There are several elements to configuring a modern IFE system. These include the selection and provisioning of an external cabin connectivity and one of several main cabin IFE systems. The product offerings of the main IFEC providers are reviewed.

IFE & connectivity providers survey

Configuring a complete in-flight entertainment and connectivity (IFEC) system involves several stages. Modern IFE systems include external connectivity to allow passengers to engage in different activities.

There are six main elements to configuring a modern IFE system: choosing an appropriate system for external connectivity; securing an external connectivity service contract; selecting an IFE and internal connectivity system and the relevant hardware; selecting and acquiring any relevant ancillary hardware; completing all the necessary engineering design and certification for installation with the rest of the aircraft's hardware; and acquiring the appropriate content.

The main suppliers in each of these elements are identified in this survey. Many offer products for more than one element. Systems were traditionally configured by considering each element separately, starting with the type of service an airline wants to offer, followed by hardware and connectivity service selection, and engineering and installation design. Many or all of these stages are the remit of airlines' commercial, marketing, passenger service and engineering departments.

The modern approach to system configuration is for the airline to define what services it requires. The remainder of the process can then be sub-contracted to specialists that complete the configuration of all the relevant systems for the airline. This includes integrating it with the aircraft, and even financing the system or leasing it to the airline, so that the entire system is taken care of as a complete package. An example of a complete service provider is PaxLife of Potsdam, Germany.

External connectivity systems

Although airlines start the process of IFE system configuration by determining the type and standard of service they want, the external connectivity system chosen has the largest influence over what services can be provided in the passenger cabin.

The lowest external connectivity downlink rates of 1-2 megabits per second (Mbps) are required for e-mail, text messaging and voice calls. Higher rates of at least 3Mbps are required for internet browsing and live credit card transactions.

The transmission rates required for live TV are at least 1Mbps per channel. US carrier jetBlue provides 36 channels, and so requires an external connectivity downlink rate of at least 36Mbps for this service. Experience has shown that an external connectivity rate of 70Mbps is required for this, when combined with other services.

The highest external connectivity transmission rates of 1-2Mbps per passenger using the service are required for streaming live visual content from the ground, known as video on demand (VoD). This includes live TV and movies from ground-based providers, such as Netflix, so a downlink rate to the aircraft of at least 50Mbps, and probably 100Mbps, would be required.

The external connectivity systems are either air-to-ground (ATG) or satellite communication (Satcom) systems.

ATG systems are those that transmit signals to the aircraft from ground-based antennae, and so are only effective when operating over land masses. Satcom systems transmit signals from ground-based antennae via satellites to the aircraft. This allows aircraft to receive signals while operating both over the ground and over extensive areas of water.

Once external signals are received by an antenna or antennae on the aircraft, the aircraft's IFE system requires a wireless internal connectivity system to make signals available to passenger seats and the cabin crew. This is achieved by using wireless access points (WAPs) installed in the cabin ceiling.

ATG systems

There is currently only one ATG service in the world available to airlines, provided by Gogo in North America.

Gogo

Based in Illinois, USA Gogo has a licence for a 3Mhz bandwidth of cellular transmissions from 200 ground transmitters located across North America. It uses these transmitters to provide its ATG service, which has been used by a large number of North American carriers to offer either complimentary or paid-for in-flight internet access. The service is also used by the business aviation market.

Several variants of ATG have been launched. The first had a transmission rate of 3Mbps, allowing e-mail, text messaging, phone calls and internet browsing. A later variant has a transmission rate of 10Mbps.

Gogo's customers for these services include Aeromexico, American Airlines, Air Canada, Alaska Airlines, Delta Air Lines, GOL, United Airlines and Virgin America.

Inmarsat

Inmarsat is an international satellite provider, with offices in London, Geneva, Dubai, Washington, DC and Singapore. It

Embedded IFE systems have increased in sophistication. This includes a larger choice of content for the user, the streaming of content wirelessly from a server, and the use of remote controls and secondary screens for systems in premium class cabins.

has 1,600 staff globally. Originally it provided satellite systems for maritime services, but it has since added other industries and applications.

Similar to Gogo's ATG in North America, Inmarsat will be launching a system in Europe called S-band. This will provide coverage in the airspace of the 28 countries in the European Union (EU), and cover the Mediterranean, North Sea and the Bay of Biscay.

The transmissions will emit cellular signals from a network of towers, with a data transmission rate of 70Mbps, on the European mainland.

Satcom systems

The three main categories of satcom transmissions are L-band, Ku-band and K-band.

L-band is mainly used for flightdeck communications because the radio waves are not attenuated by water droplets, and are therefore stable. L-band, however, has a low transmission rate of just 480 kilobits per second (Kbps), making it suitable only for a limited service of phone calls, text messaging and low-level internet browsing.

Ku-band

K-band waves are attenuated by water droplets, so they can experience interference from clouds and rain, but they have high data transmission rates.

Ku-band satellites operate at low orbits in large numbers, so they provide full global coverage, including over the polar regions.

Ku-band satellites were originally used for live TV transmissions into domestic homes, and were later adapted for other applications and industries.

Ku-band satellites are operated by companies that include Eutelsat, Intelsat, Hughes and SES. These companies have a limited number of satellites that only provide regional coverage. No Ku-band satellite company has global coverage, so the use of several Ku-band satcom operators has to be patched together to achieve global coverage. This is often done through a satellite service provider.

The older variant of K-band is Ku-band. Ku-band satellites were first launched in the 1960s, using widebeam technology, and providing data transmission rates of 1-2Mbps. The latest Ku-band satellites have higher downlink rates of 10Mbs, and future generations of high throughput satellites (HTS) have transmission rates of at least 30Mbps.

Intelsat

Intelsat is headquartered in Luxembourg, but has offices around the world. It has a constellation of Galaxy Ku-band satellites that provide various regional services.

These include six satellites for the USA and Canada, one for the whole of North America and the Caribbean, one for South Africa, one for Brazil, and one for the whole of South America.

Besides aviation and air transport, Intelsat provides satcom operations for a variety of other applications. It does not provide Ku-band services directly to the airlines; instead its satcom system is provided as a service to airlines via connectivity providers.

Eutelsat

France's Eutelsat has a fleet of 38 Ku-band and Ka-band satellites.

Its Ku-band satellites are earlier generation K-band satellites, and most of its fleet are Ku-band satellites, and a minority are Ka-band satellites.

The satellite fleet is in geostationary orbit. Each provides regional coverage, and the area of the globe covered stretches from 116 degrees west to 72 degrees east.

Each satellite provides coverage to a specific region. The westernmost satellites reach to the West Coast of the US, as well providing coverage to all of Central and South America. The eastern satellites provide coverage to most of the Asia Pacific and Oceania regions, including Australia and New Zealand.

Like Intelsat, Eutelsat does not provide services directly to airlines. Its Ku-band coverage is offered to airlines via connectivity providers.

Hughes

Based in Maryland, USA, Hughes has a fleet of Ku- and Ka-band satellites.

Some of its constellations are new-generation satellites with high data transmissions rates of up to 10Mbps. The system is good for high-quality audio and visual content.

Hughes operates purely as a satellite operator, and offers its service via connectivity provider GEE, previously known as Row44. GEE uses the Hughes satellite operation to provide Southwest Airlines external satcom connectivity for its in-flight broadband connectivity and internet protocol (I.P.) live TV service (IPTV).

SES

SES is headquartered in Luxembourg. It has fleet of more than 30 Ku-band satellites, subdivided across five generations.

The first generation is AMC satellites that were launched from 1996 to 2008, equipped with 16-24 transponders. The second generation is the fleet of 12 Astra Ku-band satellites with 22-56

IFE systems in premium cabins provide both sophisticated embedded IFE systems together with in-cabin WiFi for the use of personal electronic devices (PEDs). Many airlines are also providing USB ports for users to charge their devices.

transponders, launched from 2006 to 2014. The third generation of NSS satellites was launched from 2002 to 2009, with 28-60 transponders. The fourth generation is the SES satellites, the first of which was launched in 2010. Nine have been launched to date, with 12-81 transponders. The fifth generation is a YAHSAT satellite that was launched in 2011, with 23 spotbeams.

All five generations provide regional coverage in concentrated locations. The main land masses are covered, with the exception of the Russian Federation and many countries in the Commonwealth of Independent States (CIS). The only ocean to receive any significant coverage is the Atlantic.

SES does not provide Ku-band services directly to airlines.

Ka-band

Ka-band is a later generation K-band Satcom system. The first K-band satellites used spotbeam technology and had one transponder per spotbeam. Modern generation satellites have 5-10 transponders per spotbeam.

Future generations of Ka-band satellites will operate at high frequency spectrums, so each transponder will operate at downlink data transmission rates of about 500Mbps.

The satellites could also have multiple transponders, further increasing the data transmission rates.

Inmarsat

Inmarsat is the only satellite operator to have a constellation of Ka-band satellites that provides full global coverage.

Its current Global Express (GX) fifth-generation I5 satellites have data transmission rates of 4-5 gigabits per second (Gbps). It has four I5 satellites in geostationary orbit at 36,000km above the earth's surface, at various degrees of longitude around the Equator, providing almost full global coverage. Only the polar regions are not within visual range of the satellites' transmissions.

Two of the four satellites are at intervals of 120 degrees of longitude around the Equator, and cover the Pacific Ocean and from Eastern Europe to the Asia Pacific. The other two are at closer degrees of longitude, providing more concentrated coverage over the Americas and Europe.

Two more I5 satellites may be launched in 2021-22 to provide additional data transmission capacity.

Each I5 satellite has 72 transponders that are simultaneously active. The I5 satellites also have six steerable, high-capacity beams that can provide extra capacity in areas of high demand when needed.

There are several transponders for each beam, so each beam has the same capacity of a transponder on a Ku-band satellite. Each Ka-band beam is, therefore, concentrated over a smaller area of the world.

The data transmission downlink rates to the aircraft are 50Mbps per beam, and 4-5 gigabits per second (Gbps) for the whole satellite.

Inmarsat's Ka-band GX service is not provided directly to airlines, but via several connectivity providers instead, including Gogo, Honeywell, Rockwell Collins, SITA OnAir, and Thales.

ViaSat

US company ViaSat from California provides regional coverage with Ka-band.

ViaSat has three satellites all providing Ka-band coverage over the US. The first two, smaller satellites provide a total capacity of 9Gbps. The largest, ViaSat-1, with a capacity of 140Gbps, covers all of the US and Canada, and an area in the Western Atlantic along the Eastern Seaboard of the US.

ViaSat will launch a fourth satellite called ViaSat-2, with a capacity of 280Gbps, in 2016. It will cover a larger area than ViaSat-1, and so also provide services to the Caribbean, the northern part of South America, and much of the northern Atlantic Ocean between North America and Europe.

ViaSat-1 and -2 have 100-200 spotbeams each, while the older satellites have 36.

Not only does ViaSat operate with high-capacity satellites, but it also sells directly to airlines, which it says delivers a lower cost per unit of data.

ViaSat recently announced that it has begun an evaluation process with Boeing for airlines to specify installation of the ViaSat in-flight WiFi system on Boeing aircraft. This gives airlines the option of having the system installed on the aircraft on the production line.

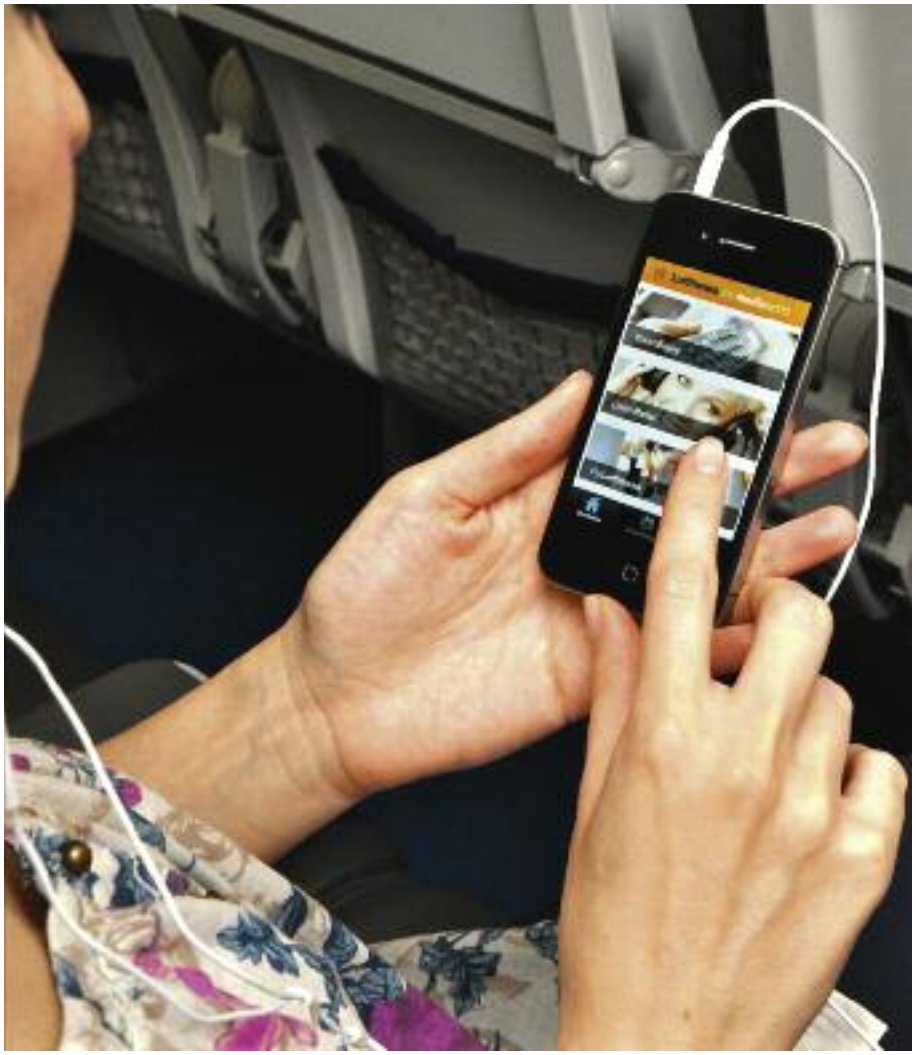
Eutelsat

Eutelsat has a Ka-band satellite providing coverage over 50 European countries and the Mediterranean. The satellite was launched in 2010 and provides 90Gbps of downlink capacity. The KaSat satellite has about 82 spotbeams, and achieves its high data transmission rate by reusing frequencies.

The satellite is used by several industries and applications. Airlines access its services via connectivity providers.

Hughes

US aerospace company Hughes operates Ka-band satellites in addition to its Ku-band fleet. Its Spaceway 3 and Jupiter satellites were launched over the



Lufthansa Systems's BoardConnect is a seat-embedded and a wireless IFE system that operates with both airline-supplied and PEDs. BoardConnect is thus a hybrid IFE system.

past 10 years to provide broadband satcom connectivity over North America.

The Jupiter satellite has a multiple spotbeam architecture, and a data transmission rate of 100Mbps. The Spaceway 3 satellite has an overall capacity of 10Gbps.

Connectivity providers

Airlines can approach a large number of providers for their external connectivity requirements. Connectivity providers operate by leasing capacity from satcom operators, or paying for capacity in terms of a certain volume of data, or on a pay-as-you-go basis.

Acquiring capacity from satcom operators can involve leasing the capacity provided by a transponder or a fraction of a transponder that provides transmissions to a particular area of the world. Eutelsat's and SES's Ku-band satellites, for example, each cover a particular area, as illustrated on their websites. As most satcom operators' fleets do not provide complete global coverage, the connectivity provider has to acquire capacity from several satellites and providers for global coverage.

The main issue of connectivity services is providing units of data at the lowest possible cost. Airlines require a service level agreement (SLA) from a connectivity provider. This guarantees a minimum transmission rate to each seat at a particular percentage of the time.

There are a large number of connectivity providers. These can be divided among those that provide ATG, Ku-band, Ka-band, and a combination of two or three types of external connectivity.

Global Eagle Entertainment

Global Eagle Entertainment (GEE), previously known as Row44, has several bases, including Los Angeles and London. Its main activity has been as a connectivity provider, but it is also a content provider.

It specialises in providing Ku-band, and uses capacity from SES, Hughes and Eutelsat satellites. The downlink rate of this Ku-band service is about 10Mbps, and GEE claims this is enough for 50-70 passengers to browse the internet and watch up to 15 different channels of IPTV.

Southwest uses GEE's service to provide 15 channels of IPTV on 540 of its aircraft, using the transmissions from Hughes's HX satellites. The same satellite system allows Southwest to offer high-speed internet browsing, e-mail, and video services to passengers using their personal electronic devices (PEDs) on its aircraft.

Meanwhile, Norwegian Airlines has used the service, with up to 160 of its passengers simultaneously using the IPTV service.

GEE is also a content provider, and offers both EW and LW content.

Gogo

Gogo is based in Chicago and is one of the largest connectivity providers. It offers both ATG connectivity in North America, as well as a Ku-band service. It is also extending its services into providing content.

Gogo provides the services of its own ATG network direct to airlines, rather than acting as a connectivity provider for connectivity operator.

Gogo's ATG 1.0 and 4.0 services are used extensively by airlines in North America. About 1,400 aircraft operated by airlines in North America are equipped with the system. ATG 1.0 has a data download transmission rate of 3Mbps. The system allows basic internet browsing, and airlines either charge passengers to use the service or provide it on a complimentary basis.

The latter product ATG4, which was launched in 2012, has a data downlink rate of about 10Mbps. This has responded to increased demand from more passengers requiring internet access and higher levels of connectivity. Not only does ATG4 make possible higher data transmission rates for the internet, but it can also be used to provide a small number of live TV channels. More than 750 aircraft are equipped with ATG4.

In addition to its own ATG services, Gogo is a connectivity provider of an enhanced Ku-band service called 2Ku-band, so-called 2Ku-band because the aircraft is equipped with two phased array Ku-band antennae under one radome. It will enter service in late 2015, and will have a data downlink rate of 70Mbps. Unlike ATG, which is available only over most of the North American land mass, 2Ku-band is available globally.

2Ku-band is Gogo's own proprietary solution, and it uses satellite services from SES. These are widebeam satellites, but spotbeam satellites will be used in the future. 2Ku-band will be trialled by Air

Canada. The downlink rate of 2Ku-band will allow live TV. It is also optimal for I.P.TV. The downlink rate may be increased to 100Mbps in the future.

Gogo will also be offering a Ka-band service, using Inmarsat's GX satellites, from 2015.

Honeywell

Honeywell Aerospace is based in Phoenix, and has other global offices. It provides connectivity, and an extensive line of IFE hardware products.

Honeywell is one of five connectivity providers of Inmarsat's GX services for Ka-band. It works with manufacturers to provide in-flight connectivity for the corporate jet market and offers connectivity services to airlines.

Honeywell is the exclusive provider of Ka-band to the business aviation market, via a complete network of distribution partners through its Ovation Select cabin management system.

While Honeywell is one of five connectivity providers to offer Ka-band services to airlines, it also provides its JetWave hardware to airlines that allow it to connect to Inmarsat's GX satellites.

Lufthansa Systems

Lufthansa Systems is based in Frankfurt. It is a multi-product provider of IFE systems.

Lufthansa Systems has a modern IT platform called BoardConnect, that provides a Europe-wide ATG service, similar to Gogo's in the US. The service will be called European Aviation Network (EAN).

From 2017 Lufthansa Systems will offer ATG connectivity services in partnership with Inmarsat and Deutsche Telekom within Europe.

The ground-based connectivity will come from Deutsche Telekom's 300 transmitters that provide S-band frequency transmissions. Inmarsat will provide the associated satcom connectivity over oceanic areas, including the Mediterranean. The satcom service will also be based on S-band. Lufthansa Systems will provide the wireless, internal connectivity service on the aircraft, the WAPs in the cabin, and the on-board portal for passengers to log on to the system. Inmarsat will sell the EAN service directly to airlines, including Lufthansa Systems' cabin network.

Overall the system will provide a data transmission rate to the aircraft of 70Mbps. It is designed for wireless IFE systems.

Lufthansa Systems also provides a Ka-band connectivity service that uses Inmarsat's GX satcom operation. Lufthansa recently announced that it will equip its short- and medium-haul flights with GX Inmarsat.

Panasonic

Panasonic is globally recognised as one of the largest providers of IFE equipment and services. Its main headquarters are at Lake Forest, California. It has more than 275 airline customers for its IFEC solutions. These are tailored to meet each of the airline's brand and business requirements.

Panasonic's connectivity offering is Ku-band, provided by satcom operators Intelsat, Eutelsat and SES. It also offers IFEC hardware, equipment and content.

Rockwell Collins

Rockwell Collins is based in Cedar Rapids, Iowa. It has a number of other global offices. Like Honeywell, Rockwell Collins provides all the main elements of services for IFE, with the exception that it is not a connectivity or satcom operator.

Rockwell Collins will be one of the distributors and providers of the S-band ATG service in Europe, provided by Inmarsat.

It is also one of the providers of Inmarsat's GX Ka-band system to airlines. Rockwell Collins' platforms and hardware will also support Ku-band.

SITA OnAir

SITA OnAir is headquartered in Geneva. It provides one of the most comprehensive IFEC services, so it supplies most of the elements, starting with connectivity services. To date, it has secured almost 400 airline customers that operate more than 14,000 aircraft.

Its IFE hardware and related aircraft systems can operate with all the main types of satellite and ATG external connectivity systems. SITA OnAir is one of the five distribution partners for Inmarsat's GX Ka-band product.

While SITA OnAir does not re-sell any Ku-band connectivity, it does operate as an internet service provider for airlines, such as Emirates, that use Ku-band external connectivity.

Thales

Thales InFlyt Experience is a division of Thales, and is based in Irvine, California. It has provided services and hardware to more than 100 airlines around the world.

Like Honeywell, Panasonic, Rockwell Collins, and SITA OnAir, Thales InFlyt Experience is a comprehensive provider of all main elements of IFE services and hardware.

This starts with external connectivity. Thales InFlyt Experience currently offers L-band, provided by Iridium, although its downlink rate is probably only suitable for communications made by cabin crew members. It is one of the five distributors of Inmarsat's GX Ka-band service, and plans to offer an ATG service in the future.

In addition to the main satcom operators, there are three companies that provide Ku-band for live TV services. Direct TV provides Ku-band for live TV service over the US; Bell Express View provides for live TV over Canada; and Sky Brazil supplies live TV viewing when flying over Brazil.

These are provided through CSP Thales. Live TV services are used by Frontier, WestJet, jetBlue, United Airlines, and Azul.

Zodiac

Zodiac Inflight Innovations is another comprehensive provider of IFEC services and hardware. It is headquartered in Brea, California. Its main airline customers include Aer Lingus, Aerolineas Argentinas, Air Berlin, Austrian Air, Brussels Airlines, Gulf Air, Icelandair, SAS, Sri Lankan, and Thomas Cook.

Connection provision services is a product that Zodiac offers. Its connectivity software allows the aircraft's IFE system to be interfaced with any type of external connectivity link that an airline prefers to use.

ViaSat

ViaSat is based in Carlsbad, California. In addition to operating its own Ka-band satellites, it is also a connectivity provider.

ViaSat is unique in that it is the only satellite operator to provide satcom connectivity services directly to airlines, rather than through a connectivity provider or distributor.

ViaSat provides Ka-band services to airlines from its own three Ka-band satellites that cover North America and part of the Atlantic Ocean. ViaSat has partnered with European satellite operator Eutelsat to provide extended Ka-band coverage over most of the northern Atlantic Ocean and Europe by using Eutelsat's Ka-band satellite.

While ViaSat's own Ka-band satellites provide some of the highest rates of data transmission, its satellite services are used by airlines in the US for internet browsing. jetBlue, for example, has both Ka- and Ku-band connectivity for its fleet. The airline uses Viasat's Ka-band for internet browsing, while using Ku-band from Direct TV for live TV access.

Virgin America, United Airlines and El Al also use Viasat's Ka-band service for in-flight WiFi.

Viasat is also a connectivity provider for Ku-band. Viasat is the only satellite service provider that can operate Ku- and Ka-band satellite networks on the same aircraft, with jetBlue being an example. ViaSat has deployed its new Ku-/Ka-band hybrid antenna that allows airlines to stay connected anywhere in the world and use the high downlink rates of ViaSat's and Eutelsat's Ka-band when operating in North America, the northern Atlantic, and over Europe. The same aircraft can then use Ku-band in all other areas of the world.

IFE systems & content

IFE systems can be subdivided into several categories of hardware, including:

BAE Systems's Intellicabin is a wireless system that works with either airline-supplied or PEDs. BAE Systems has an agreement with Samsung to supply tablets where airlines prefer to supply the viewing devices. Airline-supplied devices are required for the user to access EW content.

external connectivity hardware; internal connectivity hardware; on-board servers and roll-on/roll-off portable servers; seatback screens and associated hardware and wiring connections; remote control systems; drop-down screens; table devices and portable recharging carts; and in-seat plugs and accessories, such as frames for passengers' own PEDs.

There are several suppliers of IFE systems, offering some or all of these items. There are different types of IFE systems, however, and not all IFE system suppliers supply hardware for all types.

There are now three main categories of IFE system: traditional embedded systems; standalone systems with content supplied on tablet devices; and wireless systems.

These all depend on either hardwire or wireless internal connectivity. Each type can also have, as is now common, external connectivity to make internet access and streaming of in-flight content available.

The main feature of an embedded system is the seatback screen, hardwired from a server hosting the content. These have traditionally been used exclusively for medium- and long-haul operations. The functionality of modern systems is more sophisticated, and this includes larger servers that hold more content. An example is Lufthansa Systems' server on its BoardConnect system that has a solid stage storage disk whose capacity has been increased to 3.2 terabytes (TB).

Modern embedded systems are being installed in some narrowbody fleets that will be used on short-haul services. This is an alternative to the old-fashioned drop-down screens that show visual content for the whole cabin. Some narrowbodies are still being fitted with these as a cheap solution.

The most sophisticated systems that are used in the premium cabins of some long-haul airlines have two screens: a main one and a small one for use as a control panel. This may be accompanied by a remote control. They may also operate together with wireless connectivity in premium cabins, so that users can access the internet with their PEDs. These are regarded as hybrid systems.

Standalone systems are based on the airline supplying devices with pre-loaded content. An example of this is Bluebox, which has a system based on iPads with audio and visual content pre-loaded.

Legal issues prevent the streaming or loading of early window (EW) content on passenger-owned devices, but this is not an issue in airline-supplied devices.

Since a standalone system has pre-loaded content, it does not need a server on board the aircraft, or any wireless transmission in the cabin and internal connectivity, and the associated connectivity.

A standalone system does, however, require a storage rack for the tablets on the aircraft; this may also serve as a re-charging rack. A second rack and shipset of tablets is also needed for each aircraft at outstations. The storage and re-charging racks are, therefore, roll-on/roll-off equipment because iPads will lose their charge after about 10 hours.

As with embedded systems, there is always the possibility of having wireless internal connectivity in the cabin. This will allow passengers to access the internet through the supplied tablets, in addition to accessing the pre-loaded content. This configuration can also be regarded as a hybrid system.

Wireless systems can be subdivided into those that use airline-supplied devices, and those that are bring your own device (BYOD). They are predominantly used by airlines in short-haul operations as a low-cost alternative to embedded systems, for example, by providing the server with the content as a portable, roll-on/roll-off device.

A wireless system that has content streamed wirelessly to the viewing devices is similar to passengers being supplied with pre-loaded tablet devices by the airline. This type of system, therefore, requires the hardware for internal wireless connectivity, as well as the tablets and related storage and recharging carts.

The BYOD system needs less on-board hardware; it only requires wireless connectivity and the related systems.

Arconics

Arconics is based in Dublin. Its main customers include Aer Lingus, Cathay Pacific Airways, Philippine Airlines, Qatar Airways, Ryanair and Thomson Airways.

It offers a software and IFE hardware-bundling service, with the hardware provided by another party. It distributes

Bluebox Avionics specialises in providing a portable, standalone IFE system that provides passengers with iPads that have pre-loaded visual and audio content. The system can also have a cabin wireless connectivity system, which allows the users to access the internet.

its own software for IFE systems, as well as electronic flight bag (EFB) systems.

Although Arconics is not a hardware manufacturer, its IFE software is hardware-agnostic. It provides different hardware solutions for different projects with different variables. Arconics also provides portable servers that will suit airlines looking for a low-cost solution.

Arconics also provides an implementation and certification process through its partners, including provision of wireless and hardwired internal connectivity. In addition, Arconics can provide a complete solution that includes external connectivity using various types of satcom. Its IFE system is agnostic to the type of external connectivity used.

Arconics is also a content provider. Depending on customer preferences, it can either provide content directly, or work with other content service providers (CSPs). Arconics is able to supply EW content when used on airline-supplied devices; this applies to all CSPs.

Axinom

Axinom is based in Fuerth, Germany and specialises in providing content management systems (CMSs) and as a CSP.

The Axinim CMS is based on the Axinom Workflow Engine (AWE). The Axinom CMS solution manages a variety of content that incudes: video and visual, audio content, live TV channels, products and advertising, and media.

BAE systems

BAE Systems is based in Endicott in the state of New York. It also has numerous offices globally, including in the UK. It supplies its wireless Intellicabin IFE system and related services to more than 300 airlines.

BAE Systems' main product offering is the hardware for its Intellicabin product, as well as seating and other IFE-related hardware.

The main hardware provided includes: installed on-board servers; portable viewing devices; hardware for wireless and internal connectivity; and in-seat charging plugs that can be used by passengers to charge PEDs. These can be used by passengers to recharge their devices, so Intellicabin can also operate as a hybrid system. It can operate either as a wireless system or one where viewing devices take power from in-seat power outlets.

BAE Systems provides wireless IFE that is encrypted to support EW content to either PEDs or airline-owned tablets. BAE Systems has an exclusive agreement with Samsung to provide the wireless IFE through the tablets that it supplies.

BAE Systems also provides EW or LW content, depending on the type of devices being used.

Bluebox Avionics

Bluebox Avionics is based in Langley, UK and also has offices in Australia. It specialises in its portable, standalone IFE system, using pre-loaded iPads. Its main customers include Air Italy, Air Serbia, British Airways, Dragonair, El Al, Etihad Airways, Hawaiian Airlines, Jetstar, TAP Air Portugal, and Vietnam Airlines.

The main types of hardware it provides are installed servers, portable viewing devices, and the wireless internal connectivity hardware. Bluebox also provides a content provisioning service.

Bluebox's portable wireless IFE (wIFE) system has been designed to work with all types of third-party connectivity providers. It is intended to be an agnostic solution, allowing airlines the freedom to select the connectivity system they need.

Bluebox wIFE supports the delivery of LW and EW content. The streaming of EW content to airline-supplied devices can be supported by the Bluebox Avionics portable solution. Bluebox Hybrid portable devices, the airline-supplied devices for passenger viewing, are approved by the Hollywood studios for delivery of pre-loaded EW content. It is also allowed to connect to a number of streaming servers for LW content. Bluebox Hybrid can, therefore, be retrofitted in a cabin that already uses wireless IFE systems without EW content.

Gogo

In addition to the ATG and satcom external connectivity systems and services it provides, Gogo provides the hardware required for wireless IFE systems, including installed servers, and wireless internal connectivity hardware.

Gogo also offers content provisioning, including live streamed content. It will launch Gogo TV, a live TV product, in 2016 with Brazilian airline GOL. This will stream live TV to PEDs, or be integrated into the airline's existing embedded system that can then be customised. The system uses Gogo's 2Ku-band connectivity service.

GoGo also provides EW content via its Gogo Vision product, entertainment on demand system, through partnerships it already has with various studios.

Havelsan

Havelsan is based in Ankara, Turkey. It provides turnkey solutions for IFE systems, both hardware and software. It is a partner with Turkish Airlines for its

Panasonic is a CSP for Ku-band, and is also one of the world's largest suppliers of IFE hardware equipment. It has partnerships with JAZZ seats and B/E Aerospace.

IFE systems.

Havelsan acts as a system integrator. Its main focus is designing the entire IFE system, and installing and implementing it together with the software components.

It is also a provider of both EW and LW content.

IFPL

IFPL is based on the Isle of Wight in the UK. Its main service is innovating, designing and installing IFE products, such as iPhone docking stations and passenger seat armrests. It also provides other ancillary equipment for wireless IFE systems, such as audio jacks, USB power plugs, and near field communication (NFC) payment hardware.

IFPL also installs a wireless local area network (WLAN), which is the hardware that provides internal wireless connectivity in the passenger cabin.

In addition, IFPL provides hardware for wireless IFE systems, including roll-on/roll-off portable servers, and a virtual and augmented reality headset.

IFPL designs and provides a semi-embedded wireless IFE system configured for viewing devices that fit into tablet mounts on seatbacks. The tablet holders that IFPL provides rotate so that they can be turned away from the passenger during takeoff and landing. The semi-embedded design also features reversible USB interfaces to provide power to PEDs in one direction, and access content from the IFE server in the other direction.

The content is streamed wirelessly over WiFi from the IFE server. These features make it a low-cost alternative to traditional embedded systems.

A relatively unique feature offered by IFPL is its virtual reality (VR) and augmented reality (AR) accessories. IFPL has developed a device to combine the two, and so combines content, information and situational awareness.

KID-Systeme

KID-Systeme is based in Buxtehude, Germany. Its two main activities are providing hardware for a wireless IFE system, and the related hardware and components for internal connectivity and in-seat power plugs. It mostly provides for BYOD/PED wireless systems. KID-Systeme is also a content provider.

KID-Systeme offers its SKYfi on-board connectivity platform that comprises hardware and software components. SKYfi provides a wide range of communication options.

The main elements of hardware it provides are: installed on-board servers, remote control systems, internal connectivity hardware and wireless transmission, in-seat power plugs and USB ports, and other seating hardware related to the IFE system.

The wireless system is interfaced with L-band satcom that is provided via connectivity provider SITA OnAir.

KID-Systeme also provides content, but as it focuses on BYOD wireless systems, this is limited to LW only.

Kontron

Kontron is based in Poway and Fremont, California. It is both a hardware designer and manufacturer, and specialises in hardware for IFE systems.

The main components and elements of the IFE systems it provides are hardware for satcom external connectivity, the IFE on-board server, and WAPs for streaming information to passengers in the cabin. The streaming products it provides include high-definition visual entertainment in high-demand situations.

The number and variety of servers it offers has been steadily increasing since 2006. Two of its main IFE and cabin hardware products are the Cab-n-connect WAP and cabin distribution system, and the A100 and the ACE Flight Server 4600 for IFE content. In addition to IFE systems and internal connectivity, it also manufactures 4G and satellite antennae for external connectivity systems.

Kontron now has more than 30 years of experience in installing IFE hardware on aircraft, and to date has equipped more than 3,500 aircraft.

It now provides comprehensive and cost-effective IFEC systems.

Lufthansa Systems

Lufthansa Systems is based in Raunheim, Germany. As well as connectivity services, it also provides an IFE hardware platform, including its BoardConnect connectivity portal. Lufthansa Systems describes its IFE product as both a seat-integrated system and a wireless system that operates with tablet devices and content streamed from the server via in cabin WiFi connectivity. The systems operate with both airline-supplied devices and as a BYOD system.

The viewing devices can be mounted in special seatback holders called Smart trays that can be integrated by the seat manufacturers. The Smart trays have been developed by Lufthansa Technik to provide in-seat options that include

power ports and recharging trolleys for tablet devices.

Lufthansa Systems also provides seat-integrated IFE hardware, installed IFE servers, and docking stations for the viewing devices.

Lufthansa Systems has more than 300 airline customers globally for a range of products. In addition to IFE hardware and equipment, Lufthansa Systems is a content provider, including LW content on PEDs and airline-owned devices, and EW and LW content on airline-owned devices.

Lumexis

Lumexis is based in Irvine, California and is one of the few remaining manufacturers of traditional embedded systems. The embedded systems it now provides incorporate modern technology.

A large percentage of aircraft are still being delivered with traditional embedded IFE systems. Lumexis manufactures an IFE system that combines traditional in-seat viewing screens that are connected to an IFE server via a hardwire cable connection. This avoids the heavy and obstructive underseat boxes that served each seat in previous-generation embedded systems.

The visual content sent to each seat is a full high-definition quality, and because it is hardwired can provide both EW and LW content.

In addition to the main hardware elements of an embedded IFE system, Lumexis also manufactures in-seat USB ports to allow passengers to charge PEDs.

Media in Motion

Media in Motion is based in London and Dublin. Its main products are installed and roll-on/roll-off servers. Main customers are Monarch Airlines, SunExpress of Turkey, Titan Airways, TAG Aviation, and TUI Travel.

Its main overall product is a wireless IFE system, combined with a retail and advertising connectivity platform that incorporates software, content management, technical support, and hardware integration with the aircraft.

Media in Motion provides software that integrates with external connectivity solutions. This includes Ku-band satcom, but it could also interface with ATG.

It is also an LW and EW content provider, the latter only being available on airline-owned devices.

Panasonic

Panasonic Avionics Corporation is one of the most comprehensive providers of IFE hardware and services.

In addition to its connectivity services, Panasonic provides IFE hardware and equipment, and related seating and ancillary equipment with its partners JAZZ Seat and B/E Aerospace. It is also a content provider with its partners.

It provides comprehensive embedded and wireless IFE systems, including: embedded system seatback screens; on-board installed servers; remote control systems; drop-down screens for low-cost IFE systems; the related hardwiring for embedded and wireless systems; in-seat plugs and power outlets; and other ancillary equipment and hardware.

These IFE systems interface with Ku-band external connectivity.

Panasonic is also a provider of EW and LW content.

PaxLife

PaxLife is based in Potsdam, Germany. In addition to connectivity, it provides wireless IFE system hardware and content. PaxLife's main activity is as a system integrator by: co-ordinating the design of an IFE system; acquiring all relevant elements; arranging all certification and implementation; making all arrangements to acquire content, and dealing with contracts; and managing all revenue streams. PaxLife can also arrange financing for the system, if required. For

the fully comprehensive service that PaxLife arranges, the airline pays a flat fee, or shares the revenue with PaxLife.

The main hardware elements PaxLife provides for wireless systems are installed on-board servers, and the associated wireless transmission and internal connectivity hardware. PaxLife co-ordinates a wireless system, based either on passenger- or airline-owned tablet devices that can be provided by any supplier, including Apple, Samsung, or Sony. PaxLife is also a provider of EW and LW content.

Rockwell Collins

Rockwell Collins based in Cedar Rapids, Iowa provides services to nearly all airlines globally for all of its products and services, including its IFE systems and hardware.

In addition to connectivity services, Rockwell Collins provides IFE system hardware, including: embedded seatback screens; installed on-board servers; drop-down screens for low-cost embedded solutions; hardwiring and associated cabling for IFE systems; internal connectivity hardware; in-seat plugs and power ports; seating and other ancillary hardware for IFE systems; and hardware for interfacing with external connectivity systems.

Rockwell Collins also provides live streamed, and EW and LW content. It can stream live content from ground sources, although this has limitations. It also offers video on demand (VOD), streamed from the IFE server. For PEDs, Rockwell Collins provides LW content via its PAVEs wIFE with audio/visual on-demand (AVOD). For airline-supplied devices, Rockwell Collins provides EW content via its PAVES on-demand seat-centric IFE system.

SITA OnAir

SITA OnAir of Geneva is a full IFE system supplier and integrator, but it does not manufacture any hardware.

In addition to providing an external connectivity service, SITA OnAir provides virtually all hardware and system elements of embedded and wireless IFE systems by configuring and co-ordinating all hardware elements, and so acts as a service provider for airlines. SITA OnAir describes itself as a tier-one supplier. Airlines can acquire hardware directly from suppliers, but SITA OnAir will provide implementation, certification, internal connectivity, and content provisioning services.

The internal connectivity element of SITA OnAir's service includes elements such as: a roaming service and cabin WiFi; a user interface that is an on-screen portal; retail facilities that include a price plan supplied by SITA OnAir; and regulatory approval. A factor to be appreciated is that providing a roaming service for in-flight telephone calls requires agreements to be reached with all countries that an aircraft flies over. SITA OnAir now has in-flight roaming agreements with a large number of countries, and the number is increasing.

SITA OnAir can provide all possible types of in-cabin services, including: Mobile OnAir, roaming service for in-flight phone calls; Internet OnAir, WiFi hotspot service in the cabin; and OnAir play, the streaming of content from the aircraft's servers to viewing devices.

SITA OnAir is also a content provider, but only considers news and sports to be relevant to live TV and worth streaming from the ground; it does not plan to offer live streamed content.

SITA OnAir has developed OnAir Play to stream IFE content from the server to PEDs. SITA OnAir, however, leaves airlines to select their own CSPs.

Skycast Solutions

Skycast Solutions of Renton, Washington is a provider of wireless IFE hardware systems and related seating and ancillary equipment. Main customers

include Alaska Airlines and WestJet, both of which operate its wireless system by providing airline-owned tablet devices.

Skycast Solutions provides installed on-board servers, portable viewing devices, and seatback hardware for holding portable airline-owned tablet devices.

Skycast Solutions is also a content provider, offering EW movies, TV and games on portable, airline-supplied devices.

Thales InFlyt Experience

Thales InFlyt Experience of Irvine, California is a provider of turnkey IFE solutions, ranging from wireless cabin to premium-class in-seat systems. It has delivered IFE systems to 100 airlines.

In addition to IFE hardware and related systems, Thales is a content and connectivity service provider.

The main elements of IFE system hardware and equipment that Thales provides include embedded 9- and 12-inch seatback screens, and 26-inch screens for wallmounted IFEs. It also provides: installed on-board servers with up to 2TB of disk capacity; remote control units and touch-control second screens for premium cabin systems; drop-down screens for older style systems; hardwire and associated cabling for embedded systems; all associated WAPs and hardware and equipment for wireless IFE systems; in-seat plugs and power outlets; in-seat USB ports for charging PEDs; and all required external connectivity hardware.

Thales Inflyt Experience can provide live streamed content, including live TV to each passenger seat, as well as for 100 or more Sirius/XM radio channels through S-band satellite connectivity. Both types of content can be streamed to PEDs. Thales Inflyt Experience also provides both EW and LW content.

Vision Systems

Vision Systems is based in Lyons, France. with subsidiaries in Florida and Singapore. It is a provider of a BYOD and airline-supplied wireless IFE systems.

Vision Systems has two principal products: an audio/visual on-demand (AVOD) product streamed by WiFi; and a broadcast IFE system. Its customer for its AVOD product is French all-business-class operator La Compagnie. Customers for its other Broadcast IFE products include Interjet on the SSJ100, and UTAir and Air Tahiti on the ATR72-600.

It provides a 3G/4G internal connectivity board and cabin access points. The other main elements of its IFE system include on-board servers, 5-, 7- and 10-inch dropdown screens, and a range of portable viewing devices, including Android, iPad or other tablets.

Vision Systems says it has developed a cutting-edge wireless IFE system, called Visi-Stream, that wirelessly transmits content to PEDs, allowing information to be sent to passengers' PEDs.

Vision Systems is also a content provider, with IFE systems able to handle AVOD, and EW and LW content.

Zodiac Inflight Innovations

Zodiac Inflight Innovations is based in Brea, California, with a subsidiary in Oberfaffenhofen, Germany. Besides being a connectivity service provider, its main activity is as an embedded and wireless IFE systems hardware provider.

The elements of IFE systems that it provides include: embedded seatback screens; installed on-board servers; roll-on/roll-off portable servers; associated cabling for embedded IFE systems; wireless transmission and internal connectivity hardware; seating and other related IFE hardware; and external connectivity hardware. AC

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