Introduction to SwiftBroadband

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Contents

1 Introduction

This document is intended as a high level overview of the SwiftBroadband service. The purpose of this paper is to answer the most common questions posed by end users and partners of Inmarsat.

It is intended for distribution partners, service providers and anyone who wants to use a SwiftBroadband terminal to connect to the Inmarsat Network and use network services. A previous knowledge of satellite communications and avionics is useful, but not essential.

All information contained within is correct at time of publishing. However it is subject to change at the discretion of Inmarsat.

2 Inmarsat

Inmarsat has, since its creation in 1979, been providing Maritime, Land and Aero connectivity solutions over its fleet of geostationary satellites.

The Aeronautical Services introduced on the second and third generation satellites (Aero H, H+, I, L, Mini M Aero and Aero C) are being referred to as "Classic Services". The first Aeronautical service, Aero H, was introduced in 1991, and has become the de facto standard of cockpit data communication for many of the world's airlines and private aircraft, giving Inmarsat a reputation of reliability and longevity.

With the addition of Swift 64, in 2002 the first high speed data service was added to the portfolio and has since proven to be an extremely popular solution for business and military users who need ISDN data connectivity.

With SwiftBroadband, Inmarsat has introducing a high speed IP based data service allowing even higher data throughput at a lower cost than the traditional circuit switched services.

The timeline below shows the history of Inmarsat's Aeronautical Services.
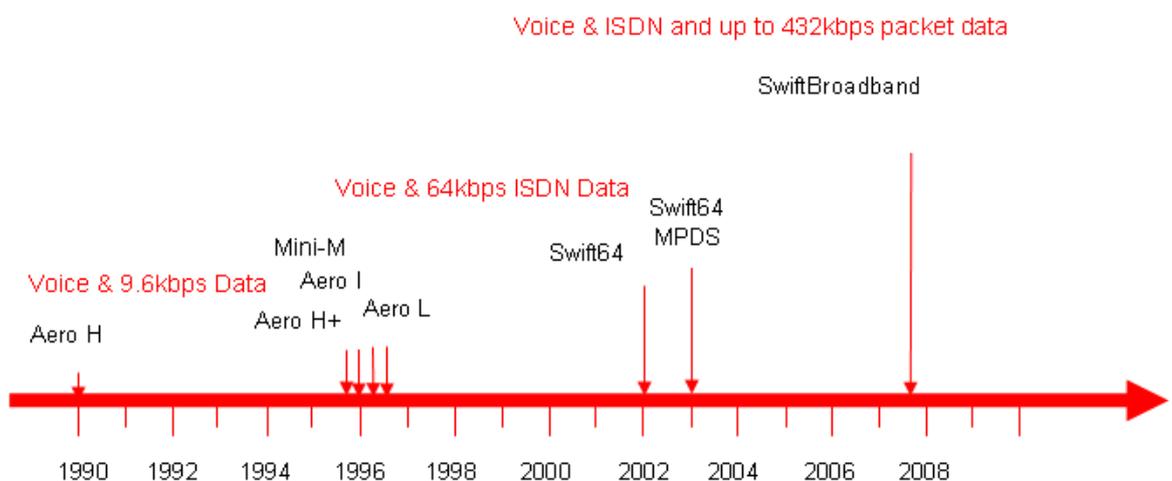
3 Introduction to SwiftBroadband

SwiftBroadband is a UMTS based service which is being provided over the fourth generation of Inmarsat satellites. The main difference between SwiftBroadband and earlier circuit switched services such as Swift 64 is that it provides an "always on" background service and enables higher bandwidth than its predecessors.

3.1 Inmarsat 4 satellites

SwiftBroadband is being provided over a constellation of three Inmarsat 4 (I-4) satellites. The first two were launched in 2005 and the third was launched in 2008.

The I-4 satellites are designed to provide higher bandwidth and to use the L-band spectrum more efficiently than previous generations of satellites. This is achieved by using very narrow spot beams that allows efficient re-use of the available spectrum and to dynamically allocate resources to the areas where it is most needed i.e. the network operates in an analogous manner to a terrestrial GSM network. Each of the I-4 satellites has 16 times the traffic bearing capacity compared to their predecessors.

3.2 SwiftBroadband basics

SwiftBroadband is an IP based packet switched service that provides an always on data connection of up to 432kbps throughput per channel on a contended basis. This is the same model that terrestrial broadband services use and for the end user this means that the performance experienced will vary depending on the number of users transferring data at any given point in time. Inmarsat allow up to for channels to be used per aircraft.

If an application needs guaranteed bandwidth it can request a streaming class which will provide a predetermined quality of service to the application. If the application support it, the system is also able to provide dynamic streaming, allowing a dynamic change between streaming classes without change of PDP context

The streaming classes available are 8, 16, 32, 64, 128kbps and SwiftBroadband X-stream wich offer full channel streaming. The predetermined streaming classes can be combined to a total maximum of 224kbps per channel. This theoretical maximum is dependant on a number of factors such as the class of terminal being used and the angle of elevation to the satellite.

SwiftBroadband will allow for a combination of packet switched services to run concurrently. For example, a streaming class can be used for video conferencing or used by an application while internet browsing and sending emails is also happening in the background over contended IP.

In addition to the packet switched contexts SwiftBroadband provides a high quality voice channel, with the full functionality of traditional phone services and a generic SMS service.

Further, for backward application compatibility SwiftBroadband also provides a circuit switched ISDN line.

Although all the services described above are part of SwiftBroadband, an Avionics manufacturer may choose to omit support for some of these services in their avionics.

The diagram on the next page shows how the different context available in the circuit switched and packet switched domains on each individual channel.

SwiftBroadband channel schematic
Available on each of the channels to the aircraft (Class 6)
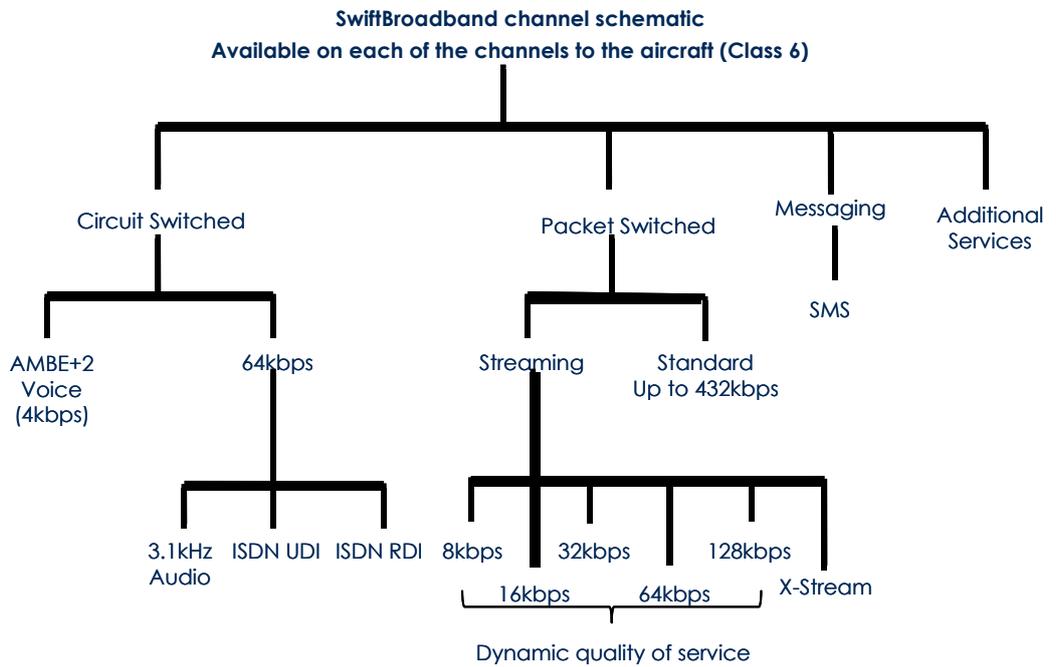
It is possible to have combination of multiple packet switched and circuit switched contexts active at the same time, however only one circuit switched context may be used at a time.

3.3 Availability

SwiftBroadband is available over the Inmarsat 4 satellite constellation, providing near global coverage.
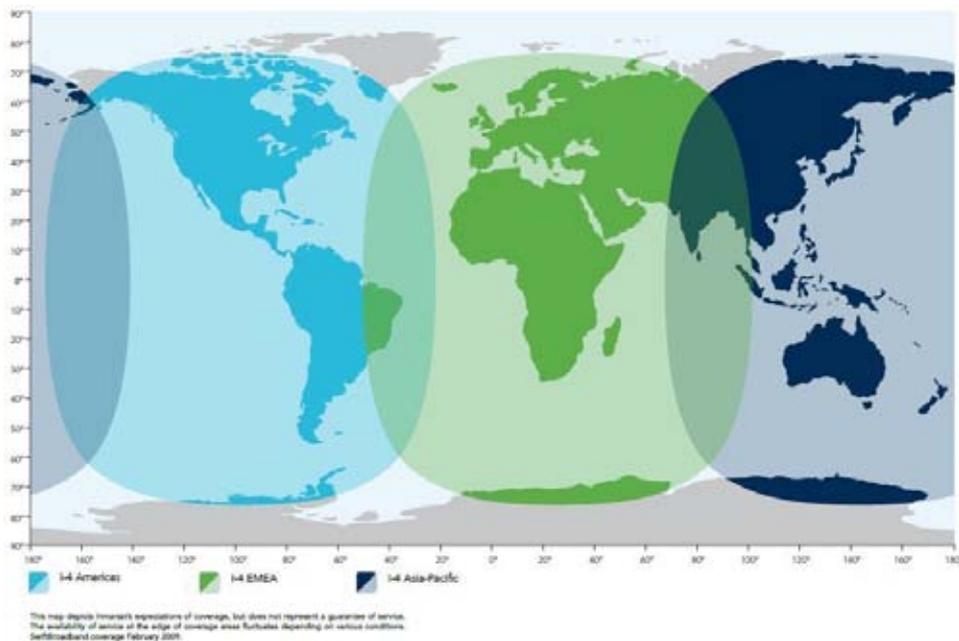
4 Performance and capabilities

4.1 I-4 satellites

SwiftBroadband is delivered through three separate classes of terminals dependant on the gain of the antenna used.

- Class 6 installations utilise a high gain antenna (max 4 channels/ aircraft)
- Class 7 installations utilise an intermediate gain antenna (max 2 channels/ aircraft)
- Class 15 (SB200) installation utilises an omni directional low gain antenna (single channel)

SwiftBroadband baseline performance is dependant on the class of terminal/antenna installed as well a number of factors such as the geography the equipment is operated in and the elevation angle between the antenna and the satellite. The end user performance depends upon the native performance of SwiftBroadband as well as any performance enhancing technologies that are also being used. Examples of these are IP optimisations, data compression and application optimisation.

4.2 SwiftBroadband baseline performance

The basic packet switched IP service provides symmetrical data rates of up to 432kbps/channel over a high gain antenna, up to 332 kbps over an intermediate gain antenna and up to 200 kbps for SB200 using an omni directional antenna. The standard IP mode is an "always on" service which is shared with other concurrent users of the system providing a "best effort" service. The performance an end user will see depends on the satellite loading, the number of concurrent aircraft in a spot beam and the number of users in a particular aircraft.

Depending on the usage, multiple channels (four over a high gain and two over an internedate gain antenna) can provide higher bandwidth as they are treated as separate independent channels by the network, even though they are contained within a single avionics unit.

In addition to the background IP service, the Packet Switched domain also provides streaming classes of 8, 16, 32, 64 or 128kbit/s which will operate in parallel with the background IP service and X-stream full channel streaming up to 218+ kbps. The pre determined straming classes can be combined to achieve a maximum streaming throughput per channel on a high gain installation of 224kbit/s, depending on the elevation angle the antenna operates at and the location of operation. On a multi channel installation it is possible to concurrently utilise streaming on each of the SwiftBroadband channels. When using X-stream this is restricted to two of the channels.

In the Circuit Switched domain the ISDN circuit will provide a 64kbps connection, and SwiftBroadband also provides a dedicated voice channel on the circuit switched service which has been optimised to carry voice.

4.3   SwiftBroadband application performance

To further enhance performance, end user applications can be optimised to extract the maximum performance from SwiftBroadband. Commercial applications have been developed that allow the user to take further advantage of SwiftBroadband by improving the utilisation of the available bandwidth to the end user.

4.4 SwiftBroadband capable solutions

The SwiftBroadband IP connection can be used as a backbone for a variety of solutions and application similar to a terrestrial broadband connection.

It is important to note the difference between satellite-based connectivity and terrestrial connectivity when considering application performance and cost of usage. It is recommended that the applications used are properly configured for use over a satellite link and that relevant IP compression/ acceleration is implemented otherwise the end user experience will be influenced by technical limitations such as latency due to the round trip from the aircraft to the satellite.

Below are some of the most common solutions and applications used over SwiftBroadband either as aircraft embedded solutions (cockpit, seatback etc) or running on the passengers own devices. , together with some key consideration for the implementation. (*For further discussion see the separate "best practice" document)*

Email

The background IP service is ideal for sending and receiving emails.

Consideration:

Reduce unnecessary email replication and minimize traffic by only downloading email headers.

Internet access

The background IP service is best suited for internet browsing.

Consideration:

The latency will make web browsing feel slightly slower than on a terrestrial connection. If possible, it is recommended that internet content is being cached on the server in the aircraft.

VPN

Standard IP is suitable for VPN connections.

Consideration:

Standard VPN solutions generate background traffic when keeping the connection alive. Due to the latency it is sometimes necessary to adjust the time out value on the VPN connection. If multiple users on the aircraft are accessing the same VPN server it is recommended that a local VPN server is implemented on the aircraft to reduce the cost of sending duplicated traffic over the satellite link.

FTP

Background IP is optimised for sending and receiving files.

Consideration:

The cost of file transfer can be significantly reduced by using file compression.

Voice

Voice calls can be made over the native Voice service in SwiftBroadband or as Voice over IP, either as a part of a dedicated VoIP solution or using third party VoIP software on the passenger's computers.

Consideration:

The native voice service provides a high quality bandwidth efficient voice service. However, use of a streaming context might be required to guarantee a consistent quality of service for a VoIP service for multiple users.

Fax

Fax can be sent using either the voice service in SwiftBroadband or using a fax over IP solution.

Consideration:

Fax over the voice circuit requires a traditional fax machine, utilising a fax over IP solution requires a laptop/scanner/printer for sending or receiving paper based faxes.

Video conferencing

SwiftBroadband is suitable for use with most video conference equipment that can use an IP connection.

Consideration:

Use of a suitable streaming class is recommended to guarantee the quality of the video conferencing session.

IFE integration

SwiftBroadband can be used as the communication link between the head end of an IFE system and the ground.

Considerations:

To ensure the most cost efficient operation it is recommended that as much content as possible is stored on the aircraft servers and only time critical information and updates are transferred to the aircraft over the satellite link.

GSM/GPRS/Cell phone use in aircraft

SwiftBroadband is being used as the backbone for the cell phone/GSM in aircraft solutions - these are being developed by AeroMobile and OnAir for both data and voice usage. These solutions will allow passengers to use their own devices to make phone calls, text messages and emails.

Consideration:

Depending on the projected usage a traditional phone service might prove to be more cost efficient alternative is some types of aircraft

5 How to obtain SwiftBroadband

5.1 SwiftBroadband requirements

To operate SwiftBroadband on aircraft the following is required:

- SwiftBroadband Avionics, the satellite modem that accesses the service
- Aircraft Antenna capable of receiving SwiftBroadband and related equipment such as Diplexer, LNA, HPA and cabling
- An agreement with a SwiftBroadband service provider who handles service provision and billing

Depending on individual circumstances the technical requirements of the above may require the end user to:

- Complete a new SwiftBroadband installation on the aircraft *(see 7.2)*
- Upgrade existing "SwiftBroadband Ready Avionics" *(see 7.3)*
- Upgrade existing Inmarsat equipment to become SwiftBroadband capable *(see 7.4)*
- Compliment an existing Inmarsat installation with SwiftBroadband avionics *(see 7.5)*

These scenarios are outlined below in more detail. In all instances it is strongly recommended that you consult with your avionics and antenna manufacturers who will be able to advise in detail, what option applies to each installation.

5.2 Complete a new SwiftBroadband installation on the aircraft

This section explains what is required to equip an aircraft without any previous Inmarsat services with SwiftBroadband.

On an aircraft without any Inmarsat equipment installed there is a choice between SwiftBroadband only avionics and avionics that provide both classic aeronautical services (for safety services) and SwiftBroadband.

When selecting an antenna the choice is between a high gain and low gain antenna, which determines the data throughput and if it is going to be mounted in the tail or on the fuselage.

If ordering a new aircraft SwiftBroadband might already be on the option list depending on the manufacturer. In a retrofit situation any of the avionics manufacturers will be able to provide advice regarding what combination on avionics and antenna would be suitable for a particular aircraft.

5.3 Upgrade existing "SwiftBroadband Ready Avionics"

This section explains the process of upgrading existing "SwiftBroadband Ready Avionics".

Aircraft with recent Swift 64 installations are often referred to as having "SwiftBroadband Ready Avionics". Each avionics manufacturer will have their own programs for providing the necessary upgrade to operate SwiftBroadband. Depending on the avionics, antenna and diplexer installed this could include a software upgrade, hardware upgrade or a combination of both.

5.4 Upgrade existing Inmarsat equipment to become SwiftBroadband capable

This section explains what is required to replace their existing avionics with SwiftBroadband capable avionics.

In situations where the existing avionics installed are not "SwiftBroadband Ready" an upgrade must be undertaken where the existing avionics are replaced with SwiftBroadband capable avionics. Depending on whether the requirement is to continue using classic aeronautical services (safety services) together with SwiftBroadband or stand alone SwiftBroadband the existing avionics are being replaced with a new unit which will be providing SwiftBroadband only or a combination of classic aeronautical services and SwiftBroadband. Depending on if the antenna already installed on the aircraft fulfil the technical requirements for SwiftBroadband it can be used for both services. In some instances a change of antenna and diplexer might be required.

5.5 Complement existing Inmarsat installation with SwiftBroadband avionics

This section explains how to compliment an existing Inmarsat installation with SwiftBroadband capable avionics.

On aircraft with an existing installation of classic services (safety services) the existing installation can be complimented with the addition of stand alone SwiftBroadband avionics. In this scenario both systems would be using the same antenna. Depending on if the antenna already installed on the aircraft fulfil the technical requirements for SwiftBroadband it can be used for both services. In some instances a change of antenna and diplexer might be required.

5.6 How to upgrade existing antennae and avionics

Depending on the equipment already installed on the aircraft users of Inmarsat classic services like Aero H/H+, I and Swift 64 who upgrade to SwiftBroadband can expect the following type of SwiftBroadband services.

Existing service	Class 6 (HGA)	Class 7 (IGA)	Class 15 (SB200)
Swift 64	Yes	No	No
Aero H	Yes	No	No
Aero H+	Yes	No	No
Aero I	n/a	Yes	Yes
Aero L	n/a	n/a	Yes
Mini M Aero	n/a	n/a	Yes
Aero C	n/a	n/a	n/a

The upgrade to SwiftBroadband is conducted via one of the following generic processes:

- Software upgrade (Some "SwiftBroadband Ready" Swift 64 avionics)
- Avionics upgrade (some Classic Aero Avionics and some Swift 64 avionics)
- Avionics and associated equipment upgrade (some Classic Aero Avionics and some Swift 64 avionics)

The minimum update requirement to operate SwiftBroadband on an existing aircraft installation is a software upgrade; this is applicable when the aircraft is equipped with a "SwiftBroadband Ready" installation.

If the avionics onboard the aircraft is either Classic Aero only, or an older Swift 64 installation, a hardware change of the avionics is probably required to be able to get SwiftBroadband.

Other situations may require replacement or upgrading of associated equipment like cabling, diplexer, HPA etc to achieve the minimum requirement for SwiftBroadband compatibility.

It is necessary to consult with relevant avionics and antenna manufacturers to establish the upgrade path for each particular aircraft configuration

6 Avionics availability

Aircraft manufacturer /OEMs have their own timetables for when avionics are being certified on their airframes.

It is recommended that the avionics manufacturers and the aircraft manufacturer are consulted on if SwiftBroadband avionics will be availability for any specific aircraft.

6.1 Avionics type approval

The type approval process for SwiftBroadband is different to Swift 64 as the whole instillation as well as its constituent parts need to be type approved by Inmarsat.

The four major components (DLNA, HPA, Antenna and SB terminal) have to be individually type approved by Inmarsat. In addition the combination of components has to be tested and the results submitted to Inmarsat for assessment.

Combinations which have already been assessed can be found in the type approved list, A combination that has already been approved and can be installed without further testing

The current list of type approved equipment is available on the Inmarsat website:
www.inmarsat.com/support/swiftbroadband

6.2 Pricing and billing principles

There are two types of pricing for SwiftBroadband services, time based and volume based.

In the packet switched domain the background IP service and the SMS service are charged by the volume of data transferred, while the streaming classes and all the circuit switched services (ISDN and Voice) are charged by the time the service is being used.

SwiftBroadband channel schematic

Available on each of the channels to the aircraft (Class 6)
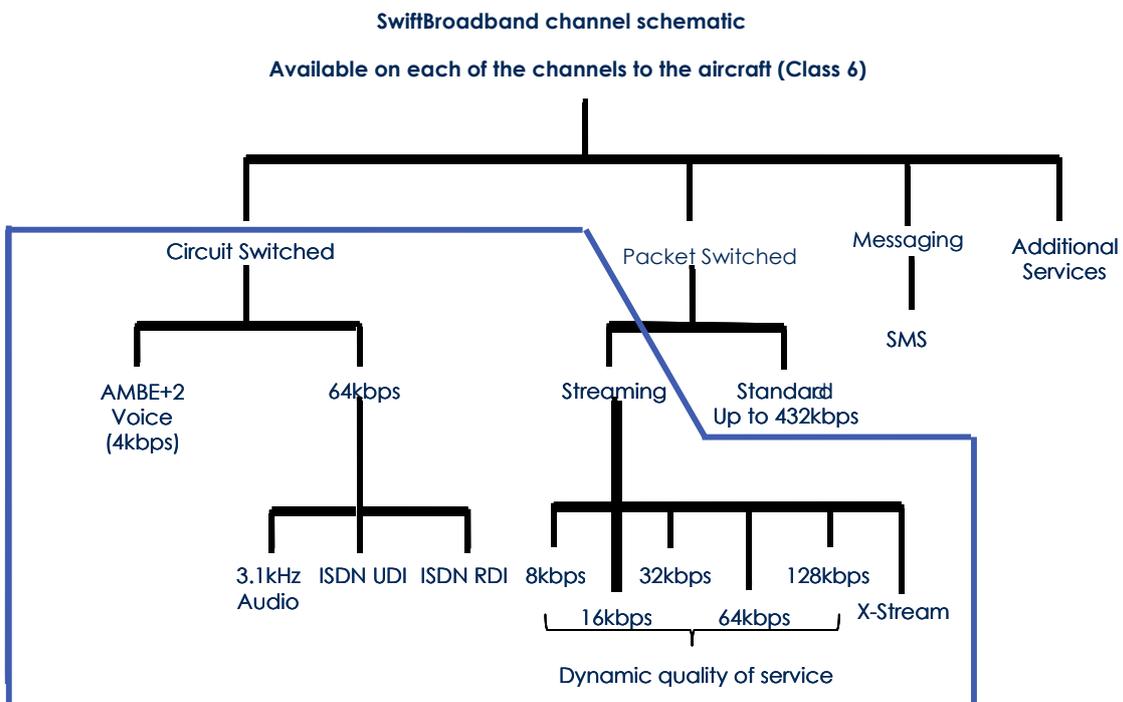
SwiftBroadband is billed by the services provider and any questions relating to pricing packages and billing should be directed to the selected service provider.

7 SwiftBroadband and Classic Services

In order to provide access to both SwiftBroadband and Safety Services over the same aircraft antenna, a subset of Inmarsat Classic Services are being provided in parallel with SwiftBroadband on the I-4 satellites. The

Service	I-3 satellites		I-4 satellites	
	Voice	Data	Voice	Data**)
Swift 64	✓	✓	n/a	n/a
SwiftBroadband (including SB200)	n/a	n/a	✓	✓
Aero H+	✓	✓	✓ *)	✓
Aero H	✓	✓	n/a	✓
Aero I	✓	✓	n/a	✓
Aero L	n/a	✓	n/a	✓
Mini M Aero	✓	n/a	n/a	n/a
Aero C	n/a	✓	n/a	n/a
*) Only C8400 supported, C21000 not supported				
**) Data on I4 satellites = Data 2 & Data 3 only				

8   Future enhancements

Over the coming years Inmarsat are planning to implement further enhancements to the SwiftBroadband service. The enhancements currently being planned are:

Safety services on SwiftBroadband

Inmarsat are working closely with our partners, relevant Industry bodies and has a program in place to introduce Safety Services over SwiftBroadband by 2013. Safety Services over SwiftBroadband is expected to reduce the cost of Safety Services with up to 1/3 compared to the existing services and will bring additional functionality and benefits like prioritised high speed IP data to the cockpit which can be used for EFB and operational applications.

Increased throughput

Through the introduction of HDR (High Data Rate) bearers, Inmarsat will be able to increase the throughput of the X-stream service up to 700kbps. This upgrade is planned for the end of 2012 with service availability currently scheduled for beginning of 2013.

Helicopter Waveform

Inmarsat are upgrading our network to enable the use of SwiftBroadband services on rotary wing platforms. This upgrade is planned for the end of 2012 with service availability currently scheduled for beginning of 2013.