Aircraft-to-ground and inter-aircraft communication technology has developed in recent years that makes it possible to offer in-flight mobile phone and internet services. The different technologies available and the potential for airlines to generate new revenue streams is examined.

Technology for on-board sales

The technology available to allow airlines to provide a wider range of on-board sales and services has expanded in recent years to include: the use of mobile and portable phones, and personal digital assistants (PDAs); connection to the internet; and in-flight credit card transactions in real-time, which allow airlines to securely sell films, games, gambling services, shopping and other in-flight entertainment products and reduce the incidence of credit card fraud.

Technological step

Some in-flight services have been available for some time now. Airlines have been offering seatback movies, videos and games for more than 10 years, as well as credit card and cash shopping for items carried on board the aircraft.

In-flight entertainment (IFE) equipment now allows passengers to watch movies or recorded TV programmes and play games of their choice at times of their choosing. There is also limited scope for providing live television. IFE is an expensive item for airlines to offer, however, with a total annual global spend of $2 billion, most of which covers the cost of equipment and content.

For many years airlines have provided in-flight shopping services paid for in cash or by credit card. These transactions have been time-consuming and limited mainly to goods carried on the aircraft. An additional problem has been revenue losses due to fraud, caused by the fact that credit card sales had to be completed on the ground after the flight, so that it was not possible to detect stolen cards in the air. Moreover, passengers were limited to purchasing in-flight meals and drinks, and goods listed in catalogues carried on the aircraft.

New technologies have become available in recent years that allow a wider range of in-flight products and services to be offered, as well as real-time communication between the aircraft and the outside world and ground services. This real-time communication to and from the aircraft first allows credit card transactions to be made in-flight, thereby providing better detection of stolen credit cards, and reducing the level of fraud.

This has also made it possible for airlines to offer more in-flight services and products, thereby increasing their potential to gain from in-flight sales. The principal products that can now be offered are the use of mobile phones, PDAs and the internet. The combination of the internet and real-time credit card transactions makes on-board shopping via established websites possible.

Gambling could also be provided through established gambling websites, although there are legal issues that make offering such services on aircraft difficult.

Superior quality satellite communication to the aircraft also makes on-board broadcast TV possible, but providing this still remains a challenge for airlines.

Telephone and internet services provide airlines with a new potential revenue stream.

Communication links

The use of phones and PDAs, and access to the internet are now possible due to technology that allows real-time communication between the aircraft and the ground, as well as technology that provides signals in the aircraft cabin.

The first main communication technology required for a range of on-board services is communication between the aircraft and the ground. This is achieved either with an air-to-ground system or air-to-satellite (Satcom) system.

The main air-to-ground communication system is offered by Aircell. This provides a 3MHz wide bandwidth, which is only possible over land, and not over seas or oceans. It has the limitation of requiring a large number of land-based transmitters. Aircell believes, however, that it provides a higher level of service quality and reliability than air-to-satellite technology.

Aircell has an exclusive licence, issued by the Federal Communications Commission (FCC), to offer air-to-ground communications in the USA. Aircell provides WiFi signals in the aircraft cabin. While technically this makes it possible for airlines to offer in-flight mobile phones in the aircraft, the FCC currently prohibits the use of cellular technology and phones on board commercial aircraft flying in US airspace. Aircell's GoGo product offers an in-flight internet service, using WiFi signals, so that passengers can use laptop computers. While it is technically possible for them to use their laptops for phonecalls via Skype, they may only use GoGo for using the internet and e-mails. Passengers can also use WiFi-enabled phones and PDAs on aircraft in the US.

The Aircell network and GoGo also provide airlines with the ability to offer other services such as portable gaming, video, audio and broadcast television in the future. This will clearly provide airlines with an opportunity to generate a new tranche of ancillary revenue. Virgin America has already announced plans to integrate its RED seatback entertainment system with GoGo, and Aircell's other airline partners are expected to do the same in the future.

Airlines gain revenue from passengers by forming an alliance with Aircell that includes a revenue-sharing agreement.

While Aircell's GoGo service is

Airlines have a choice between air-to-ground and air-to-satellite technology for communication outside of the aircraft. Both of these make it possible for airlines to conduct credit card transactions in real-time, reducing the incidence of credit card fraud. This communications technology should enhance on-board sales.

currently only available in the US, it is expanding its network to include Canada, Mexico and the Caribbean in the future.

Cellular technology and phones on commercial aircraft may become legal on aircraft in the US in the future. There are two main suppliers of on-board cellular technology available to US carriers.

The second main air-to-ground technology available to airlines is some type of air-to-satellite or Satcom technology, of which there are three main types: Iridium, Inmarsat and Ku-band. All use signals between the aircraft and satellites, and allow an aircraft to receive communications whatever its geographical location.

There are several issues to consider with Satcom systems: bandwidth, data rate and relative cost per byte or megabyte of information transfer.

"Iridium is cheap, but it provides a narrowband channel and has a low rate of data transmission, which makes it suitable only for transmitting small amounts of valuable data, such as e-mails and credit card transactions, but little else. It is not appropriate for using portable phones or downloading large amounts of data from the internet," explains Wale Adepoju, chief analyst at IMDC, a UK-based in-flight technologies consultancy.

Inmarsat provides a broadband connection and has a high data transmission rate. It is the minimum required for downloading large quantities of information from the internet, and for multiple voice channels that make the simultaneous use of several portable phones on the aircraft possible.

"Inmarsat is standard on modern widebody aircraft, since it is the system certified for extended twin-engine range operations (Etops), and is the system recognised by the International Civil Aviation Organisation (ICAO) as a communications channel. It is what airlines use for satellite navigation, and is standard on types like the A330, A340, 777, 747-400 and A380," explains Adepoju. "It will also be standard on the 787. This presence means that these aircraft already have an air-to-satellite communication capability, so they only need to install equipment for on-board signals. Narrowbodies do not require satellite navigation capability for Etops, and so they do not have Inmarsat installed. OnAir, however, provides the necessary hardware to install Inmarsat on narrowbody aircraft, which would consequently allow them to offer on-board phone and internet services.

"Inmarsat is good for e-mails and telephones, but it is relatively expensive, so it is not good for internet access, which requires a lot of bandwidth," continues Adepoju. "Similarly, 'Connexion by Boeing', which had heavy antennae and expensive systems on the aircraft, was prohibitively expensive for airlines. 'Connexion by Boeing' was ahead of its time, but technology has advanced since then."

The third type of air-to-satellite communication system is Ku-band. "Ku-band is the satellite protocol used for TV, and provides the largest bandwidth and data transmission speed for all aircraft communication systems," explains Adepoju. "Ku-band is also cheaper per byte than Inmarsat, which makes it the most appropriate system for internet and multiple mobile phone use in the air. Only a few airlines are currently using Ku-band: Lufthansa, Southwest and Alaska Airlines. Ku-band requires a new set of equipment to be installed on the aircraft. What should be appreciated is that the airline buyer must be confident that passengers will have a high level of internet usage to make the business case for Ku-band."

There are three service providers for Ku-band: Row 44, Panasonic and T-Mobile.

Communication with the outside world from an aircraft is a recent development. Only about 90 aircraft have the capability, including 31 with Emirates and 15 with American Airlines. BMI, TAP Air Portugal, Southwest and Alaska Airlines are trialling various systems with a small number of aircraft.

On-board communication

The second element of enhanced in-flight services and sales is communication within the aircraft. This is necessary to provide wireless communications to every seat so that mobile phones and connection to the internet are possible.

Two types of wireless inter-aircraft communication are now available: cellular technology and WiFi wireless transmissions within the aircraft cabin. As it is currently illegal to provide cellular services on-board passenger aircraft in the US, US airlines only provide WiFi services. Cellular signals are permitted in aircraft flying in other parts of the world.

Cellular technology is the same as that provided by a mobile phone global system for mobile communication (GSM) provider. The use of cellular technology on the aircraft effectively provides a roaming service. It allows passengers to use mobile phones, Blackberries, PDAs, and laptop computers with general packet radio service (GPRS) cards in them. It also allows passengers to send text messages. If the aircraft has Inmarsat Satcom equipment then passengers can also connect to the internet, although this will be relatively expensive.

Cellular technology also requires clearance from each country an airline flies over. While there are no countries other than the US that have categorically said no to allowing on-board cellular services, many countries have yet to decide if they will allow it. Some have already permitted on-board cellular services, which makes it feasible for two mobile service providers to offer their

In-flight mobile phone use is either through cellular or WiFi signals in the aircraft cabin. The US prohibits use of cellular phones, so Aircell's GoGo product provides WiFi signals for mobile phones. Aeromobile and OnAir use air-to-satellite on-board cellular technology. Emirates, Qantas and British Airways are users.

services to airlines.

WiFi technology on the aircraft is the same as that used in offices. It only has a short-range capability, but it makes it possible to use laptop computers, portable IFE equipment, new technology mobile phones, and iPhones on the aircraft. WiFi and either an Inmarsat or Ku-band air-to-satellite system on the aircraft also makes it possible for passengers to shop and play games on the internet through established websites.

In-flight phones

The first type of in-flight service to attract interest from airlines is the use of mobile phones. This is primarily through on-board cellular technology to suit all mobile phones, although some of the next technology phones also have WiFi chips in them.

Although the US does not allow cellular signals and phones on-board commercial aircraft, it does permit WiFi phones. A large number of countries do permit cellular phones, and others have yet to decide if they will allow cellular technology and in-flight use of phones. The ability to offer mobile phone services on board aircraft also depends on whether the on-board mobile phone service provider has an agreement with the passenger's GSM provider.

The use of in-flight phones requires a high bandwidth air-to-satellite capability. One provider of on-board cellular phone technology is Aeromobile. "The system works on the concept of providing a virtual country inside the aircraft so that the passenger has use of a roaming service. This is similar to the roaming service that a GSM provider has for its customers when they are in another country," explains Peter Tuggey, chief commercial officer at Aeromobile. "The cellular signal inside the aircraft allows mobile phones, Blackberries and other PDA devices and laptops with GPRS cards in them to be used in-flight. However, GPRS cards in laptops do not provide a broadband connection, and so laptops in this case are really only good for sending and receiving e-mails, and not sufficient for surfing the internet.

"Our system has to use Inmarsat for the air-to-satellite communication, since this gives a wide enough bandwidth to allow a large number of voice transmissions," continues Tuggey. "The system works by coming live after the aircraft takes off and auto-enables at cruise altitude. Then a roaming service becomes available in the cabin. Our service started in April 2007 on some of Qantas' international flights, and the airline is now committed to offering it on its domestic fleet from late 2009. We also started services in March 2008 on 31 of Emirates' aircraft, which it operates to up to 49 countries. Emirates will eventually equip its whole fleet with our system. We have several other customers, including Malaysian Airlines, Virgin Australia and Saudia."

Aeromobile has a relationship with Panasonic, which sells Aeromobile's hardware as a distribution partner. The on-board system works using five line replaceable units (LRUs) installed on the aircraft. This includes a server, a control, panel, a pico cell, a network control unit (NCU), and an aerial combiner unit (ACU). The pico cell is a miniature phone station. Signals are distributed through the aircraft cabin, and airlines have to market the product through seatback literature and demonstration videos at the start of the flight.

Tuggey says that the system comes with the relevant service bulletins (SBs) that allow mechanics to install it on the aircraft. Installation takes takes one and a half days and uses 100-200 man hours (MH), while the equipment itself costs about $250,000 and adds 200lbs to the aircraft's weight.

One reservation that some have had with the use of mobile phones on-board aircraft is social disturbance, and airlines have to observe that social etiquette is maintained in the cabin.

"There is a huge upside for airlines, with airlines gaining a few cents of revenue each minute that a passenger is on the phone in the aircraft cabin. This is in the order of at least 10 cents per minute per passenger," says Tuggey. "The system works by each mobile phone GSM provider charging a roaming rate to the passenger. These roaming rates on the aircraft vary between GSM providers. Aeromobile has a wholesale agreement with the GSM providers. These pay Aeromobile, and we pay the airline a percentage of what we receive from the GSM providers.

"Despite concerns by some of the acceptance of mobile phone use by passengers, we are seeing an average use of 31%," says Tuggey. "Use is generally higher during daytime flights. At this level of use the cost of installing the system can be recouped within three years. Our system allows for up to 24 simultaneous calls, although most of our customers have a system that allows up to six calls."

Aeromobile currently has approvals for in-flight mobile phones from 64 countries. "These include countries under the flightpaths of Emirates and Malaysian, and the number of our approvals is increasing," says Tuggey. "We will be adding Australia and New Zealand because of Qantas."

Aeromobile has live agreements with 121 GSM providers, and 185 signed agreements. The number is constantly increasing, although 200 have a 90% market share.

A second provider of in-flight phone services is OnAir, which provides both GSM cellular and WiFi services inside the aircraft, and uses an Inmarsat Satcom capability. "Our GSM cellular product allows passengers to use regular mobile phones and send SMS messages, as well as smart phones and GPRS. These can be

There are three levels of air-to-satellite technology. Iridium provides a narrowband channel which is only suitable for e-mails. Immarsat is already present on modern widebody aircraft, and is good for e-mails but not the internet. Ku-band provides the largest bandwidth and is the best system for on-board internet.

used to access the internet, send e-mails, download attachments and open documents," explains Stephan Egli, chief commercial officer at OnAir. "We offer this service for short-haul operations. Our customers include Air Asia, British Airways, Royal Jordanian, Ryanair and TAP Air Portugal.

"We also have a WiFi internet product for long-haul operations. This will shortly be going into service with Oman Air, and Kuwait start-up carrier Wataniya. This also uses Inmarsat, and we are keeping an open mind on using Ku-band in the future," continues Egli.

ONAir's GSM cellular product generates revenue for the airline in the same way that airlines gain revenue from Aeromobile's product. Passengers are billed for roaming calls by their GSM providers, and these pay a percentage to OnAir. OnAir then pays a percentage of its revenue to the airlines.

OnAir does not provide blanket global coverage for GSM roaming service, since the US, for example, does not permit use of cellular phones. "We have agreements with more than 200 GSM providers, and the number is constantly increasing," says Egli. "This gives us virtually global coverage outside the US, but there are about 900 GSM providers in the world. This means that while some passengers will be able to use their phones inflight, others will not because we do not have an agreement with their GSM provider. We analyse our airline customers' route networks, and the passengers' rejected calls and we are constantly signing up new roaming agreements. We have the most agreements in Europe and the Middle East, which is where the majority of our customers are based.

"Only six calls can be made simultaneously with our current system, which is ample considering that the average call is only about two-and-a-half minutes long," says Egli. "We have the capability to increase to 12 calls, but we do not actually need this. SMS messages and e-mails do not interfere with the six calls being made."

OnAir's WiFi internet service works by the passenger paying an initial log-on fee. This is either by swiping a credit card in the IFE system, or when logging on to the airline's home page with their laptop computer. "This second system is like logging on to a WiFi service in a hotel room. Airlines gain revenue revenue from this log-on fee," says Egli. "We are only making this service available for long-haul operations, since we have seen little demand for it on short-haul flights. People use smart phones for logging on to the internet on short-haul services. Oman Air will be the first WiFi internet customer later this year when this is installed on its A330s, and Kingfisher will also soon launch the same service on its A330s. This WiFi service uses Inmarsat, although we could use Ku-band in the future. Besides passengers being able to browse the internet, airlines can also make real-time credit card transactions for their own in-flight sales."

In-flight entertainment

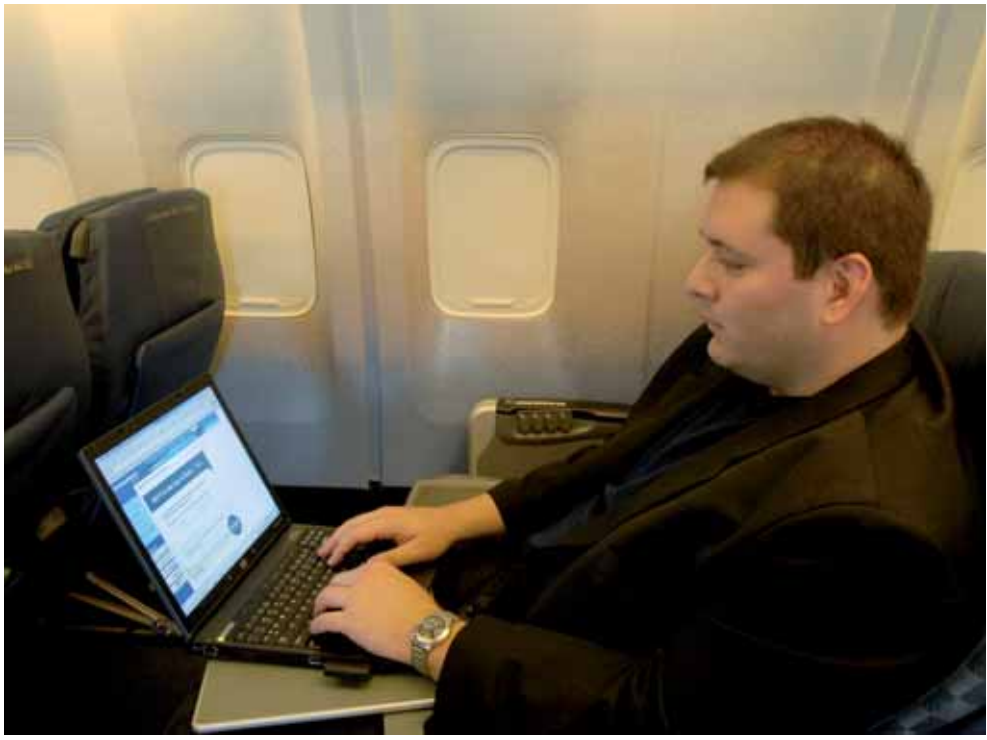
Besides on-board mobile phones, the other on-board sales possibilities are dependent on cellular or WiFi signals in the cabin and the ability to use the internet, and make real-time credit card transactions.

Wingspeed is a communications and server provider that has a system which uses WiFi in the cabin, and an Iridium air-to-satellite system for communication outside the aircraft. "The WiFi and Iridium systems allow passengers to use laptops and handheld computers, portable IFE systems, new high-end mobiles, and Apple iPhones," says Ciaran Bernard, director of sales at Wingspeed. "The system allows flight attendants to use point-of-sale (POS) equipment for real-time credit card transactions. This means in-flight meals and drinks, duty-free goods and items from a catalogue on the aircraft's server can all be sold. Shopping on the internet is not possible.

"The air-to-satellite communication also allows airlines to charge for paid IFE content, such as movies or games," continues Bernard. "While the Iridium Satcom system is too narrow for passengers to download movies, the WiFi signal means that they can watch in-flight movies that are on the aircraft's server on their laptops. The airline can charge for this."

Wingspeed is partnered with Novo IVC and Cluetrader, which provide the handheld POS terminals used by the flight attendants. Wingspeed is also partnered with Bluebox, which provides handheld devices and hardware for IFE. "Portable IFE equipment can be rented out to passengers," explains Bernard. Portable IFE players and equipment are desirable for older aircraft types that were not originally fitted with seatback IFE systems. These have a high installation and maintenance cost, which cannot be justified on older types like the MD-80 or 767. It costs about $100,000 to install the system and its three pieces of avionics on a narrowbody. There is also the cost of acquiring the POS hardware and portable IFE players.

The real-time credit-card transactions for POS shopping mean faster sales, and airlines can also take a revenue share from on-board shopping. Bernard claims airlines can generate about $200,000 per aircraft per year from this last activity. There is also potential to charge for gaming and movie content. The Iridium system also allows the cabin crew to place orders for more inventory in the aircraft and make other reports while in the air. Moreover, the Satcom link also allows a voice and data link that allows information to be passed between the aircraft and airline operations department. This includes technical logs,



Passengers can browse the internet with Ku-band and WiFi technology. While airlines are unlikely to be able to charge passengers for visiting different websites, passengers will probably be prepared to pay initial fees for logging on in flight.

charts and allows an automated paperless operation.

In-flight shopping

Southwest Airlines is testing a Satcom and WiFi in-flight internet system that will allow it to offer shopping for its passengers. The system is free for passengers during the test phase, but clearly has revenue-generating potential.

The aircraft is using Ku-Band, with Row 44 the service provider. Three more aircraft were being added to the test programme in March 2009.

Southwest has partnered with Yahoo!, which has provided a homepage where passengers initially log on during the flight. They can then access the contents, which include local sports and entertainment events, news, weather and entertainment guides for the aircraft's destination. This way passengers can book tickets or make reservations for restaurants or hotels on the way to their destination. Passengers can also access Yahoo! games, and the home page also has potential for passengers to shop on established websites. This system clearly has the potential for Southwest to gain revenue by charging passengers a log-on fee and by taking commissions for tickets sold for sports and other entertainment events.

American Airlines is also undertaking an in-flight trial using air-to-satellite technology. It is using on-board sales recorder (OSR) sales terminals to charge passengers for in-flight snacks, meals, drinks and headsets. American plans to convert to cashless sales for US domestic and US-Canadian flights by summer 2009, using the OSR terminals that will allow real-time credit-card transactions in-flight.

Purchased items currently have to be entered manually into the OSR terminals, but American hopes to take the process a stage further by adding a barcode system. This will use a barcode for each product which can be read automatically by the sales terminals, and so speed up the sales process.

The revenue-generating potential from in-flight shopping has yet to be exploited by airlines. This clearly requires internet access, and so requires a minimum of Inmarsat Satcom technology. Adepoju points out that Ku-band is preferable, since several passengers browsing the internet simultaneously will require the aircraft to have a high bandwidth capability. Shopping is unlikely to be through an airline's own website, since so many established shopping websites already exist. Airlines are therefore more likely to gain revenue from just charging passengers to log on to the internet in-flight with a credit card transaction. There is potential for airlines to derive commissions for hotel reservations, car hire and travel insurance policies in the same way that they do through their own websites when passengers make seat reservations.

It was hoped that airlines would also be able to provide in-flight gambling services. While this is technically possible with Satcom communication and the ability to use established gambling websites in-flight, there are many legal issues which have prevented this.

Another possible in-flight revenue stream is broadcast TV. "This requires the aircraft to have a Ku-band Satcom system," explains Adepoju. "Broadcast TV has several practical difficulties, however. News and weather are the easiest to transmit on the aircraft. An obvious choice would also be major sporting events. The problem here is that the transmission rights held for these present a large obstacle for airlines to overcome. The airline would have to negotiate with the company holding the rights for these events for transmission when flying over a particular country, and the airline would also have to a pay a fee to the company holding the rights. This cost would have to be passed on to the passenger. International flights flying over several countries would mean airlines have to make a separate negotiation for every country the aircraft flies over. This would make the cost of providing the ability to watch these sports events too high for most passengers. This means that live TV is likely to be limited to news and weather."

JetBlue uses a product from the company Live TV to provide broadcast TV in the seatbacks of its aircraft. The same product also allows internet access. JetBlue also has transmission rights for certain high-profile sports events, which is economically viable for the carrier because it overflies a single country.

Another potential that new communications technology offers is improved customer relationship management (CRM). CRM involves an airline obtaining and managing information about its passengers so that it can identify the ones generating the highest revenue. CRM then uses the data and information generated for intelligent and targeted marketing. If used well, these data can then be used to welcome particular passengers at check-in and departure lounges, as well as provide the possibility of upselling to passengers during various stages of their check-in, pre-departure, boarding and flying process. With internal and external communications, passengers can now be sent messages directly to their mobile phones and PDAs with information on delays, gate changes and even which carousel their baggage will be on. Although this does not directly gain revenue, this adds to CRM and enhances passenger loyalty. AC