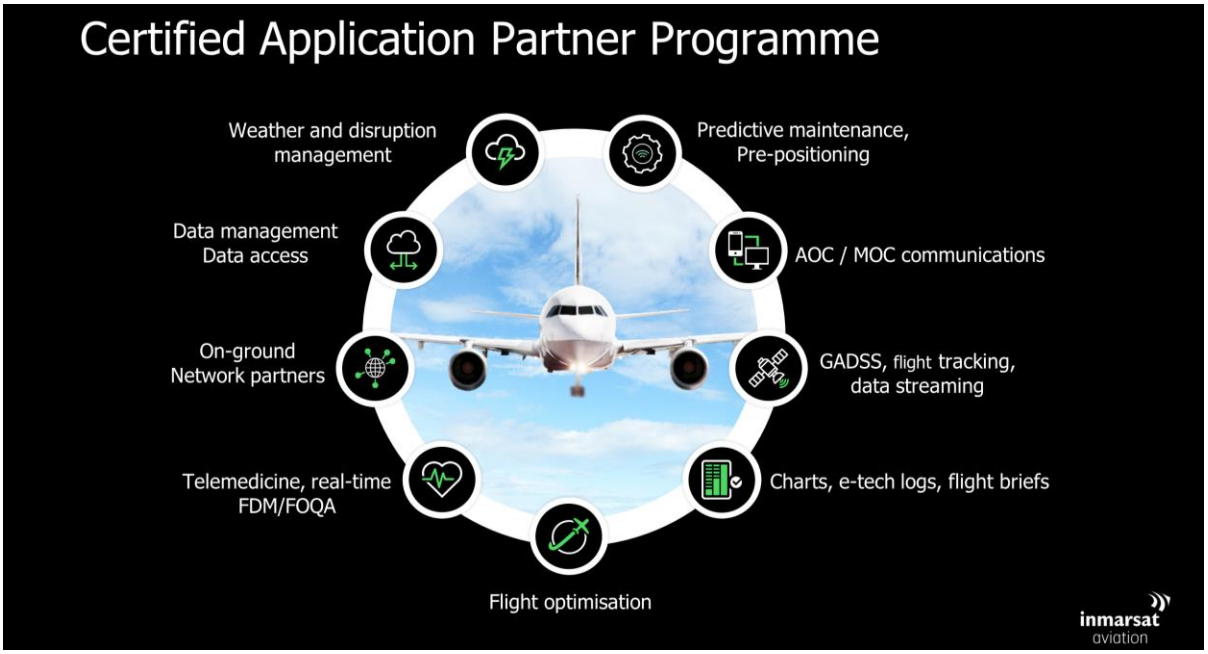

Figure 7: SB-S Applications

4.2.3. Regulated Safety Services over IP

The powerful Air Traffic Services applications that have enabled improved safety and efficiency in oceanic airspace will be faster, stronger, and more reliable on SB-S. With SB-S powering cockpit avionics, surveillance with Automatic Dependent Surveillance – Contract (ADS-C) and communication with CPDLC will help airlines exceed performance standards required by aviation regulators across the world.

Communications - CPDLC

Surveillance – ADS-C

Figure 8: Regulated Safety Services

> "In the past, prior to this system, it would take several minutes to send and receive messages via data link, and now it just take seconds. The quality of voice communication has improved so much that it's like using a telephone, or your cell phone, or a very good landline."
>
> **Captain David Valente, Boeing 767 Fleet Captain, Hawaiian Airlines**

4.2.4. A new platform for Air Navigation Service Providers

SB-S' new secure, IP-based network provides greater speed and capacity, with the quality of service needed for existing worldwide ADS-C, CPDLC, and satellite voice communications, and for applications that are beginning to transform today's air traffic and airline operations. Satcom services (both surveillance and communication) over IP will not only allow ANSPs to achieve further efficiency improvements through reduced separation and increased flexibility, the speed and capacity of satcom (compared to terrestrial systems) are creating opportunities for new, secure IP-based exchanges between the aircraft systems and the ground systems (ATC and AOC).

Initial 4D is a key modernising concept that will be deployed globally bringing the necessary airspace capacity and safety to cope with air traffic growth. With terrestrial data link technologies reaching their capacity limits in the next 10 years, satellite data link is ready to provide this quality of service, on a global basis and in any airspace type (oceanic and continental). SB-S will enable ADS-C Extended Projected Profiles (EPP) for 4D trajectory based operations (TBO): continuous climb and continuous descent, in particular, are expected to result in significant fuel/time savings for airlines and enable ANSPs to safely control more landings and take-offs. Ultimately SB-S will support transition to a full 4D trajectory concept in a multi-link ATM system where Satcom will be one of the primary data link technologies. If 4D operations over SB-S are clearly a major benefit, ANSPs anticipate additional benefits from Satcom (vs terrestrial systems), such as single aircraft fit for all flights and regions, and global coverage allowing ANSPs to get flight data intent much further in advance to better organise airspace management.

4.2.5. Real-time Flight Tracking

Real-time flight tracking, often one of the most talked-about features that will be enabled with SB-S, is a separate and fully automated function that provides regular transmission of position reports and flight performance data – in addition to ADS-C position reports. This real-time flight tracking provides latitude, longitude, altitude, true heading, and groundspeed, at an interval that is configurable from the ground.

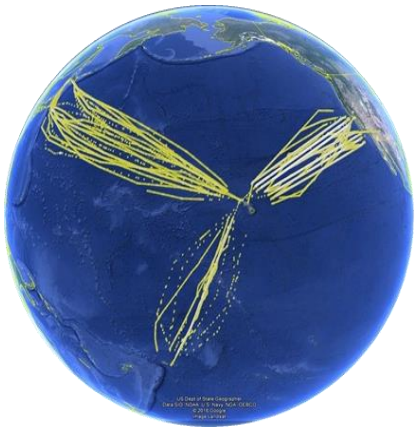

Figure 9: Hawaiian Airlines Routes Using SB-S

4.2.6. Black Box in the Cloud™

Inmarsat has a rich heritage of supporting safety and security on land, sea and air. In fact, it is how our organisation began – as a provider of Safety of Life services at sea. Inmarsat is currently the only Global Maritime Distress and Safety System (GMDSS) satellite safety service provider in the world. The International Civil Aviation Organisation recently developed the Global Aeronautical Distress and Safety System (GADSS) concept, aimed at preventing the loss of aircraft experiencing distress. In the event of an abnormality in flight, an aircraft's position reporting interval must decrease to 1 minute, thereby significantly enhancing the positional awareness of that particular flight. This shortened interval phase is called Autonomous Distress Tracking – and SB-S allows vital Flight Data Recorder information to be streamed off the aircraft in real time, a concept we call the Black Box in the Cloud™.

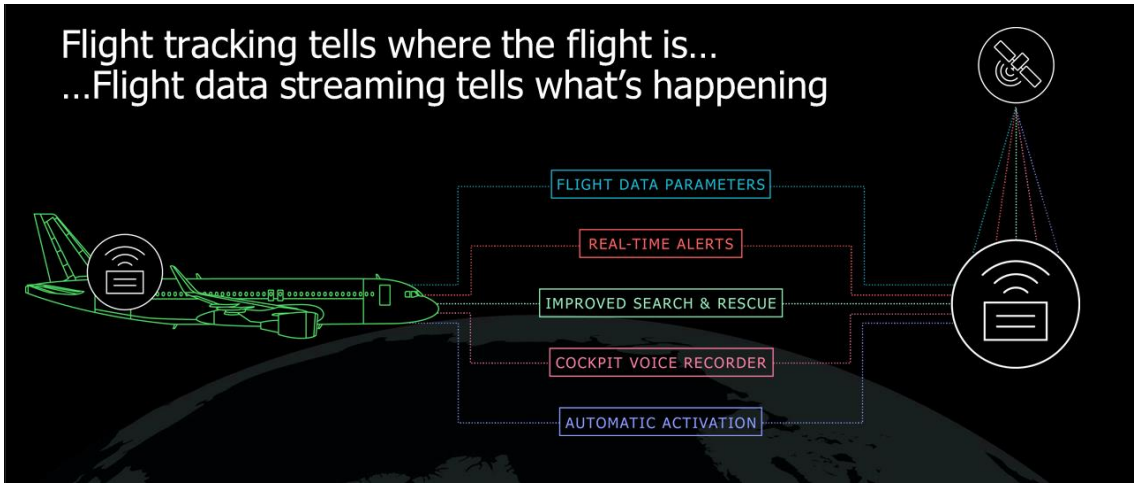

Figure 10: GADSS Concept

4.3. Hardware

SB-S terminals are smaller, lighter, easier to install, more efficient, and generate less heat. Terminals are being produced by Inmarsat's partners Cobham and Honeywell. All terminal types will support global coverage down to 5 degrees elevation, and provide voice and ACARS data performance that is better than Classic Aero and ground-based radio, while also supporting Prioritised IP data communications to the cockpit, as well as the position reporting service. Specifically, SB-S hardware weighs about 6.1 kilos (about 13 pounds) as compared some current systems that can weigh approximately 120 kilos (about 265 pounds). SB-S antennas are about the size of an tablet computer, compared to the current antenna that is the size of a surfboard. SB-S systems are ten times smaller and lighter, yet ten times more capable, and translate into big savings and flexibility for the airline. In many cases, SB-S terminals can replace existing terminals with the ease of 'plug and play.'

Figure 11: Data Volumes of Modern Aircraft[5]

4.4. Availability

SB-S recently received endorsement from the FAA. The Performance Based Aviation Rulemaking Committee Communications Working Group (PARC CWG) announced it will recommend Inmarsat's SB-S for avionics systems that provide direct data link communication between the pilot and an air traffic controller. The PARC based their recommendation on more than two years of operational data that demonstrated SB-S to be a highly reliable platform for aircraft communications and surveillance.

Hawaiian Airlines has been flying with SB-S since 2015, guaranteeing its robustness over oceanic areas. It has now selected the service for installation on its new Airbus A321neo fleet. United Airlines is flying with SB-S with its Boeing 767 aircraft, as is Shenzhen Airlines with its Airbus 320s. SB-S has also been selected by Airbus as a cockpit communications solution for the A320 and A330 aircraft families, establishing SB-S as the flight deck communications platform for the future of aviation.

SB-S is available through a global network of leading distribution partners including SITAONAIR, Rockwell Collins and China Transport Telecommunication Information Group Company Limited (CTTIC) / Aviation Data Communication Corporation (ADCC) in China.

4.5. Security

Cybersecurity is on top of the agenda for virtually every major organisation – whether public or private. As the world's leading provider of global mobile satellite communications, Inmarsat dedicates significant resources to ensuring the protection of its network. Our safety and operational services include the latest security architecture in keeping with the most recent security standards determined by the Radio Technical Commission for Aeronautics (RTCA) and the Airlines Electronic Engineering Committee (AEEC) as agreed to by the aviation industry. These standards establish advanced firewalls and segregation of systems that adhere to the latest software security standards. This protects the integrity of the data at the highest level by keeping each system functioning independently from the others.

[5] http://www.aerospacemanufacturinganddesign.com/article/millions-of-data-points-flying-part2-121914, December 2014; Airline data

5. SB-S Will Power the Next Generation Flight Experience

The aviation industry is booming, and broadband for the cockpit is arriving at the perfect time. The industry has grown 85% in the last 15 years, and about 3.5 billion[6] passengers took flight last year alone – equal to nearly half the world's population. In the next 20 years, that number is expected to double to 7 billion[7] passengers, as aircraft manufacturers are expected to deliver more than 33,000[8] new aircraft.

To accommodate this increased demand for air travel, aviation authorities in North America and Europe are comprehensively overhauling their airspace systems: The FAA's NextGen and similar efforts in Europe such as the Single European Sky ATM Research (SESAR) programme and Iris, are leading the effort to modernise the way air traffic is managed.

SB-S will provide the platform for Iris, a ground-breaking project with the European Space Agency (ESA) that uses satellite-based communication to enhance and modernise air traffic management over Europe. The Iris programme supports SESAR masterplan to alleviate airspace congestion, reduce flight times and delays, and enhance safety and security. The programme will focus on using advanced satellite technology to improve aeronautical data link services, enabling flight plans to be updated continuously, even while aircraft are on route to their destination. This will lead to the significant optimisation of European airspace and airport capacity, in addition to overall reductions in flight times, fuel burn and CO2 emissions.

These modernisation programs will offer momentous benefits – at the highest level they will boost economic vitality, spare the environment from unnecessary emissions, and increase safety – but these benefits would not be possible without the power of satellite networks and systems. Satellites will guide, track, and connect aircraft more precisely and efficiently, allowing us to fit more planes closer together, reduce in-flight delays, and avoid bad weather. And with SB-S, Inmarsat offers the most advanced satellite services in the sky.

Broadband data over IP is the game-changer. Today, our space-based communications technology finally exceeds the capabilities of ground-based data link. Satellite broadband is faster, more robust, and can reach over oceans and continents.

The modernisation of the world's air transportation system is not simply assisted by satellite technology – it *relies* on satellite technology. SB-S is here now – proven and reliable – and ready and able to support airlines and airspace authorities in the next era of air traffic management, delivering improved efficiency and safety, increased capacity, analytics, and cost savings.

[6] http://www.icao.int/Newsroom/Pages/Continuing-Traffic-Growth-and-Record-Airline-Profits-Highlight-2015-Air-Transport-Results.aspx, December 2015

[7] http://www.iata.org/pressroom/pr/Pages/2015-11-26-01.aspx, November 2015

[8] http://www.airbus.com/company/market/global-market-forecast-2016-2035, 2016