In April 2016 ICAO published Standards and Recommended Practices (SARPs) relating to aircraft tracking. These will form the basis of forthcoming aircraft tracking regulations. New aircraft tracking solutions continue to enter the market and are summarised here.

Developments in aircraft tracking

A host of new aircraft-tracking solutions have been introduced over the past 12 months, and others are in development. Some of these were created in response to the proposed Global Aeronautical Distress & Safety System (GADSS). The concept for the GADSS was established in the wake of several high-profile incidents where aircraft could not be located.

The latest developments relating to aircraft- (or flight-) tracking requirements are summarised here. The technological solutions intended for airline use that are available to satisfy requirements are also addressed. Airlines will generally be responsible for ensuring their aircraft are tracked. Airline case studies demonstrate how aircraft-tracking solutions are being put into practice.

GADSS & aircraft-tracking update

The concept for the GADSS was proposed by an International Civil Aviation Organisation (ICAO) working group, and recommended for adoption in February 2015. The long-term goal of the system is to provide improved awareness of an aircraft's last known position and, therefore, a smaller, more focused search area in the event of an accident or incident. It also aims to improve current practices related to the recovery of flight data.

The initial draft concept of operations (CONOPS) for the GADSS proposed a system consisting of three main functions: i) aircraft tracking; ii) autonomous distress tracking (ADT); iii) and the retrieval of flight data.

System-wide information management will ensure relevant information is passed to the appropriate stakeholders, including search and rescue (SAR) agencies, in the event of a flight developing abnormal or distress conditions.

The final operational structure of the GADSS and some related procedural requirements are still in development, but ICAO has now produced standards and recommended practices (SARPs) relating to certain functions including aircraft tracking and ADT. Only national and regional regulatory authorities have the jurisdiction to mandate any of these recommended procedures and practices.

The draft CONOPS for the GADSS is based on a phased introduction of its three main components. This would include a near-term introduction of the aircraft-tracking function, which can be satisfied by existing technology.

The ADT and flight data retrieval functions will both require the introduction of new technology. Current ICAO SARPS indicate that ADT capability will be required for new aircraft from 2021.

There is still some debate about the level of capability that will be required to satisfy the flight data retrieval function. There are currently no ICAO SARPS related to the data retrieval function, and there is no indication of the timeframe within which this capability is expected to be available.

This article will focus exclusively on the aircraft-tracking function of the GADSS and related requirements, since this is the first phase for which airlines will need to be suitably equipped.

Aircraft tracking

The draft CONOPS for the GADSS proposes two sets of aircraft-tracking initiatives. The first relates to tracking aircraft that are operating under normal conditions. The second involves tracking aircraft when an abnormal operational event has been detected. It is not yet clear what qualifies as an abnormal event.

The frequency of aircraft position update intervals varies depending on the density and procedures in place in certain airspace regions.

Air traffic control (ATC) surveillance systems already monitor aircraft position data almost in real time in most high-density airspace over land. These surveillance systems may not be available in more remote or oceanic areas, and in some cases the interval between position reports may be up to one hour. If an emergency situation were to occur in such remote airspace shortly after a position report is made it could be nearly an hour before the relevant authorities and SAR agencies become aware that there is a problem, leaving a search area of potentially several thousand square miles.

Normal aircraft-tracking initiatives proposed as part of the GADSS call for position reports to be received at least once every 15 minutes when the aircraft is experiencing normal operating conditions. In some remote or oceanic airspace this could give authorities a more accurate picture of an aircraft's last known position, and a smaller search area, in case of an emergency.

The draft concept of operations for the GADSS also called for the capability to reduce an aircraft's position update interval to at least once every minute if an abnormal event is detected. An abnormal event would involve an increased risk to a flight and require immediate crew action.

Aircraft tracking SARPs

ICAO issued SARPs for normal aircraft tracking in April 2016. These will become applicable on 8th November 2018. National or regional regulatory authorities are then expected to mandate normal aircraft tracking practices.

The normal aircraft-tracking SARPs

In some remote airspace, standard ATC surveillance systems such as secondary radar and ADS-B may not be available. New aircraft tracking solutions have been developed to help combat gaps in aircraft position reports.

call for a minimum position-reporting interval of 15 minutes or less. These reports should include the aircraft's identification and four-dimensional position (4D). A 4D position report includes latitude, longitude, and altitude data, and the precise time the aircraft was at each position.

The ICAO SARPs feature either recommendations or required standards for aircraft tracking, depending on an aircraft's certified take-off mass and seating capacity.

It is recommended that operators of aircraft with a maximum certified take-off mass of over 27,000kg (59,525lbs) and more than 19 seats, should have the means to automatically track their aircraft at least every 15 minutes in any airspace where ATC surveillance systems currently obtain position information at greater than 15-minute intervals.

The 15-minute tracking requirement would, however, be an obligatory standard for all aircraft with a certified take-off mass in excess of 45,500kg (100,310lbs) and more than 19 seats, when operating in oceanic airspace where ATC surveillance systems obtain position reports at intervals longer than every 15 minutes. These requirements will apply to any qualifying aircraft, regardless of its age.

The normal aircraft-tracking SARPs establish requirements for the retention of aircraft-tracking data to help identify an aircraft's last known position. They do not, however, specify how long these data should be retained for. Initial indications suggest that operators will be required to retain tracking data at least until the aircraft has landed.

The normal tracking SARPs discuss when an operator should report missing aircraft position information. Guidance material for this requirement will be available before the SARPs become applicable.

There are currently no SARPs relating to abnormal tracking conditions. Abnormal tracking is expected to be addressed in the form of guidance in the updated GADSS CONOPS.

Aircraft-tracking regulations

The ICAO aircraft tracking SARPs are only recommendations, and have no regulatory jurisdiction. National or regional authorities are responsible for mandating any aircraft-tracking requirements. The ICAO SARPs are high-level recommendations that can be transformed into national or regional regulations in different ways. This could mean that aircraft-tracking regulations may differ between some global regions.

Since ICAO's normal tracking SARPs were only published in April 2016, relatively few regulatory authorities have confirmed the aircraft-tracking standards and practices they plan to implement. The European Union (EU) has, however, already published some amended air operations rules relating to future aircraft-tracking requirements.

The aircraft-tracking regulations planned by the EU differ slightly from the standards and procedures proposed by the ICAO SARPs. The EU's requirements can be found in the air operation rules, in paragraph CAT.GEN.MPA.205, which was introduced by EU regulation 2015/2338. The proposed acceptable means of compliance (AMCs) and guidance material (GM) will be drawn up by the European Aviation Safety Agency (EASA).

The proposed EU tracking regulations will apply to qualifying aircraft that are registered in an EU country. The regulations stipulate that it is the operator's responsibility to track qualifying aircraft, but unlike the ICAO SARPs the tracking requirement extends from take-off to landing, and is not restricted to oceanic airspace. The EU tracking requirements will, however, only be necessary when part of the planned route falls outside ATC surveillance coverage. The regulations will not require the operator to track a flight where the planned route or diversion route is completely covered by ATC surveillance, provided that:

1. The airline has given sufficient contact information to the relevant Air Navigation Service Providers (ANSPs).

2. The ATC surveillance systems provide position reports at acceptable intervals.

In situations where tracking is necessary, operators will be required to receive uninterrupted position reports, even when the aircraft is under ATC surveillance. This can include a feed of surveillance data from an ANSP.

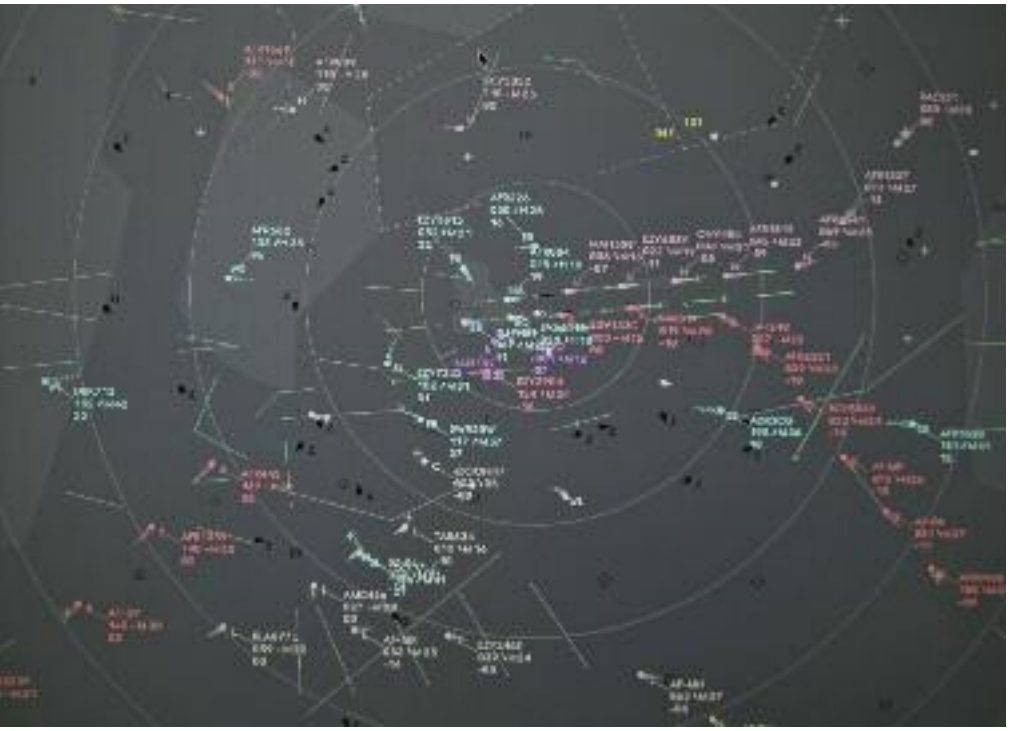
The EU tracking requirements will require the implementation of an aircraft tracking system by 16th December 2018, about one month after the ICAO SARPs become applicable. The EU requirements will apply to operators of certain qualifying aircraft, including those with an individual certificate of airworthiness (CofA) issued on or after 16th December 2018 and which have:

1. More than 19 seats and a maximum take-off mass of more than 27,000kg; or

2. A maximum take-off mass of more than 45,500kg.

Operators of these qualifying types with a CofA issued prior to 16th December 2018 will only be required to track their aircraft if it is already equipped with a separate on-board solution to provide position information, in addition to the Secondary Surveillance Radar (SSR) transponder. Aircraft manufactured before the regulations come into force will therefore not be subject to the tracking regulations, unless they are already suitably equipped. This means retrofitting will not be necessary.

Unlike the ICAO SARPs, the EU regulations will make tracking obligatory for aircraft with a certified take-off mass



The GADSS was proposed by an ICAO working group and recommended for adoption in 2015. It proposes a normal minimum aircraft tracking interval of 15 minutes, and the ability to track every minute in abnormal conditions.

of 27,000-45,500kg, depending on their age and level of equipage. The EU standards also account for both passenger and freighter aircraft with a take-off mass in excess of 45,500kg. Most large regional jets and all narrowbody and widebody aircraft have a certified take-off mass in excess of 27,000kg.

EASA has not yet finalised the AMCSs and GM in relation to the EU's aircraft-tracking regulations. It is, however, expected that the initial required tracking interval for normal operations will be at least every 15 minutes.

Aircraft tracking solutions

The latest developments in aircraft-tracking solutions are identified here. This includes a summary of some of the main solutions currently available or in development.

These solutions will be capable of satisfying the normal tracking requirements proposed in the GADSS CONOPS and ICAO SARPs. They will also be capable of meeting the proposed guidance for abnormal tracking. It is likely that they will satisfy any associated mandates for aircraft-tracking standards, although these could vary slightly by national or regional authority. Operators should check with solution providers once specific aircraft-tracking mandates have been published by their governing regulatory authority.

The normal and abnormal tracking proposals are performance-based initiatives. This means there is no single specified technical solution to meet the tracking requirements. Airlines can choose from the available solutions that most suit their operation.

An aircraft-tracking system requires on-board hardware and software which act as a data source that can generate and/or capture and then export the required aircraft identification and position information. It also requires an air-to-ground communications link and a ground-based information server for processing and storing aircraft position information. Airlines will also need a graphical user interface (GUI) or access portal where the aircraft's flight track can be displayed.

On-board data sources

Many aircraft are already equipped with on-board technology that can be used to satisfy the normal and abnormal tracking requirements. These solutions can be split between ATC surveillance and other systems. A brief summary is provided here. *Aircraft Commerce* has previously provided a detailed explanation of most of these systems and the on-board equipment they require (see *Aircraft tracking initiatives & systems, Aircraft Commerce, June/July 2015, page 16*).

ATC surveillance

The main contemporary ATC surveillance systems are secondary surveillance radar (SSR), automatic dependent surveillance-broadcast (ADS-B) and automatic dependent surveillance-contract (ADS-C).

SSR and ADS-B are only available over land. ADS-B is expected to eventually replace SSR as the main means of ATC surveillance over land. Both technologies require the use of on-board transponders to transmit aircraft identification and position information.

ADS-B OUT constantly broadcasts a range of aircraft position data, including: the date and time; aircraft registration; flight number; airline code; latitude; longitude; altitude; speed; and vertical speed.

ADS-B OUT can provide more accurate real-time surveillance than SSR, since it is constantly broadcasting information that can include precise GPS positions. In addition to its tracking functions, ADS-B technology could help to increase airspace capacity by reducing the minimum aircraft separation distance.

Aircraft require an extended squitter transponder and a position source such as an inertial navigation systems (INS) or a global navigation satellite system (GNSS) for ADS-B capability. By 2020 mandated ADS-B capability will be in place in many high-density airspace regions.

The main limitation of current SSR and ADS-B systems is that they rely on land-based infrastructure, and therefore only have an effective range of 200-250 nautical miles (nm) from land-based receivers.

ADS-C is therefore the only ATC surveillance system available in oceanic airspace and some remote regions. ADS-C is the surveillance component of the Future Air Navigation System (FANS) which was developed to provide more efficient routeings for long-haul aircraft travelling through remote and/or oceanic airspace. FANS also includes navigation and communication functions, and is generally referred to as FAN-1/-A. FANS-1 is the Boeing standard and FANS-A is the Airbus standard.

ADS-C sends automated 4D position and aircraft identification information to ATC. Unlike ADS-B OUT, ADS-C position reports are not broadcast continuously and are therefore not used to provide a live surveillance feed. The frequency of ADS-C transmissions is determined by one of three contract types between the relevant ANSP and the aircraft. These are current, periodic or event-based contracts.

ADS-C transmissions are generated when an on-board position source interfaces with an aircraft's flight management computer (FMS). The resulting position information is sent to ATC ground stations as Aircraft Communication and Reporting System (ACARS) messages. These will be sent via

FLYHT's AFIRS solution enables its FLYHTLog and FLYHTASD aircraft tracking solutions. It can provide a live stream of 4D position reports with 100% global coverage.

satellite communication (satcom) channels when operating over oceanic areas.

These ADS-C transmissions are categorised as air traffic services (ATS) messages, and so have to be sent over safety-approved communication channels. The approved communications pipes for ATS messages in remote and oceanic airspace are Inmarsat Classic Aero, and Iridium satcom, or high-frequency data link (HFDL). It will also be possible to send them over the new Inmarsat Swiftbroadband (SBB) safety service.

Many long-haul aircraft are already equipped with FANS-1/-A and ADS-C capability as standard. These aircraft will be able to comply with the proposed 15-minute and one-minute tracking requirements, since ADS-C periodic contracts can be established at these time intervals.

Non-ATC sources

In addition to existing ATC surveillance equipment on board the aircraft, there are a number of other on-board solutions that can provide position data.

ACARS can include a position reporting function. ACARS position reports can be configured to transmit at pre-determined intervals, including every 15 minutes or one minute if necessary. The transmission interval can be set up by the flightcrew or from the ground.

ACARS position reports normally include latitude, longitude, time, aircraft identification and flight number. The time can be omitted, in which case the operator would need to refer to the timestamp on the ACARS message. In addition, altitude is not generally included in ACARS position reports. This would mean they cannot be used in isolation to provide a comprehensive solution to the aircraft-tracking SARPs. It is possible to include full 4D information in ACARS position reports, but the cost of doing so could vary considerably.

Many aircraft are equipped with ACARS router functions on the production line. For others there are various retrofit solutions available. Some ACARS messages are classed as aircraft operational communication (AOC) messages.

In remote or oceanic airspace, ACARS messages are most likely to be sent over Inmarsat Classic and Iridium satcom channels, or over an HFDL pipe. It will also be possible to send them over Inmarsat SBB.

In high-density airspace over land, ACARS messages could be sent using very-high frequency (VHF) radio or VHF digital radio (VDR). Airlines need to contract with Rockwell Collins or SITAONAIR to send and receive ACARS messages via their ground-based networks. This is the same as for all other types of ACARS messages already being transmitted by commercial aircraft, so virtually all airlines will already have this capability in place.

Rockwell Collins is the only provider of an HFDL service. This communication pipe can be used to send ACARS messages, including ADS-C position data, in remote or oceanic airspace.

The HFDL network also transmits back-channel data for diagnostic purposes. This is referred to as frequency and performance data and includes some positional information including an aircraft's latitude and longitude as well as a message time stamp. The back-channel HFDL transmissions are sent at 10-minute intervals. They do not, however, include altitude data, and so could not be used as an exclusive source for 4D position information.

Inmarsat SwiftBroadband safety

The Inmarsat SBB satcom service has been available since 2007. It has not, however, been certified for ATS transmissions. SBB has higher data-transfer rates than the first-generation Inmarsat Classic and Iridium satcom solutions, and can send data in an internet protocol (IP) format.

"The SBB service for ATS transmissions is currently in the process of being validated in trials," explains Captain Mary McMillan, vice president of safety and operational services at Inmarsat Aviation. "SBB is our next-generation flightdeck safety service. It offers global high-speed, secure connectivity for the ATS transmissions to and from the flightdeck. It enables IP-based, broadband flightdeck applications, from continuous positional awareness and electronic flight bag (EFB) updates to high-speed voice and data communications. In a distress situation it also delivers continuous flight data streaming."

Inmarsat's SBB safety service includes an integrated aircraft-position reporting function that provides identification and 4D position information. These data are made available to the SBB system through aircraft avionics interfaces.

The aircraft-position data made available by SBB can be sent to aircraft operators via Inmarsat's distribution partners, or direct to airlines from Inmarsat.

Inmarsat does not provide a user interface for SBB position data monitoring, since it expects that airlines will combine these data with other position sources and use an existing graphical user interface (GUI). The 4D aircraft position information made available by Inmarsat SBB can be incorporated within other third-party aircraft-tracking solutions.

Other third party

A number of third-party providers

have developed on-board hardware and/or software solutions that can provide aircraft position data for aircraft tracking solutions. These include FLYHT Aerospace Solutions Ltd (FLYHT), iJet Technologies, UTC Aerospace Systems (UTAS) and Panasonic Avionics.

Aircraft tracking providers

There are a range of aircraft-tracking systems available or in development. Solution providers have adopted varying approaches to satisfy impending aircraft tracking requirements.

Rockwell Collins – ARINC MultiLink℠

Rockwell Collins has developed the ARINC MultiLink℠ flight tracking service. This is a ground-based software application that collects position information from multiple sources, harmonises the data into a common format, and presents the resulting 4D flight track in a situational awareness display.

A primary goal of the ARINC MultiLink solution was to make it affordable for airlines by maximising the use of any aircraft position data they already generate. The system can extract information from ADS-C, ACARS, and ADS-B position reports, ANSP radar data and HFDL performance and frequency data. Rockwell Collins already has experience of handling ACARS and HFDL data through its GLOBALink℠ network, which receives and distributes voice and data messages from aircraft. ARINC MultiLink is the only tracking solution that uses back channel HFDL data as a source of position information, since Rockwell Collins is the only service provider with an HFDL network.

In addition to these established systems, ARINC Multilink has been designed to incorporate position information from other data sources as and when they become available.

Rockwell Collins says that ARINC MultiLink will use all available data feeds all of the time. It claims that this could allow the system to differentiate between an individual system failure or a more serious problem with an aircraft.

Airlines have the option to feed data from ARINC MultiLink into their own in-house user interfaces. Alternatively, ARINC MultiLink tracking data can be integrated in Rockwell Collins' WebASD or Web Mapper situational displays that are part of the ARINC OpCenter and Hermes flight operations systems, that are already in use by airlines. Rockwell Collins has also been working with third-party providers to integrate the ARINC MultiLink feed into their situational displays.

ARINC MultiLink can be used to provide aircraft identification and 4D position information at 15-minute and one-minute intervals, provided the appropriate data feeds are available. Aircraft-tracking data can be stored for up to 93 days. Airlines can manually adjust the frequency at which position reports are received. By early 2017, ARINC MultiLink users will also be able to set automatic event or periodic triggers for ADS-C position reports.

Several undisclosed airlines are now signed up to the ARINC MultiLink service.

SITAONAIR AIRCOM® FlightTracker

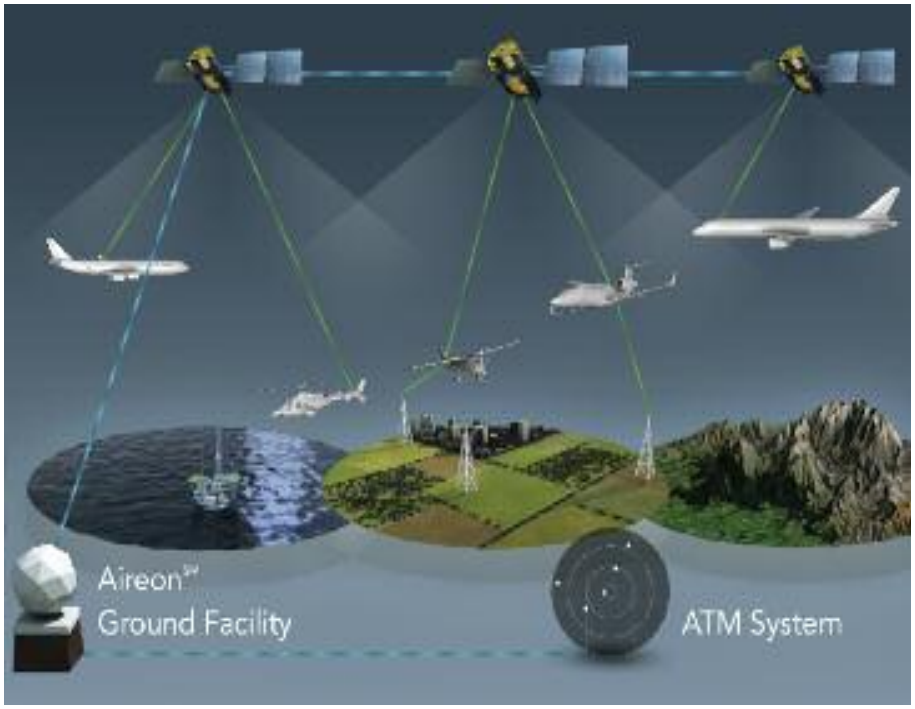
SITAONAIR provides data communication services, among other capabilities. Its AIRCOM® FlightMessenger system provides its ACARS messaging service that is used by about half of the global ACARS-equipped fleet.

SITAONAIR has developed an aircraft-tracking solution called AIRCOM® FlightTracker. This is a ground-based software add-on for the AIRCOM FlightMessenger system. Version two of this aircraft-tracking solution has recently been released, and features new flight deviation and area-based alerting capability.

AIRCOM FlightTracker was designed to use existing position data sources in order to minimise any requirement for airlines to install new equipment. It combines data from multiple aircraft position sources including ATC radar, ADS-B, ADS-C and ACARS. AIRCOM FlightTracker can automatically request position data to fill gaps in terrestrial ATC surveillance coverage.

"AIRCOM FlightTracker features configurable alerting so that the airline can be notified and take automatic action when an aircraft does something unexpected," explains Paul Gibson, AIRCOM portfolio director at SITAONAIR. "Alerts can be generated when an aircraft stops reporting its position. Airlines can also configure AIRCOM FlightTracker for area-based alerting, and ACARS-based alerting or flight deviation alerts.

"The operator can use FlightTracker



Aireon's unique space-based ADS-B solution will provide 100% global surveillance coverage. ASD-B out signals broadcast by aircraft will be relayed via satellite to a ground-based processing centre, from where it will be distributed to ANSPs.

to define and display geographic areas," continues Gibson. "Alerts can be generated when an aircraft enters or leaves one of the defined areas. FlightTracker can also be configured to trigger alerts based on the content of ACARS messages, such as those containing certain operational warnings or systems status faults.

"The flight deviation alert is new to version two of the FlightTracker," adds Gibson. "This service continually monitors all flights and compares the aircraft's position with the flight plan. An alert is generated if a flight deviates laterally or vertically from the flight plan."

AIRCOM FlightTracker displays each aircraft's position on a Google Maps display. It can provide aircraft identification and 4D position information at 15-minute or one-minute intervals, provided the appropriate data sources are available.

"The latest version of FlightTracker incorporates views of FANS datalink communications between ATC and individual aircraft," says Gibson.

Versions of AIRCOM FlightTracker are currently in service with about 40 airlines including Azul, Norwegian and Royal Brunei. Aircraft-tracking data are stored within the core application database and can be retained for an extended period.

FLYHT

FLYHT provides aircraft tracking capability using the FLYHTLog™ and FLYHTASD™ solutions, accessed through its web-based user interface. These solutions are enabled by FLYHT's on-board Automated Flight Information Reporting System (AFIRS™).

The AFIRS 228 Iridium satcom unit includes integrated GPS dual Iridium voice/data modems and FLYHT's proprietary software. It collects data from various aircraft systems, then transmits the data to the ground via Iridium short burst data (SBD).

AFIRS can provide a live stream of 4D position reports with 100% global coverage. It can also facilitate voice and text communications, as well as the live streaming of FDR data. The AFIRS 228 unit has also been approved as a FANS-certified satcom solution for combined Iridium voice and datalink communications.

FLYHT's tracking solutions, FLYHTLog and FLYHTASD, are part of a wider range of services accessible through a web-based user interface. FLYHTLog provides automated aircraft movement messages, along with fully configurable, automated, manual and autonomous distress tracking capabilities.

FLYHT's Aircraft Situational Display (ASD) is fully integrated with the other FLYHT products. It is an interactive global aircraft-tracking map that features built-in alerts and notifications for tracking the progress of a flight and monitoring the status of an aircraft.

FLYHTLog and FLYHTASD allow the frequency of position reports to be adjusted in three ways. The reporting interval can be adjusted manually from the ground or on the aircraft. It can also be programmed to automatically increase or decrease reporting times, depending on the aircraft's geographic position.

Onboard algorithms can be set to automatically adjust the aircraft-position reporting interval in response to abnormal behaviour, such as an unexpected deviation in course, speed or altitude. FLYHT's aircraft-tracking solutions can provide position reports at intervals as often as every 20 seconds.

"In today's climate an awareness of an aircraft's location is not enough anymore," says Graham Ingham, director of product development and sales support at FLYHT. "We also need to provide insight into the aircraft's status. Is everything operating normally or is some form of abnormal or emergency event developing? FLYHT combines aircraft-tracking with an ability to monitor vital aircraft health and operational data in real time, including live flight data recorder (FDR) streaming capabilities."

iJet Technologies – iJet Airborne

iJet Technologies is a Seattle-based software company focused on data access applications and analytics for the aerospace industry.

iJet provides a data access platform which consists of airborne and ground-based software elements. This software platform accesses raw data from multiple aircraft systems, transforms the raw data into modern engineering units and then processes the data while on-board the aircraft. The data are then selectively sent to the ground according to business rules across IP links, where it is aggregated and analysed by the ground platform. The data access platform is hosted on the aircraft by a third-party server or aircraft interface device (AID). The software can run on any onboard server and requires an interface to the raw aircraft data sources. While stand-alone AIDs and servers have been the norm, some providers, including Teledyne and Scandinavian Avionics, now offer single avionics units that include both AID and server functions.

iJet offers aircraft-tracking capability via its iJet Airborne software application. This is a cloud-based software solution that uses real-time aircraft data provided by iJet's data access platform. By accessing raw data parameters from aircraft systems, the iJet Airborne aircraft-tracking solution can provide a live feed of aircraft identification and 4D position information.

"Coverage levels for the aircraft-tracking solution are driven by the operator and are a function of the connectivity solution installed on the aircraft," explains John Schramm, chief

executive officer at iJet Technologies. "We can access any and all IP-based onboard connectivity systems, including cellular systems and Ku-, Ka- and L-band satcom. Iridium can also be used to send aircraft-tracking data in IP format, since the required bandwidth is minimal."

iJet's tracking solution reverts to ATC surveillance data if connectivity with an aircraft is lost. "The logic behind our solution is that the aircraft should be the position-source for aircraft tracking, rather than an ATC surveillance-based intermediary," says Schramm.

iJet also provides the capability to monitor aircraft's system's data for maintenance purposes. "Our software can derive abnormal aircraft behaviour by analysing individual parameters," claims Schramm. "Triggers can be established so that the software will start streaming critical system data in the event of a developing abnormal situation."

Operators can access the user-interface and situational display for iJet Airborne aircraft tracking via a cloud-based portal.

The aircraft-tracking solution will enter operation with Icelandair in 2016, where it will report an aircraft's position every five seconds.

It is possible for aircraft-tracking data from iJet Airborne to be imported into third-party tracking solutions. iJet can store an operator's aircraft-tracking data for as long as required.

Panasonic AirMap

Panasonic Avionics has introduced an aircraft-tracking solution which includes on-board hardware, an air-to-ground communications pipe and a ground-based software application.

"Our global tracking system is based on Panasonic's Global Communications Services (GCS) and FlightLink™ satcom solutions," explains Jeffrey Rex, director at Panasonic Avionics. "By adding the AirMap application to either of these satcom solutions, airlines can meet the normal and abnormal tracking requirements proposed for the GADSS.

"FlightLink is an Iridium-based satcom solution designed for air-to-ground flightdeck communications," explains Rex. Panasonic's FlightLink unit includes autonomous GPS and Satcom functions. FlightLink can generate 4D aircraft position and identification information and transmit it over the Iridium satcom pipe with 100% global coverage.

"The GCS solution uses Panasonic's own Ku-band eXConnect satcom pipe, and is mainly used for providing broadband Internet connectivity for the passenger cabin," explains Rex. This solution has a larger bandwidth than the FlightLink system, and it sends data in IP format. GCS can send position information obtained from the integrated GPS system within Panasonic's second-generation Ku-band antenna.

Aircraft position and identification data from the FlightLink or GCS solutions are sent to Panasonic's ground-based server. "The AirMap application is the enabling tool that allows airlines to view and interact with these tracking data," explains Rex.

AirMap is a web-based application that is hosted on Panasonic servers. It acts as a user interface for Panasonic's aircraft-tracking customers. AirMap provides a graphical representation on which airlines can monitor and track their aircraft. It can also provide alerts based on configurable thresholds. This might include alerting the operator if the aircraft has deviated from its filed flight plan or the provision of notifications related to fuel or maintenance status. The tracking interval can be configured by airlines and is manually adjustable. AirMap also provides voice and text messaging capability in the event that an operator needs to contact an aircraft based on the situational tracking data they receive.

No additional on-board equipment is required to activate Panasonic's aircraft-

Azul introduced SITAONAIR's AIRCOM FlightTracker in 2015. The solution is used to monitor the airline's entire fleet at 15 minute intervals. Tracking data is sourced from ACARS position reports and ADS-B surveillance data.

tracking solution for existing FlightLink and GCS satcom users. The only incremental costs are those associated with the introduction of the AirMap application.

The AirMap tracking solution was launched in June 2016 and is currently being trialled by three airlines.

UTAS – ADM aircraft tracking

UTAS can provide aircraft position information via its Aircraft Data Management (ADM) solutions. The UTAS aircraft tracking-solution includes on-board hardware and software and a ground-based server and user interface.

UTAS's ADM systems were primarily developed for the electronic flight bag (EFB) market and include an AID. The AID can be installed as a standalone device, separate from an EFB solution. A software add-on for the AID provides it with the capability to download 4D aircraft position information from the navigation system. The AID software upgrade also enables aircraft condition monitoring system (ACMS) data to be downloaded to monitor aircraft health.

The UTAS ADM aircraft-tracking solution can provide position information at 15-minute or one-minute intervals. The exact position reporting interval can be configured by UTAS as required. Position information is transmitted to the ground as an ACARS message over the VHF, VDR, HFDL, Inmarsat or Iridium satcom pipes.

Position information is sent from the AID to a cloud-based server. Airlines can then access this from a UTAS user-interface. The ADM aircraft-tracking solution is capable of automatically triggering an increase in the position-reporting interval if an abnormal event occurs. This automatic response would be activated by algorithms hosted on the AID that are designed to detect specific scenarios.

UTAS's aircraft-tracking function can be included as an add-on to its other ADM solutions, or taken as a standalone feature. A Beta test version is now available.

Aireon – Space-based ADS-B

Aireon is developing a unique space-based ADS-B solution, and will be capable of providing 100% global surveillance coverage. It will be able to provide a continuous stream of position information and will plug any gaps in the existing ATC surveillance framework. The company is a joint venture between satcom provider Iridium and ANSPs including NAV Canada, ENAV, the Irish Aviation Authority and Naviair.

Aireon's spaced-based ADS-B system will provide real-time aircraft identification and 4D position information. ADS-B OUT signals broadcast by aircraft will be relayed via satellite, using a unique system, to Aireon's ground-based data processing centre, from where the data will be distributed to the ANSPs.

Aireon's data processing centre and its ADS-B satellite payloads have been completed. The space-based ADS-B receivers were manufactured by Harris and will be hosted on the Iridium NEXT satellite constellation. The first Iridium NEXT satellites are expected to launch during September 2016. The complete constellation will consist of 66 satellites in low earth orbit. Aireon expects to begin initial trials of its system two months after the first satellites are launched.

"Aireon already has eight ANSPs signed up to data service agreements for its space-based ADS-B system," explains Don Thoma, chief executive officer at Aireon. "These include NAV Canada, the IAA and the UK's NATS. The North Atlantic will be the first airspace region to introduce space-based ADS-B capability.

One of the main benefits of space-based ADS-B is that it will allow an increase in airspace capacity through reduced separation standards. The current separation minima in North Atlantic Track (NAT) airspace is 30nm longitudinal for FANS-equipped aircraft with ADS-C, and 80nm longitudinal for non-FANS aircraft.

The use of space-based ADS-B could bring longitudinal separation standards down to 15nm in NAT airspace."

Aircraft that are already equipped for terrestrial ADS-B surveillance will not require any further modifications in order to be tracked by Aireon's space-based solution.

Aireon is currently fully focused on providing space-based ADS-B as a surveillance grade service to ANSPs. "We have not offered a direct service to airlines yet, but that is something we could potentially look at in the future," says Thoma. "We are exploring the best model to make space-based ADS-B available to the airlines for aircraft-tracking."

One service Aireon is committed to providing is a free emergency alert system called Aireon aircraft locating and emergency response tracking (ALERT). Aireon will receive position data from all aircraft with ADS-B OUT capability when the space-based ADS-B system is activated. It will make these data available free of charge in an emergency situation, even in airspace where the ANSP does not subscribe to Aireon's service. The emergency alert service will be run from a 24-hour facility at the IAA's Ballygirreen site in Ireland.

Icelandair is in the process of implementing the iJet Airborne flight tracker solution. The tracking service will make use of on board hardware being installed as part of the airline's EFB solution.

Airline case studies

Azul

Azul decided to introduce aircraft-tracking capability to satisfy impending regulatory requirements, but also to improve operational efficiency. This included using an aircraft-tracking solution to minimise the impact of weather on its flights.

Azul introduced a trial version of SITAONAIR's AIRCOM FlightTracker in June 2015, and has been using the full version since September 2015. The airline was already a customer for SITAONAIR's AIRCOM server for air-to-ground communications, including ACARS functionality. The aircraft-tracking solution was taken as an add-on service to the AIRCOM server.

Azul's entire fleet is monitored by the AIRCOM FlightTracker solution. The main sources of position information are ACARS position reports and ADS-B surveillance data. Some of Azul's aircraft will require retrofitting with ADS-B capability to ensure that the aircraft tracking solution can access the widest possible range of position data. This is planned for the near future. About half its fleet is equipped for ADS-B surveillance.

ACARS-based position information can be sent to the ground using VHF/VDL systems on Azul's turboprop and RJ aircraft. Its A330 fleet has Satcom capability in addition to VHF/VDL pipes. All of the fleet will eventually be equipped for ADS-B functionality.

"We have AIRCOM FlightTracker configured to provide position reports at 15-minute intervals," explains José Jovita Mello Filho, manager of operations IT at Azul. "We are considering establishing different position update intervals, depending on the phase of flight."

"Azul uses AIRCOM FlightTracker to track its aircraft at all times, even when they are in airspace that is covered by ATC surveillance systems," continues Mello Filho. "Eventually all flight dispatchers and coordinators will be able to track their individual flights. We use SITAONAIR's FlightTracker interface to visually monitor aircraft position, and use SITAONAIR's AIRCOM server database to store our aircraft tracking data."

Icelandair

Icelandair is implementing the iJet Airborne Flight Tracker solution from iJet Technologies as one element of its current Electronic Flight Bag (EFB) initiative. "Our initial interest in iJet's services centred around its analytics capabilities," explains Alvar Sverrisson, flight standards specialist & project manager at Icelandair. "This included the capability of iJet's on-board server software to retrieve and decode data from aircraft systems and make select information available to our EFB systems and ground data repositories. Our aim with the aircraft-tracking solution was to satisfy potential mandates resulting from the proposed GADSS, by using existing hardware on-board our aircraft."

iJet's aircraft-tracking service will use on-board hardware that Icelandair is already installing for its planned EFB solution. The EFB solution will include hardware in the form of a mounting device, control box and server provided by Scandinavian Avionics (SA), along with Panasonic Toughpad tablet devices. It will also include software applications from International Flight Support (IFS) and Lufthansa Lido. iJet Technologies will provide its on-board data access software platform, which will be hosted on the EFB server. The iJet solution will receive position data from the on-board data platform.

"The tracking interval will be fully configurable by Icelandair," explains Sverrisson. "It will be possible to configure position reporting intervals to satisfy the GADSS requirements, be it every one or 15 minutes. The system can also be configured to automatically trigger position reports based on certain aircraft condition parameters."

Icelandair will track its aircraft at all times subject to communications coverage. The iJet aircraft-tracking solution will download position data using a Ku-band satcom pipe provided by Global Eagle Entertainment (GEE) on Icelandair's passenger fleet, while Iridium Classic satcom will be used to send position data for its freighters.

Sverrisson suggests that traditional ATC radar coverage will be used as a back-up tracking source if there is a loss in satcom coverage. "We are still investigating whether Icelandair needs to take additional steps to meet the ICAO aircraft-tracking mandate," he adds.

"iJet Technologies provides us with an on-line aircraft tracking interface where Icelandair can maintain a situational awareness of its fleet," explains Sverrisson. "This has already been integrated with several Icelandair systems, such as the flight planning system. Data from the aircraft can, however, be fed via the iJet services to any system of our choosing."

Icelandair will have the capability to store aircraft-tracking data. Its aircraft-tracking solution is expected to be operational before the end of 2016. "We are launching our EFB evaluation phase in July 2016," says Sverrisson. "The activation of the iJet service is scheduled for September/October 2016, and we expect to achieve our target for full aircraft-tracking around that point." AC