Terms of Reference

for a rulemaking task

Integrated Modular Avionics (IMA)

RMT.0456, RMT.0621 AND RMT.0622 — ISSUE 2 — 24/10/2013

Applicability		Process map	
Affected regulations and decisions:	CS-ETSO Subpart A CS-ETSO Subpart C AMC 20	Rulemaking lead:	R4
		Concept Paper:	Yes (in Appendix 1)
Affected stakeholders:	• Certification Authority (i.e. EASA for aircraft whose design is in its scope) • Applicant/Holder of Type Certificate (TC) or Supplemental TC (STC) for the aircraft • IMA System Integrator • Application Suppliers • Platform, Module suppliers	Rulemaking group:	No
		RIA type:	Light
		Technical consultation during NPA drafting:	Yes
		Publication date of the first NPA (RMT.0456):	2014/Q1
		Publication date of the second NPA (RMT.0622):	2015/Q1
		Publication date of the third NPA (RMT.0621):	2015/Q2
Driver/origin:	Level playing field	Duration of NPA consultation:	3 months for each NPA
		Review group:	No
Reference:	Industry (ASD) comments to draft ToR RMT.0186 (ETSO.008)	Focussed consultation:	Yes
		Publication date of the Opinion:	N/A
		Publication date of the first Decision (RMT.0456):	2014/Q3
		Publication date of the second Decision (RMT.0622):	2015/Q3
		Publication date of the third Decision (RMT.0621):	2016/Q1

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1. Issue and reasoning for regulatory change

1.1 The use of Integrated Modular Avionics (IMA) has rapidly expanded in the last two decades and it is expected to progress even more in the future. Today IMA can be found in all classes of aircraft, including on types certified by the Agency. IMA is a shared set of flexible, reusable and interoperable hardware and software resources that, when integrated, form a 'system' that provides computing resources and services, designed and verified to a defined set of functional, safety and performance requirements, to host applications performing aircraft functions. In other words, IMA architecture integrates several aircraft functions on the same platform, provided by different hosted applications that historically have been contained in functionally and physically separated 'boxes' or Line Replaceable Units (LRUs).

1.2 From a regulatory standpoint, there are no specific requirements within the current EASA Certification Specifications (CSs including CS-ETSO) or AMC 20 series, for the certification aspects of IMA. Additional guidance is hence needed to address specific aspects at:

- platform level (i.e. design and production of the IMA platform, integrating hardware and software, but not yet applications performing aircraft functions;
- system level (i.e. when applications performing aircraft functions are integrated on the IMA platform, but not yet at aircraft level); and
- aircraft level when the IMA platform and all the aircraft functions hosted by it, is installed and integrated on the airframe.

1.3 Today there is no Agency regulatory guidance at any of these three levels.

1.4 The current IMA related information in the EASA certification process in fact:

a) is based on Certification Review Items (CRIs) with interpretative materials, which are however Type Certificate (TC)/ Supplemental Type Certificate (STC) specific and therefore not publicly available to other interested parties;

b) is dedicated to the IMA development and installation in a specific aircraft in the frame of a TC or a STC process;

c) does not approve the platform independent of the aircraft, whereas IMA platforms are composed of modules which are designed to be reusable on several aircraft and independent of the aircraft;

d) does not allow a delivery of platforms and components accompanied by an ETSO authorisation, which penalises European manufacturers, in comparison with US ones.

1.5 The EUROCAE standard ED-124 (equivalent to the RTCA standard DO-297) on 'Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations', published in July 2007, provides guidelines to deal with the development and certification of IMA architectures but it is not yet enshrined by any regulatory material issued by the Agency, which is an additional reason to take regulatory action.

1.6 IMA design approval could be made incremental by introducing the following steps:

a) voluntary ETSO authorisation for platform or other IMA hardware (e.g. Integrated Avionics Display) modules (aircraft independent), encompassing

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hardware qualification and design approval of basic functions, including modules of core software (but not aircraft functions);

b) voluntary ETSO authorisation for integration of aircraft functions (e.g. autopilot) on an already authorised IMA platform;

c) installation of the avionics on board the aircraft demonstrated by the TC/STC applicant.

More information is provided in the concept paper in appendix 1 to this ToR.

2. Objectives

The objectives are to ensure a cost-efficient and transparent certification process by:

a) offering to IMA manufacturers the possibility to obtain ETSO authorisations at platform/module level, independent from aircraft;

b) offering to integrators of aircraft functions on already authorised IMA platforms the possibility to obtain ETSO authorisations, independent from aircraft;

c) providing public guidance for incremental certification of IMA, starting from platform modules and culminating with installation on aircraft and covering all connected aspects (e.g. impact on Master Minimum Equipment List – MMEL).

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3. Activities

Issue analysis	Objective	Activities
No possibility of ETSO Authorisation for IMA platforms	2a)	Draft new requirements to address the hardware and software resources that, when integrated, form a IMA platform that provides computing resources and services
No possibility of ETSO Authorisation for aircraft functions integrated on IMA platforms	2b)	Draft new requirements for the integration of aircraft functions on an already authorised IMA platform, taking into account that the manufacturers could be different organisations
Lack of clarity on the incremental certification approach to IMA, up to aircraft level	2c)	Provide guidance at aircraft level when the IMA platform and all the aircraft functions hosted by it, is installed and integrated on the airframe

4. Deliverables

a) RMT.0456 will develop ETSO-2C153 enabling authorisations at platform/module level, independent from aircraft; this ETSO would be different from the corresponding FAA TSO-C153 for the reasons presented in the 'concept paper' attached to issue 1 of these ToR;

b) RMT.0621 will develop amendments to CS-ETSO Subpart A to enable ETSO Authorisations when aircraft functional modules are integrated on the already authorised IMA platform, during the initial design phase;

c) RMT.0622 will develop AMC 20-170 to provide public guidance for incremental certification of IMA, from platform modules up to aircraft level (same number of corresponding FAA AC).

5. Interface issues

Differently from FAA AC 20-170, EASA AMC 20-170 will not contemplate 'letters of acceptance', since on the one hand, this additional paperwork is not considered necessary, while on the other hand, no approval processes can be legally introduced by the Agency through 'soft rules' (like e.g. CSs or AMCs).

6. Focussed consultation

Focused consultation is already foreseen at this stage, possibly including:

— meetings with stakeholders (mainly ASD group on IMA);

— information provided at E/TSO world-wide technical workshops.

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7. Technical consultation

No Rulemaking Group will be established.

Agency will draft all the required regulatory documents, including the Explanatory Note, the light RIAs for the NPAs and the proposed amendments to CS-ETSO Subpart A.

However, the initial draft of the proposed ETSO-2C153 and AMC 20-170 will be provided by ASD, as well as inputs for drafting the proposed CS-ETSO Subpart A amendments.

The Agency will organise regular project meetings with ASD.

Wider technical consultations may be organised, should the need arise.

8. Annex I: Reference documents

8.1. Applicable regulations

Part 21[1] and in particular Subparts: B ('Type certificates and restricted type certificates') and O ('European technical standard order authorisations') therein.

8.2. Affected decisions

a) ED Decision 2003/12/RM on general acceptable means of compliance for airworthiness of products, parts and appliances (AMC-20);

b) Decision 2003/10/RM of the Executive Director of the European Aviation Safety Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for European Technical Standard Orders (CS-ETSO).

8.3 Reference documents

a) Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1). Regulation as last amended by Commission Regulation (EU) No 6/2013 of 8 January 2013 (OJ L 4, 9.1.2013, p. 34).

b) Subpart O (ETSO Authorisation) in Section A of Part 21 (Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations.

c) CS-25.1301 and CS-25.1309

d) CS-23, CS-VLA, CS-27, CS-29

e) Federal Aviation Administration (FAA), Technical Standard Order TSO C153 Integrated Modular Avionics Hardware Elements, May 2002

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[1] Annex to Commission Regulation (EC) No 1702/2003 of 24/09/2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production, lastly amended by Commission Regulation (EC) No 1194/2009 of 30/11/2009 amending Commission Regulation (EC) No 1702/2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances as well as for certification of design and production organisations. *(OJ L 321, 8.12.2009, p. 5).*

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f) Federal Aviation Administration (FAA), Advisory Circular 20-170 Integrated Modular Avionics Development. Verification, Integration and Approval using RTCA/DO-297 and Technical Standard Order C153

g) Federal Aviation Administration (FAA), DOT/FAA/AR-07/48 Handbook for Real-Time Operating Systems Integration and Component Integration Considerations in Integrated Modular Avionics System, January 2008

h) ED-124 (equivalent to the RTCA standard DO-297) 'Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations' (July 2007)

i) FAA Policy Statement PS-ANM-25-08 of 11 June 2012 'Application of AC 20-170. Integrated Modular Avionics development. Verification, integration and approval using RTCA DO-297 and TSO-C153

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Appendix 1

CONCEPT PAPER

RMT.0456

Integrated Modular Avionics (IMA)

EXECUTIVE SUMMARY

FAA TSO-C153 contains the following two key features:

- Only limited hardware qualification based on TSO-C153, which does not include modules of core software; and
- No mention of specific Minimum Performance Specifications (MPS).

The proposed Agency's approach could deviate from the FAA's one by also covering modules of core software and prescribing MPS to be demonstrated by applicants for ETSO authorisation.

In such a case, ETSO-2C153 would be published in 'Index 2' (i.e. ETSOs technically different from the corresponding FAA TSO) of CS-ETSO.

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1 Background

FAA published TSO-C153 on Integrated Modular Avionics in 2002. There is no corresponding Agency regulatory material.

So far the Agency has successfully dealt with IMA at aircraft level during the (S)TC process. But the absence of specific ETSOs implies that:

- the information (e.g. CRIs) developed during the aircraft certification projects is not publicly available;
- European manufacturers, unlike US ones, cannot use any ETSO to market their IMA products, which is a competitive disadvantage on the global scale.

RMT.0456 is scheduled in RMP 2013-16 to be initiated in 2012 with ETSO-2C153 to be published two years later.

ETSOs of the series '2C' are different from the corresponding FAA ones, which could lead to controversy.

The Agency therefore deemed it appropriate to compile this concept paper to explain why ETSO-2C153 should depart from the corresponding FAA TSO-C153, with the objective of obtaining endorsement of the proposed approach by AGNA and SSCC, before developing the related NPA.

2 Description of the issue

2.1 Identification of the issue

Integrated Modular Avionics (IMA) is a shared set of flexible, reusable and interoperable hardware and software resources that, when integrated, form a 'system' that provides computing resources and services, designed and verified to a defined set of functional, safety and performance requirements, to host applications performing aircraft functions.

When an IMA is installed in aircraft, a conventional set of Line Replaceable Units (LRUs) (e.g., sensors, actuators, displays) is used and is in charge of providing/receiving the information coming from the IMA System software applications. Furthermore, a Communication Network is designed and is the primary means of data communication between IMA Platforms and LRUs.

IMA architecture integrates many aircraft functions on the same platform or other hardware (e.g. Integrated Avionics Display), provided by several hosted applications that historically have been contained in functionally and physically separated 'boxes' or LRUs.

IMA platforms are composed of modules which are designed to be reusable in order to reduce development cost and occasionally facilitate certification programmes. Some platforms provide only mechanical, possibly cooling and electrical power supply functions. Others include core software and associated computing capabilities.

The IMA modules are usually both generic and configurable, and the same platform could therefore be used on different aircraft models.

As per Eurocae standard ED-124 (equivalent to the RTCA standard DO-297), the following definitions are applicable:

- Aircraft Function: the capability of the aircraft that may be provided by the hardware and the software of the systems on the aircraft;
- Application: software and/or application-specific hardware with a defined set of interfaces that, when integrated with the platform, performs a function;

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- Component: a self-contained hardware, software part, database or combination thereof that is configuration controlled. A component does not provide an aircraft function by itself;
- Core Software: the operating system and support software that manage IT resources to provide an environment in which applications are executed. Core Software is a necessary component of the platform which typically consists of one or more modules;
- IMA System: consists of (an) IMA platform(s) and a defined set of hosted applications;
- Incremental acceptance: A process for obtaining credit towards approval and certification by accepting or finding that an IMA module, application, and/or off-aircraft IMA system complies with specific requirements. This incremental acceptance is divided into tasks. Credit granted for individual tasks contributes to the overall certification goal. Incremental acceptance provides the ability to integrate and to accept new applications and/or modules in an IMA system and to maintain existing applications and/or modules without the need for reacceptance;
- Interoperable: The capability of several integrated modules to operate together to accomplish a specific goal or function. This requires defined interface boundaries between the modules and allows the use of other interoperable components. To describe this concept in physical terms, an IMA platform may include interoperable modules and components, such as physical devices (processor, memory, electrical power, Input/Output (I/O) devices), and logical elements, such as an operating system, and communication software;
- Module: A component or collection of components that may be accepted by themselves or in the context of IMA. A module may also comprise other modules. A module may be software, hardware, or a combination of hardware and software, which provides resources to the IMA-hosted applications. Modules may be distributed across the aircraft or may be co-located;
- Platform: Module or group of modules, including core software, which manages resources in a manner sufficient to support at least one application. IMA hardware resources and core software are designed and managed in a way that provides computational, communication and interface capabilities for hosting at least one application. Platforms by themselves do not provide any aircraft functionality. The IMA platform may be accepted independently of hosted applications.

Currently the FAA and EASA approval processes for IMA substantially differ:

- The FAA issues authorisations to IMA hardware platform modules (no software; no MPS; only limited hardware environmental qualification), which allow US manufacturers to dispatch those platforms all around the world with a declaration of conformity with the specifications, although very limited, contained in TSO-C153;
- The Agency cannot issue similar authorisations in the absence of a specific ETSO on IMA;
- The approval at aircraft level is issued by the FAA in two stages: first, a letter of acceptance for aircraft specific IMA installation, based on AC 20-170 and then a (S)TC;
- The Agency's certification process is heavier, since only limited credit for previously applied IMA platforms can be granted in the absence of an ETSOA;
- Furthermore, the Agency's approval process at aircraft level is largely based on CRIs, which are not public documents that industry could consult during the early phases of respective projects.

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These different processes are summarised in Figure 1 below:

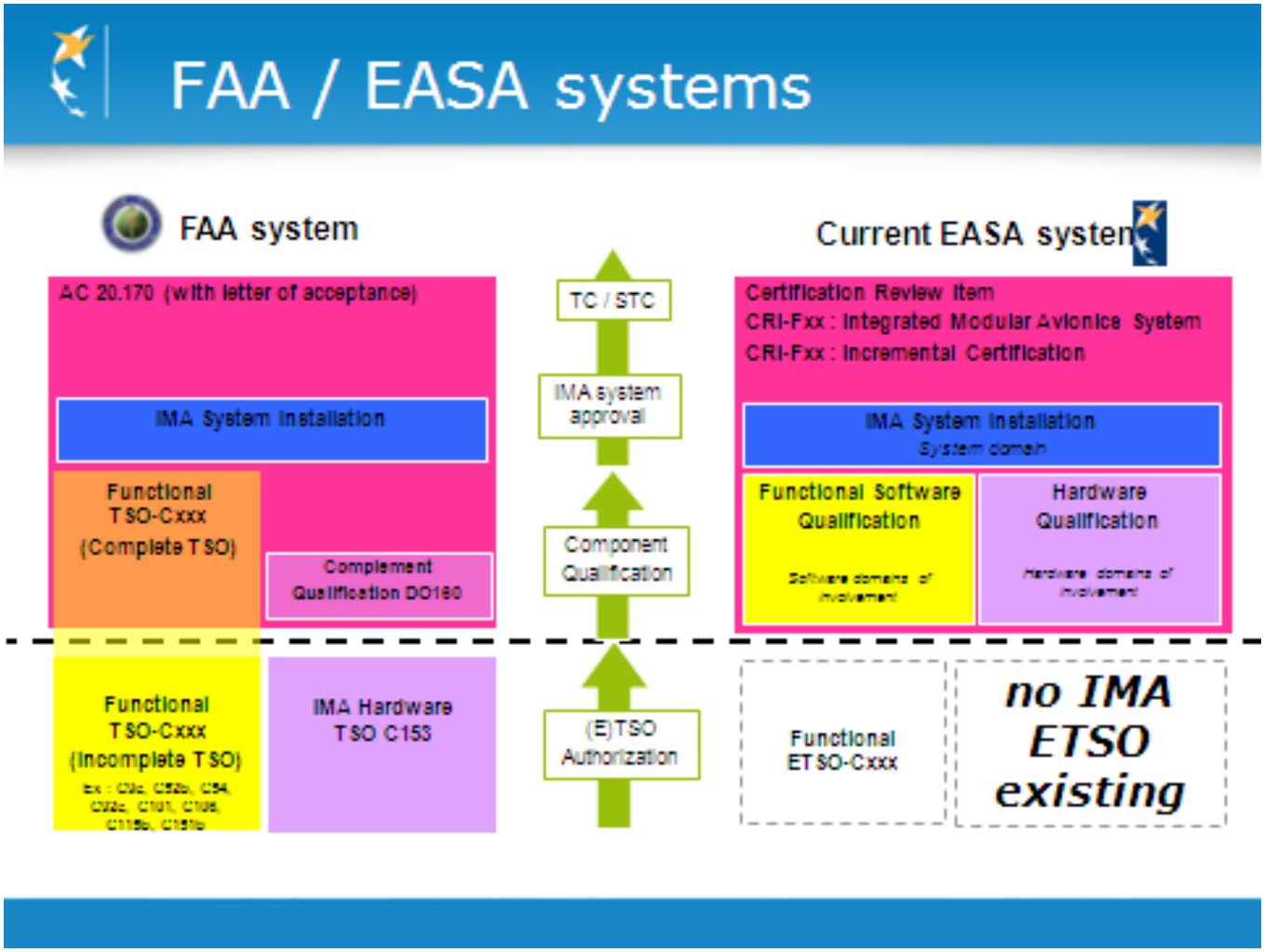

Figure 1: different processes for IMA in FAA and Agency

The preliminary Regulatory Impact Assessment (pre-RIA) on RMT.0456 clearly demonstrated the benefits of issuing an Agency ETSO on IMA: i.e. reduction of the burden for certification at aircraft level and possibility for EU industry to compete on a level playing field world-wide.

However, further decisions need to be taken on whether the proposed EASA ETSO should be identical to the corresponding FAA one (i.e. ETSO-C153 in index 1 of CS-ETSO) or whether some differences with respect to the corresponding FAA one should be introduced (i.e. ETSO-2C153 in index 2 of CS-ETSO).

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2.2 Objective

The objectives are to ensure a cost-efficient and transparent certification process allowing a level playing field for European manufacturers when competing with manufacturers from other continents.

2.3 Identification of the possible options

The Agency considers that FAA TSO-C153 has a very limited scope (i.e. only hardware; no MPS; limited environmental qualification of hardware). Therefore, a more comprehensive ETSO-2C153 may be needed.

This possible ETSO-2C153 could provide the minimum requirements for IMA platform modules which are parts designed to compose an IMA platform in order to allow identification with the envisioned 2C153 ETSO marking.

Each IMA platform module could be considered as a Line Removable Module (LRM) Part according to Part-21.

ETSO-2C153 could identify several basic types of IMA platform modules or MPS classes. Some classes would provide only mechanical, possibly cooling and electrical power supply functions. For each MPS class, the Minimum Performance Specification (MPS) could be the minimum post-conditions to be guaranteed by the ETSO holder. As a minimum, the following classes are envisaged:

- TYPE A: Mechanical rack module;
- TYPE B: Application (Hosting) Computing module;
- TYPE C: Data Storage module;
- TYPE D: Communication module;
- TYPE E: Cooling module;
- TYPE F: Power Supply module.

Depending on the IMA platform architecture, some candidate Part Numbers can be compliant with several TYPE definitions.

- *Example n°1: a Computing and Input/Output Module racked into a cabinet is a TYPE B + TYPE D module*
- *Example n°2: a standalone (this means with its own packaging and dedicated power supply) Computing and Input/Output Module is a TYPE A + B + D + F module.*

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A possible example of IMA architecture is presented in Figure 2:

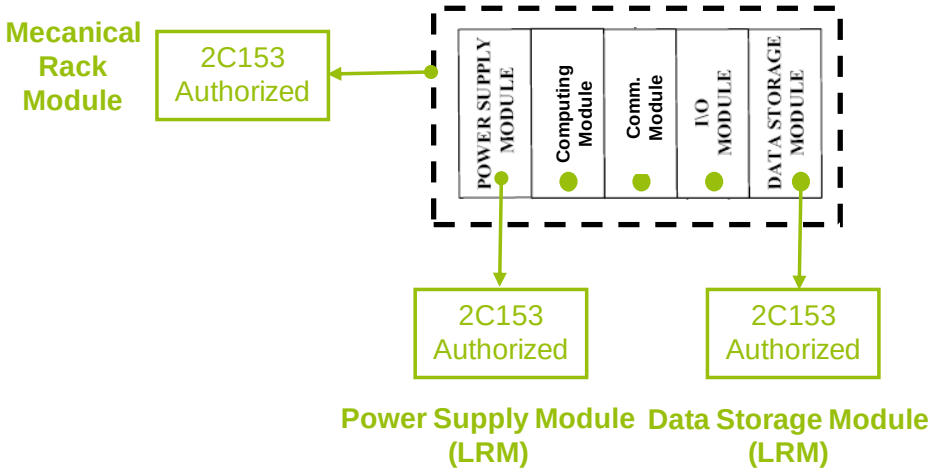

Figure 2: example of IMA platform architecture

The development, integration and qualification of hosted applications would not be covered by ETSO-2C153 Authorisation, but will be part of the [S]TC process or a further application for ETSOA based on a published functional ETSO (e.g. autopilot) authorisation.

The ETSO-2C153 Authorisation could be based on the principle of certification credit obtained using the *'incremental certification process',* which has already been applied by the Agency during the airworthiness approval of IMA systems for a [S]TC, based on Eurocae ED-124 and the dedicated Certification Review Item (CRI).

The *'incremental certification process'* is the process to certify aircraft systems embedding digital equipment for which the Agency agrees to grant some certification credit for the pre-qualified component/module, before that module is configured and integrated in the aircraft system.

Until now, the certification credit granted has been limited to a specific aircraft type certification (TC), or to a subsequent aircraft level certification of a system modification (MOD). There is currently no means to benefit from the certification credit granted within a S(TC) in the frame of another product certification project.

The objective of an ETSO-2C153 Authorisation is therefore to approve an IMA platform module independently of a [S]TC.

The ETSO-2C153 to be drafted could contain Minimum Performance Specification (MPS) and installation constraints:

- for each module type, the Minimum Performance Specification (MPS) could be the minimum post-conditions to be guaranteed by the ETSO applicant to the end users (application developers and the [S]TC applicant);
- the installation constraints of one IMA Platform Module Part Number could be specified by the ETSO applicant as the exhaustive list of pre-conditions to be respected by application developers and the [S]TC applicant to obtain the certification credit, including requirements that are necessary to confirm that the usage domain is ensured;
- the guaranteed post-conditions of one IMA Platform Module Part Number could be declared in its Declaration of Design and Performance (DDP) or in technical annexes such as a User guide or Datasheet.

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The possible scope of the ETSOA is presented in Figure 3:

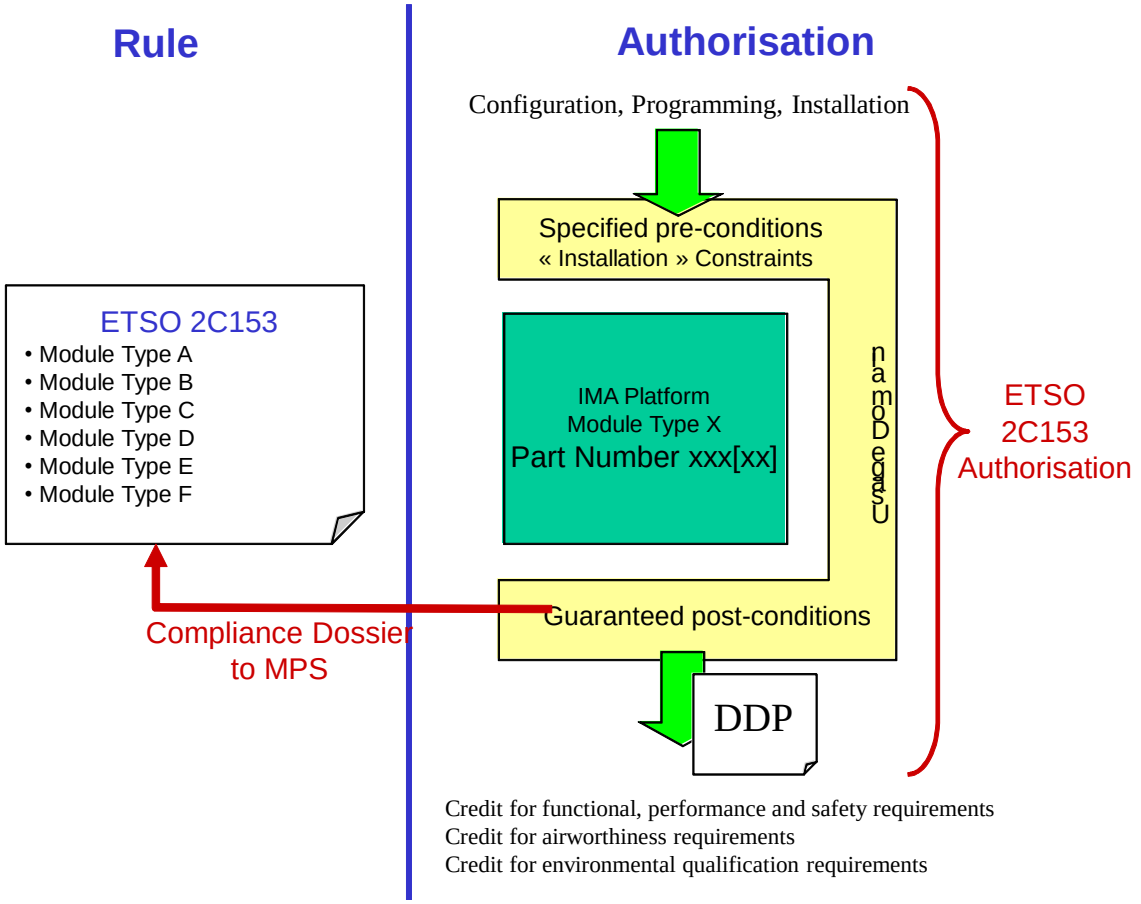

Figure 3: possible scope of the ETSOA-2C153

Based on the above considerations, the following five options have been identified:

Table 1: Possible options

Option	Description
1	**'Copy and paste'** FAA TSO-C153 into ETSO-C153 in index 1 of CS-ETSO (i.e. only hardware; no MPS; limited environmental qualification)
2	Transpose (with differences) FAA TSO-C153 into ETSO-2C153 in index 2 of CS-ETSO to encompass possible modules of core **software**; still no MPS and limited environmental qualification
3	Transpose (with differences) FAA TSO-C153 into ETSO-2C153 in index 2 of CS-ETSO to encompass possible modules of core **software.** Concerns detected by EASA into TSO C153 'Environmental Conditions' requirements section would be more detailed; still no MPS
4	As 3 plus **MPS**
5	As 4 and with the ETSOA covering not only the IMA platform, but also at least one function at aircraft level (e.g. autopilot).

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2.4 Analysis of impacts for the possible options

All identified impacts are qualitatively assessed and expressed in terms of a score = a numerical single digit from –3 (highly negative) to +3 (highly positive).

Safety scores, since safety is the primary objective of the Agency as per Article 2 of the Basic Regulation, are assigned a 'weight' of 3. Environmental scores, based on the same article, have a weight of 2. Other scores have a weight of 1.

2.4.1 Safety impact

In any case all IMA platform modules, integrated aircraft functions, integration into the avionics system and installation on board, would be assessed before issuing any (S)TC.

All the proposed options are hence neutral in safety terms.

2.4.2 Environmental impact

IMAs not only allow more flexibility and greater integration of on-board system, but they also allow the total weight and volume of avionics to be reduced.

However, most probably any reduction of the weight and volume of avionics would be exploited to accommodate more payloads on a given airframe.

In conclusion, all the proposed options are neutral from the environmental perspective (both noise and emissions).

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2.4.3 Social impact

Options	1	2	3	4	5
	'copy and paste' TSO-C153	**TSO-C153 plus SW modules**	**As 2 plus ENV qualification**	**As 3 plus MPS**	**ETSOA covering at least one aircraft function**
Assessment	Allows EU industry to compete on a level playing field with US manufacturers in the global market and therefore maintains (or creates) high quality jobs	As 1, but with the additional advantage of offering to potential customers more 'credit' (= fewer activities required at aircraft level). EU industry becomes more competitive and therefore able to create high quality jobs	As 2	Even better than 2, for the same reasons	Removes flexibility for marketing IMA, since software for aircraft functions is aircraft specific. No possibility of ETSOA only for the IMA platform, which reduces competition and may destroy high quality jobs
Score (un-weighted)	1	2	2	3	-2
Weight	Multiply the un-weighted score by: 1				
Score (weighted)	**1**	**2**	**2**	**3**	**-2**

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2.4.4 Economic impact

Options	1	2	3	4	5
	'copy and paste' TSO-C153	**TSO-C153 plus SW modules**	**As 2 plus ENV qualification**	**As 3 plus MPS**	**ETSOA covering at least one aircraft function**
Assessment	Burden on (S)TC applicants to complete environmental qualification, to specify MPS and to demonstrate safe integration of core software	Burden on (S)TC applicants to complete environmental qualification and to specify MPS	Burden on (S)TC applicants to specify MPS	ETSOA holder provides to (S)TC applicants complete environmental qualification and demonstration of safe integration of core software to specified MPS	ETSOA invalidated (i.e. major change) any time a new aircraft function is added to an IMA platform, removed or modified
Score (un-weighted)	-3	-2	-1	3	-2
Weight	Multiply the un-weighted score by: 1				
Score (weighted)	**-3**	**-2**	**-1**	**3**	**-2**

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2.4.5 Proportionality issues

Options	1	2	3	4	5
	'copy and paste' TSO-C153	**TSO-C153 plus SW modules**	**As 2 plus ENV qualification**	**As 3 plus MPS**	**ETSOA covering at least one aircraft function**
Assessment	Not much interest for Small Medium-sized Enterprises (SMEs) to manufacture only hardware	Potential interest for SMEs to deliver hardware with software, or even only software modules, which can have their own ETSOA per Art. 3(d) of Basic Regulation	As 2	As 2	Very difficult for SMEs to develop software for aircraft functions
Score (un-weighted)	-1	2	2	2	-2
Weight	Multiply the un-weighted score by: 1				
Score (weighted)	**-1**	**2**	**2**	**2**	**-2**

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2.4.6 Impact on regulatory coordination and harmonisation

Options	1	2	3	4	5
	'copy and paste' TSO-C153	**TSO-C153 plus SW modules**	**As 2 plus ENV qualification**	**As 3 plus MPS**	**ETSOA covering at least one aircraft function**
Assessment	Complete harmonisation of technical requirements with the FAA. ETSO-C153 in index 1 of CS-ETSO	Technical content not contrasting with FAA TSO-C153, but more comprehensive. ETSO-2C153 in index 2 of CS-ETSO Possible validation of ETSOA by FAA without much additional activity Additional demonstrations required by Agency to validate FAA TSOAs	As 2	As 2	Contrasts with the principle of 'incremental certification', since it does not allow ETSOA only for the IMA platform
Score (un-weighted)	3	1	1	1	-3
Weight	Multiply the un-weighted score by: 1				
Score (weighted)	3	1	1	1	-3

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2.4.7 Impact on existing organisations including the Agency

Options	1	2	3	4	5
	'copy and paste' TSO-C153	**TSO-C153 plus SW modules**	**As 2 plus ENV qualification**	**As 3 plus MPS**	**ETSOA covering at least one aircraft function**
Assessment	Manufacturers usually design and test their IMA platforms including the embedded core software modules Part of this verification activity may not fully benefit customers in case of this option	Takes advantage of any software development assurance activity carried out by IMA manufacturers	As 2, but also for complete environmental qualification, for which ETSOA holders are normally equipped	As 3, but in addition also providing clear guidelines to IMA manufacturers to design their products against clear MPS	More cumbersome procedures since ETSOA invalidated (i.e. major change) any time a new aircraft function is added to an IMA platform, removed or modified
Score (un-weighted)	-2	1	2	3	-3
Weight	Multiply the un-weighted score by: 1				
Score (weighted)	**-2**	**1**	**2**	**3**	**-3**

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3 Conclusion

Using the Multi-Criteria Analysis (MCA) methodology, the 'weighted' scores assigned above are algebraically summed:

Options	1	2	3	4	5
	'copy and paste' TSO-C153	TSO-C153 plus SW modules	As 2 plus ENV qualification	As 3 plus MPS	ETSOA covering at least one aircraft function
	Weighted score				
Safety	0	0	0	0	0
Environment	0	0	0	0	0
Social impact	1	2	2	3	-2
Economic impact	-3	-2	-1	3	-2
Proportionality	-1	2	2	2	-2
Regulatory harmonisation	3	1	1	1	-3
Impact on organisations	-2	1	2	3	-3
TOTAL	**-2**	**4**	**6**	**12**	**-12**

Options 1 ('copy and paste TSO-C153') and 5 (i.e. ETSOA covering at least one aircraft function) have total negative scores, although being neutral (as all other options) in terms of safety.

Options 2 (i.e. core software modules in the scope of ETSOA) and 3 (i.e. include also complete environmental qualification) have a moderately positive total score, but they are both negative from the economic perspective.

Only option 4 (i.e. include also MPS in ETSO-2C153) has not only the highest total score, but it is positive from any perspective, excluding safety and environmental impact, for which it is neutral as any other option.

Therefore, Option 4 (i.e. include in the scope of ETSO-2C153 IMA hardware, core software modules related MPS and complete environmental qualification) is the preferred one.

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