

ICAO STANDARDIZATION ROADMAP CONCEPT

1. BACKGROUND

1.1 The 41st Session of the ICAO Assembly endorsed “the priorities of ICAO on the promotion of innovation in aviation in support of the ICAO Strategic Objectives and of the ICAO Member States, including the development of a regulatory roadmap building upon and consistent with ICAO's existing work...” (paragraph 23.6 a of Doc 10183, Report of the Executive Committee refers).

1.2 During its 229th Session, the Council invited the Air Navigation Commission to formalize a proposal for the conceptualization and deployment of a Standardization Roadmap, based on the principles developed by the ANC Ad Hoc Working Group on Innovation and subsequently presented to the SGI (C-DEC 229/5 refers).

1.3 The Council noted that the scope of the first iteration of the Standardization Roadmap would be dedicated to, inter alia, the aircraft and engine technologies identified in the work associated with the Long-Term Aspiration Goal (LTAG), and that the methodology developed for this purpose would then be applied to other aspects of the LTAG work, and ultimately to other Strategic Objectives.

1.4 The Council also agreed that the Standardization Roadmap should capture all technological and process innovations in support of the ICAO Strategic Objectives, with a view to supporting the effective planning and resource management of the Organization, while also providing greater certainty and predictability to the industry regarding the timely development of the relevant Standards and Recommended Practices (SARPs).

1.5 The Standardization Roadmap and its associated process do not alter the existing ICAO Standard-setting processes. In publishing information on the Standardization Roadmap, it should be understood that this does not represent any form of commitment by ICAO.

1.6 The Council endorsed this concept at its sixth meeting of its 233th Session (C-DEC 233/6 refers).

2. DEFINITION OF THE STANDARDIZATION ROADMAP

2.1 The Standardization Roadmap (also hereafter referred as the “Roadmap”) is a rolling timeline which represents ICAO’s assessment of innovative technologies and processes at different levels of maturity that contribute to the Organization’s mandate.

3. OBJECTIVES AND SCOPE

3.1 The objectives of the Roadmap are that it will:

- a) serve as a means of collecting information on innovations to enable forward-planning with respect to ICAO’s mandate;
- b) provide a dynamic view of expectations in terms of the innovators’ timelines for new technologies, processes and operational innovations, with regard to their maturity as well as their anticipated dates for entry into service; and

- c) provide a clear picture, across all disciplines, of where and when new provisions might be needed to enable those innovations to be implemented in a safe and globally harmonized manner.

3.2 Consistent with the tasking by the Council, the scope of the Roadmap will initially, cover the aircraft and engine technologies, as well as the technological and process innovations identified in the work associated with the achievement of ICAO's LTAG. Subsequently, it will include all innovations relevant to ICAO.

4. **PRINCIPLES**

4.1 The principles of the Roadmap and associated process include:

- a) Transparency: this applies to the decision-making process, the consultation process and the dissemination of information on the work on innovation.
- b) Independence and neutrality: any decision made within the context of this Roadmap and related process, shall be in the collective interest of all ICAO Member States.
- c) Effectiveness: the process developed should focus on fulfilling the identified purpose(s).
- d) Efficiency: synergies with existing ICAO processes and mechanisms should be identified and leveraged upon.
- e) Equity and inclusivity: the application of the process shall be fair, open and impartial to all stakeholders, and,
- f) Adaptability: the roadmap and associated process should be able to efficiently adapt to changes to the scope of the Roadmap.

5. **ENTITIES THAT CAN SUBMIT INNOVATIONS**

5.1 The following entities can submit applications for innovations to be considered for entry onto the Roadmap:

- a) ICAO Member States; and
- b) International organizations on the *List of International Organizations that may be invited to attend suitable ICAO Meetings*.

5.2 In addition, recognizing that there needs to be a mechanism for innovators and startups to submit innovations, and they may not necessarily be members of international organizations, information will be provided on the Innovation portal about how they may engage with either Member States or international organizations to be able to submit an application for their innovation to be included on the Roadmap.

6. **ROLES AND RESPONSIBILITIES**

6.1 The following table outlines the roles and responsibilities of the various stakeholders.

Note.— these roles and responsibilities supplement, and do not alter any of the existing roles and responsibilities of the listed entities.

Entity	Roles and Responsibilities
Council	Endorses the Standardization Roadmap concept and the associated process.
ANC	- Conceptualizes the Standardization Roadmap and associated process. - Reviews the status of innovations in the roadmap at each gate, and decide on actions to be taken as appropriate. - Oversees the implementation of the process associated with the Standardization Roadmap. - Amends the process as necessary. - Updates the Council as required.
Innovator	Provides the submitting entity with the required information to be submitted to ICAO for evaluation and possible inclusion in the Standardization Roadmap.
Submitting Entity	Makes the formal submission and provides timely updates to ICAO.
Expert Group	Performs evaluations, as assigned by the ANC, and provide recommendations based on their assessment to the ANC.
Secretariat	- Implements the process (including liaising with submitting entities, the ANC and expert groups as appropriate, updating the database and online tools). - Performs an initial assessment according to the Gate process (described in paragraph 7), and makes an initial recommendation to the ANC. - Liaises with innovators and submitting entities on various inputs required by the process

7. **GATE PROCESS**

7.1 The gate process, comprising of three gates, is the mechanism aiming to identify innovative technologies and processes presented to ICAO, ascertain the level of maturity and validate their global suitability. This should allow ICAO to determine when the various aspects of the Standard-setting processes could commence, and the resulting resource requirements; helping to facilitate the timely availability of provisions (Standards, Recommended Practices, Procedures for Air Navigation Services (PANS) or guidance materials), as necessary. The resulting Roadmap of the proposed timelines for the entry into service of such innovations would also provide the global community with a clearer view of the progress of these innovations.

7.2 The principles related to the gate process are as follows:

- a) the gate process is repeatable and administered consistently;
- b) the gate process is a complementary process to the existing ICAO processes; and
- c) the gate process captures innovations of global suitability.

7.3 Global suitability means that the proposed innovations are suitable to enable the development of globally applicable provisions that will be technology neutral and serve the interests of the global civil aviation system. These innovations must also support interoperability and harmonized implementation worldwide. Innovations with limited applicability (such in the scope of local/regional or of limited purpose) should not be favoured for inclusion in the Standardization Roadmap.

7.4 Each gate is a point of assessment where each developing innovation can be evaluated against a set of criteria. The information gathered on each innovation is used to build a clear and dynamic picture of timelines for innovative technologies and processes.

7.5 Evaluation against the criteria at each gate will be re-evaluated as the innovation passes through subsequent gates to confirm that they continue to meet the criteria required for the previous gate(s) to ensure there are no gaps.

7.6 As there may be cases when innovations are submitted to ICAO at different levels of maturity, all items must be evaluated against all relevant requirements of previous gates even if their maturity level qualifies them for subsequent gates. This is to ensure that all the pertinent information is collected, and all relevant evaluations are undertaken in a consistent manner.

8. **GATE 1**

8.1 Purpose of Gate 1

- a) To ensure that the submission merits inclusion into the Roadmap for monitoring purpose.

8.2 Criteria:

- a) The innovation fits the current scope of the Roadmap.
- b) The innovation demonstrates potential for global suitability.

- c) Innovation is under development; and is undergoing testing or prototyping in a relevant environment as applicable. For a technology, this is the equivalent of Technology Readiness Level (TRL) 5 (Attachment B refers).
- d) Timeframe for entry into service is understood. The submitting entity should be able to provide timeframe for planned rollout and certification, if applicable.

Note. — An initial assessment, conducted by the Secretariat will serve as the basis for the ANC to agree with the inclusion (passing of Gate 1) of the innovation in the Roadmap (see Attachment A for more details).

9. **GATE 2**

9.1 Purpose of Gate 2

- a) To confirm the developing innovation has reached a sufficient level of maturity to warrant further consideration by ICAO; particularly, whether amendments to, or development of provisions and/or amendments to the Global Plans will be needed.

9.2 Criteria:

- a) The innovation has fulfilled or continues to fulfill the criteria defined for Gate 1.
- b) The innovation demonstrates global suitability in principle.
- c) The innovation is stable in design, and under testing and/or validation. This may include flight testing, in a relevant environment, or as a component bench test for avionics equipment etc., as applicable. For a proposed procedural change, the new process has completed a proof-of-concept trial. For new technology proposals, this is the equivalent of TRL6.
- d) Timeframe for certification, if applicable, and entry into service is demonstrated. Information might include an approved certification plan, operational trial, etc. Information to assess the level of maturity as defined in the Global Air Navigation Plan (GANP) should also be provided by the submitting entity.
- e) The extent that the innovation is compatible with ICAO global plans, concepts, and policies, as applicable, is known.
- f) Impact on aeronautical frequency spectrum usage, if applicable, is compatible with ICAO related strategies.

Note. — A preliminary gap analysis (high level) against the provisions and/or to the Global Plans presented by the submitting entity must provide sufficient information to be evaluated by designated Expert group(s) for their recommendations to the ANC (see Attachment A for more details).

10. **GATE 3**

10.1 Purpose of Gate 3:

- a) To confirm the innovation has reached an adequate level of maturity to require further consideration by ICAO; particularly, whether or not amendments to, or development of provisions may still be required.

10.2 Criteria:

- a) Continues to fulfil the criteria defined for Gates 1 and 2.
- b) The innovation demonstrates global suitability.
- c) For technology and systems, a prototype demonstration in an appropriate operational environment has been completed (equivalent of TRL7).
- d) For operational changes, the new process has been satisfactorily tested in a real-world environment.
- e) Certification and/or other approvals, if needed, are underway, for example test flight approval or equivalent.

Note. — A detailed Gap Analysis presented by the submitting entity on relevant ICAO Provisions must provide sufficient information to be evaluated by designated Expert group(s) for their recommendations to the ANC (see Attachment A for more details).

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ATTACHMENT A

OVERVIEW OF THE GATE PROCESS MECHANISM

This attachment presents the overall mechanism including actions to be taken by key stakeholders associated with the various functions of the Gate process.

ANC REVIEW AND GATE FUNCTIONS

The ANC reviews the overall status of the Roadmap on an annual basis. This could take place concurrently to the annual review of the AN work programme or whenever the ANC deems suitable. The following apply for an innovation to pass each gate:

- a) Gate 1: Upon review of the initial assessment performed by the Secretariat, the ANC agrees/disagrees with the inclusion (passing of Gate 1) of the innovation in the Roadmap, to be further monitored by ICAO.
- b) Gate 2: the ANC reviews the outcome of the preliminary gap analysis and designates expert group(s) (such as GANP SG, ANC panels and other groups as appropriate) to further evaluate the submission and to closely monitor the evolution of the innovation. Independently from the Roadmap, existing processes and procedures apply for new inclusion in Global Plans and ICAO work programme.
- c) Gate 3: The ANC should perform the review of innovations proposed for assessment at Gate 3 as soon as practical. Following the assessment of the detailed gap analysis by designated expert group(s), the ANC will decide whether the innovation has met the criteria for passing Gate 3 and consider further actions as it sees fit. Existing processes and procedures will be applied for the inclusion of the innovation into the AN work programme if necessary.

Note.— In all the above instances, details of the innovation(s) should be kept in a database by the ICAO Secretariat. The information in the database should also be regularly updated, through the submitting entities.

1. GATE 1

	Stakeholder	Actions
Step 1	Submitting Entity	The entity (State or international organization) proposing the innovation completes and submits to ICAO, through the “normal” communication channel (i.e., the Secretary General) with a description of the innovation under development, a self-assessment against the criteria for Gate 1, estimated dates of entry into service, and including a description of how the innovation is of global suitability, any other appropriate supporting information such as details of prototyping status, the outcome of research and development, etc. and/or any complementary work by an international Standards Making Organizations (SMO).

	Stakeholder	Actions
Step 2	Secretariat	Initial assessment of the submission: a) checks for completeness; b) enters details into a database; c) checks to see if the type/category of innovation is already captured as part of the Global Plans or covered by existing job cards; and d) submits a report on the initial assessment to the ANC for consideration before publication on the Roadmap.
Step 3	ANC	Assess the report on submission produced by the Secretariat (in Step 2) and determine if it meets the criteria by taking on the following options: a) indicate that entry has passed Gate 1; b) if deferred (due to insufficient maturity), the status remains as “Before Gate 1” with a statement of why it was deferred; and c) if the determination is made that it is not in scope, then the status is set as “No further action required by ICAO”.

2. GATE 2

Step 4	Submitting Entity	The submitting entity provides: a) a preliminary gap analysis of likely impacts to ICAO provisions; b) an outline Concept of Operations; and c) a high-level self-assessment of likely impact on global plans ¹ .
Step 5	Secretariat	On receipt of the submission at Gate 2, the Secretariat adds: a) any interdependencies such as impacts on other Strategic Objectives, possible impacts on other parts of the aviation system and a further identification of existing job cards or activities that would be affected; b) relevant references to the Global Plans; and c) data collated regarding similar innovations/ generic innovation known to ICAO.
Step 6	ANC	Designates expert group(s) and assigns task to evaluate submission as required.
Step 7	Expert group(s)	Evaluates the submission and makes recommendations to the ANC
Step 8	ANC	a) Reviews the recommendation and, if it agrees that it has passed Gate 2, then designates the status of “Passed Gate 2”. b) If deferred (due to insufficient maturity), the status remains as “Before Gate 2” with a statement of why it was deferred. c) If the determination is made that it is not in scope, then the status is set as “No further action required by ICAO”.
Step 9	Secretariat	Informs the submitting entity of the change in status and updates the Roadmap.

¹ In anticipation of Step 6, the Secretariat may provide clarifications to the submitting entity on existing ICAO work programmes and global plans as needed.

3. GATE 3

Step 10	Submitting entity	a) The submitting entity provides evidence demonstrating that the technology or process has reached sufficient maturity for evaluation against Gate 3. b) The submitting entity should present a detailed gap analysis. c) If the initial entry is submitted straight into Gate 3, then all relevant criteria for Gates 1 and 2 will also be assessed.
Step 11	Expert group(s)	Expert group(s) designated by the ANC, if required, will assess the innovation update and the detailed gap analysis and submit their recommendations to the ANC regarding the ICAO work programme.
Step 12	ANC	The ANC reviews the submission and the recommendations provided by expert group(s) and decides whether or not the innovation passes Gate 3. Based on the outcome, but independently from the Gate process, the ANC may take appropriate actions with respect to the AN work programme.
Step 13	Secretariat	The Secretariat: a) informs the submitting entity on the outcome of the ANC review; b) updates the Roadmap and implement ANC's decision as required.

ATTACHMENT B**TECHNOLOGY READINESS LEVELS (TRL) AND GANP MATURITY LEVELS**

Note. — These Technology Readiness Levels (TRLs) are provided on a provisional basis and will be amended based on the initial application of the roadmap.

Technology readiness levels			Some explanatory notes from: https://ised-isde.canada.ca/site/innovation-canada/en/technology-readiness-levels
Research	TRL 1	Basic principles observed	Scientific research begins to be translated into applied research and development. Activities might include paper studies of a technology's basic properties.
	TRL 2	Technology concept formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Activities are limited to analytic studies.
	TRL 3	Experimental proof of concept	Active research and development is initiated. This includes analytical studies and/or laboratory studies. Activities might include components that are not yet integrated or representative.
Development	TRL 4	Technology validated in a lab	Basic technological components are integrated to establish that they will work together. Activities include integration of "ad hoc" hardware in the laboratory.
	TRL 5	Technology validated in a relevant environment	The basic technological components are integrated for testing in a simulated environment. Activities include laboratory integration of components.
	TRL 6	Technology demonstrated in a relevant environment	A model or prototype that represents a near desired configuration. Activities include testing in a simulated operational environment or laboratory.
Deployment	TRL 7	System prototype demonstration in an operational environment	Prototype at planned operational level and is ready for demonstration in an operational environment. Activities include prototype field testing.
	TRL 8	System complete and qualified	Technology has been proven to work in its final form and under expected conditions. Activities include developmental testing and evaluation of whether it will meet operational requirements.
	TRL 9	Actual system proven in an operational environment	Actual application of the technology in its final form and under real-life conditions, such as those encountered in operational tests and evaluations. Activities include using the innovation under operational conditions.

GANP maturity levels	
Concept	This maturity level focuses on exploratory research and includes scientific research, investigation of basic principles observed and reported and definition of the concept.
Validation	This maturity level focuses on industrial research and validation and includes proof of concept validation, standalone prototyping implementation and test, testing and prototyping in representative environment and the full engineering demonstration in actual system validation.
Standardization	This maturity level focuses on the definition of provisions necessary for the interoperability of systems and the harmonization of procedures.
Ready for implementation	This maturity level focuses on the end of system development and the initial operational capability at a global level.

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ATTACHMENT C**TEMPLATE FOR ENTRIES****Information provided by the Submitting Entity**

The Submitting Entity (State/s or International Organization/s recognized by ICAO) should complete all boxes below with as much detail as required to enable ICAO to make an assessment of the maturity and global suitability of the innovation.

Information below to be provided by the Submitting Entity when the innovation meets the criteria for Gate 1

ID	Item	
	<i>Note – all references are to the paragraphs in the main document</i>	
G1-1	Submitting Entity (Ref: paragraph 5)	<i>This should be an ICAO Member State or an international organization approved by ICAO</i>
G1-2	Provide a detailed description of the innovation	
G1-3	Indicate how the innovation contributes to the ICAO strategic objectives e.g. LTAG (Ref: paragraph 8.2 a))	
G1-4	Describe the global benefits and suitability of this innovation (Ref: paragraph 8.2 b))	
G1-5	Please provide details of the stage of development. Is the innovation under development; and is it undergoing testing or prototyping in a relevant environment as applicable. This should be supported by relevant	<i>[For a technology, this is the equivalent of Technology Readiness Level (TRL) 5]</i>

ID	Item	
	<i>Note – all references are to the paragraphs in the main document</i> documentation/ information. (Ref: paragraph 8.2 c))	
G1-6	Expected timeframe for entry into service date (Ref: paragraph 8.2 d))	<i>[Provide timeframe for planned rollout and certification, if applicable.]</i>
G1-7	Link to related work of Standard Making Organizations (SMOs)	<i>Provide a link to relevant organization website or material, accessible to ICAO. If it is not possible to provide access via a link then details of related work should be captured here.</i>
	For Internal Use Only	
G1-I-1	Does the innovation fit within the mandate of ICAO?	
G1-I-2	Is the innovation likely to be suitable for global implementation?	
G1-I-3	Does the innovation meet the criteria for Gate 1?	
G1-I-4	Other notes/remarks?	

Information below to be provided by the Submitting Entity when the innovation meets the criteria for Gate 2

G2-1	Please update or, if entering in Gate 2, provide information for questions G1-1, G1-2, G1-3, G1-4 and G1-7 (Ref: paragraph 9.2 a) and b))	
G2-2	Demonstrate that the innovation is stable in design and is undergoing testing and/or validation. Please provide details and supporting information. (Ref: paragraph 9.2 c))	<i>[This may include flight testing, in a relevant environment, or as a component bench test for avionics equipment etc., as applicable. For a proposed procedural change, provide evidence that the new process has completed a proof-of-concept trial. For new technology proposals, this is the equivalent of TRL6].</i> <i>Information to enable ICAO to assess the level of maturity (as defined in the Global Air Navigation Plan (GANP)) should also be provided by the submitting entity].</i>
G2-3	Update on the timeframe for entry into service (Ref: paragraph 9.2 d))	<i>[Information might include an approved certification plan, operational trial etc.]</i>
G2-4	Details of progress towards certification/approval, if applicable (Ref: paragraph 9.2 d))	
G2-5	Provide a high-level gap analysis (high level) against the ICAO provisions and/or to the Global Plans (Ref: paragraph 9.2 d and note)	<i>[This information may need to be provided in an attachment]</i> <i>[Information to assess the level of maturity as defined in the Global Air Navigation Plan (GANP) should also be provided]</i>
G2-6	Provide an outline Concept of Operations (Ref: paragraph 9.2 e))	

G2-7	Please describe any impact on aeronautical frequency spectrum usage, if applicable. (Ref: paragraph 9.2 f))	
	For Internal Use Only	
G2-I-1	Is the innovation still likely to be suitable for global implementation	
G2-I-2	Does the innovation meet the criteria for Gates 1 and 2	
G2-I-3	Other notes/remarks	

Information below to be provided by the Submitting Entity when the innovation meets the criteria for Gate 3

G3-1	Please update or if entering in Gate 3 provide information for questions G1-1, G1-2, G1-3, G1-4, G1-7, G2-3, G2-4 and G2-7 (Ref: paragraph 10.2 a) and b) and note)	
G3-2	Has the innovation already been implemented in an operational context? If so, please provide details and supporting information. (Ref: paragraph 10.2 c), d) and e))	<i>[For technology and systems, a prototype demonstration in an appropriate operational environment has been completed (equivalent of TRL7)</i> <i>For operational changes, the new process is being has been satisfactorily tested in a real-world environment.</i> <i>Certification and/or other approvals, if needed, are underway, for example test flight approval or equivalent]</i>

G3-3	Provide a detailed gap analysis against the ICAO provisions and/or to the Global Plans (Ref: paragraph 10.2 note)	
G3-4	Provide a detailed Concept of Operations (Ref: paragraph 10.2 note)	
	For Internal Use Only	
G3-I-1	Is the innovation still likely to be suitable for global implementation?	
G3-I-2	Does the innovation meet the criteria for all three Gates?	
G3-I-3	Other notes/remarks	

Assessments by the Secretariat

Assessments by the Secretariat at Gate 1

G1-S-1	Entry is complete?	
G1-S-2	Mapping to existing work	<i>[Indicate if the type/category of innovation is already captured as part of the Global Plans or covered by existing job cards.]</i>

Assessment by the Secretariat at Gate 2 and updated at Gate 3

G2/3-S-1	Entry is complete?	
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G2/3-S-2	Interdependencies	<i>[Indicate any interdependencies such as impacts on other Strategic Objectives, possible impacts on other parts of the aviation system and a further identification of existing job cards or activities that would be affected.]</i>
G2/3-S-3	Any other known similar innovations	<i>[Data regarding similar innovations/ generic innovation known to ICAO.]</i>

– END –