



International Civil Aviation Organization

**SEVENTH MEETING OF THE SOUTHEAST
ASIA AND BAY OF BENGAL
SUB-REGIONAL ADS-B IMPLEMENTATION
WORKING GROUP (SEA/BOB ADS-B WG/7)**



Chennai, India 28 – 30 November 2011

Agenda Item 6: Any other business

**ADS-B SYSTEM INTEROPERABILITY AND DATA
HARMONIZATION IN APAC REGIONS**

(Presented by Hong Kong, China)

SUMMARY

This paper highlights potential system interoperability issues caused by variations of implementation among ADS-B ground stations in sending out optional data items via ASTERIX Category 21, and a need to harmonize classification of ADS-B mandatory and optional data items between Eurocontrol ASTERIX Category 21 and EUROCAE ED-129 specifications to facilitate data sharing in the Asia and Pacific (APAC) Regions. To ensure system interoperability and harmonize ADS-B implementation in the APAC Regions, this paper thus recommends a need for States/Administrations to agree on a list of data items in the exchange of ADS-B data for subsequent use by ATM automation system, and address the discrepancies in classification of ADS-B data items between Eurocontrol ASTERIX Category 21 and EUROCAE ED-129 specifications as soon as possible.

This paper relates to –

Strategic Objectives:

A: *Safety – Enhance global civil aviation safety*

C: *Environmental Protection and Sustainable Development of Air Transport – Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment*

Global Plan Initiatives:

GPI-12 Functional integration of ground systems with airborne systems

1. INTRODUCTION

1.1 The “All Purpose Structured Eurocontrol Surveillance Information Exchange” (ASTERIX) Category 21 is a data format standard globally accepted by the Air Traffic Management (ATM) system manufacturing industry for sharing of ADS-B data with ATM automation system. To ensure interoperability of ADS-B ground stations in the Asia Pacific (APAC) Regions, during the 16th APANPIRG Meeting held in August 2005, the ASTERIX Category 21 version 0.23 was adopted as the baselined ADS-B data format for deployment of ADS-B ground stations and sharing of ADS-B data in the APAC Regions.

2. DISCUSSION

2.1 Since the ASTERIX Category 21 version 0.23 was issued in November 2003, it has undergone continuous revisions with some 14 subsequent versions. The latest version 2.1 was issued in May 2011 which has fully incorporated the latest DO260B standard. Various manufacturers have tried to keep enhancing their ADS-B ground station products with a view to catching up with most updated versions of ASTERIX Category 21.

ADS-B Optional Data Items under ASTERIX CAT 21

2.2 Under ASTERIX Category 21, two types of ADS-B data items are classified: mandatory and optional data items. For mandatory data items, they shall be presented in every ASTERIX Category 21 data record. In an ADS-B trial conducted by Hong Kong, China using one ADS-B ground station from one equipment supplier capable of sending out ASTERIX Category 21 version 0.26, it was revealed that the ADS-B ground station did not send out one mandatory data item, namely “Link Technology Indicator” (I021/210). Besides, the ADS-B ground station only sent out 9 out of 23 nos. of optional data items (see Appendix 1 – Table 1). One optional data item “Ground Vector” (I021/060), which was used by the ATM automation system to display heading and ground speed information for aircraft targets, was not sent out initially. This data item was obtained after the supplier performed a software upgrade to the ground station system.

2.3 Hong Kong, China initiated another ADS-B trial using one ADS-B ground station by another supplier capable of sending out ASTERIX Category 21 version 0.23. In this trial, although all the 5 nos. of mandatory data items could be output this time, only 10 out of 21 nos. of optional data items were output (see Appendix 1 – Table 2). While it is obvious that the reason for not sending out some of the optional data items, such as “MET Report” (I021/220), was due to unavailability of such information from the aircraft, it was observed that different suppliers of ADS-B ground stations have different interpretation and implementation on whether a particular optional data item shall be output by their ADS-B ground stations. Besides, different suppliers of ATM automation systems also have different requirements on data items from ADS-B ground stations to perform their intended functions. As a result, it could happen that the ADS-B data items not implemented by one State/Administration will be required by another State/Administration. To ensure system interoperability and harmonize ADS-B implementation in the APAC Regions, it is recommended to agree on a list of data items for the exchange of ADS-B data among States/Administrations.

Discrepancies between ASTERIX CAT 21 and EUROCAE ED-129

2.4 Besides the Eurocontrol ASTERIX Category 21, the “European Organization for Civil Aviation Equipment” (EUROCAE) has published a specification “ED-129 Technical Specification for a 1090 MHz Extended Squitter ADS-B Ground Station” in June 2010. Currently, most of the ADS-B ground station products available in the market declare their full compliance with the ED-129 specification. In this specification, ADS-B data items output by an ADS-B ground station

are classified into two types: minimum (i.e. mandatory) and optional data items. For minimum data items, they shall be presented in every ASTERIX Category 21 data record output by the ADS-B ground station. Upon detailed study and comparison, it was identified that there exist discrepancies on classification of ADS-B mandatory/minimum and optional data types between ASTERIX Category 21 and EUROCAE ED-129 as highlighted in Appendix 2. The discrepancies are summarized as follows:

- a) Mandatory vs Not Used
items being classified as “mandatory” under ASTERIX Category 21 (version 1.4) but “not used” under EUROCAE ED-129 (e.g. I021/260 “ACAS Resolution Advisory Report”);
- b) Optional vs Minimum
items being classified as “optional” under ASTERIX Category 21 but “minimum” under EUROCAE ED-129 (e.g. I021/090 “Figure of Merit”, I021/145 “Flight Level”, I021/160 “Ground Vector”, etc.); and
- c) Optional vs Not Used
items being classified as “optional” under ASTERIX Category 21 but “not used” under EUROCAE ED-129 (e.g. I021/110 “Trajectory Intent”, I021/220 “Met Report”, I021/230 “Roll Angle”, etc.)

2.5 It is also noted that EUROCAE ED-129 only defines classification of data items for two versions of ASTERIX Category 21, namely version 0.23 and 1.4. The latest ASTERIX Category 21 version 2.1 with full incorporation of DO260B is not covered by EUROCAE ED-129. The above observations will induce not only potential integration problems between ADS-B ground stations and ATM automation systems locally but also interoperability problems among ADS-B ground stations in the Asia Pacific Regions with adverse impacts on sharing of ADS-B data. It is thus recommended to develop guidelines to address the different classification schemes under ASTERIX Category 21 and EUROCAE ED-129 so as to eliminate the discrepancies.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note different suppliers have different interpretation and implementation on whether a particular optional data item shall be output by the ADS-B ground station;
- b) agree among States/Administrations a list of data items to be included for exchange of ADS-B data;
- c) note discrepancies on classification of ADS-B mandatory and optional data items between ASTERIX Category 21 and EUROCAE ED-129; and
- d) consider development of guidelines to address the different classifications of ADS-B mandatory and optional data items between ASTERIX Category 21 and EUROCAE ED-129.

Table 1 – ADS-B trial on one ADS-B GS by Supplier A (ASTERIX CAT. 21 Ver. 0.26)

Data Items	Description	Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 0.26 Specification	Output by ADS-B Ground Station (Y/N)
I021/010	Data Source Identification	M	Y
I021/020	Emitter Category	O	Y
I021/030	Time of Day	M	Y
I021/032	Time of Day Accuracy	O	Y
I021/040	Target Report Descriptor	M	Y
I021/070	Mode 3/A Code in Octal Representation	O	N
I021/080	Target Address	M	Y
I021/090	Figure of Merit	O	Y
I021/095	Velocity Accuracy	O	Y
I021/110	Trajectory Intent	O	N
I021/130	Position in WGS-84 co-ordinates	O	Y
I021/131	Signal Amplitude	O	N
I021/140	Geometric Altitude	O	N
I021/145	Flight Level	O	Y
I021/146	Intermediate State Selected Altitude	O	N
I021/148	Final State Selected Altitude	O	N
I021/150	Air Speed	O	N
I021/151	True Air Speed	O	N
I021/152	Magnetic Heading	O	N
I021/155	Barometric Vertical Rate	O	N
I021/157	Geometric Vertical Rate	O	N
I021/160	Ground Vector	O	Y*
I021/165	Rate of Turn	O	N
I021/170	Target Identification	O	Y
I021/200	Target Status	O	Y
I021/210	Link Technology Indicator	M	N
I021/220	Met Report	O	N
I021/230	Roll Angle	O	N

Note (*) : Data item output by ADS-B GS after performing a software upgrade

Appendix 1

Table 2 – ADS-B trial on one ADS-B GS by Supplier B (ASTERIX CAT. 21 Ver. 0.23)

Data Items	Description	Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 0.23 Specification	Output by ADS-B Ground Station (Y/N)
I021/010	Data Source Identification	M	Y
I021/020	Emitter Category	O	Y
I021/030	Time of Day	M	Y
I021/032	Time of Day Accuracy	O	N
I021/040	Target Report Descriptor	M	Y
I021/080	Target Address	M	Y
I021/090	Figure of Merit	O	Y
I021/095	Velocity Accuracy	O	Y
I021/110	Trajectory Intent	O	N
I021/130	Position in WGS-84 co-ordinates	O	Y
I021/140	Geometric Altitude	O	Y
I021/145	Flight Level	O	Y
I021/146	Intermediate State Selected Altitude	O	N
I021/148	Final State Selected Altitude	O	N
I021/150	Air Speed	O	N
I021/151	True Air Speed	O	N
I021/152	Magnetic Heading	O	N
I021/155	Barometric Vertical Rate	O	N
I021/157	Geometric Vertical Rate	O	Y
I021/160	Ground Vector	O	Y
I021/165	Rate of Turn	O	N
I021/170	Target Identification	O	Y
I021/200	Target Status	O	Y
I021/210	Link Technology Indicator	M	Y
I021/220	Met Report	O	N
I021/230	Roll Angle	O	N

Appendix 2

Table 3 – Discrepancies (highlighted in yellow) between ASTERIX CAT. 21 Ver. 0.23 and EUROCAE ED-129

ASTERIX Category 21 Version 0.23			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 0.23 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
I021/010	Data Source Identification	Identification of the ADS-B station providing information	M	M
I021/020	Emitter Category	Characteristics of the originating ADS-B unit	O	O
I021/030	Time of Day	Time of applicability (measurement) of the reported position, in the form of elapsed time since last midnight, expressed as UTC	M	M
I021/032	Time of Day Accuracy	The maximum difference between the actual time of applicability of the reported position and the time reported in the Time of Day item (I021/030)	O	Not used
I021/040	Target Report Descriptor	Type and characteristics of the data as transmitted by a system	M	M
I021/080	Target Address	Target address (emitter identifier) assigned uniquely to each target	M	M
I021/090	Figure of Merit	ADS figure of merit (FOM) provided by the aircraft avionics	O	M
I021/095	Velocity Accuracy	Velocity uncertainty category of the least accurate velocity component	O	M
I021/110	Trajectory Intent	Reports indicating the 4D intended trajectory of the aircraft Format	O	Not used
I021/130	Position in WGS-84	Position in WGS-84 Co-ordinates	O	M

ASTERIX Category 21 Version 0.23			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 0.23 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
	co-ordinates			
I021/140	Geometric Altitude	Minimum altitude from a plane tangent to the earth's ellipsoid, defined by WGS-84, in two's complement form	O	O
I021/145	Flight Level	Flight Level from barometric measurements, not QNH corrected, in two's complement form	O	M
I021/146	Intermediate State Selected Altitude	The short-term vertical intent as described by either the FMS selected altitude, the Altitude Control Panel Selected Altitude, or the current aircraft altitude according to the aircraft's mode of flight	O	O
I021/148	Final State Selected Altitude	The vertical intent value that corresponds with the ATC cleared altitude, as derived from the Altitude Control Panel	O	Not used
I021/150	Air Speed*	Calculated Air Speed (Element of Air Vector)	O	M
I021/151	True Air Speed*	True Air Speed	O	M
I021/152	Magnetic Heading	Magnetic Heading (Element of Air Vector)	O	O
I021/155	Barometric Vertical Rate	Barometric Vertical Rate, in two's complement form	O	O
I021/157	Geometric Vertical Rate	Geometric Vertical Rate Definition : Geometric Vertical Rate, in two's complement form, with reference to WGS-84	O	O
I021/160	Ground Vector	Ground Speed and Track Angle elements of Ground Vector	O	M
I021/165	Rate of Turn	Rate of Turn, in two's complement form.	O	Not used
I021/170	Target Identification	Target (aircraft or vehicle) identification in 8	O	M

ASTERIX Category 21 Version 0.23			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 0.23 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
		characters, as reported by the target		
I021/200	Target Status	Status of the target	O	M
I021/210	Link Technology Indicator	Indication of which ADS link technology has been used to send the target report	M	M
I021/220	Met Report	Meteorological information	O	Not used
I021/230	Roll Angle	The roll angle, in two's complement form, of an aircraft executing a turn	O	Not used

Note (*) : Reporting of airspeeds may be disabled as a ground station configuration option

Appendix 2

Table 4 – Discrepancies (highlighted in yellow) between ASTERIX CAT. 21 Ver. 1.4 and EUROCAE ED-129

ASTERIX Category 21 Version 1.4			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 1.4 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
I021/008	Aircraft Operational Status	Identification of the operational services available in the aircraft while airborne	O	O
I021/010	Data Source Identification	Identification of the ADS-B station providing information	M	M
I021/015	Service Identifier	Identification of the service provided to one or more users	O	O
I021/016	Service Management	Identification of services offered by a ground station (identified by a SIC code).	O	O
I021/020	Emitter Category	Characteristics of the originating ADS-B unit	O	O
I021/040	Target Report Descriptor	Type and characteristics of the data as transmitted by a system	M	M
I021/070	Mode 3/A Code	Mode-3/A code converted into octal representation	O	O
I021/071	Time of Applicability for Position	Time of applicability of the reported position, in the form of elapsed time since last midnight, expressed as UTC	O	M
I021/072	Time of Applicability for Velocity	Time of applicability (measurement) of the reported velocity, in the form of elapsed time since last midnight, expressed as UTC	O	Not used
I021/073	Time of Message	Time of reception of the latest position squitter	O	M

ASTERIX Category 21 Version 1.4			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 1.4 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
	Reception for Position	in the ground station, in the form of elapsed time since last midnight, expressed as UTC		
I021/074	Time of Message Reception for Position – High Precision	Time at which the latest ADS-B position information was received by the ground station, expressed as fraction of the second of the UTC Time	O	O
I021/075	Time of Message Reception for Velocity	Time of reception of the latest velocity squitter in the ground station, in the form of elapsed time since last midnight, expressed as UTC.	O	M
I021/076	Time of Message Reception for Velocity – High Precision	Time at which the latest ADS-B velocity information was received by the ground station, expressed as fraction of the second of the UTC Time.	O	O
I021/077	Time of Message Transmission	Time of the transmission of the ASTERIX category 021 report in the form of elapsed time since last midnight, expressed as UTC.	O	M
I021/080	Target Address	Target address (emitter identifier) assigned uniquely to each target	M	M
I021/090	Quality Indicators	ADS-B quality indicators transmitted by a/c according to MOPS version	M	M
I021/110	Trajectory Intent	Reports indicating the 4D intended trajectory of the aircraft Format :	O	Not used
I021/130	Position in WGS-84 co-ordinates	Position in WGS-84 Co-ordinates	O	M
I021/131	Position in WGS-84 co-ordinates, high resolution	Position in WGS-84 Co-ordinates in high resolution.	O	O

ASTERIX Category 21 Version 1.4			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 1.4 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
I021/132	Message Amplitude	Amplitude, in dBm, of ADS-B messages received by the ground station, coded in two's complement	O	O
I021/140	Geometric Altitude	Minimum altitude from a plane tangent to the earth's ellipsoid, defined by WGS-84, in two's complement form	O	O
I021/145	Flight Level	Flight Level from barometric measurements, not QNH corrected, in two's complement form	O	M
I021/146	Intermediate State Selected Altitude	The short-term vertical intent as described by either the FMS selected altitude, the Altitude Control Panel Selected Altitude, or the current aircraft altitude according to the aircraft's mode of flight	O	O
I021/148	Final State Selected Altitude ¹	The vertical intent value that corresponds with the ATC cleared altitude, as derived from the Altitude Control Panel (FCU/MCP)	O	Not used
I021/150	Air Speed ²	Calculated Air Speed (Element of Air Vector)	O	M
I021/151	True Air Speed ²	True Air Speed	O	M
I021/152	Magnetic Heading	Magnetic Heading (Element of Air Vector)	O	O
I021/155	Barometric Vertical Rate	Barometric Vertical Rate, in two's complement form	O	O
I021/157	Geometric Vertical Rate	Geometric Vertical Rate Definition : Geometric Vertical Rate, in two's complement form, with reference to WGS-84	O	O
I021/160	Ground Vector	Ground Speed and Track Angle elements of Ground Vector	O	M

ASTERIX Category 21 Version 1.4			Mandatory (M) or Optional (O) items as per ASTERIX Category 21 Version 1.4 Specification	Minimum (M) or Optional (O) items as per EUROCAE ED-129 Specification
Data Items	Description	Definition		
I021/161	Track ID	An integer value representing a unique reference to a track record within a particular track file.	O	Not used
I021/165	Track Angle Rate ¹	Rate of Turn, in two's complement form	O	Not used
I021/170	Target Identification	Target (aircraft or vehicle) identification in 8 characters, as reported by the target	O	M
I021/200	Target Status	Status of the target	O	M
I021/210	Link Technology Indicator	Indication of which ADS link technology has been used to send the target report	M	M
I021/220	Met Report	Meteorological information	O	Not used
I021/230	Roll Angle	The roll angle, in two's complement form, of an aircraft executing a turn	O	Not used
I021/250	Mode S MB Data ³	Mode S Comm B data as extracted from the aircraft transponder.	M	Not used
I021/260	ACAS Resolution Advisory Report ⁴	Currently active Resolution Advisory (RA), if any, generated by the ACAS associated with the transponder transmitting the RA message and threat identity data	M	Not used
I021/271	Surface Capabilities and Characteristics	Operational capabilities of the aircraft while on the ground	O	O
I021/295	Data Ages	Ages of the data provided.	O	Not used
I021/400	Receiver ID	Designator of Ground Station in Distributed System	O	Not used

Note :

- (1) This item will not be transmitted for the technology "1090 MHz Extended Squitter".
- (2) Reporting of airspeeds may be disabled as a ground station configuration option
- (3) This item shall be present in every ASTERIX record provided BDS data has been extracted in the last reporting period.
- (4) This item shall be present when a Resolution Advisory is active