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RTCA SC- 186/WG-6 (Working Group On DO-242A MASPS)
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Draft Text for DO-242A
Intent Descriptions and Requirements

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This paper shows Richard's proposed text to explain and define TCPs and intent information in section 2 and to specify their requirements in Section 3.

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2.1.2.20 Intent Information

The reason for considering broadcast of intent information in ADS-B systems is to extend the domain of predictability of aircraft trajectories beyond short-term extrapolations using current aircraft position and velocity states. Many applications of ADS-B currently under consideration could require intent information to extend look-ahead time for trajectory predictions beyond the current flight segment, or as a means of enhancing integrity of extrapolated path predictions. Proposed air-air applications of intent information include airborne separation planning where more than a few minutes look-ahead time is desirable for conflict detection and conflict prevention, and conflict resolution, where broadcast of intended resolution maneuvers may be important for situation awareness of all nearby equipped aircraft. ADS-B intent information is also proposed to enable advanced air-ground applications such as sequencing and merging of terminal area flow streams, conformance monitoring, and use of precision trajectory separation concepts for aircraft arrival and departure flows in congested airspace.

Intent information over ADS-B is supported by two on-condition reports: Target State Report (TSR, paragraph 3.4.7) and Trajectory Change Report (TCR, paragraph 3.4.8) ~~may be categorized as "short tem" and "long term"~~. These reports correspond to short and long-term intent, respectively. Short-term intent provides information on the current horizontal and vertical targets for the active flight segment. These targets reflect the current path and automation states being used for aircraft guidance and control. Primary short-term intent elements include target altitude and target heading or track angle. Long-term intent provides strategic path information, consisting of TCP's and their connecting flight segments. While short-term intent is available in almost all operational flight modes, four dimensional long-term intent is only available when equipped aircraft are using sophisticated FMS and area navigation (RNAV) systems.– Appendix N provides a detailed discussion of intent availability related to aircraft control state and equipment.

One of the challenges in developing and evolving intent information for ADS-B, is that most current aircraft avionics, including many advanced digital FMS based systems, do not output much intent information on avionics buses for downstream use by avionics other than those directly used to communicate to the pilot or to navigate, guide, or control an airplane. The MASPS deals with this situation two ways: allowing aircraft which output some intent information to communicate such intent when appropriate through the TSR and TCR formats, and providing intent provisioning in the report formats for future incorporation of more comprehensive intent data. These changes provide an incremental approach to intent broadcasting, which allows for partial broadcasting of limited intent in DO-242A, with evolution to more comprehensive intent data on both an individual aircraft basis as avionics systems are upgraded, and with further concept development anticipated in future revisions to the ADS-B MASPS.

This MASPS incorporates TSR and TCR elements that are sufficiently understood and developed, with strong preference to those currently available as inputs on a data bus. Intent elements not currently available on data buses are provided in DO-242A in cases where they can likely be derived by current avionics systems and when needed to support international intent applications, such as the European Downlink of Airborne Parameters (DAP) program. Intent elements expected to be of operational value for future applications, but lacking sufficient development, are provisioned in the TSR and TCR. Further development and validation of these concepts will likely be undertaken in future MASPS revisions. Provisioned intent information includes conformance monitoring assessment by the transmitting aircraft and the inclusion of waypoint constraint Trajectory Change Point (TCP) types in the TCR. Appendix N provides a more detailed rationale for the incorporation and provision of TSR and TCR elements, in addition to discussing future plans for intent development.

This MASPS defines requirements for the TSR and first two TCR's (TCR+0 and TCR+1). Requirements for additional TCR's beyond TCR+1 are deferred for later MASPS revisions, pending the results of ongoing studies. Current work on management of multiple TCR's is documented in Appendix N.

Receiving ADS-B participants may use capability class codes to assess the transmitting A/V's ability to support TSR and TCR information. This assessment may be needed to determine pairwise compatibility for certain applications. These codes are described in sub-paragraphs **Error! Reference source not found.** and **Error! Reference source not found.**, respectively.

Detailed intent element requirements, along with required update rates and conditions for broadcasting TSR and TCR information, are described in paragraphs 3.4.7 and 3.4.8, respectively.

~~2.1.2.18.1~~2.1.2.20.1 Short Term Intent

Short-term intent is reported in the Target State Report (TSR, sub-paragraph 3.4.7) and consists primarily of the target altitude (or appropriate substitutes for target altitude, see sub-paragraph 3.4.7.14) and target heading ~~(~~or target track angle for the active flight segment.~~) that the A/V's guidance system is being commanded to follow.~~These parameters represent the aircraft's tactical intent and are often selected directly by the pilot through an autopilot control panel. Examples include selected altitude for limiting a descent or climb transition and selected heading when following vectors issued by air traffic control. Target altitude and target heading or track angle can also refer to the current intended targets flown by an autopilot in more automated modes, such as those supported by RNAV and FMS. In this case, the target track angle may be the track to the next waypoint.

The TSR provides a way for aircraft equipped with less sophisticated automation systems or flying in tactical flight modes to exchange short-term intent information. This information can be used for separation assurance and clearance verification applications.

For equipage classes A2 and A3, the ADS-B system shall (R2.xx) provide the capability to transmit and receive messages in support of the TSR. TSR capability is optional for equipage class A1 and prohibited for equipage class A0.

~~While short term intent is available in almost all operational flight modes, four dimensional long term intent is only available when equipped aircraft are using sophisticated FMS and area navigation (RNAV) systems.~~

~~The TSR provides information on the horizontal and vertical targets for the active flight segment. The active flight segment refers to the current path and automation states being used for guidance and control of the aircraft. Primary TSR elements include the target altitude and target heading or track. These parameters reflect short term tactical intent and are typically input by the pilot. Examples include selected altitude for limiting a descent or climb transition or selected heading or track when These targets may be a command to hold and maintain the current altitude or heading. Target altitude and target heading or track can also refer to the next intended targets flown by an autopilot in more automated modes, such as those supported by RNAV and FMS. The OC TSR provides a way for aircraft equipped with less sophisticated automation systems or flying in tactical flight modes to exchange short term intent information.~~

Short term ~~vertical~~ intent is conveyed in the Target State Report (TSR, paragraph 3.4.7) and includes the following report elements:

- Participant Address (sub-paragraph **Error! Reference source not found.**)
- Address Qualifier (sub-paragraph **Error! Reference source not found.**)
- Time of Applicability (sub-paragraph 2.1.2.1)
- Horizontal Data Available (sub-paragraph 1.1.1.1)
- Target Heading (sub-paragraph 3.4.7.3) or Target Track (sub-paragraph 3.4.7.4)
- Heading/Track Indicator (sub-paragraph 1.1.1.1)
- Horizontal Target Source Indicator (sub-paragraph 0)
- Horizontal Mode Indicator (sub-paragraph 1.1.1.1.1)
- Vertical Data Available (sub-paragraph 1.1.1.1.1)
- Target Altitude (~~section~~sub-paragraph 3.4.7.11)
- Target Altitude Type (~~section~~sub-paragraph 3.4.7.12)
- Target Altitude Capability (~~section~~sub-paragraph 3.4.7.14)
- Vertical Target Source Indicator (~~section~~sub-paragraph 3.4.7.15)
- Vertical Mode Indicator (~~section~~sub-paragraph 3.4.7.16)

2.1.2.20.2 Long-Term Intent

Long-term intent is reported in the Trajectory Change Reports (TCRs, sub-paragraph 3.4.8) and includes information on Trajectory Change Points (TCP's) and their connecting flight segments. Additional elements help facilitate path re-generation, data confidence assessment, and conformance monitoring. TCR elements represent strategic intent and are expected to be beneficial for applications such as flight path deconfliction and traffic flow management.

A TCP may be described as a 3D location or intersection of a 2D plane with the aircraft's velocity vector where the current aircraft trajectory is intended to change. This definition includes cases where flight segment changes do not occur at a known 3D point. For example, an aircraft may be climbing in a constant vertical speed mode towards a target altitude. In this case, the aircraft may not take actual wind conditions into account when predicting the level-off location. Level-off prediction in a climb may also depend on changing aircraft performance. These uncertainties make it difficult to predict an accurate 3D intercept point. An analogous lateral situation may occur when an aircraft flies at constant heading to intercept a flight plan route. The intercept point is also dependent on wind parameters that may not be accurately known.

TCR elements are designed to reflect the capabilities of existing and future aircraft avionics. TCR fields are filled based on information availability aboard the transmitting aircraft and the TCP type. A list of required elements for horizontal and vertical TCP types is provided in sub-paragraphs 3.4.8.7.2 and 3.4.8.8.2, respectively. Example TCP types include 2D routing changes, the start and end points of a specified turn transition, FMS predicted Top of Climb and Top of Descent points, and selected altitude from an autopilot control panel when currently in climb or descent transitions. A full list of ADS-B supported TCP types is provided in sub-paragraphs 3.4.8.7.2 and 3.4.8.8.2. All broadcast TCR information must correspond to a supported TCP type. Additional TCP types, such as waypoint altitude constraints, may be incorporated into future MASPS revisions.

Trajectory change data are provided by broadcast media to supply real-time, event-related data to proximate air and ground systems involved in advanced air operations requiring real-time intent. Details involving more complete flight plans or procedures are conveyed, when required, via addressed datalink media. For certain pairwise operations, an addressed crosslink may be used external to the ADS-B system.

For equipage class A2, the ADS-B system shall (R2.xx) provide the capability to transmit and receive messages in support of one TCR (TCR+0). For equipage class A3, the ADS-B system shall (R2.xx) provide the capability to transmit and receive messages in support of two TCR's (TCR+0 and TCR+1). TCR capability is prohibited for equipage classes A1 and A0.

Long-term intent is conveyed in the Trajectory Change Report (TCR, paragraph 3.4.8~~3.4.7~~) and contains the following report elements:

- Participant Address (sub-paragraph 2.1.2.3.1)
- Address Qualifier (sub-paragraph 2.1.2.3.2)
- Time of Applicability (sub-paragraph 2.1.2.1)
- TCR Cycle Number (sub-paragraph 3.4.8.4)
- Time to Go (sub-paragraph 3.4.8.6)
- Horizontal Data Available (sub-paragraph 3.4.8.7.1)
- Horizontal TCP Type (sub-paragraph 3.4.8.7.2)
- TCP Latitude (sub-paragraph 3.4.8.7.3)
- TCP Longitude (sub-paragraph 3.4.8.7.4)
- Turn Radius (sub-paragraph 3.4.8.7.5)
- Track to TCP (sub-paragraph 3.4.8.7.6)
- Track from TCP (sub-paragraph 3.4.8.7.7)
- Horizontal Command/Planned (sub-paragraph 3.4.8.7.9)
- Vertical Data Available (sub-paragraph 3.4.8.8.1)
- Vertical TCP Type (sub-paragraph 3.4.8.8.2)
- TCP Altitude (sub-paragraph 3.4.8.8.3)
- TCP Altitude Type (sub-paragraph 3.4.8.8.4)
- Vertical Command/Planned (sub-paragraph 3.4.8.8.8)

~~**2.1.2.18.3Trajectory Change Intent (Current and Future)**~~

~~2.1.2.19~~2.1.2.21 Other Information

2.2 System Performance – Standard Operational Conditions

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3.4.7 Target State Report (TSR)

The Target State Report (TSR) provides information on the horizontal and vertical targets for the active flight segment. ~~The Target State Report (TSR) contains information about the current heading or altitude towards which the aircraft is being controlled.~~ Table 3.4.7 lists the elements of this report.

Table 3.4.7: Target State Report (TSR) Definition.

	TSR Elem. #	Contents	[Resolution or # of bits]	Reference Section	Notes
ID	1	Participant Address	[24 bits]	**Error! Reference source not found.**	
	2	Address Qualifier	[4 bits]	**Error! Reference source not found.**	1
TOA	3	Time of Applicability	[1 s resolution]	2.1.2.1	
Target Heading or Track Angle	4a	Horizontal Data Available	[1 bit]		
	4b	Target Heading or Track Angle	[1 degree]	3.4.7.3 3.4.7.4	
	4c	Target Heading / Track Indicator	[1 bit]	1.1.1.1	

	4c	(Reserved for Target Heading/Track Capability)[1 bi	<<Richard to provide text>>	
	4d	Target Source Indicator (Horizontal) [2 bits]	0	
	4e	Mode Indicator (Horizontal) [1 bit]	3.4.7.9	
	4f	(Reserved for Horizontal Conformance ~~Validity Flag~~) [1 bit]		
Target Altitude	5a	Vertical Data Available [1 bit]	1.1.1.1.1	
	5b	Target Altitude [100 ft resolution]	1.1.1.1.1	
	5c	Target Altitude Type [1 bit]	3.4.7.17.1	
	5d	Target Altitude Capability [2 bits]	<<Richard to provide text>>	
	5e	Vertical Target Source Indicator [2 bits]	1.1.1.1.1	
	5f	Vertical Mode Indicator- [1 bit]	1.1.1.1.1	
	5g	(Reserved for Vertical Conformance) [1 bit]		
Reserved		(Reserved for future growth) [2 bits]		

Notes for Table 3.4.7:

1. *The minimum number of bits required by this MASPS for the Address Qualifier field is just one bit. However, when ADS-B is implemented on a particular data link, more than one bit may be required for the address qualifier if that data link supports other services in addition to the ADS-B service. For example, address qualifier bits might be needed to distinguish reports about TIS-B targets from reports about ADS-B targets. The number of bits shown in the table for the Address Qualifier field is 4 only because experience in encoding that field ~~the MOPS~~ for particular ADS-B data link~~s~~ MOPS seems to indicate that 4 bits is sufficient for encoding this field.*

3.4.7.1 Conditions for Transmitting TSR Information

An airborne ADS-B participant of equipage class A2 or A3 shall (R3.xx) transmit messages to support the ~~OC~~ TSR ~~report~~ when the flight director or autopilot is engaged consistent with the axis of the target being sent. The class A2 or A3 participant shall (R3.xx) transmit these messages when either of the following conditions is met:

a. Target altitude or an acceptable substitute for target altitude (sub-paragraph 3.4.7.14) is available from the automation system, or

b. Target heading or target track is available from the automation system.

3.4.7.2 Update Interval for TSR Information

The air-to-air update interval for TSR information shall (R3.xx) be as specified in Table 3-4(c)~~3.4.7.2~~ for a 95% probability of successful update at the specified ranges.

Do we want to state the Table 3-4(c) requirements in words here? Should the Table 3-4(c) notes specifying the equations (actual update rate requirements) be stated here?

(This table is redundant with Table 3-4(c)).

Table 3.4.7.2: TSR Update IntervalAs A Function of Range Between Aircraft.

	R £ 20 NM (95% Probability of Reception)	20 NM < R £ 40 NM (95% Probability of Reception)
Following Target State Changes	≤ 12 s	≤ 12 s
Nominal	≤ 12 s	max(12 s, 0.45 × R)

Note: In the above table, the formula, "max (12 s, 0.45 ´ R)" means the larger of (a) 12 seconds, or (b) 0.45 seconds per nautical mile times the range in nautical miles.

3.4.7.2.1Short Term Horizontal Intent

Short term horizontal intent is conveyed in the Target State Report (TSR) and includes the following report elements:

? Target Heading (subparagraph 3.4.7.2.1.1) or Target Track (subparagraph 3.4.7.2.1.2)

? Target Heading / Target Track Indicator (subparagraph)

? Horizontal Target Source Indicator (subparagraph 3.4.7.2.1.3)

? Horizontal Mode Indicator (subparagraph 3.4.7.2.1.4)

3.4.7.2.1.13.4.7.3 Target Heading << move to section 3>>

Target heading is the aircraft's intended heading after turn completion or its current intended heading if in straight flight. Target heading shall (R32.xx) be provided with a range of 0 to 359 degrees <<possible rewording here?>> and shall (R32.xx) have a resolution of one degree of arc or smaller. Target heading is only provided if the aircraft is being controlled to an air referenced heading angle.

3.4.7.2.1.23.4.7.4 Target Track Angle

Target track angle is the aircraft's intended track angle over the ground after turn completion or its current intended track angle if in straight flight. Target track shall (R32.xx) be provided with a range of 0 to 359 degrees <<possible rewording>> and shall (R32.xx) have a resolution one degree of arc or smaller. Target track is only provided if the aircraft is being controlled to a ground referenced track angle.

3.4.7.5 Horizontal Data Available

The Horizontal Data Available element shall be ONE to indicate that data in the target heading or track angle field is available and valid, or ZERO otherwise.

3.4.7.6 Target Heading / Track Indicator

The Target Heading/Track Indicator indicates whether the TSR is providing target heading or target track angle. This field shall be ZERO to indicate that the "Target Heading or Track Angle" field conveys target heading, or ONE to indicate that it conveys target track angle. The reference direction (true north or magnetic north) is conveyed in the MS report.

3.4.7.7 Reserved for Target Heading/Track Capability

A bit is reserved to indicate whether or not the aircraft has the capability to provide target heading or track. Future revisions of this MASPS may allow substitutes for target heading, such as the selected heading from an autopilot control panel. In this MASPS, this bit shall (R3.xx) be ONE.

~~3.4.7.2.1.3~~3.4.7.8 Horizontal Target Source Indicator ~~<< move to section 3>>~~

The Horizontal Target Source Indicator ~~in the Target State Report~~ provides the aircraft system or state acting as the source of target heading or track angle information. An aircraft system is considered to be the target source when a change to that system's settings (for the current operational mode) would cause the aircraft trajectory to change. The ADS-B system shall (R3~~2~~.xx) support the following three sources of horizontal target state information~~options~~:

- FMS or RNAV system (indicates track angle specified-relative to a waypoint) ~~by leg type~~);
- Autopilot control panel selected value, such as Mode Control Panel (MCP) or Flight Control Unit (FCU);
- Maintaining current heading or track angle ~~(e.g., autopilot mode select)~~.

~~3.4.7.2.1.4~~3.4.7.9 Horizontal Mode Indicator ~~<< move to section 3>>~~

The Horizontal Mode Indicator ~~element of the Target State Report~~ reflects the aircraft's state relative to the target heading or track angle. The ADS-B system shall (R3~~2~~.xx) support the following two options:

- Acquiring target heading or track angle.
- Capturing or maintaining target heading or track angle.

3.4.7.10 Reserved for Horizontal Conformance

A bit is reserved for horizontal conformance assessment by the transmitting aircraft. This bit would provide an indication of pilot or autopilot conformance to the horizontal target state.

~~3.4.7.3Horizontal Data Elements in TSR Report~~

~~3.4.7.3.1Horizontal Data Available~~

~~The Horizontal Data Available flag for the target heading, TSR element #9, shall be ONE to indicate that data in the target heading or track angle field (element #4) is valid, or ZERO otherwise.~~

~~3.4.7.3.2Heading/Track Indicator~~

~~The orientation type (heading or track angle) is conveyed in the Heading/Track Indicator. This field shall be ZERO to indicate that the "Target Heading or Track Angle" field conveys target heading, or ONE to indicate that it conveys target track angle. The reference direction (true north or magnetic north) is conveyed in the MS report.~~

~~3.4.7.3.3Reserved for Target Heading/Track Capability~~

~~A bit is reserved to indicate whether or not the aircraft has the capability to provide the horizontal guidance target. In this "revision A" version of the MASPS, this bit shall (R3.xx) be ZERO.~~

~~3.4.7.3.4Horizontal Target Source Indicator~~

~~The Horizontal Target Source indicator is a two bit field that indicates the source of the Target Heading/Track Angle information. <<Need text to define the values of this field.>>~~

~~3.4.7.3.5Horizontal Mode Indicator~~

~~The Horizontal Mode Indicator is a one bit flag that …. <<Need text to define the values of this field.>>~~

~~3.4.7.4~~3.4.7.11 ~~Vertical Data Elements in Target State Report~~ **Target Altitude**

Target Altitude is the aircraft's next intended level flight altitude if in a climb or descent or its current intended altitude if commanded to hold altitude. Target altitude shall (R3~~2~~.xx) be represented as the operational altitude recognized by the transmitting aircraft's guidance system. In order to ensure a consistent reference for target altitude, all aircraft must follow standard conventions by using barometric corrected altitude (altimeter set to local setting) below the transition level and pressure altitude (altimeter set to 29.92 in Hg or 1013.25 hPa) above the transition level. Target altitude shall (R3~~2~~.xx) be provided with a range of 1,000 feet up to 100,000 feet and shall (R3~~2~~.xx) have a resolution of 100 feet.

Note: The 100-foot resolution for target altitude was chosen because that is the resolution supported by the Mode Control Panel (MCP) or Flight Control Unit (FCU) equipment in use on commercial aircraft. Since target altitude can only be input in multiples of 100 feet, there is no need for a finer resolution for the encoding of target altitude. This MASPS requirement does not, of course, dictate how target altitude will be encoded on a particular ADS-B data link.

3.4.7.12 Vertical Data Available

Vertical Data Available is a one-bit field in the Target State Report. This field shall (R3.xx) be ONE if Target Altitude data is available and valid, or ZERO otherwise.

~~3.4.7.4.1~~3.4.7.13 Target Altitude Type

The target altitude type is used to determine whether the target altitude is represented as a ~~pressure altitude or a~~ barometric corrected altitude or a pressure altitude. Target altitude type shall (R3~~2~~.xx) be ZERO to indicate that ~~whether~~ the target altitude is ~~above or~~ below the transition level and ONE to indicate that the target altitude is above the transition level.

~~3.4.7.4.2~~3.4.7.14 Target Altitude Capability

Alternate values of target altitude may be provided by aircraft unable to support the general definition of target altitude. The target altitude capability describes the value occupying the target altitude field. The ADS-B system shall (R3~~2~~.xx) support 2~~3~~ levels of target altitude capability:

- Holding current altitude or autopilot control panel selected altitude.
- ~~Holding altitude, autopilot control panel selected altitude, or FMS/RNAV cruise altitude.~~
- Holding current altitude, autopilot control panel selected altitude, or any FMS/RNAV level-off altitude.

~~3.4.7.4.3~~3.4.7.15 Vertical Target Source Indicator

The Vertical Target Source Indicator provides the aircraft system or state acting as the source of target altitude information. An aircraft system is considered to be the target source when a change to that system's settings (for the current operational mode) would cause the aircraft trajectory to change. The ADS-B system shall (R3.xx) support the following three sources of vertical target state information:

~~The Vertical Target Source Indicator in the Target State Report provides the source of target altitude information. The ADS-B system shall (R2.xx) support the folloing three options:~~

- FMS or RNAV system (cruise altitude or waypoint altitude constraint).
- Autopilot control panel selected value, such as Mode Control Panel (MCP) or Flight Control Unit (FCU).
- Holding current a~~A~~ltitude.

In cases where the aircraft is operated in a vertical FMS/RNAV mode and the FMS/RNAV target altitude is the same as the autopilot control panel selected altitude, the Vertical Target Source Indicator shall (R3.xx) be set to "FMS or RNAV system."

~~3.4.7.4.4~~3.4.7.16 Vertical Mode Indicator

The Vertical Mode Indicator reflects the aircraft's position relative to the target altitude. The ADS-B system shall (R3~~2~~.xx) support the following two options:

- Acquiring t~~T~~arget a~~A~~ltitude.
- Capturing or m~~M~~aintaining t~~T~~arget a~~A~~ltitude

3.4.7.17 Reserved for Vertical Conformance

A bit is reserved for vertical conformance assessment by the transmitting aircraft. This bit would provide an indication of pilot or autopilot conformance to the target altitude.

~~3.4.7.4.5Vertical Data Available~~

~~Vertical Data Available is a one bit field in the Target State Report. This field shall (R3.xx) be ONE if Target Altitude data is available and valid; otherwise, it shall be ZERO.~~

~~3.4.7.4.6Target Altitude~~

~~Target altitude is the aircraft's next intended level flight altitude if in a climb or descent or its current intended altitude if commanded to hold altitude. Target altitude shall (R3.xx) be represented as the operational altitude recognized by the transmitting aircraft's guidance system. In order to ensure a consistent reference for target altitude, all aircraft must follow standard conventions by using barometric corrected altitude (altimeter set to local setting) below the transition level and pressure altitude (altimeter set to 29.92 in Hg, or 1013.25 hPa) above the transition level. Target altitude shall (R3.xx) be provided with a range from -1000 ft to +100,000 feet and shall (R3.xx) have a resolution of 100 feet.~~

~~3.4.7.4.7~~3.4.7.17.1 Target Altitude Type

(this MASPS should incorporate Target Altitude Type)

~~The Target Altitude Type field is a one bit field in the Target State Report that is reserved for future use to indicate whether the target altitude is represented as a pressure altitude or as a barometric corrected altitude.~~

~~*Notes:*~~

~~*1.It is expected that a future version of this MASPS target altitude type information to be conveyed in messages that support the TSR report.*~~

~~*2.It is expected that, when target altitude type information is required, this field will be ZERO to indicate pressure altitude or flight level (target altitude above the transition level), or ONE to indicate baro corrected altitude (target altitude below the transition level.*~~

~~3.4.7.4.8Vertical Target Source Indicator~~

~~The Vertical Target Source Indicator field in the TSR indicates the source of target altitude information. The ADS-B system shall (R3.xx) support the following three options:~~

~~3.4.7.4.9Vertical Mode Indicator~~

~~<< Need text>>~~

3.4.8 Trajectory Change Reports (TCR, TCR+1, etc.)

Table 3.4.8 shows the overall structure for Trajectory Change Reports (TCRs). The structure shown here is intended to accommodate up to four trajectory change points, and to provide for additional fields as more types and subtypes of TCR reports are developed for later versions of this MASPS.

Table 3.4.8: Trajectory Change Report (TCR) Definition.

			Needed Only For TCR+0 Reports		
	TCR Elem. #	**Contents [Notes]** **[Resolution or # of Bit**		**Reference Section**	**Notes**
ID	1	Participant Address [24 bits]		**Error! Reference source not found.**	
	2	Address Qualifier [4 bits]		**Error! Reference source not found.**	
TOA	3	Time of Applicability [1 s resolution]		2.1.2.1	
TCR #	4	TCR Sequence Number- [2 bits]		3.4.8.3	1
TCR Version	5a	TCR Cycle Number [2 bits]		3.4.8.4	
	5b	(Reserved for TCR+0 Transition Flag) [1 bit]	•	3.4.8.5	
TTG	6	Time To Go [1 s resolution]		3.4.8.6	
Horizontal TCP Information	7a	Horizontal Data Available [1 bit]		3.4.8.7.1	
	7b	Horizontal TCP Type [4 bits]		3.4.8.7.2	2
	7c	TCP Latitude [0.1 NM]		3.4.8.7.3	3
	7d	TCP Longitude [0.1 NM]		3.4.8.7.4	3
	7e	Turn Radius [0.1 NM]		3.4.8.7.5	3
	7f	Track to TCP [1 degree]		3.4.8.7.6	
	7g	Track from TCP [1 degree]		3.4.8.7.7	
	7h	(Reserved for Horizontal Conformance) [1 bit]	•	3.4.8.7.8	
	7i	Command/Planned (Horizontal) [1 bit]		3.4.8.7.9	
Vertical TCP Information	8a	Data Available (Vertical) [1 bit]		3.4.8.8.1	
	8b	Vertical TCP Type [4 bits]		3.4.8.8.2	
	8c	TCP Altitude [100 ft resolution]		3.4.8.8.3	
	8d	TCP Altitude Type [1 bit]		3.4.8.8.4	
	8e	Reserved for Altitude Constraint Type [2 bits]		3.4.8.8.5	
	8f	(Res. for Able/Unable Altitude Constraint) [1 bit]	•	3.4.8.8.6	
	8g	(Res. For Vertical Conformance) [1 bit]	•	3.4.8.8.7	
	8h	Command/Planned (Vertical) [1 bit]		3.4.8.8.8	

Notes for Table 3.4.8:

1. (note)

2. (note)

3. Finer resolution than 0.1 NM may be required for future precision approach/departure applications. It is expected that new TCP types will be defined for applications with finer resolution requirements.

3.4.8.1 Conditions for Transmitting TCR Information

<<Text TBD >>

3.4.8.2 Update Interval for TCR Information

<<Text TBD>>

3.4.8.3 TCR Number ("N" in "TCR+N")

The TCR number is a sequence number for the set of Trajectory Change Reports that describe a target's current intent; it is "N" in the expresseion "TCR+N". The current TCR ("TCR+0") is a trajectory change report that describes the next point (Trajectory Change Point, TCP) at which the aircraft's trajectory will change. "TCR+1" is a Trajectory Change Report that describes the next trajectory change after the one described in the TCR+0 report. And so on.

The TCR Number field in the TCR data structure shall (R3.xx) contain a value in the range from 0 to 3, as defined in Table 3.4.8.3.

Table 3.4.8.3: TCR Number Definition.

TCR Number	Meaning
0	The TCR report describes the current trajectory change (TCP) towards which the aircraft is being directed.
1	The TCR+1 report describes the next TCP after the current TCP.
2	The TCR+2 report describes the next TCP after the TCP described in the TCR+1 report.
3	The TCR+3 report describes the next TCP after the TCP described in the TCR+2 report.

3.4.8.4 TCR Cycle Number

The TCR Cycle Number indicates a current "version number" for the numbering of the TCR reports.

Each TCR report (subparagraph 3.4.8 above) includes both a TCR number (the "N" in "TCR+N") and a TCR cycle number for the current numbering of the TCR reports. When a TCR report is inserted into or deleted from the list of current TCRs, or the trajectory change point described in the current TCR+0 report is reached, the TCR cycle number is incremented.

The TCR Cycle Number shall (R2.xx) be a number in the range from 0 to 3 that is incremented (modulo 4) each time the numbering of TCR reports changes. That is, the TCR cycle number is incremented from 0 to 1, then from 1 to 2, then from 2 to 3, and then from 3 back to 0.

3.4.8.5 TCR+0 Transition Flag

The TCR+0 transition flag is used to indicate when a transmitting ADS-B participant has just reached the current TCP (described in the TCR+0 report) so that the numbering of TCR reports (the TCR numbers, the "N" in "TCR+N") has changed.

Normally, this flag should be ZERO. When the transmitting ADS-B participant reaches the trajectory change point described in the current TCR+0 report, it shall (R2.xx) set the transition flag to ONE for a period of TBD seconds in the messages it transmits to support the MS report. After the TBD second interval has expired, the transmitting participant shall reset the transition flag to ZERO.

[AI 9-12] Tony Warren will provide updates for this text.

3.4.8.6 Time To Go (TTG) Field in TCR Reports

~~**3.4.8.6**~~

3.4.8.7 Horizontal TCP Information

3.4.8.7.1 Horizontal Data Available

3.4.8.7.2 Horizontal TCP Type

3.4.8.7.3 TCP Latitude

3.4.8.7.4 TCP Longitude

3.4.8.7.5 Turn Radius

3.4.8.7.6 Track to TCP

3.4.8.7.7 Track from TCP

3.4.8.7.8 Reserved for Horizontal Conformance

3.4.8.7.9 Command/Planned (Horizontal)

3.4.8.8 Vertical TCP Information

3.4.8.8.1 Vertical Data Available

3.4.8.8.2 Vertical TCP Type

3.4.8.8.3 TCP Altitude

3.4.8.8.4 Reserved for TCP Altitude Type

3.4.8.8.5 Reserved for Altitude Constraint Type

3.4.8.8.6 Reserved for Altitude Constraint Conformance

3.4.8.8.7 Reserved for Vertical Conformance

3.4.8.8.8 Command/Planned (Vertical)

3.5 ADS-B Subsystem Requirements

3.5.1 Aircraft/Vehicle Interactive Subsystem Requirements

3.5.2 Broadcast-Only Subsystem Requirements

3.5.3 Ground Receive-Only Subsystem Requirements

3.6 ADS-B Functional Level Requirements

3.6.1 Required Message Generation Function

3.6.2 Required Message Exchange Function

3.6.3 Required Message Exchange Function