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An Introduction to Aircraft Satellite Tracking

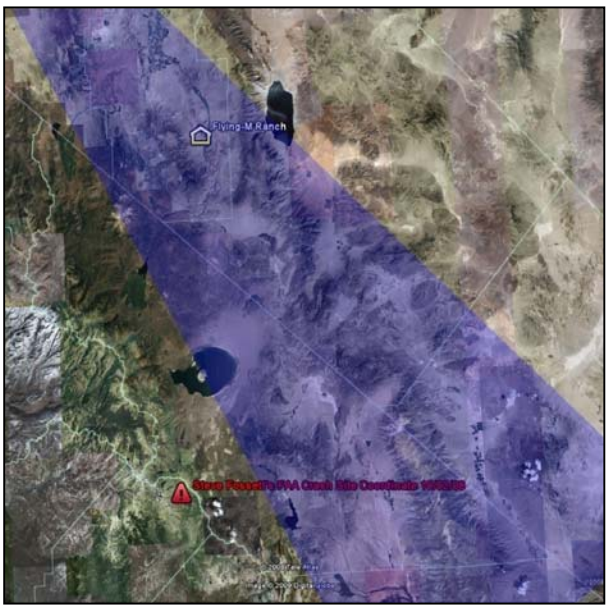
The advent of satellite tracking of aircraft as a technology available to all aircraft operators has seen a huge amount of discussion over the benefits, costs and general usefulness of the various systems available in the marketplace. As with most hot topics, there is quite a lot of conjecture and limited actual understanding of the major reasons why an operator should consider using one in each aircraft in their fleet. This article hopes to shed some light on the various technologies, practical uses and real-world benefits that an aircraft owner/operator should expect from an investment in this technology.

Safety Benefits

Everyone can immediately see the benefit of knowing where an aircraft is in real-time – since man first started flying around the skies in the first part of last century, he was closely followed by developments in radar and other communication technology that kept track of his progress through the skies. In the latter part of the century, as technology moved faster and faster, more advanced systems became available, including onboard GPS navigation, collision avoidance, satellite phones and more.

When it came to feedback from the aircraft, the operator was largely in the dark. Commercial airlines have had ACARS reporting since the late 1970s, but even these leave something to be desired – consider the recent tragic loss of Air France Flight 447. Even after transmission of a number of ACARS reports that there were multiple systems failures on board, the Search & Rescue attempt had to comb a huge area of the Atlantic, based on their flight path from the last radar contact.

Even with all these technologies, the general aviation operator has had no feedback on the flights conducted by their aircraft other than the flight folio times and feedback from the aircrew after the flight. There are many cases where an aircraft has gone missing and is found sometimes days or weeks later, when there was a possibility that the occupants could have been helped if the Search & Rescue operation had a location to start the search.



1 The search for Steve Fossett

An extreme case was the search for Steve Fossett in the USA, who was located 13 months after disappearing in September 2007. The 406MHz ELT failed to trigger, and during the search (which cost an estimated **US$2.6m**!) the teams located 8 unrelated and previously uncharted crash sites! The search area was about 30,000nm^2, and the wreck was eventually located by chance by a hiker some 60nm outside of the area being scoured. If he had a tracking system on board, the search would have taken hours instead!

So there are obvious safety benefits to having the aircraft regularly reporting its position, but are all tracking systems allowed in an aircraft?

Not all are equal

Most tracking solutions being marketed to the aviation industry have evolved from the products used to track cars, trucks, containers, ships and train carriages. There are a couple of problems with such systems that an aircraft operator should be aware of:

Firstly, according to ICAO regulations, any equipment used on an aircraft is supposed to be approved for aviation use (with DO-160 certification), but it is the aircraft operator's decision as to allow the equipment to be used on board or not (hence the requirement to switch off mobile phones during commercial flights, whilst laptops and other electronic devices are allowed during cruise). It is this loophole that is being exploited by a number of tracking system providers who convince unknowing operators that no certification is required. Such operators should be aware that all satellite transmissions are the cause of high-level electromagnetic energy, and careful thought should be given before positioning such a source of interference in close proximity to compass and flight instruments without some assurance that it has been successfully passed the tests for aviation use. Strictly speaking, it is up to the owner to determine whether the equipment is suitable for use on their aircraft, but most are unaware of this responsibility, and use the equipment regardless of potential interference or worse.

Secondly, Doppler shift at the higher speeds associated with aircraft operation results in some systems being unable to track an aircraft at speeds of over 120kts – whilst acceptable for some operations that fly at lower speeds, most aircraft are not going to be reliably tracked by these systems, and the operator would have wasted their money.

Lastly, not all systems provide features that are useful to an aircraft operator, as they have been developed to provide generic tracking for any mobile asset. So what features are of real benefit to an aircraft operator?

A Plethora of Features

The safety benefit of knowing where an aircraft's location aside, an aircraft owner/operator should look for the following benefits in a tracking system:

> ***Automatic Position Reporting*** – surprisingly, some aircraft operators are trying to use cheap personal tracking systems (some even on mobile phone!) that require a button to be pressed before the system will transmit its position. This is clearly completely useless in an aircraft operation, where the point of the system is to *reliably*, and without the possibility of human error, report the position of the aircraft. Any tracking system for aircraft purposes MUST have an automatic reporting facility, preferably one that has a configurable reporting interval.
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> ***Alert*** – this is a must-have feature. With a simple trigger (either button or switch) the aircrew can notify operations of a situation on board. The best systems will also change the reporting interval from the normal interval to a much shorter interval, so as to reduce the possible distance since the last reported position.
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> ***Search & Rescue*** – some countries have automated SAR cancellation processes, and some tracking providers have the ability to provide the SAR authorities in those countries with

a SAR cancellation, or automatic closure of a flightplan, after the aircraft has reported a safe landing.

Communication – the ability to communicate information between ops and the aircrew is a highly useful tool. As the satellite channel is more reliable than VHF or HF communication, and the ops center can be anywhere in relation to the aircraft, it is an invaluable method of getting urgent information to and from the crew. For example, aircraft with this feature have been diverted from hostile airfields in Abeche, Chad, and a helicopter that landed in the Botswana desert with mechanical difficulties was able to communicate the cause of the problem to the operations center. The exact spare parts were flown directly to the aircraft, and it was back on route within a few hours.

Real-time Configuration – some systems allow the operator to change the configuration of the unit in real-time. Whilst this may seem unimportant and seldom used, it can save thousands of dollars over the majority of systems which require an engineer to configure the system manually, particularly when the aircraft operates far away from base, and for extended periods of time.

Automatic Notifications – systems with this feature monitor the GPS and other information available from the aircraft, and trigger certain notifications to the operations center. These may include:

- ***Power On/Off***
- ***Doors Closed/Opened***
- ***Engine On/Off***
- ***Taxi Start/End***
- ***Takeoff/Landing***
- ***Low Voltage***
- ***Weight-On-Wheels***
- ***Landing Gear Raised/Lowered***
- ***Flaps Extended/Retracted***
- ***Silent Alarm***
- ***APU On/Off***
- ***Hydraulic Pressure***

Aircraft Inputs – these systems allow the operator to gather information from various aircraft inputs, such as engine indications, environmental information and equipment status. For example, the ability to know (in real-time) the retardant level in a firefighting aircraft is crucial to the coordination of an effective operation when fighting bush- or forest-fires. Having such information readily at hand allows effective decision-making in the operations center.

Data Recording – very few systems provide this extremely useful feature. As satellite bandwidth is relatively expensive, only essential information is relayed in real-time to the operations center. If, however, the equipment is also recording the information available from the aircraft on a per-second basis, this provides the operator with feedback on ***how*** the aircraft is being flown, and not just where. Providing information to an operators FOQA and similar initiatives, this can help identify training, operational or maintenance issues within an operation, before they become a problem.

The satellite modem component of these systems essentially provides a means of getting electronic information in and out of an aircraft in real-time, and as satellite bandwidth costs are expected to drop over the next few years, more and more use will be found for the information channel. Look for a system that isn't going to become defunct in a few months because it can't keep pace with the needs of an operation – it is a relatively expensive piece of equipment to have to upgrade!

There are two basic configurations available in the market: permanently installed systems, and so-called "portable" or "mobile" solutions. An operator should consider carefully which would suit their purposes before deciding on which type to go for.

Mobile or not?

The obvious difference between a mobile system and a permanently installed one is the need with an installed system to apply for an aircraft modification with the local Civil Aviation Authority. A portable system is therefore extremely attractive to most operators, but they should be aware of a couple of things:

- Most portable solutions haven't gone through the DO-160 testing mentioned previously, and therefore their effect on the aircraft's avionics and other electronic systems is unknown.
- The fact that they are portable makes them susceptible to being tampered with, switched off or unplugged. An operator can therefore never be quite rely on the information.
- As the equipment needs line-of-site with the satellite constellation, the portable units are mounted on the glareshield. The transmissions are however frequently compromised by heating elements in the windshield, or shadowing from the aircraft roof itself. This means that the modem is quite often unable to transmit the position of the aircraft, and a broken tracking pattern will result.

Most operators (whether they expect it or not) become very reliant on the tracking information provided by these systems, and get extremely frustrated when the position reports do not come through like clockwork. There is no question that a permanently fitted system provides far more reliable information than a portable system.

Having chosen the tracking hardware that best suits their operation, most aircraft owners don't realize that most of the functionality and benefits come from the quality of the software provided with the hardware.

It's all in the software…

Without a feature-rich software package providing the operations crew with the information being reported by the aircraft, the value or benefit to an aircraft operator is pretty close to zero. Some systems can only send an email containing the last reported position in a text form, but most have some form of mapping to show the aircraft.

As the majority of tracking systems have evolved from a non-aviation solution, the software they provide tend to try and track the aircraft on terrestrial mapsets. Clearly, the proximity of an aircraft to a road, railway line, residential suburbs and such is mostly useless to the operator, who is trying to establish proximity to aviation landmarks, such as VFR/IFR landing facilities, VORs, NDBs, airspace indicators etc.

Tracking an aircraft only using the popular GoogleMaps and Google Earth satellite mapping is useful when an operator wants to see in which bay the aircraft was parked, but most operators find the satellite maps barely adequate for determining the aircraft's location.

The bottom line is: make sure the software provided provides for the operational management of your aircraft – the fun of seeing a moving map on Google tends to wear off after a few days, leaving most operators wondering where the real benefit is.

Features that you should look for in a flight tracking software package should include:

- Aviation specific mapping
- Ad-hoc or scheduled reporting
- Operational reports
- Flight folio export
- Flight scheduling
- Real-Time ETA updates
- Full flight history (some only provide the last 14 days)
- Clear identification of cycle start/end
- Airspace definition and checking
- Aircraft communication history

If the software is available as an installed package, make sure it is also available as a website. Although web-based tracking is usually very heavy on bandwidth, and usually can't provide features such as real-time flight replay, you may need to check up on an aircraft through the web, and at least the same flight-following features should be available.

You get what you pay for…

As with pretty much everything, cheaper doesn't necessarily mean better. The DO-160 tests required before a piece of equipment can be safely used on an aircraft are costly, so if the tracking system you're looking at seems cheap, it probably hasn't been tested, and should therefore be considered unsafe or at the very least, unknown in an aircraft.

Get a return on your investment…

An aircraft tracking system that provides the real operational benefits may actually pay for itself in the short-term, and add to the bottom line after that. Consider that accurate flight times can be used to ensure that the correct number of hours are being invoiced, or that the cost estimates of routes are reasonable, and it can be seen that improvements to the accuracy and reliability of the information upon which these are based have a real monetary value.

The fact that flight times (both for aircraft and crew) are automatically gathered, and can be easily integrated with financial or management systems has a considerable saving in human time – no more typing into Excel spreadsheets with the associated risk of human error. The information is also available at the operations center in real-time – it no longer needs to be faxed or emailed from aircraft in the field.

In short, an aircraft operation could expect the following savings from choosing the correct equipment:

- Accurate real-time operational times mean improved billing accuracy
- Reduced manual labor costs in capturing flight times
- Improved efficiency in flight routing (saving fuel costs)
- Optimal flight scheduling based on real-time information, improving aircraft utilization
- Accurate crew flight times
- Accurate maintenance times and cycles

Studies with operators who have implemented tracking systems focused on aircraft operations have shown return-on-investment periods of as short as 3 months, with most in the region of 6 months.

In summary

Hopefully this article has highlighted the fact that there is a wide variety of systems and software packages available in the market today. An aircraft operator should always do a little homework before committing to a particular system, and knowing what to look for, and what will actually benefit an aviation operation, will save a lot of money in the medium- to long-term. Purchasing a system that can provide flight-following only is a little short-sighted, and will certainly leave an operator wishing they had done some homework beforehand. Above all, make sure it's been proven safe to use!