International Civil Aviation Organization

WORKING PAPER

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5/5/14
Revised
9/5/14

MULTIDISCIPLINARY MEETING REGARDING GLOBAL TRACKING

Montréal, 12 to 13 May 2014

Agenda Item 1: Explore the need and means available to track globally all airline flights

AIRLINE FLIGHT TRACKING: THE NEED AND AVAILABLE TECHNOLOGIES

(Presented by the Secretariat)

SUMMARY

Aviation events have once again underscored the need to establish the capability to track airline flights across the globe. This paper outlines a proposal for airlines to actively track their flights and identifies some of the means currently available today to achieve global airline flight tracking.

Action: Action by the meeting is contained in paragraph 5.

1. INTRODUCTION

1.1 Events such as the loss of AF447 and the disappearance of MH370 for a prolonged period of time have reiterated the need to improve global flight tracking capabilities in the near term. For the purpose of this working paper tracking of airline flights refers to the ability of an air operator to know the position of its flights. Some airlines currently track their flights from their own air operator's operational control centre (AOCC) or equivalent. Tracking of aircraft should not be confused with the provision of an air traffic services (ATS) surveillance service of aircraft as they serve different purposes. However, it is understood that ATS surveillance, when available, may be a source of information to be used for tracking when made available to air operators.

1.2 Issues related to flight recorders, search and rescue and accident investigation will be mentioned in the working papers of this meeting. However, these references will only be provided as background information. The objective of the meeting is not intended to address specific issues related to flight recorders, search and rescue and accident investigation, but is intended to focus strictly on the topic of global flight tracking.

2. BACKGROUND

2.1 Following the in-depth investigation of the Air France 447 (AF447) accident, the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (Accident Investigation Bureau of France, BEA) recommended that ICAO:

> *"c) study the possibility of making it mandatory for aeroplanes performing public transport flights to regularly transmit basic flight parameters (for example position, altitude, speed, heading)."*

2.2 The ICAO High-level Safety Conference in 2010 (HLSC 2010) held in Montréal from 29 March to 1 April, discussed situations where accidents occurred over the high seas, including a recent accident (i.e. AF447) and highlighted the need to improve availability of recorded on-board data, search and rescue, as well as communication and surveillance. The need to improve the surveillance capability over oceanic areas was also discussed and it was noted that available technology and equipment were not always used to their fullest extent.

2.3 The Conference declared (Declaration of the HLSC 2010) that:

> "… Contracting States have a collective responsibility for international civil aviation safety;"
>
> and
>
> "... recent accidents have demonstrated the need for improvements in communications over oceanic and remote areas, search and rescue procedures and the revision of cockpit procedures"

The Conference further recognized that:

> "… further improvements in aviation safety within and among States require a cooperative and proactive approach in which safety risks are identified and managed".

2.4 Notably, Conclusion 3/2 of the HLSC 2010 called upon ICAO to assess the changes that might be necessary to improve surveillance, flight monitoring and communications in oceanic/remote areas, including timely and adequate search and rescue services. In particular Recommendation 3/2 b) of the HLSC 2010 stated that:

> "*b) ICAO should review with priority SARPs and guidance material to improve surveillance, flight monitoring and communications of aircraft operating in oceanic/remote areas and the provision of timely and adequate search and rescue services in area of need;"*

2.5 Based on the recommendations from the BEA report and the HLSC 2010, the ICAO Air Navigation Commission (ANC) tasked the Operational Data Link Panel (OPLINKP) with the review of ICAO SARPs and guidance material with the objective of improving safety for flights over oceanic and remote areas.

2.6 Changes to ICAO Annex 10 — *Aeronautical Telecommunications*, Volume II — *Communication Procedures including those with PANS status* and ICAO *Procedures for Air Navigation*

Services — Air Traffic Management (PANS-ATM, Doc 4444) will become applicable in November 2014 to facilitate surveillance of aircraft, using existing equipage and technology. It will require operators and air navigation service providers to make better use of existing controller-pilot data link communications (CPDLC) and automatic dependent surveillance – contract (ADS-C) through the implementation of more stringent procedures to ensure successful logon between ground and airborne systems, as well as the introduction of mandatory warnings sent to air traffic control (ATC) by an aircraft whenever deviations from the cleared route of flight and level are detected. This was determined to be an initial step for the improvement of surveillance and communications over oceanic and remote areas. This was also identified as a low cost solution, using existing equipage and technology. It was not meant to mandate additional equipage.

3. DISCUSSION

3.1 ICAO has taken the initial steps required to improve safety over oceanic and remote areas. These steps primarily support ATS surveillance service which for several operators also feed flight tracking applications in AOCCs. However, even in the most sophisticated airspaces such as Europe and North America, an aircraft may be subject to procedural air traffic control for a portion of the flight (e.g. when departing or arriving at an aerodrome where there is no radar coverage).

3.2 There have been instances where an airliner has been missing for a prolonged period of time without a positive trace of its whereabouts. While most of these incidents were resolved without consequence, recent history has demonstrated that this is not always the case. An additional means to track airline flights may be needed in which airline flights are tracked by each air operator. Aircraft would need to transmit, at regular intervals, basic parameters such as coordinates (latitude and longitude), heading or track, altitude (GPS height or MSL) and ground speed with an aircraft identification and time stamp (UTC) on the messages. This position information could be used by software applications to produce a wealth of information such as aircraft position awareness, deviations from planned routes or, in the worst case, reduce the period of time required to locate an accident site. Technology is available today which can support an active approach towards tracking airline flights.

3.3 The aircraft component for global tracking may need to gather and transmit parameters such as the ones described above without any human intervention. The extent that such autonomy is needed will have an impact on the design of systems that could support such a requirement. Most ATS systems, for example, rely on some types of human intervention, whether it is ensuring that the transponder is turned on, making sure that the correct code is selected, or associating the transponder code with a call sign. The need to gather and transmit parameters, such as those described above, without any human intervention needs to be addressed.

3.4 A questionnaire was developed and sent to vendors of systems and/or applications that could support global tracking of aircraft. The questionnaire is reproduced at Appendix A to this working paper. The list of vendors who responded to the ICAO questionnaire is in Appendix B. A summary of results from ICAO questionnaire on technology for tracking flights globally is in Appendix C. The questionnaire and summary of replies is intended to provide background information concerning the capabilities of various technologies, as well as indicative costs, to assist in the deliberations of this meeting.

3.5 There are some air operators that, based on their particular operational requirements (i.e. not mandated by regulations), have tracking systems in place, some of which use autonomous equipment on-board. The concept of tracking is also not particular to the aviation industry. However, the ability to do so in oceanic and remote areas makes it more challenging. Additionally, the speeds associated with modern air transport type aircraft make the reporting rate an important consideration for determining cost. Other industries, such as the maritime sector, are already using technologies that allow tracking of their global assets.

4. CONCLUSIONS

4.1 Aircraft tracking experience is currently available in the aviation industry but it is not a wide spread practice. Other industries may have faced and perhaps overcome similar challenges; all of these should be explored.

4.2 Actions have been taken and additional work is underway to ensure that the location of an accident site can be accurately and rapidly identified. However, an additional approach may be needed that would allow air operators to track their flights. Advances in technologies and aircraft equipage are key to a successful implementation. Beyond these issues, however, the community must reach consensus on the need and the means to achieve this.

5. ACTION BY THE MEETING

5.1 The meeting is invited to:

a) agree that there is a near-term need for air operators to track their flights; and

b) note the information provided in the Appendices to this working paper concerning available technologies and indicative costs.

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APPENDIX A

ICAO QUESTIONNAIRE ON TECHNOLOGY FOR TRACKING FLIGHTS GLOBALLY

Company name:		
1. Please describe current technologies and/or services your company offers that could provide tracking of flights worldwide or could be used as a component in a larger system used to track flights:		
2. Can your system provide position reports with the following parameters:		
• Lat/long position	Y / N	
• Altitude (GPS height or MSL)	Y / N	
• Ground speed	Y / N	
• Heading or track	Y / N	
• Time of the position fix (UTC)	Y / N	
• Aircraft ID	Y / N	
3. Are there additional parameters that your system can provide?	Y / N	
If yes, please specify below:		
4. Is the technology or service described above available today?	Y / N	
If no, please provide below the expected date that the technology/service will be available:		

5.	Please describe the assumed architecture of the flight tracking system. Include all the segments of the end-to-end system from the airplane systems to the end user. Note which parts of the system your company offers and assumptions regarding interfaces to other parts of the system.
6.	Please describe the concept of operation including pertinent use cases for the proposed system. Include how data is generated, packaged, routed, who receives the data, who gets access to the data, how and where the data is retained and for how long, etc. Please indicate coverage area if not global.
7.	Please describe how the authenticity, originality and integrity of the data transmitted through the overall network is ensured:
8.	Please describe a typical aircraft installation and precise aircraft interfaces (e.g. cooling, power supply, etc.):

9.	Can this system be installed as a retrofit to out-of-production airplanes in service?	Y / N
	If yes, please specify below the nature of the upgrade including categories such as (include more than one, if applicable): a) software upgrade of an existing system b) new hardware and/or software installation c) modification of ground and/or satellite equipment	

d) any other (please specify):		
Is your product certified for installation on aircraft?	Y / N	
If yes, describe the experience of the certification process (e.g. supplemental type certificate (STC)) and the aircraft types for which the product is certified:		
10. Can this system be operated autonomously without any human interaction or interference?	Y / N	
How is the system operated, configured, customized, set on/off?		
11. Is the system protected against interruption or failure of the aircraft power system?	Y / N	
If yes, please specify the protection used:		
12. Given the system described above, please provide estimates for the following cost breakdown:		
a) airplane equipment costs:	U.S.$	
b) airplane system integration costs (non-recurring	U.S.$	

engineering):		
c) airplane installation costs:	U.S.$	
d) estimate required time for airplane installation:	___________ (no.) hours	
e) scheduled maintenance:	Work duration: ______hours Intervals: ___________	
13. If equipage already exists, please estimate the number of installed units in the field:		
14. Please describe non-aircraft infrastructure requirements and note where such infrastructure does or does not exist, or where existing infrastructure would require modifications to support global airline flight tracking worldwide:		
15. Please provide information for the following items covering recurring communications:		
a) cost of air-to-ground transmission of short position reports (assume ~20-40 bytes per report):	U.S.$	
b) maximum position reporting rate supported:	___________reports per min	
c) limitations (e.g. bandwidth) of the non-aircraft infrastructure (e.g. to support flight tracking of up to 20 000 aircraft):		
16. Please estimate the probability that the tracking functionality would be unavailable on a per hour basis (assuming the aircraft power and data inputs are available):		
17. Do you anticipate any potential technical barriers (e.g. frequency spectrum availability, unusual aircraft attitude, polar route, not worldwide service coverage, etc.) that might prevent you from providing your flight tracking service? If yes, please describe below:	Y / N	

18. Global flight tracking could start through an industry led initiative. However, do you feel that a complementary regulatory framework would facilitate implementation? If yes, please describe below:	Y / N	

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APPENDIX B

LIST OF VENDORS THAT RESPONDED TO THE ICAO QUESTIONNAIRE

Aireon LLC
ATH Group, Inc.
BLUE SKY NETWORK, LLC
Dale F. Sparks (JT1 Aerospace Corp.)
DUT South Africa
FLYHT Aerospace Solutions Ltd.
Globalstar Inc. / SPOT LLC.
Honeywell Aerospace
Indigo SAT – Apex Flight Operations
Inmarsat
International Communications Group, Inc. (IGC)
International Council of Aircraft Owner and Pilot Associations (IAOPA)
Iridium Communications, Inc.
MTSAT / Civil Aviation Bureau of Japan
OPS Aeronautics
Rockwell Collins
SAR Technology
SkyTrac Systems Ltd.
Spider Tracks Ltd.
Star Navigation Systems Group Ltd.
Team Airborne Data Services Ltd.
Thales Alenia Space Deutschland
Troo Corporation

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APPENDIX C

SUMMARY OF RESULTS FROM THE ICAO QUESTIONNAIRE ON TECHNOLOGY FOR TRACKING FLIGHTS GLOBALLY

The responses received so far to the ICAO questionnaire showed that there are existing commercial off-the-shelf solutions providing global coverage for hardware costs under USD $100 000. Most of them require some aircraft modifications and certification. Some responses did not provide a complete tracking solution, only providing a data pipe or only acting as a data aggregator. These were not included in the analysis. The figures in this appendix represent the main findings from the analysis of the responses received.

Figure 1 presents the summary of responses received. In total, 22 responses where received; they were categorized based on the usability of the data.

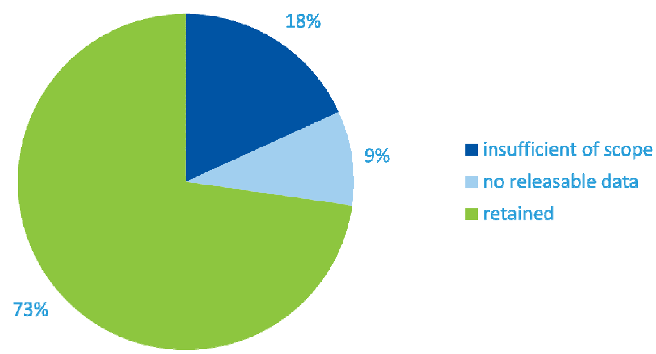

Figure 1.– Summary of questionnaire responses

Figure 2 illustrates the geographical areas of coverage: global, less than global and other, which includes regional coverage or non-specified.

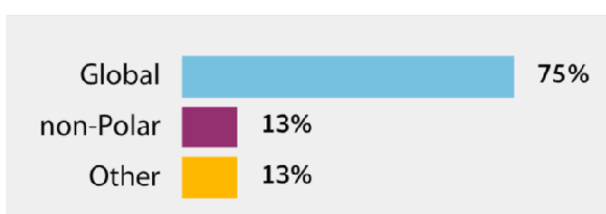

Figure 2.– Geographical areas of coverage

Figure 3 outlines the entities that receive the data. Most solutions send data to the provider, who gives access via a web portal. Some solutions send data directly to the air navigation service provider (ANSP) or to the airline.

Figure 3.– Data recipients

Figure 4 presents the aircraft modifications. These include: hardware only (HW), software only (SW), both or none.

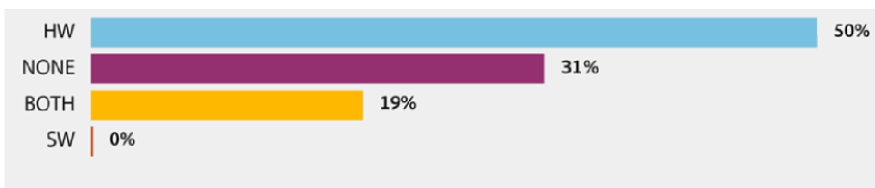

Figure 4.– Aircraft modifications

Figure 5 presents the hardware costs per airframe that were provided, in US dollars.

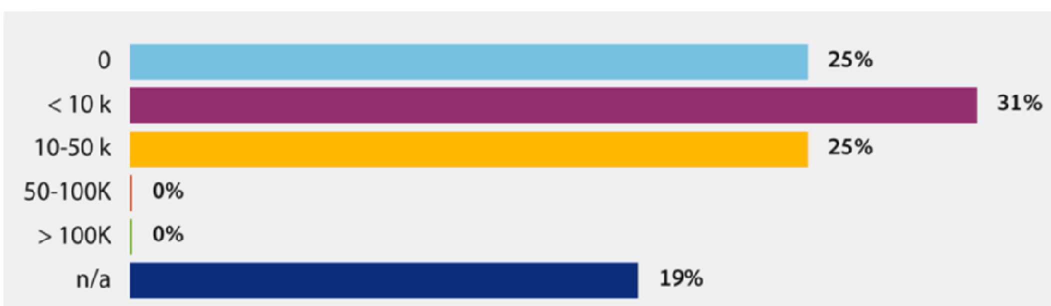

Figure 5.– Hardware costs per airframe (USD)

Figure 6 outlines the installation costs estimates that were provided, per airframe in US dollars.

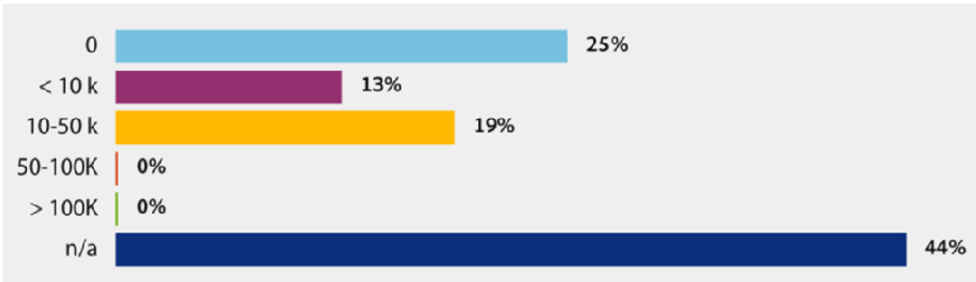

Figure 6.– Installation costs per airframe (USD)

Figure 7 illustrates the data expressed per message in terms of retail costs. Some data packages may be available that would mitigate costs. Some message costs include added value data that may increase data costs

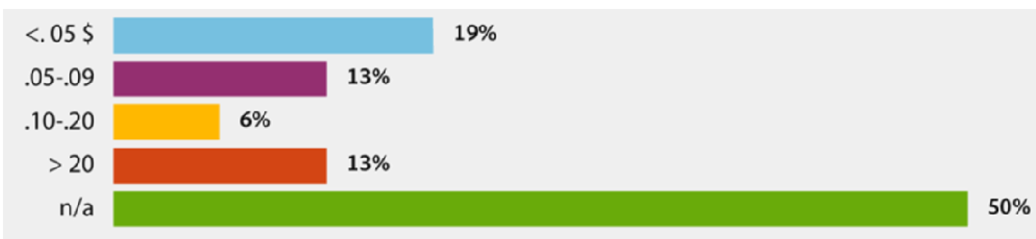

Figure 7.– Data expressed per message: Retail costs

Figure 8 presents the impact on aircraft certification, including the need for a supplemental type certificate (STC).

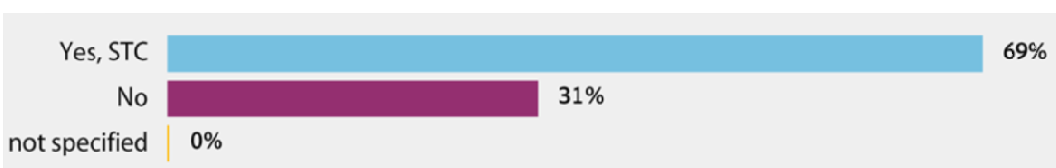

Figure 8.– Impact on aircraft certification

Figure 9 presents the results related to the need for a new ground station. Most of the vendors noted that the ground infrastructure is already developed and ready for use.

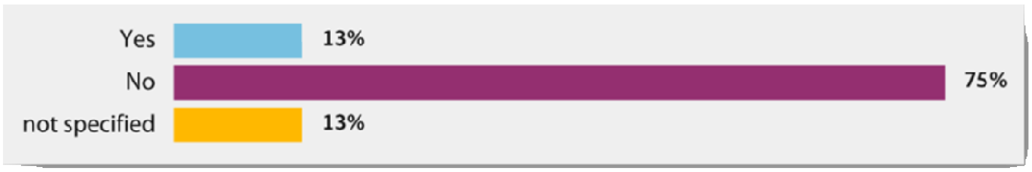

Figure 9.– Additional ground infrastructure required

Figure 10 presents the results related to the full data block. This means that all the following criteria are met:

a) Latitudinal / longitudinal position;
b) Altitude (GPS height or MSL);
c) Ground speed;
d) Heading ort track;
e) Time of the position fix (UTC); and
f) Aircraft identification (ID).

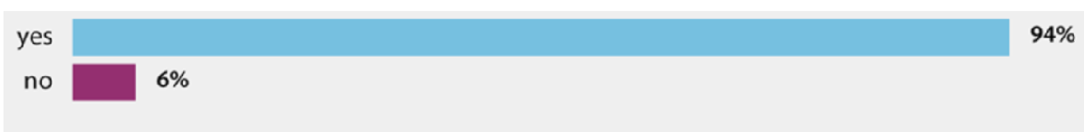

Figure 10.– Full data block

Figure 11 illustrates autonomous (auto-ON) features of the system. These do not consider tamper resistance.

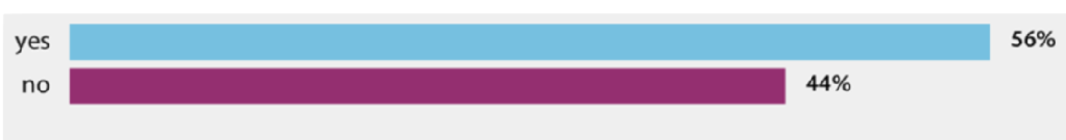

Figure 11.– Independent (Auto-ON)

Figure 12 presents communications technology. All surface or HF datalink solutions also include satellite. It should be noted that for HF datalink, the vendors noted that they could support it, not that it was available.

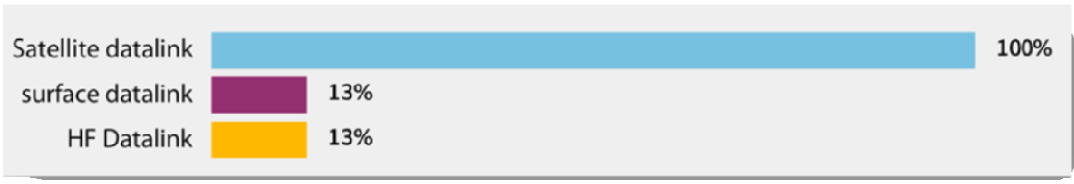

Figure 12.– Communications technology

Figure 13 outlines the satellite providers; these have been de-identified.

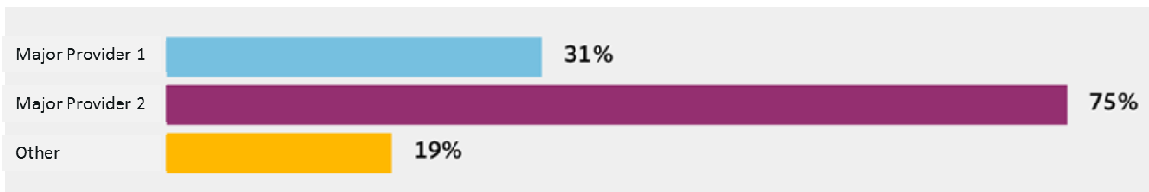

Figure 13.– Satellite provider

Figure 14 presents technologies/systems that are currently in operation.

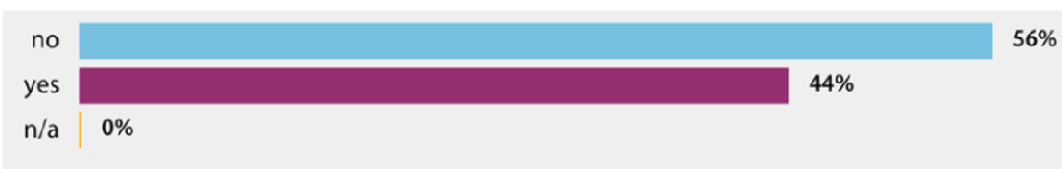

Figure 14.– Currently in use

Figure 15 illustrates the time to operational use. If the technology/system is currently not in use, estimated time until it is available is presented.

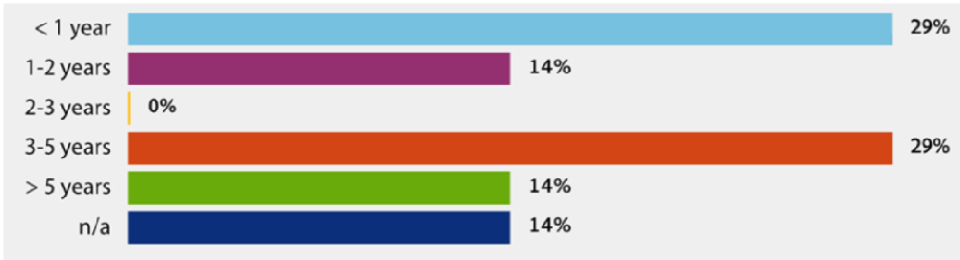

Figure 15.– Time to field

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