

RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #10

**Proposal to Revise the Capability Code (CC) and
Operational Mode (OM) Subfields of the
Aircraft Operational Status Message**

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Summary
The present organization (in DO-260) of the CC and OM fields in the Aircraft Operational Status Message is wasteful of bits. The organization of these fields proposed here more efficiently encodes the capability codes and operational modes described in the draft DO-242A revised ADS-B MASPS.
After presenting arguments justifying the re-design of the structure of the CC and OM subfields in the Aircraft Operational Status message, this paper goes on to propose draft text describing the restructured CC and OM subfields.
“Revision A” corrects a few blunders in the original version of this working paper.

1 Introduction To The Problem

1.1 CC and OM Fields of DO-242A's MS Report

The CC and OM fields in the Aircraft Operational Status Message are intended to convey the “Capability Class (CC) codes” and “Operational Mode (OM) parameters,” which are fields in the MS (Mode-Status) report described in DO-242, the ADS-B MASPS, and now in more detail in the draft DO-242A revision of that MASPS. [Table 1](#) shows the current assignment of capability codes and operational mode codes from the draft revised MASPS, DO-242A. This table is extracted from the “Mode-Status Report Definition,” [Table 3.4.4](#) in the draft DO-242A MASPS.

Table 1: CC and OM Fields in DO-242A Mode-Status Report

	MS Elem. #	Contents	[Resolution or # of bits]
CC, Capability Codes	7	Capability Class Codes	[16 bits]
		7a: CDTI Display Capability	[1 bit]
		7b: TCAS/ACAS Installed and Operational	[1 bit]
		7c: (Reserved for Service Level)	[4 bits]
		7d: TS Report Capability Flag	[1 bit]
		7e: TC Report Capability Level (CC codes reserved for future growth)	[2 bits] [7 bits]
OM, Operational Mode	8	Operational Mode Parameters	[16 bits]
		8a: TCAS/ACAS resolution advisory active	[1 bit]
		8b: IDENT switch active	[1 bit]
		8c: Requesting ATC services	[1 bit]
		(Reserved for future growth)	[13 bits]

1.2 CC and OM Fields in DO-260's Aircraft Operational Status Message

Notice from [Table 1](#) that DO-242A does *not* require that capability class codes be classified according to the phase of flight in which those capabilities would be used. Likewise, DO-242A does *not* classify the operational mode codes according to phase of flight. In DO-260, however, the CC and OM fields of the aircraft operational Status Message are each subdivided into four 4-bit subfields:

- CC_4, a 4-bit subfield “to indicate En Route Operational Capabilities” of the transmitting aircraft;
- CC_3, a 4-bit subfield “to indicate Terminal Area Operational Capabilities” of the transmitting aircraft;
- CC_2, a 4-bit subfield “to indicate Approach and Landing Operational Capabilities” of the transmitting aircraft;
- CC_1, a 4 bit subfield “to indicate Surface Operational Capabilities” of the transmitting aircraft;
- OM_4, a 4-bit subfield “to indicate the status of the En Route Operational capabilities” of the transmitting aircraft;

- OM_3, a 4-bit subfield “to indicate the status of the Terminal Area Operational Capabilities” of the transmitting aircraft;
- OM_2, a 4-bit subfield “to indicate the status of the Approach and Landing Operational Capabilities” of the transmitting aircraft; and
- OM_1, a 4-bit subfield “to indicate the status of the Surface Operational Capabilities” of the transmitting aircraft.

Moreover, each of these 4-bit subfields is in turn divided into two 2-bit subfields, with the first 2-bit subfield announcing which of four possible meanings are to be assigned to the second 2-bit subfield.

All this elaborate structure was unjustified by any requirements in the original DO-242 MASPS, and is unjustified by any requirements in the draft “revision A” of that MASPS, DO-242A. WG-3 just made it up!

The unfortunate consequence of this unjustified invention in the DO-260 MOPS is that there is room to encode only two “en route” capabilities at a time:

- “TCAS operational or unknown” vs. “TCAS not operational;” and
- “CDTI not operational or unknown” vs. “CDTI operational.”

[Reference: DO-260, §2.2.3.2.7.3.3.1]

If any additional operational capabilities are to be encoded for the “en route” phase of flight, the DO-260 method for organizing the CC field in the Aircraft Operational Status Message would require additional Aircraft Operational Status Messages to be broadcast! This is wasteful of bandwidth.

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Proposed Solution

We should be careful as we define the structure of Aircraft Operational Status Message for DO-260A, to provide for both forward and backward compatibility with the structure previously defined in DO-260.

Fortunately, we now have a “Version Number” subfield, which will help us achieve “forward compatibility.” That is, an ADS-B transmitting subsystem that conforms to our new DO-260A MOPS will announce that fact by setting the Version Number field to 1, while earlier equipment, that follows the original DO-260 MOPS, will transmit zeroes in the bits that are now assigned for the Version Number field. This will at least permit new, Version 1 (DO-260A compliant) ADS-B receiving equipment to know whether an Aircraft Operational Status Message that it receives came from a Version 0 (DO-260) or a Version 1 (DO-260A) ADS-B transmitting subsystem.

But what about backward compatibility? How will a Version 0 (DO-260 compliant) receiving equipment know how to interpret the “CDTI” and “TCAS” capability code bits coming from new Version 1 (DO-260A compliant) equipment? In order for older equipment correctly to interpret the CC codes coming from newer equipment, we must take care that we encode at least those

two capability class codes in the new equipment in exactly the same way as they were encoded in DO-260.

That is, we must encode bits 9, 10, 11, and 12 of the ME field in the Aircraft Operational Status message as follows:

- Bits 9 and 10 must both be ZERO, so that Version 0 (DO-260 compliant) equipment will know that bits 11 and 12 have the meanings defined below;
- Bit 11 must be ZERO to mean “TCAS operational or unknown,” or ONE to mean “TCAS not operational,” just as in DO-260; and
- Bit 12 must be ZERO to mean “CDTI not operational or unknown,” or ONE to mean “CDTI operational,” just as in DO-260.

In light of these arguments, I therefore propose the following text for DO-260A.

2.2.3.2.7.3 “AIRCRAFT OPERATIONAL STATUS” Messages

The “Aircraft Operational Status” message is used to provide the current status of the aircraft. Format of the message is provided in [Figure 2-10](#), while further definition of each of the subfields is provided in the subsequent subparagraphs.

Figure 2-10: Aircraft Operational Message Format

“AIRCRAFT OPERATIONAL STATUS” MESSAGE “ME” FIELD										
MSG BIT #	33-37	38-----40	41-----56	57-----72	73-75	76-79	80-81	82-83	84	85-88
“ME” BIT #	1---5	6-----8	9-----24	25-----40	41-43	44-47	48-49	50-51	52	53-56
FIELD NAME	TYPE = 31 [5]	SUBTYPE [3]	CAPABILITY CLASS [16]	OPERATIONAL MODE [16]	Vers. # [3]	NAC _P [4]	SIL [2]	Res. for BAQ [2]	Res. for NIC _{baro} [1]	Res. [4]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	0	0 0 0 0

Note: “[#]” provided in a subfield indicates the number of bits in that subfield.

Figure 2-10: “Aircraft Operational Status” ADS-B Message Format

2.2.3.2.7.3.1 “TYPE” Subfield in Aircraft Operational Status Messages

The “TYPE” subfield was previously defined for the Airborne Position Message in §2.2.3.2.3.1 and remains the same for the Aircraft Operational Status Message, which uses Type Code 31.

2.2.3.2.7.3.2 “SUBTYPE” Subfield in Aircraft Operational Status Messages

The “SUBTYPE” subfield is a 3-bit (“ME” bits 6 through 8, Message bits 38 through 40) subfield used to indicate various types of Aircraft Operational Status Messages as defined in [Table 2-53](#).

Table 2-53: “SUBTYPE” Subfield Encoding in Aircraft Operational Status Messages

Subtype Coding	Meaning
0	Message contains Aircraft Operational Status data as shown in Figure 2-10 .
1 - 7	Reserved for future growth

2.2.3.2.7.3.3 “CAPABILITY CLASS (CC)” Subfield in Aircraft Operational Status Message

The “Capability Class (CC)” subfield is a 16-bit field (“ME” bits 9 through 24, Message bits 41 through 56) that itself contains subfields that are used to indicate capabilities of a transmitting ADS-B participant to the receiving ADS-B participants as defined in the following subparagraphs. [Table 3.2.3.2.7.3.3](#) below shows the overall structure of the Capability Class (CC) subfield.

Table 3.2.3.2.7.3.3: Subfields within the Capability Class (CC) Subfield.

CAPABILITY CLASS (CC) CODES [16]							
MSG BIT #	41--42	43	44	45--48	49	50--51	52--56
“ME” BIT #	9--10	11	12	13--16	17	18--19	20--24
FIELD NAME	Reserved [2]	TCAS Capability [1]	CDTI Capability [1]	Res. for Service Level [4]	TS Report Capability [1]	TC Report Capability Level [2]	Reserved for Future Growth [5]
Value	0 0	0 or 1	0 or 1	0 0 0 0	0 or 1	0 0	0 0 0 0 0

Note: “[#]” provided in a subfield indicates the number of bits in that subfield.

2.2.3.2.7.3.3.1 “Reserved” Subfield within the “CC” Subfield

The first two bits of the “CC” Subfield (ME bits 9 and 10, Message bits 41 and 42) are reserved for future use. Transmitting ADS-B equipment that is DO-260 or DO-260A compliant (Version 0 or Version 1 equipment) shall set both these bits to ZERO.

Note: To promote backward compatibility with the initial (DO-260) version of this MOPS, these should be the last CC bits to be allocated in future versions of this MOPS.

2.2.3.2.7.3.3.2 “TCAS Capability” Subfield within the “CC” Subfield

The “TCAS Capability” subfield of the CC subfield is a one-bit field (ME bit 11, Message bit 43) that shall be encoded as defined in [Table 2.2.3.2.7.3.3.2](#):

Table 2.2.3.2.7.3.3.2: Encoding of “TCAS/ACAS Capability” Subfield

Encoded Value	Meaning
0	TCAS Operational or Unknown
1	TCAS Not Operational

Notes for Table 2.2.3.2.7.3.3.2:

1. A value of zero will advise applications on board receiving aircraft that it is preferable to use horizontal, rather than vertical, maneuvers if needed to avoid the transmitting aircraft. (A TCAS equipment, if installed and operational, will advise vertical maneuvers in any TCAS Resolution Advisories that it may issue.)

2. A value of one will indicate that vertical maneuvers may be used to avoid the transmitting aircraft, because it is known either that TCAS is not installed on the transmitting aircraft, or that TCAS, if installed, is not operating in a mode in which it can give TCAS Resolution Advisories.

2.2.3.2.7.3.3.3 “CDTI Capability” Subfield within the “CC” Subfield

The “CDTI Capability” subfield within the CC subfield is a one-bit field (“ME” bit 12, Message bit 44) that shall be encoded as defined in Table 2.2.3.2.7.3.3.3 below:

Table 2.2.3.2.7.3.3.3: Encoding of “CDTI Capability” Subfield

Encoded Value	Meaning
0	CDTI Not Operational or Unknown
1	CDTI Operational

2.2.3.2.7.3.3.4 “Reserved for Service Level” Subfield within the “CC” Subfield

The “Reserved for Service Level” subfield is a four-bit (“ME” bits 13 through 16, Message bits 45 through 48) that shall be set to all ZEROES by transmitting ADS-B equipment that conforms to this (DO-260A) MOPS.

Note: The ASA MASPS, a document that is currently under development, will define non-zero values for the Service Level. Once the ASA MASPS has been approved, a future version of this MOPS will include the Service Level values as defined in the ASA MASPS.

2.2.3.2.7.3.3.5 “TS Report Capability” Subfield within the “CC” Subfield

The “TS Report Capability” Subfield is a one-bit (“ME” bit 17, Message bit 49) subfield of the CC subfield that shall be encoded as defined in Table 2.2.3.2.7.3.3.5.

Table 2.2.3.2.7.3.3.5: Encoding of “TS Report Capability” Subfield

Encoded Value	Meaning
0	Transmitting aircraft cannot send messages to support the TS report.
1	Transmitting aircraft’s ADS-B system is capable of sending messages to support the Target State (TS) report.

2.2.3.2.7.3.3.6 “TC Report Capability” Subfield of the “CC” Subfield

The TC Report Capability Subfield is a two-bit (“ME” bits 18 and 19, Message bits 50 and 51) subfield of the “CC” code subfield that indicates the transmitting ADS-B participant’s level of capability for sending messages to support Trajectory Change (TC) reports. ADS-B transmitting equipment that complies with this (DO-260A) MOPS shall set both bits of this subfield to ZEROES.

Note: A TC report capability level of zero indicates that the transmitting ADS-B system does not have the capability of sending messages to support TC reports.

2.2.3.2.7.3.3.7 “Reserved for Future Growth” Bits in “CC” Subfield

The last five bits of the “CC” subfield (“ME” bits 20 through 24, Message bits 52 through 56) are reserved for future growth. ADS-B transmitting subsystems that comply with this (DO-260A) MOPS shall set all these bits to ZEROES.

Note: As more capability codes are defined for future versions of this MOPS, the bits for such capability codes should be allocated from these last five bits (“ME” bits 20 to 24 before any of the first two bits (“ME” bits 9 and 10) are allocated. The first two bits should be allocated last, in order to preserve, for the longest time possible, backward compatibility with equipment that complies with the initial (DO-260) version of this MOPS.

2.2.3.2.7.3.4 “OPERATIONAL MODES (OM)” Subfield in the Aircraft Operational Status Message

The “Operational Modes (OM)” subfield is a 16-bit field (“ME” bits 25 through 40, Message bits 57 through 72) that itself contains subfields that are used to indicate a transmitting ADS-B participant’s operational modes. [Table 2.2.3.2.7.3.4](#) shows the overall structure of the Operational Mode (OM) subfield.

Table 3.2.3.2.7.3.4: Subfields within the Operational Modes (OM) Subfield

	OPERATION MODE (OM) Codes [16]			
MSG BIT #	57	58	59	60--72
“ME” BIT #	25	26	27	28--40
FIELD NAME	TCAS (ACAS) Resolution Advisory Active [1]	IDENT Switch Active [1]	Requesting ATC Services [1]	Reserved for Future Growth [13]
Value	0 or 1	0 or 1	0 or 1	All ZEROES

Note: “[#]” provided in a subfield indicates the number of bits in that subfield.

2.2.3.2.7.3.4.1 “TCAS (ACAS) Resolution Advisory Active” Subfield of the OM Subfield

The “TCAS (ACAS) Resolution Advisory Active” subfield of the OM subfield in the Aircraft Operational Status message is a one-bit subfield (“ME” bit 25,

Message bit 57) that indicates whether or not a transmitting aircraft equipped with TCAS currently has an active TCAS Resolution Advisory. This bit shall be ONE if the transmitting participant is equipped with TCAS and has an active TCAS Resolution Advisory; otherwise, this bit shall be ZERO.

2.2.3.2.7.3.4.2 “IDENT Switch Active” Subfield of the OM Subfield

The “IDENT Switch Active” subfield of the OM subfield in the Aircraft Operational Status message is a one-bit subfield (“ME” bit 26, Message bit 58) that is activated by an IDENT switch.

Note: If the ADS-B transmitting subsystem is incorporated within a Mode S transponder, the IDENT switch will be the IDENT switch on the transponder’s control panel. Class A0 transmitting subsystems, however, are not necessarily, incorporated within transponders. Such Class A0 transmitting ADS-B equipment may have a different location for the IDENT switch. It is beyond the scope of this MOPS to specify exactly how the IDENT switch is connected to the ADS-B transmitting subsystem.

Initially, the “IDENT switch active” subfield shall be ZERO. Upon activation of the IDENT switch, this subfield shall be ONE for a period of 18 ± 1 seconds; thereafter, it shall be reset to ZERO.

2.2.3.2.7.3.4.3 “Requesting ATC Services” Subfield of the OM Subfield

The “Requesting ATC Services” subfield of the OM subfield in the Aircraft Operational Status message is a one-bit subfield (“ME” bit 27, Message bit 59) that is used to indicate whether or not the transmitting ADS-B participant is requesting to be provided with ATC services. When set to ONE, this code shall indicate that the transmitting ADS-B participant is requesting to be provided with ATC services; otherwise, this subfield should be set to ZERO.

Note: This MOPS does not specify the means by which a pilot will indicate to the ADS-B transmitting subsystem whether or not he (or she) is requesting ATC services. For transponder-based ADS-B transmitting subsystems on board aircraft operating within the United States National Airspace System, it is expected that the “requesting ATC services” flag would be ZERO when pilot has entered “1200” as the Mode A identity code in the transponder control panel, and ONE when a value other than “1200” has been entered as the Mode A identity code. For aircraft operating in other parts of the world, a different code than “1200” might be used for this purpose.

2.2.3.2.7.3.4.4 “Reserved for Future Growth” Subfield of the OM Subfield

The last 13 bits of the Operational Mode subfield (“ME” bits 28 through 40, Message bits 60 through 72) are reserved for future growth and shall be set to ZERO by ADS-B transmitting subsystems that comply with this (DO-260A) MASPS.

2.2.3.2.7.3.5 “Version Number” Subfield in Aircraft Operational Status Message

The “Version Number” subfield is a three-bit field (“ME” bits 41 through 43, Message bits 73 through 75) that is used to indicate the Version Number of the formats and protocols in use on the aircraft installation. Encoding of the Version Number shall be as shown in Table A-21.

ADS-B Receiving subsystems that comply with this (DO-260A) version of this MOPS will initially assume a version number of Zero (binary 000) until received Version Number data indicates a non-zero version number.