Live TV is just one changing feature of in-flight entertainment and the total passenger experience. Charles Williams examines what airlines need to consider in terms of the IFE system hardware they are using, the type of TV system available in their region of operation, licensing issues, and the connectivity systems available.

The technical issues for providing live TV

Airline passengers' expectations of on-board service standards continue to grow, and now include the provision of live television (TV), on-board connectivity, internet access, and in-flight streaming and shopping. These expectations follow naturally from the complimentary, high bandwidth WiFi provided in public places on the ground. The supply of on-board connectivity has led to the development of multiple methods for generating ancillary revenues in the passenger cabin *(see Hardware for growing ancillary revenue streams, Aircraft Commerce, December 2016/January 2017, page 27).* Live TV is provided by a small but growing number of airlines on a complimentary basis, in addition to the more established on-board connectivity-related products. Live TV requires additional connectivity and data feed to the aircraft over and above what passengers use for one- and two-way communication for all internet-related activities. The technical issues to make live TV possible on-board aircraft are examined here.

Live TV & IFE

Live TV is one of the latest new on-board services and in-flight entertainment (IFE) products offered by airlines. Live TV adds to the requirement for a certain amount of external connectivity bandwidth, delivered via satcom, already required for the standard services of in-flight connectivity, text messaging, voice calls, and internet browsing. The burden that live TV places on external connectivity bandwidth has restricted some airlines to transmitting only a limited number of TV channels live to the aircraft from outside sources via satellite, and preloading other TV shows and programmes onto the aircraft's IFE server. This limits the degradation of internet access services, and all its related activities, and the quality of TV channels that are transmitted to the aircraft. TV channels that need to be truly live, or transmitted within a few minutes or hours of their live transmission to domestic residences on the ground, are those featuring news and weather bulletins, and live sports matches.

Many other TV shows, such as comedy programmes, soap operas, documentaries, lower profile sports games, and even less time-sensitive news can be pre-loaded onto the aircraft's IFE server and transmitted. These can even be loaded onto the server several times a day to make the content reasonably up to date. "For example, an evening US news broadcast can be uploaded to the aircraft's IFE server on a westbound transatlantic flight just before a night-time departure at a US gateway airport so that it can be viewed shortly after the flight is airborne, even though it may have been transmitted on regular TV a few hours before," says Glenn Latta, vice president of product management for network solutions at Global Eagle. "If the flight is going to the UK, the early morning news transmitted from British TV channels may be transmitted live to the aircraft in its last 60-90 minutes of flight just before arrival, since the news items will have developed overnight during the flight's progress."

This mix of live transmitted and pre-loaded TV shows can minimise the burden on the aircraft's external connectivity systems, since each live TV channel can require a downlink rate from the satcom system of 1-2 mega bits per second (Mbps). The cost of external connectivity systems is still relatively expensive for most current satcom systems.

Given the downlink rate and cost per kilo or mega bit provided by many current external connectivity systems, just a small number of live TV channels are probably feasible and economic for most airlines. This is gradually changing, however, mainly as a result of satcom and air-to-ground (ATG) systems with higher data rates gradually becoming available.

Live TV technology

Various elements are needed to make live TV feasible on board commercial aircraft. "These include the licensing required to transmit TV shows in the aircraft cabin, a relationship between the satellite network operators and the TV broadcasters, the transmission of live TV channels to the aircraft from correctly-configured satcom systems, the appropriate receiving antenna for external connectivity, the hardware and modem for decoding the received transmissions, and a suitably configured IFE system," says Richard Nordstrom, marketing director of cabin systems at Rockwell Collins.

IFE systems are either embedded with seatback screens, or wirelessly transmit TV shows from the IFE server to passengers' personal electronic devices (PEDs). IFE configuration will influence what type of live TV can be shown in the cabin. One of the first issues to consider is the two categories of live TV: direct broadcast satellite (DBS) TV; and internet protocol (IP) TV; referred to as IPTV.

DBS TV was the first to be used on board commercial aircraft. DBS has been used for satellite transmissions of regular national TV channels to homes in several countries for several decades; the first being in the US in the late 1970s. The transmission of TV to a large number of homes on a large land mass, where a single language is spoken, has been used in other large countries, including Brazil, Canada, Australia and India. Similar systems have also since been adapted by smaller countries to replace the original method of transmitting from radio towers and signals being picked up by aerials located at individual residences.

United provides complimentary live TV on its 737s and 757-300s operated on its US domestic network. The live TV system is DBS TV, and the airlines sources Direct TV via Ku-band satcom.

The satellite networks used for transmitting DBS to domestic residences include Direct TV and DISH TV in the US, Bell Express View in Canada, Sky Brazil in Brazil, Foxtel in Australia, and Sun Direct in India. Satellite networks in smaller countries include SKY and Freesat in the UK, and Canal in France.

Some of these domestic TV satellite networks have been adapted for transmitting live TV on board commercial aircraft. One of the first systems was developed by Live TV, and first used by US carrier jetBlue. The same basic system, using one of several DBS satellite networks, is also used by United Airlines on its domestically operated 737s, by Azul on its domestic Brazilian route network, and by Virgin Blue in Australia. It was also used by Westjet for its entire fleet, and by Frontier in the US.

The main feature, therefore, of DBS TV is that it is transmitted from a dedicated satellite that has already been configured and launched to exclusively transmit TV to people's homes. For many years, the satellites used for DBS have been Ku-band, although this is now changing to Ka-band.

As a consequence, the TV channels received on board an aircraft are the same as those transmitted as regular TV channels. They are therefore also transmitted at the same time as regular TV shows viewed at home.

Another feature of DBS TV is that because it uses the same satellites used for transmission to people's homes, satellite coverage is largely restricted to a large land mass, although there may be some coverage over the oceanic areas close to a coastline. This limits DBS TV to domestic and overland operations by airlines, since there is limited coverage over water.

IPTV is different in that the TV transmission is received as internet data. The most important feature of IPTV channels and shows is that they are not available for general consumption in the same way that DBS TV is, although this has begun to change. Because IPTV is internet protocol it can be transmitted from the same satellites as those that provide internet connectivity to the aircraft. "This is the main advantage that IPTV has over DBS TV," says Latta. "The satellites used for IPTV are both Ku- and Ka-band. Some Ka-band systems are now delivering high bandwidth rates to the aircraft, which is reducing the cost of supplying bandwidth to the aircraft."

An IPTV channel is technically the same as a passenger viewing an internet page or website. IPTV is provided by specialist providers, and can only be viewed by specific authorised users on hotels, ships, and aircraft. Even if IPTV is transmitted in a region, it cannot be received and viewed in the same way that broadcast TV can.

A second main feature of IPTV is that the TV shows are only transmitted by a licensed broadcaster via satellite. In the case of commercial aircraft, the three main licensees for IPTV are Panasonic, Global Eagle, and Gogo. There are also differences between regular TV shows and IPTV shows. The licensee acquires transmission rights from the TV show producers, but the shows are edited by the IPTV licensees. Examples are an edited version of a major sports game.

Connectivity for live TV

As described, the downlink rate required per channel of live TV is 1-2 Mbps, although up to 1Mbps can be sufficient in most cases. This is the rate required for standard definition quality, and will be higher at 3-5Mbps for higher definition screen resolution. Latta explains that this requires a configuration change on the satellite.

"These are also the rates required regardless of how many passengers are simultaneously watching the channel. That is, the transmission to people's homes is multicast," explains Latta. An airline that wants to have 10 live TV channels available in the cabin will need to have a downlink rate to the aircraft of up to 20Mbps. The bandwidth of DBS TV satellites is big enough to provide 100-200 live TV channels.

This is in addition to the downlink rate the aircraft will require for all connectivity-related IFE activities. This connectivity will be supplied by a different satcom system operated specifically for industries such as aviation and shipping.

By comparison, sending e-mails, text messaging, and making phone calls require a downlink rate to the aircraft of 1-2Mbps. Two-way communication is clearly needed. Accessing and surfing the internet requires a higher downlink rate to the aircraft of at least 3Mbps, as do live internet shopping and credit card transactions. This also needs to be a bi-directional data communication. The highest downlink rates are required for the live streaming of movies, and are about 1Mbps per passenger. A relatively small number of passengers live-streaming Netflix, for example, on a narrowbody can add 20-50Mbps to the aircraft's overall downlink requirement. This places the highest burden on the downlink rate an aircraft needs over all other on-board demands. It also increases the need for low-cost data transmission.

To date, the only external connectivity systems capable of supporting live TV have been satcom systems. Gogo's air-to-ground (ATG) external connectivity system, which is only available over North America, operates on a frequency spectrum of 3 mega hertz (MHz), and delivers a data rate to the aircraft of about 3Mbps. The later version, ATG4, delivers a data rate of about 9.8Mbps. The rate per aircraft is reduced, however, as more airlines subscribe to Gogo's ATG service. Airlines charge passengers for using Gogo's ATG, and it is mainly used for internet-related activities, so its

Global Eagle is one of three IPTV providers for airlines. It has more than 100 channels to choose from for airlines operating over the US. It distributes more than 50 live bespoke channels to the maritime industry, and expects to see a large development in an increase in the number of bespoke channels that can be offered to airlines over the next few years.

remaining data rate is insufficient for live TV to be streamed to the aircraft.

SmartSky Networks in the US is due to launch a new ATG system for the continental US, through the use of 230 transmitter towers. This system configuration is similar to Gogo's, but SmartSky has 60Mhz of bandwidth, so it has a higher data rate than Gogo's ATG4.

The SmartSky system will be bi-directional, although the 60MHz bandwidth will not be split evenly with 30MHz for downlink and 30MHz for uplink. SmartSky expects to support a demand per aircraft of 1.5 giga bytes of data per hour.

SmartSky says the system will allow passengers to access any TV commercially available through the internet, which is different to the IPTV channels made available through specialist suppliers. The data rate will also be sufficient for IPTV through licensed suppliers and for passengers to stream movies through Netflix.

The European Aviation Network (EAN) system will come into operation during the second half of 2017 across the geographical area of the 28 European Union (EU) countries, including the Baltic Sea, North Sea, Irish Sea, Bay of Biscay and the Mediterranean. EAN will be a combination of ATG and satcom connectivity systems. Towers operated by Deutsche Telekom will provide the ATG connectivity across the EU28. EAN is due to go into service with British Airways on its A320 family fleet.

"The EAN system will have a frequency spectrum of 30MHz, and each ATG transmission tower will have a specified data transmission rate of 75Mbps; 65Mbps more than Gogo's ATG4 in North America," says David Coiley, vice president of strategy and external relations at Inmarsat. "The EAN system will provide IP connectivity to aircraft, and its wide frequency spectrum will allow it to provide high enough data rates to the aircraft for live TV and internet-related activities. This will make it the first ATG system that can be used for live TV in addition to satcom systems."

Satcom systems

Satcom systems provide most live TV connectivity, including for all long-haul services. The satcom systems used for DBS and IPTV are Ku- and Ka-band satellites. About 90% of the satcom systems are used for DBS TV, with a minority now using Ka-band satellites.

The Ku-band widebeam satellites dedicated for DBS TV to homes have bandwidths and the capacity to transmit 100-200 live TV channels. An example is the Direct TV satellite used for the entire main area of the US.

These compare to the Ku-band satellites used by commercial aviation for in-flight connectivity. The earliest generation widebeam Ku-band satellites used by commercial aviation have one-way communication, and data downlink rates of 1-2Mbps. These rates steadily improved as the technology of Ku-band satellites progressed, and downlink rates are as high as 10Mbps. The standard for future generation widebeam Ku-band satellites will be 30Mbps.

"Widebeam satellites have advantages and disadvantages," says Scott Easterling, director business development connectivity and TV at Thales. "The first advantage is that a widebeam that covers a large area of the globe, such as the US, is highly efficient for large-scale communication to the area and the millions of homes in that area. This is because the same information is being transmitted to hundreds of thousands or millions of recipients. This is the same as a radio station transmitting a show that can be picked up by thousands or millions of devices. The quality of transmission for each recipient is not diminished as the number of recipients grows."

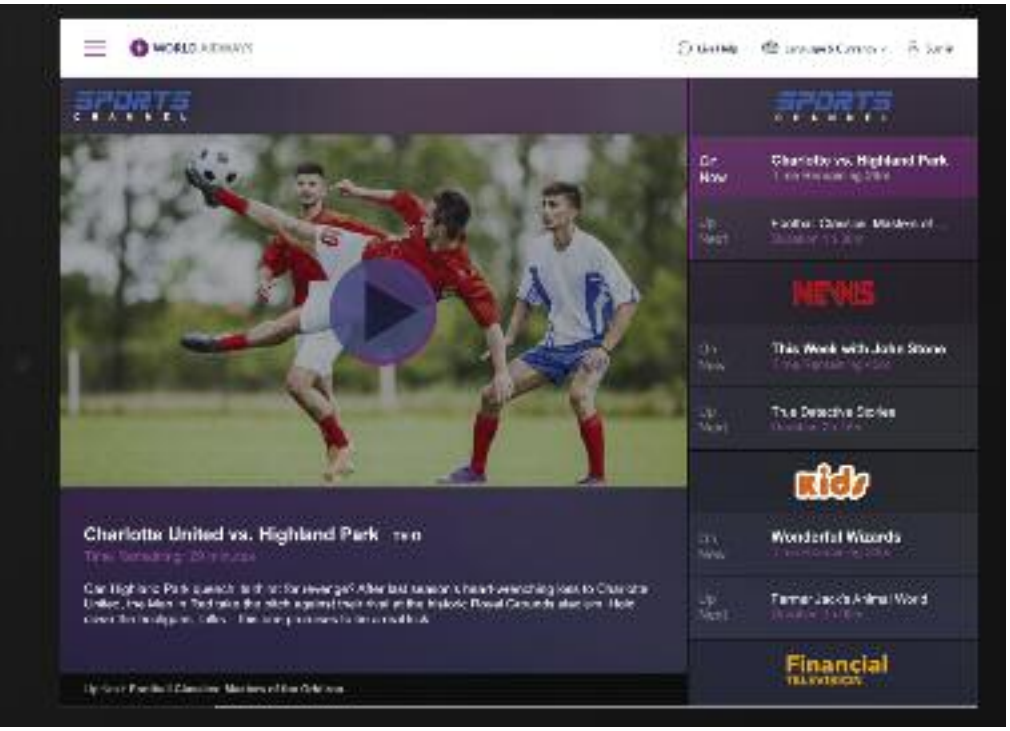
This is the phenomenon of multicast transmissions, and it also applies to transmitting TV shows both through a widebeam or a spotbeam.

"The disadvantage of a widebeam is that when a signal is spread over a wide area, the beam's bandwidth is not as wide as a spotbeam's bandwidth, so the widebeam's data rate is limited," continues Easterling.

The basic issue of data capacity is related to the frequency spectrum in the satellite. Specific transponders will be used for commercial aviation, and each transponder will have a frequency spectrum for data transmission. The data rate generated is about 1 bit per Hz, so a 24MHz Ku-band satellite or Ka-band satellite spotbeam, for example, will have a capacity of about 24Mbps in its target area. 1-2MHz of frequency is required to provide a sufficient data rate of 1-2Mbps for a live TV channel on an aircraft, so up to 20 live channels would be possible.

Ka-band satellites entered service and were adapted for commercial aviation later than Ku-band satellites. Ka-band satellites are configured with spotbeams, with each spotbeam covering a fraction of the area of a widebeam satellite. Ka-band satellites also have two-way communication, so they are used for internet connectivity for homes and commercial buildings, and have been adapted for in-flight connectivity by commercial aircraft. Moreover, Ka-band satellites have higher data transmission rates. Each of the beams in a cluster of adjacent beams transmitted from a Ka-band satellite can re-use the same frequencies, which increases the satellite's overall capacity. Some recent generation Ku-band satellites have been configured as spotbeam satellites, and are referred to as high throughput satellites (HTS).

"With a Ka-band satellite, the



Gogo offers three live TV channels to airlines. These are news, business and sports. It also offers near-live channels to airlines that want to customise their channel selections. Most airlines will opt to provide up to 20 live channels, with affordability restricting a larger number.

frequency bandwidth of its transponder is usually much larger, say 250Mhz," says Easterling. "Each beam will therefore have a data rate of about 250Mbps to the target area. This also means the satellite's total capacity is increased, because the capacity of each beam is multiplied by the number of beams. This drives down the cost of supplying each bit."

Moreover, each beam covers a fraction of the target area that is covered by a Ku-band satellite's large widebeam, with a spotbeam having a diameter of about 400nm and an area of 125,000 square miles. The spotbeam configuration is more efficient for high data rate, point-to-point and bi-directional data communication, such as internet browsing and shopping, than a widebeam Ku-band satellite.

The issue of frequency re-use in multiple beams from the same satellite relates to its overall capacity. Each beam from a spotbeam satellite will cover an area with a diameter of a few hundred miles. The US, for example, may be covered by a Ka-band satellite with 30 or 40 beams, so an aircraft flying across the country will fly over the area covered by several beams, and spend several minutes under each beam. The aircraft will use a specific frequency spectrum or bandwidth for receiving a particular TV channel when under that beam. The same frequency bandwidth cannot be used in any adjacent beam, but can be used in non-adjacent beams, so an aircraft can pick up the same frequency spectrum in the area of a third beam as the first beam for a TV channel. Thales, for example, has four different beam frequency configurations in its spotbeam set-up, so a satellite with 40 spotbeams would have 10 sets of frequency bandwidths.

DBS TV

DBS TV transmits regular and national TV shows from a dedicated widebeam satellite over a large land mass that has been being adapted for commercial aircraft.

The satellites used are mainly Ku-band, with widebeam configuration, and have single direction transmission. These are different to satellites used for bi-directional data transmission for internet connectivity. DBS TV can, however, also be transmitted from Ka-band spotbeam satellites, and in a minority of cases it is.

DBS TV therefore has two main disadvantages. The first is that it is only available in a few regions of the world where existing satellites are configured and used for DBS TV. It is therefore only available for regional and domestic flights, and there is only limited coverage over a country's coastlines and none over oceanic areas.

The second disadvantage is that the aircraft requires a second antenna if the airline offers both internet connectivity and live TV. "This is because a single antenna cannot point to the two different satellites that broadcast the DBS TV and the bi-directional internet connectivity," says Nordstrom.

This is shown in every airline that uses DBS TV. One example is US domestic operator jetBlue Airways, which uses Ku-band satellite Direct TV for on-board TV, offering 36 live channels on its E-190s and A320s, and more than 100 channels on its A321s. It also uses Ka-band satcom supplied by ViaSat for high data rate internet connectivity.

Another example is United Airlines, which uses Direct TV, but via Ku-band satcom supplied by Thales. The system is provided in some of United's 737 and 757-300 domestic US fleet. More than 100 channels are available through Direct TV, in addition to nine new-release movie channels and a flight map channel which are pre-loaded on the aircraft's IFE server. While United uses Ku-band to access Direct TV, it also uses Ka-band and Gogo's ATG to provide connectivity. The aircraft therefore have separate Ku- and Ka-band antennae.

A third example of a DBS TV user is Delta Airlines. It has equipped more than 250 737s and 757s with live DBS TV. The airline sources live DBS TV channels through DISH Satellite TV. It provides 18 live channels to the aircraft, including ESPN, ESPN2, NFL Network, CNN, Fox News, CNBC, Bravo, Comedy Central, Cartoon Network, and Discovery. Delta uses a separate satcom system, rather than Ku- or Ka-band satcom.

The channels are viewed through a seatback screen IFE system, which Delta has installed on 500 of its aircraft fleet. In addition to live TV in seatback screens, the airline also offers Gogo's ATG system to provide WiFi in the passenger cabin. This allows passengers to stream content from Delta's IFE server, Delta Studio.

The installation of a second antenna for in-flight connectivity adds weight and drag, as well as operating expense to the aircraft. "This is certainly a problem in the current environment, but we have a dual-purpose antenna being developed for use on an aircraft that can accept TV transmissions and bi-directional internet transmissions," says Nordstrom. "This will have an electronically steerable arrayed antenna (ESA), so it can look at multiple satellites simultaneously, and be used for background IP for internet connectivity, while also being used for DBS TV or IPTV. We are initially developing the system for Ka-band satellites, which can be used for DBS TV or IPTV, but eventually it will be possible to use it for Ku-band satellites as well."

The basis of DBS TV is similar to that of a radio station broadcasting over a wide area to a large number of recipients. An increased number of devices tuning into the radio station does not dilute the quality of the transmission each one receives. The same applies to quality of resolution and other factors when received on the aircraft irrespective of the number of aircraft flying under the beam that are using the service.

The main issue is the frequency

bandwidth of the satellite's beam, and the data rate it provides. As described, 1-2MHz of bandwidth is needed to supply 1-2Mbps of data downlink, which is the amount required for one live TV channel. The satellite's frequency bandwidth and therefore the data downlink rate will determine the maximum number of TV channels that can be transmitted live to the aircraft. DBS satellites that were configured specifically for transmitting national TV channels, such as Direct TV, have the capacity of 100-200 TV channels.

There are several other main issues to consider with DBS TV. One of these is IFE system configuration. Several satellite operators will not provide airlines with security encryption codes that allow them to transmit live TV wirelessly in their aircraft cabins to passengers' PEDs. Direct TV is an example, and jetBlue has to show live TV channels via traditional seatback screens on its IFE system, and transfer the received TV signals by hardwire to each aircraft seat. "As well as the issue of encryption, the IFE system also needs a mechanism for converting the received DBS TV signal into an IP signal to make it possible to view TV shows on PEDs," says Jan Peter-Gaense, director project and certification at Lufthansa Systems.

Another main issue relates to licensing laws for national TV channels. It is only generally possible to view a country's national TV channel in that country's territory, or in the airspace over that country, and not far outside its national borders. Another licence is required, for example, to view BBC TV programmes transmitted in the UK in another European country near the UK, such as Ireland, The Netherlands, Belgium or France. The same applies to subscriptions to on-line accounts, such as Netflix.

"These European licensing laws are still difficult, but they are becoming more relaxed," says Peter-Gaense. "Under a new law that was passed by the European Parliament in May 2017, a European resident can now access their Netflix account anywhere in Europe, and not just within their country of domicile. The same applies to freely available IPTV channels, such as BBC iPlayer. A British national could previously only watch BBC iPlayer when in the UK, but now can watch it on their PED outside the UK. This new law means it is now easier for airlines to provide live national content while flying across many European countries."

Even if a satellite was able to transmit widebeam DBS TV signals over an area that covered several adjacent countries, such as Ireland, the UK, the Netherlands, Belgium, and France, each national TV company only transmits TV programmes to its country and the area close to its borders. For DBS TV to work over Europe, for example, the area over which the BBC's channels are transmitted would have to be increased to all the main European countries. This would make it technically possible for a passenger to watch BBC programmes transmitted nationally in the UK, while flying over several European countries.

"There is in fact one DBS TV satellite operated by SES, the Astra satellite, that transmits traditional, national TV programmes as DBS TV over multiple European countries and in multiple languages over Europe. The transmissions for each country are, however, only over each country, and not across the whole of Europe," says Peter-Gaense.

IPTV

IPTV is transmitted from the satellite as internet IP data, so it can be transmitted from the same satellite used

IPTV is the only option for live TV on long-haul, intercontinental flights. This is because of the absence of DBS TV satellites over oceanic and the majority of land masses. IPTV be transmitted either by Ku- or Ka-band satcom systems.

to give the aircraft bi-directional internet connectivity. The aircraft therefore only needs to carry a single satcom antenna. "The disadvantage of using a single satcom system, however, is that it can dilute the available bandwidth to the aircraft, since background internet connectivity will use some of what is available," explains Nordstrom. "The airline must decide how to divide the downlink transmission between what it needs for in-flight connectivity and live TV."

IPTV can be transmitted from a Ku- or Ka-band satellite, and with either a widebeam or spotbeam configuration. Using satellites designed specifically for internet connectivity, rather than adapting satellites designed for DBS TV transmission, means that IPTV is available globally since IP satellites provide global coverage; Inmarsat's Ka-band Global Express being an example. There are several Ku-band constellations or groups of constellations that are combined to provide global coverage.

Receiving IPTV transmissions via satellite on the aircraft is essentially the same as viewing another internet page.

The second main feature of IPTV is that the TV programmes are not the same as nationally broadcast TV shows. IPTV programmes can only be sent by the broadcasters to a select number of licensed recipients, including airlines. In many cases they are edited versions of national TV programmes, or are specially produced shows.

For commercial airlines there are three main IPTV broadcasters: Panasonic, Gogo and Global Eagle. "There are two main methods for sourcing TV shows," says Blane Boyton, vice president product manager for network solutions at Gogo. "The first is for the licensed IPTV broadcaster to select the programmes with the traditional TV broadcasters." Examples of edits to a TV show may be the highlights of a high-profile sports match.

The other main method is for the licensed airline recipient to negotiate directly with the traditional TV broadcasters for the TV shows it wants. "The TV broadcaster is then responsible for transmitting the TV content to the airlines via satellites," says Boyton. "It is more common for the larger airlines to produce their own content."

Latta makes the point that because the TV shows are not the same as regular nationally broadcast TV programmes, unique advertising can also be used together with the TV shows. "The IPTV broadcaster chooses the specialist advertising that is added to particular TV shows and channels. Another advantage of IPTV is that a large number of TV channels can be licensed by the broadcaster, which negotiates the rights to transmit the channels. The recipient of IPTV shows and channels decides which shows and channels it wants to make available to on its aircraft. The selected shows are determined in the aircraft's IFE system decoder," says Latta.

Satcom system

The type of satellite available where the recipient operates has several implications for the cost of operation. Long-haul operations are likely to use widebeam Ku-beam satellites for receiving IPTV transmissions. Although widebeam satellites cover a wide area that can include several countries, a chain of satellites will be used for receiving IPTV on many of the world's long-haul routes, especially on Europe-Asia Pacific.

Widebeam satellites are cheaper to operate than spotbeams, since data only has to be sent to one beam. Each TV show must be sent up to every satellite by the TV broadcaster, so using a relatively small number of widebeam satellites will be a low-cost option for medium- and long-haul operations.

Spotbeam satellites are only available in some areas and on particular route networks. "The disadvantage of this is not only that each TV show must be sent up to every satellite, but it must also be transmitted in every spotbeam to provide consistent coverage," says Peter-Gaense. "A TV channel can therefore be transmitted several dozen times to cover the same area as a single widebeam satellite where it has to be transmitted once. Spotbeams are a very efficient system for providing high data rate connectivity, but are less efficient for TV because of the replication."

"This replication of transmission increases costs, although unit data costs are declining over time," adds Latta.

The higher capacity of spotbeams means that each one can provide a larger number of live TV channels, however, as well as the additional capacity for background bi-directional internet connectivity. "While the high capacity of spotbeams and the small area they cover means that they can each provide high data transmission to a small number of aircraft, it will always be more expensive to transmit live TV via multiple spotbeams compared to a single or small number of widebeams," says Latta.

Despite the expense of replication in each beam, identical TV shows do not have to be transmitted in every single spotbeam. "This means that where a multi-beam satellite transmits over a wide area, costs can be saved by not transmitting some TV shows from all beams due to regional differences in demand for particular TV channels," says Latta. "An example is a spotbeam satellite having coverage for all of the Americas, but certain TV shows only being transmitted through the spotbeams of those that have coverage over North America."

The airline recipient also decides which of the TV channels provided by the broadcaster it wants to make available on board. These are selected in the system's decoder that is in the IFE system.

In addition to Ku- and Ka-band

Lufthansa provides live TV across its entire intercontinental network and long-haul fleet. It sources its live TV channels from Panasonic, which also supplies Lufthansa with its IFE system hardware. Panasonic provides nine live TV channels on a global basis.

satellites, the EAN system for the EU28 has enough bandwidth in the ATG system to provide both onboard connectivity and live TV. This is because the ATG system has a bandwidth of 30Mhz, enough to provide a data transmission rate of 75Mbps to the aircraft.

On board IPTV

IPTV can be used with either embedded seatback screens or wireless IFE systems and passengers' personal devices. "Use of IPTV with PEDs will depend on TV broadcasters providing airlines with encryption codes for their IFE servers. Some may require that the encryption goes all the way to the seatback screens," says Scott Scheer, director eXTV & ancillary services at Panasonic. "These restrictions are gradually easing as PEDs have improved their capability, and given broadcasters the confidence to provide airlines with encryption codes." The smaller screens on some PEDs means sufficient quality resolution is possible with a lower data transmission rate.

A main advantage of IPTV is that it avoids the complications of any licensing laws related to national TV broadcasts. For most airlines and global regions it is much easier to provide an IPTV channel on an aircraft, once the airline has an agreement with a licensed broadcaster, than transmitting a national TV channel.

Panasonic offers several channels as part of its global service, including: Al Jazeera English, BBC World, CNBC, CNN International, Euronews English, NHK World Premium (Japanese), Sky News, Arabia (Arabic), Sport 24 and Sport 24 Extra.

"These channels are generally available globally, although there are a couple of exceptions in the south-west Pacific and the southern Indian Ocean because of satellite footprints," says Scheer. "A reduced set of channels is available in this region. The maximum number of channels we offer is eight, plus one occasional channel in most parts of the world."

Canadian airline Westjet is a Panasonic customer for its live TV product. Westjet mainly operates Canadian domestic and trans-border routes to the US, but also operates a few intercontinental routes. It provides four live TV channels on all services: Sport 24, BBC News, CNBC and CNN International. Westjet also offers more than 650 hours of TV and movie content on its IFE server.

Lufthansa is another Panasonic customer, and offers live TV across all of its long-haul fleet, which uses three different generations of seatback IFE system. All provide three live IPTV channels on the airline's intercontinental route network: CNN, Euronews and Sport 24. Connectivity for IPTV is via Ku-band.

Gogo is one of the three main licensed IPTV broadcasters, and provides IPTV as part of its Gogo Vision product. Gogo offers three global live channels to its airline partners: news, business and sports. It also offers near-live options for airlines that want to customise their channel selections. Domestic airlines in the US can select custom channels. Gogo says that because each live channel uses a fixed amount of bandwidth, an increased number raises the total cost. It therefore sees airlines providing more live channels over large land masses, where widebeam DBS satcom already exists, and fewer channels on longer flights.

Gogo Vision is used to stream TV and movies to about 3,000 aircraft operated by airlines such as American Airlines, Delta Airlines, and JTA of Japan.

"Most of our customer airlines provide three to 12 live TV channels, and the balance of the channels they provide is pre-loaded on the aircraft's IFE server," says Boyton.

Gogo sees airlines opting for a maximum of 20 channels, with the number restricted by affordability.

Gogo complements its Vision product with a high data rate connectivity system called 2Ku-band. "This is a twin aperture antenna and provides data downlink rates of 100Mbps to the aircraft, but with new modem capabilities it can be up to 400Mbps to the aircraft. It is very efficient, and is coupled with a good modem," says Boyton. "The antenna's twin configuration allows one of the antennae to be dedicated to receiving IPTV transmissions, and the other to bi-directional internet connectivity. The idea of 2Ku-band is to provide good quality IPTV simultaneously with high data rate in-flight connectivity."

Global Eagle offers more than 100 TV channels, but only over the US. "There is no physical or technical hardware limitation to the number of channels an airline can offer on board," says Jim Griffiths, senior vice president at Global Eagle. "The issue is the airline's willingness to pay for bandwidth and the transmission licence fees. We distribute 50 live, bespoke channels to the global maritime industry. We expect to see a large number of bespoke channels for the airline industry being developed relatively soon. The issue of the only channels available being Al Jazeera, BBC World and CNN is about to change," continues Griffiths. "We are working to identify which IPTV channels can be shown regionally or internationally."

Global Eagle's current offerings outside the US are a small number of live channels in the Middle East and Europe, and include programmes such as Sport 24, Discovery and MBC. Typically, five channels may be bespoke to an airline. Norwegian Airlines has three channels, while Air France has run a six-month trial for five channels.