**Automated Tracking and Triggered Data Streaming from Aircraft: Facts and Fiction**

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**Summary:** The tragedy and frustration surrounding the sudden disappearance and, to date, unsuccessful search for Malaysian Airlines MH370, coming just a few years after the loss of Air France AF477, highlights the fact that current systems and flight crew initiated procedures for tracking aircraft are inadequate. There is an outcry from within the aviation community, media, and families of those missing on MH370 to provide accurate real-time track of aircraft. Industry leaders such as Fred Smith of FedEx, the Airline Pilots Association, and the Flight Safety Foundation have called upon IATA and ICAO to require implementation of improved tracking, data streaming, and emergency locator technologies. Modifications currently in place for future aircraft tracking, with technology developed in years past, such as ADS-B, have serious limitations, represent only a partial solution, and will not adequately solve the problem of real-time tracking. Additionally, these modifications do not address the practicality of live data-streaming embedded in real-time tracking solutions. The purpose of this paper is to explore real-time tracking and automatic triggered data transmission with true global coverage, independent of ground-based receivers, aircraft systems, and flight crew input.

**Background:**

PROBLEM STATEMENT: MH370 has provoked a call on a global scale for real-time tracking of aircraft, fire-walled from aircraft systems and incapable of being disabled from the cockpit. Position reporting today requires current aircraft systems and flight crew procedures that are both aircraft system dependent and voluntary on part of the flight crew. Specific aircraft system failures, or individuals with nefarious intent gaining control of an aircraft, negate an Air Traffic Control (ATC) and an operator’s operational control center (AOC or OCC) facility’s ability to accurately track an aircraft in unusual circumstances.

ARGUMENTS FOR IMPROVED AUTOMATED TRACKING

* + - Position reporting, outside of ADS-B, is entirely voluntary on the part of the flight crew. Logging in to Controller-to-Pilot Data Link Communications (CPDLC), on the North Atlantic Track System (NATS), for example, requires specific actions by the flight crew to a system that is dependent on aircraft systems operating normally, and the availability of an aircraft-to ground communications link.
    - ADS-B is an aircraft system dependent that transmits through Mode S of the transponder. Transponders can fail or be compromised through anomalies in aircraft systems, i.e. electrical issues. ADS-B is reliant on the aircraft’s GPS system functioning flawlessly.
    - ADS-B is flight crew dependent. While ADS-B requires no flight crew input to log on to the system, the transponder can be turned to “standby” thereby disabling ADS-B. Individuals with nefarious intent now know that this is a district possibility with all the media coverage surrounding MH370.
  + ADS-B and CPDLC aside, position reporting then becomes dependent on the flight crew voluntarily making position reports via VHF, HF, or SATCOM. Again, this backup procedure is aircraft system dependent and voluntary on the part of the flight crew.

ARGUMENTS FOR TRIGGERED SECURE DATA STREAMING

* Data transmitted via the ACARS is also subject to the same vulnerabilities that plague the use of ADS-B, aircraft system viability, a robust communication connection and flight crew input.
* ACARS is aircraft system dependent: VHF, HF, and SATCOM can all have their transmissions disabled by flight crew input quite easily. Individuals with nefarious intent are well aware that the ACARS can also be disabled.
* ACARS sends only limited messages and cannot send or stream data.

**OVERVIEW OF TECHNOLOGIES AND THEIR USE:**

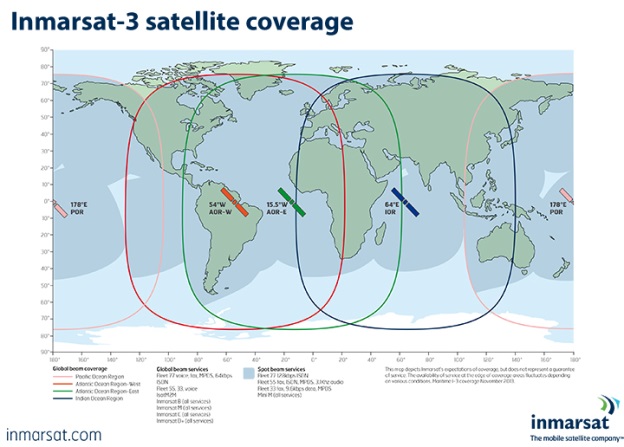
Aircraft-to-Ground communications: There are a variety of techniques that are used in routine aircraft operations to allow flight crews to communicate with their organizations’ operational control center (OCC) personnel (i.e., dispatchers) and air traffic control (ATC). These include voice, text and automated messaging, and data transmission communications over VHF radio, HF radio, and satellite channels. Within these categories is the Aircraft Communications Addressing and Reporting System (ACARS) messaging system, long used for messaging and data transmission to dispatchers, OCCs, and maintenance personnel, and the modern Automated Flight Information Reporting System (AFIRS) voice, text, tracking and data system which has been evolving over the past decade with a new generation launched in 2011. Within the airliner category of aircraft, all are equipped with VHF and HF radio voice, but not all are equipped with satellite communications (SATCOM) capability. Similarly, not all airliners use ACARS, and many that use ACARS do not have SATCOM, so there are geographic limits on the ability to connect with the personnel on ground. In any case, these communications modes are used in routine operations to provide tracking of the flight, report on aircraft status, and communicate with ATC for assignment of departure, en route, and arrival “clearances” (i.e., permission to use prescribed airspace at specific times).

Who gets what data? The role of ATC is to assign departure times and routes (“clearances”) to each aircraft, approve the enroute “waypoints” requested by the airline, and to coordinate approach and landing sequences and airspace; i.e., to control traffic. The OCC’s role is to prepare a flight plan that includes requested waypoints, fuel, departure and arrival times, weather, crew and passenger manifests, etc., as well as to manage any issues or discrepancies that occur during the flight. A key point is to recognize that, under current protocols, most data and messaging from the aircraft goes to and from the OCC and not to and from ATC.

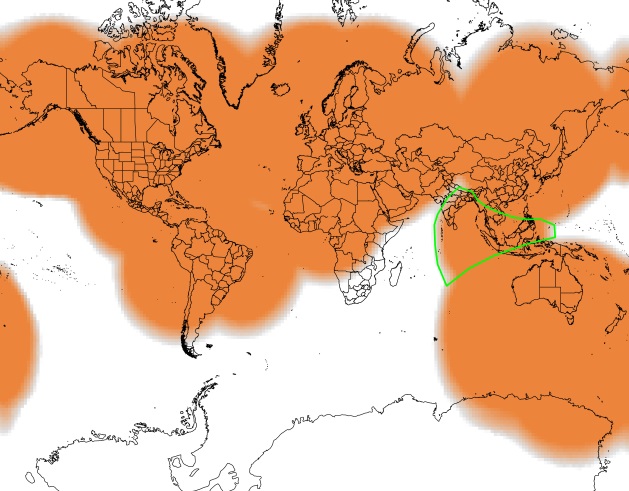
Data and Voice Recording: Data from the aircraft is recorded on a flight data recorder (FDR) (sic “black box”) that resides on board the aircraft; the current requirement is for 88 data parameters to be recorded for the most recent 25 flight hours. All airliners and some business aircraft are required to have cockpit voice recorders (CVRs) that record crew voice transmissions, cabin background conversations, and other sounds; CVRs overwrite any recordings that are more than two hours old. Some aircraft are equipped with quick access recorders (QARs) that record the same data as the FDR and often much more, but not cockpit voice. QARs are not designed to survive crashes, while FDRs and CVRs are.

GPS Tracking- satellites don’t track, they relay: Aircraft crews must know or accurately estimate the position of their aircraft in order to navigate. Today, that position information comes from inertial navigation systems (in all aircraft) and the global positioning system (GPS) in most aircraft. For aircraft that are equipped to use the Global Navigation Satellite System (GNSS), the GPS data is supplied by a number of special-purpose medium earth orbit (MEO) satellites combined with a GPS receiver located on the aircraft which uses the GPS satellite data to compute the exact position of the aircraft. In other words, the aircraft (and the flight crew) always “knows” where the aircraft is, assuming there is no failure of aircraft systems. However, in order for people on the ground to know the location of an aircraft, the aircraft communications system must communicate the aircraft’s information to a receiver on the ground. Stated another way, GNSS provides each aircraft with information to determine its own position; but such GPS satellites do not “track” the aircraft. Likewise, communications satellites such as Iridium, Inmarsat, Global Star, and Orbcomm do not “track” aircraft; they merely relay information sent from the aircraft to a receiver on the ground. In order for a communications satellite to relay information, the aircraft must be able to “see” the satellite, meaning that the aircraft’s antenna pattern must align with the satellite’s antenna pattern; with the exception of Iridium, which provides complete coverage of the earth and is therefore always visible to an aircraft, there are areas of the earth that do not allow the aircraft to “see” the satellite and these gaps are significant in some cases in the context of aircraft global communications. Further, if an aircraft is in an unusual attitude or maneuvering rapidly, the connection with the satellite may be lost, similar to losing a connection on a mobile phone. For coverage areas of various satellite constellations, please refer to manufacturers’/providers’ data:

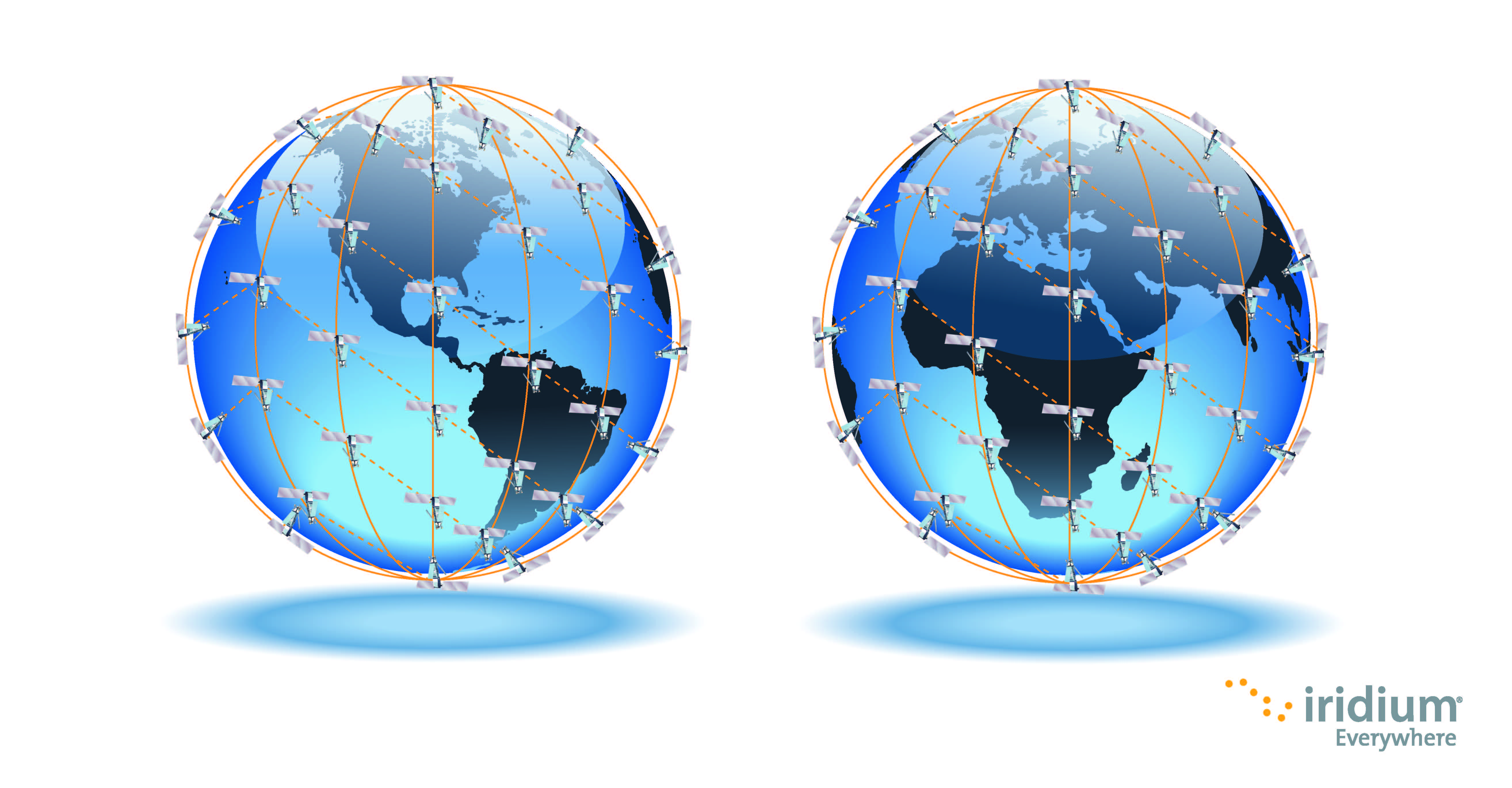
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<http://www.globalstar.com/en/index.php?cid=106&sidenav=232>



<http://www.iridium.com/DownloadAttachment.aspx?attachmentID=1175>



Radar tracking and advanced means of aircraft tracking: Aircraft that are near airports may be tracked “non-cooperatively” by “primary” ground radar that “pings” the aircraft with a radio wave and receives a reflected return from any “targets” that are within the range of the radar; the return radio wave does NOT identify the aircraft. Aircraft are also “pinged” (actually interrogated) by secondary surveillance radar (SSR), which causes a device known as a transponder on the aircraft to broadcast a reply message containing the aircraft’s identification as well as its position. Most radar of both types is used for ATC purposes and therefore located near airports, with a range of no more than a few hundred miles. Therefore, aircraft operating over oceans or land masses lacking reasonably dense primary and secondary radar ground stations will be out of radar range and therefore not able to be tracked by these means. A new type of “cooperative” tracking system aimed at improved management of airspace congestion is called Automated Dependent Surveillance-Broadcast (ADS-B), which is scheduled for full deployment by 2020 in the US and is already being deployed in other parts of the world. Like ground-based secondary surveillance radar, ADS-B relies upon a device on the aircraft to be actively broadcasting the aircraft’s position (as determined by use of GNSS or other satellite-based navigation systems) identification, heading, and airspeed; however, as is the case in all such systems, ADS-B requires a receiver that can “see” the aircraft, and, presently, such receivers are either ground-based or may be available on certain aircraft. ADS-B can be disabled by flight crew or intruders. Systems such as AFIRS, manufactured by FLYHT Aerospace Solutions Ltd., contain an independent GPS receiver and a SATCOM capability that allows the aircraft position, as well as selected data and messages, to be communicated securely to designated parties via the Iridium satellite constellation and the internet, thus providing a means for seamless global coverage and tracking without any crew action.

**Context for Application of Existing Technologies:**

Routine Operations: During routine operations, aircraft position during takeoff and landing phases is tracked by primary and secondary radar for ATC purposes, and takeoff, landing, cruise, and taxi events are reported securely to the aircraft’s OCC/dispatcher. Also, certain aircraft data is automatically computed and then transmitted securely - by one of the means described above - to the aircraft’s OCC/dispatcher/maintenance operation. During cruise, aircraft position and status (fuel on board, aircraft systems messages, etc.) are reported at fixed or pre-defined intervals which, in the case of AFIRS, can be adjusted by the operator (AFIRS routine reporting typically occurs every 5-10 minutes). If an aircraft system exceeds a predefined threshold (such as turbine temperature, oil pressure, vibration level), then those events may be reported either by the crew (at their discretion) or automatically by a messaging system (ACARS or AFIRS) if a communications link is available at the time.

There are many implementations of ACARS, but most “fire and forget” when they send a message, meaning that the system (and thereby the crew) has no means of knowing if the message was received, and there are no “re-tries” initiated by the ACARS system. By contrast, the AFIRS system sends not only a message describing the event but also a corresponding block of data that can be used by subject matter experts on the ground to understand the context of the event message. AFIRS retains the message and data until it receives confirmation from the ground receiver that the message and event data have been received. AFIRS stores ALL data and event messages in its own QAR for subsequent analysis by subject matter experts for purposes of operations analysis, maintenance planning, and fuel conservation. AFIRS also provides a mode of operation (called FLYHTStream) that allows authorized subject matter experts on the ground to “pull” data from the AFIRS system, the specific data and time period able to be selected by the ground personnel.

Non-routine situations/emergencies: In the event of an emergency, flight crews may either call (voice) or key in (type) a coded message to their OCC/dispatcher that describes the nature of the emergency. If the aircraft is equipped with ACARS, there may be messages sent that provide further details of the abnormal state of aircraft subsystem. However, ACARS does not send data (just pre-formatted short messages) so it is incapable of streaming data and it is not controllable or able to be interrogated interactively from the ground.

If the aircraft is within range of primary or secondary radar, the aircraft position will be tracked at the normal scan rate or the ground radar. If the aircraft is out of range of radar, then its position must be reported by an on board system relying upon satellite communications or, in the case of ADS-B, the availability of a receiver within range of the aircraft. If the aircraft is equipped with AFIRS, an immediate ALERT is sent to OCC and other specified IP addresses and a high data rate transmission is automatically initiated by the AFIRS system, that includes aircraft position at intervals as short as 1 second and predefined data from the FDR and other sources at rates ranging from ¼ sec to 1 sec. Such data would include, in addition to precise position, airspeed, altitude, attitude, rates of descent, pitch and roll, engine parameters, flight control settings, switch settings, cabin pressure, icing detection, smoke and fire detection, electrical system parameters, etc. Once initiated, selective streaming via AFIRS can only be terminated by an authorized person on the ground. AFIRS also provides a simple means for flight crew to initiate streaming if they require assistance from ground personnel, or ground personnel can initiate streaming.

Because AFIRS uses Iridium SATCOM, position and data streaming are available anywhere on the globe; further, the Iridium antenna patterns are very broad which allows transmissions to continue in the event that an aircraft is in an unusual attitude (AFIRS has been demonstrated to continue streaming during a +/- 110 degree roll sequence of a jet aircraft without any break in data transmission). Finally, inasmuch as AFIRS has a self-contained GPS and Iridium SATCOM capability, in the event of interruption of power to AFIRS, it can operate on a battery that would allow continued reporting of aircraft position and also any data that is still available to it from aircraft sources.

Why Stream Position and Data? It is very important to recognize that “selective streaming” during emergencies has three components:

1. instant alerting,
2. precise position tracking in real time, and
3. selected aircraft data fed directly to subject matter experts.

The value of alerting and position tracking when a crash is inevitable (or the eventual outcome of an in-flight emergency) is that Search and Rescue (SAR) actions can be initiated even before the aircraft is down, and it is well known that survival rates of crashes are very dependent upon length of time until rescue aid arrives (in fact, with AFIRS, because the precise location of the crash is known, the “”search” part of SAR becomes more akin to “navigate to the impact point”).

The value of alerting combined with streamed data is that:

(a) if it is even remotely possible to provide timely assistance to the crew to recover from a bad situation, the subject matter experts on the ground can quickly evaluate the data and contact the crew with assistance, and/or

(b) if the aircraft goes down, subject matter experts (especially the OEM and NTSB types) can determine if the cause was specific to one aircraft or a systemic issue with the particular type of aircraft that requires a fleet-wide response to insure safety. This is especially the case if there is a delay in recovery of the FDR.

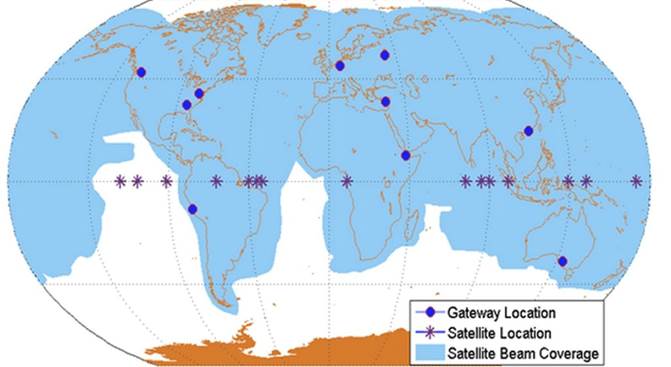
Why not “piggy back” on In-Flight Entertainment (IFE) systems that offer internet connectivity for passengers?

IFE systems are:

1. Not sufficiently reliable - in terms of both equipment and their ability to maintain connectivity in an aircraft upset
2. Not certified for navigation or flight operations uses
3. Lacking in geographic coverage (see map below)
4. Not secure
5. Not tamperproof; easily shut off by crew or third parties
6. Not widely available

The background on each of the above points follows:

1. Reliability: IFE systems are “optional” and are not designed to have high availability as compared with critical aircraft navigation and communication systems. While they could in principle be upgraded at significant costs, the suggestion that current equipment would do the job is misleading and an oversimplification of the problem. Further, passenger broadband systems use satcom that is highly “directional”, meaning that the beam from the aircraft needs to be pointed at the satellite (think of the antenna pattern as a searchlight.) This is because narrow beams are required to achieve high bandwidth. The significance of this is that if the aircraft is in an “upset” state (pitching, rolling, etc.), as would be the case in many emergencies, the connection with the satellite will be lost. This disconnect happens today even in moderate turbulence or in congested areas where aircraft must maneuver aggressively to satisfy air traffic control routing; the recovery of the connection requires the aircraft to remain in  stable position for a significant period of time, always minutes and sometimes 10-15 minutes.
2. Certification: The certification levels of IFE equipment are lower than those of navigation and primary crew communications systems. This means that they are inherently less reliable and therefore would be less likely to be available in an emergency than primary systems such as AFIRS and ACARS. Further, in the event of partial or total electrical power failure on an aircraft, these systems would be unavailable. The AFIRS system can run on its own battery and continue to transmit aircraft position and accumulated flight data even if all power is lost on the aircraft.
3. Geographic Coverage: The satellites that support passenger broadband IFE DO NOT have global coverage! They are deliberately focused on those areas that have high airline and business jet traffic and other vehicle and stationary sources and receivers (i.e., land masses) (for obvious commercial reasons). This limitation would include Inmarsat, Ku band, Ka band, etc. Iridium has NO such limitations and is the only satellite system to cover polar aircraft routes. (When Iridium NEXT is in operation (a broadband system), it then will be the only high bandwidth satcom system to have global coverage.)

[](http://www.runwaygirlnetwork.com/wp-content/uploads/2014/02/Panasonic-Ku.jpg)

**Geographic coverage of “best” IFE systems.** <http://www.runwaygirlnetwork.com/2014/02/14/graphic-panasonic-reveals-latest-ku-coverage-map-as-westjet-adopts-ku/>

1. Security: By the very nature of IFE systems with connectivity to the internet (“the cloud”), security cannot be easily assured. A significant architecture change would be required to send aircraft data (position and parametric data) over the same data “pipe” that is used for passenger e-mail and entertainment. This is not impossible, but the "already installed" equipment does not have such partitioned architecture to allow secure data and public data to be sent over the same channel. The issue of multiple gateways for IFE systems is also a cybersecurity issue. By contrast, Iridium uses two (one commercial and one military –only) highly secure gateways and secure landlines to connect to secure web servers such as provided by FLYHT Aerospace Solutions, Ltd. in support of AFIRS.
2. Tamper protection: One school of thought regarding MH370 is that certain reporting equipment was deliberately shut off. While that theory may never be able to be proven, it does point out a requirement for automated position and aircraft data reporting systems; that is, that they cannot easily be shut off. With IFE systems, there is a fundamental issue that requires flight crew to be able to shut off the systems; that is, that due to the high power consumption of these systems, they pose a potential risk of fire and smoke, and therefore the flight crew must be able to quickly interrupt power to these systems from the flight deck. Further, in the event of degraded aircraft power, the IFE system would be deemed “non-essential” and would be one of the systems taken off line to preserve power for the critical aircraft systems.  However, a dedicated low power system that is used as a primary or secondary tracking system and an on- demand data system can be configured to be virtually tamperproof and to utilize its own backup battery power in the event of an emergency.
3. Despite the aspirations of passenger entertainment system providers and many airlines, there are relatively few aircraft equipped today, although it seems inevitable that, in 5-15 years, all long haul aircraft will be equipped, but many short and medium range aircraft (including those serving remote areas where SAR is difficult) will probably not have passenger satcom IFE services.

**Costs in Context:**

As the AFIRS system is today the only system in service today to have demonstrated triggered data transmission and position reporting globally without coverage limitations and using existing satcom and ground infrastructure, it is instructive to identify the costs of implementing AFIRS in the context of aircraft capital and operating costs.

1)     Capital cost: The cost of the AFIRS box, antenna, and installation wiring and labor is “up to” $100,000 per aircraft (usually less). The price for a new airliner will range from $80M to $400M (see

<http://www.airbus.com/presscentre/corporate-information/key-documents/?eID=dam_frontend_push&docID=36716> and  <http://www.boeing.com/boeing/commercial/prices/>)

(the MH370 Boeing 777 aircraft was probably purchased for around $200+M), so the capital expense for equipping a new aircraft to achieve AFIRS benefits represents roughly 0.05-0.1% of the cost of an airliner. The payback on that investment in terms of operational, maintenance and fuel savings is usually measured in terms of a few months.

2)     Infrastructure cost: There is NO investment in infrastructure required to implement AFIRS or AFIRS-based services including position and data streaming, either by an operator or the national or international entities in which the aircraft operates. The infrastructure required for AFIRS - the GNSS global GPS satellite navigation satellite network, the Iridium satellite constellation and ground stations, and the internet - is already in place. (And, there is NO practical bandwidth limitation within this existing infrastructure!)

3)     Return on Investment (ROI): FLYHT’s customers buy AFIRS because it allows them to operate more efficiently. Each has slightly different requirements, so FLYHT’s data services are offered on a “menu” basis, with total charges to an airline ranging from a few $ to $15/flight hour. Note that the operating cost of an airliner is in the range of $7,000-$29,000 per flight hour with the fuel component of that cost constituting between $2,500/hr. for small airliners to $11,000/hr. for large aircraft (using $3.00 USD per gallon as the price, which may be low today).  Therefore, absent any payback, AFIRS services would add less than 0.1%-0.2% to an airline’s operating cost; however the payback realized is always much greater than the cost (for example, one service offered with AFIRS is a fuel management service that typically saves 3-4% of the fuel burn, or between $75-$300/flight hour, depending upon the aircraft type and operation; therefore, the fuel savings alone pays for AFIRS services many times over within months).

4)     Cost of a streaming event: When AFIRS goes into streaming mode, the cost during the streaming event might be as high as $10/minute (probably less). This cost occurs only during the emergency selective streaming mode. To put this in context, if MH370 had streamed data for the entire presumed 7 hours that it was aloft, the total cost of receiving all the flight data and second-by-second track and position information would be under $4200. The cost for one search aircraft is likely to be in the $7,000-20,000/hr. range (or higher with specialized equipment and crews). The total acknowledged cost of the AF447 black box search was at least $400M (*I can’t immediately find that reference but I am sure that the number is in the right range*); it will be much higher for MH370.

5)     Put another way, up to ten thousand (10,000) aircraft could be equipped with AFIRS for the cost of this search alone. That number would include every civil transoceanic aircraft in the world and many of those that only fly over land. And, as the system provides financial benefits to the operator on a daily basis, that entire investment would be paid back in 2 years. Not quite “free”, but close.

*Footnote: Re: Inmarsat’s recent “free tracking” offer: The recent announcement by Inmarsat that they would provide flight tracking for “free” requires some interpretation. For starters, the “free” service is only available to paying customers using Inmarsat through 3rd party service providers; Inmarsat equipage is typically many times the cost of Iridium equipage. Secondly, Inmarsat does not have coverage in parts of the globe (see links and charts above in this paper). Finally, as a communications satellite, the Inmarsat does not “track” aircraft as a self-contained unit, but rather relays messages (including possibly GPS position messages) generated by on-board equipment; if the aircraft does not have an Inmarsat satcom transceiver and antenna, then no position data can be provided by Inmarsat. (Note that the now infamous “arc” of possible positions of MH370 that was produced by Inmarsat personnel was the result of exceptional analysis of the “guts” of the satellite system by trained technicians.  This is not a process that lends itself to high volume routine and automated transactions).*

**Summary of Key Facts:**

1) The technology exists today to allow an aircraft to automatically and securely transmit data, including its precise location, when it either diverts from an approved flight plan or experiences conditions that are outside normal operating limits.

2) The technology was demonstrated after the AF447 accident to the aviation community using in-service airliners and a business jet.

3) The technology is commercially available today in a product called AFIRS, the Automated Flight Information Reporting System, developed and manufactured by Canadian firm FLYHT Aerospace Solutions Ltd., Calgary, Alberta. It is certified by the FAA, EASA (Europe), TCCA (Canada) CAAC (China), ANAC (Brazil) and several other aviation authorities, and it is currently installed on 400 aircraft on all continents, representing about 40 different operators, airlines and others. There is no other known source for proven implementation of globally connected streaming technology.

4) AFIRS records and analyzes data on board and contains rules that determine what data is sent and to whom. All data is not sent all the time; only data that is relevant to a problem is transmitted.

5) AFIRS uses the Iridium low earth orbit (LEO) satellite constellation of 66 satellites to transmit data to a web server on the ground, which then forwards the data to pre-defined IP (e-mail) addresses. AFIRS could use other satellites, but none have the global coverage provided by Iridium.

6) The entire infrastructure to support selective data streaming globally is in place today. No towers or data centers are needed as some pundits have opined.

7) Within the existing infrastructure, there is NO bandwidth limitation if aircraft data is streamed selectively on an as-required basis instead of continuously.

8) FLYHT’s customers choose AFIRS as a tool to improve operational efficiency and control, avoid unscheduled maintenance events, improve dispatch availability of aircraft, and reduce fuel usage. The capability for emergency streaming of data is latent within the product and is only used during unusual situations; it is NOT the primary reason for installation of AFIRS, but it is a very valuable adjunct benefit.

**Typical Q&A** (no particular order):

**1) Q: Isn’t streaming too expensive to consider, given that airlines operate on thin profit margins?**

*A: If a system such as AFIRS is installed for reasons other than dedicated streaming, the benefits that accrue during daily operating contribute positively to the airline’s bottom line. The cost of a streaming event is less than $10/minute (which means that streaming the ENTIRE MH370 7-hour presumed flight would have cost under $4000, which is less than one hour’s operating cost of one search aircraft). During routine operations, the cost per flight HOUR for data and associated services is typically in the $5-15 range; the savings realized by the operator are always many times the cost.*

**2) Q: Can’t pilots or intruders turn off a system like AFIRS?**

*A: Short answer is not easily. The AFIRS system can be set up to be virtually tamperproof. AFIRS can be installed in such a way that it is nearly impossible to shut off from the cockpit. Also, in the event that power is lost or shut off to the aircraft, AFIRS can be fitted with a battery that will allow it to keep sending position reports and to send stored data related to the state of the aircraft leading up to the power loss.*

*By contrast, ADS-B and ACARS are flight crew dependent. While ADS-B requires no flight crew input to log on to the system, the transponder can be turned to “standby” thereby disabling ADS-B. Individuals with nefarious intent now know that this is a district possibility with all the media coverage surrounding MH370. Position reporting, outside of ADS-B, is entirely voluntary on the part of the flight crew. Logging in to Controller-to-Pilot Data Link Communications (CPDLC), on the North Atlantic Track System (NATS) for example, requires specific actions by the flight crew to a system that is dependent on aircraft systems operating normally, and the availability of an aircraft-to-ground communications link. Likewise,* *data transmitted via the ACARS is also subject to the same vulnerabilities that plague the use of ADS-B, aircraft system viability and flight crew input. ACARS is aircraft system dependent: VHF, HF, and SATCOM can all have their transmissions disabled by flight crew input quite easily. Individuals with nefarious intent are well aware that the ACARS can also be disabled.*

**3) Q: Is there enough “bandwidth” to handle all aircraft?**

*A: The mistaken notion that is put forward by many experts and non-expert commenters is that we’re talking about streaming all the data from all the aircraft all the time. The facts are (1) that data is streamed only during exceptional events; (2) the infrastructure is in place today to handle any realistic number of simultaneously streaming events.*

**4**) **Q: Inmarsat seems to be tracking MH370. Why does the industry need a system like AFIRS?**

*A: Inmarsat (and Iridium, and Global Star, Orbcomm. etc.) are communications satellites. They do not “track” aircraft per se, but rather relay the position aircraft supplied by the aircraft itself (in other words, thanks to GPS, inertial navigation, etc., the aircraft always “knows” where it is—the problem is communicating that known information to people on the ground. The same will be true with ADS-B—the aircraft will broadcast reports but, unless the report is received, there will be no guarantee of tracking, and there are spots on the globe where ADS-B transmissions may not be easily received). The tracking data point(s) that Inmarsat scientists were able to derive for MH370 were a result of extraordinary effort and processing of a received radio signal; this is not done in real time and could never be done routinely with communications satellites as a means for global tracking of thousands of airborne aircraft.*

**5) Q: Was AFIRS on Malaysia Airlines Flight MH370?**

*A. NO-AFIRS (Automated Flight Information Reporting System) is currently installed by operators at their own discretion. AFIRS is normally installed on aircraft to support communication and operations during routine operations-it is NOT on aircraft solely for use in emergencies but is uniquely capable of automatically switching to emergency mode streaming when an aircraft is in an unusual state or upon request from the crew or the ground.*

**6) Q: If AFIRS was onboard, how and what would we know about the fate of the plane versus what is known as of today?**

*A. If it was, and if it was enabled for triggered data transmission, we would know where the aircraft was when AFIRS last had electrical power and we would know the behavior of the aircraft at all times leading up to the point at which aircraft sensors or data buses lost power, including altitude, attitude, airspeed, direction/heading, engine state, doors open/closed, and many other parameters*.

***7)* Q:****If AFIRS was installed on the plane, would we know exactly where in flight the plane had either crashed or started to experience problems.**

*A. Yes, both. As long as there is electrical power to the AFIRS unit and the antenna is intact, it will keep transmitting.*

1. **Q: Is AFIRS approved for installations on Boeing 777's?**
2. *Yes*
3. **Q: What would it have cost and how long does it take for an airplane to be installed with AFIRS*?***
4. *Less than $100k US and a few days, depending on the aircraft type and whether the installation is done during routine heavy maintenance, at which point, the installation would be coordinated with other maintenance and have little or no time impact*.
5. **Q: Is the industry planning to act to implement improved tracking and selective data streaming?**

*A. Industry leaders such as Fred Smith of FedEx and the Airline Pilots Association, and the Flight Safety foundation have called upon IATA and ICAO to require implementation of improved tracking, streaming, and emergency locator technologies. In Smith’s words (Aero Club, Washington DC 4/11/2014), “It’s time to get on with it”. ICAO and IATA have formed working groups and scheduled review meetings before June 1, as has the Malaysian government. Note also that one airline, First Air, announced on 4/15/2014 that they will be incorporating FLYHTStream into their operations (they are an existing user of AFIRS for routine operations).*

1. **Q: We hear comments about aircraft sending data to the “cloud”. What about “cybersecurity”?**
2. *It is very important that it be made clear that data sent from aircraft will not be available to the general public. The data link between the aircraft and the web server is secure (up to 32 bit encryption in the case of Iridium), and the web server itself is highly secure. The data is only available to those IP addresses that are designated in advance, such as the airline operational control center (OCC), the aircraft and/or engine manufacturer, and ATC/SAR (Air Traffic Control/Search and Rescue) personnel. If done correctly, there is NO cybersecurity risk.*