



**INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE**

Guidance for Procurement and Certification of CNS/ATM Services and Systems

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1. Introduction

1.1. Background: the need for more guidance regarding the procurement and certification of CNS/ATM services and systems

During the period 2015 to 2016, several States presented papers at various Asia/Pacific conferences and meetings about their following difficulties encountered as buyers and sellers of CNS/ATM systems:-

(A) Buyers of CNS/ATM systems

- Lack of expertise to certify that new CNS/ATM systems comply with ICAO SARPs in current background of Safety Management System (SMS), Safety Oversight Audit (SOA) and Continuous Monitoring Approach (CMA); and
- Lack of information about how innovative ways of procurement could help to overcome some of the constraints faced by ANSP in buying and commissioning new CNS/ATM systems, complying with ICAO standards.

(B) Sellers of CNS/ATM systems

- Lack of internationally recognized certification and development guidance and procedures for CNS/ATM systems. Availability of such guidance and procedures could lead to international acceptance, resulting in time and cost savings.

APANPIRG/27 meeting in September 2017 had a Conclusion to have a Workshop to share experience and best practices as well as formulate guidance on development and certification procedures for CNS/ATM systems. As a result, a Workshop was held on morning of 17 July 2017 at the ICAO APAC Regional Office before start of the CNS/21/SG meeting.

1.2. Scope and objectives of the document

This document deals with the procurement and certification of CNS/ATM systems and aims to provide guidance to States regarding:-

- (a) Procurement and commissioning of new CNS/ATM systems, complying with ICAO standards; and
- (b) Certification and development guidance and procedures for CNS/ATM systems.

1.3. Structure of the document

Further to the background and objectives exposed in the chapter 1Chapter 2 introduces how national regulations and procedures constitute the framework for any procurement or certification activities, and how to re-use evidences, when available, of acceptance, certification or effective surveillance in the regulatory context of the procuring/recipient State. It also addresses the specific case of a gift or donation between Member States.

Chapter 3 addresses the major elements of a procurement strategy, including e-procurement, benchmarking, and as required, the need for assistance with procurement or certification activities, and on how to best execute the contract once signed off.

Chapter 4 further elaborates on liability and intellectual property rights.



To go deeper

*In some of the paragraphs of this document, the mention “**To go deeper**” proposes further guidance for subject matter experts. These guidelines can be skipped if one is not a technical expert in the area and consults this guidance from the perspective of procurement or certification processes only.*

1.4 Consultation with airlines

According to the ICAO’s policies on charges for airports and air navigation facilities and services (ICAO Doc 9082), its Section III Paragraph 10 states that “providers for air navigation services for international use may require all users to pay their share of the cost of providing them such services regardless of whether or not the utilization takes place over the territory of the provider State.” The procurement of CNS/ATM of systems for supporting air navigation services would incur both capital and recurrent expenditure. For those Civil Aviation Authorities (CAAs) or Air Navigation Service Providers (ANSPs) who adopt the user-pay principle of recovering cost arising from procurement of the CNS/ATM systems from the users, it is required to consult the users (i.e. airlines) prior to making any procurement decisions in accordance with the ICAO’s key charging principles of non-discrimination, cost-relatedness, transparency and consultant with users as stated in ICAO Doc 9082.

1.5 Other documents of interest

In 2008, a guidance material was developed under an initiative of the Regional Airspace Safety Monitoring Advisory Group (RASMAG) of the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to assist air navigation service providers (ANSP) with the implementation of

data link-based air traffic management (ATM) systems. The material was adopted as Asia/Pacific regional guidance material by APANPIRG/18 (3-7 September 2007) under the provisions of Conclusion 18/5. The RASMAG retains editorial responsibility for the document.

The document can be found at
https://www.icao.int/APAC/Documents/edocs/ads_cpdlc_didc_ver2.pdf

Of particular interest are the chapters 2 – Procurement and 3 – Implementation as both chapters address procurement and implementation processes of ATM systems in a fashion that is not specific to the datalink services. These chapters are therefore relevant for those States/ANSP willing to procure systems or services in general.

Another useful document relating to the implementation of the APAC Seamless ATM objectives is the ICAO Asia/Pacific Seamless ATM Implementation Guidance Material which can be found here:

<https://www.icao.int/APAC/Documents/edocs/Seamless%20ATM%20Implementation%20Guidance%20v5-0.pdf>

In particular, the table 2 Implementation Matrix details the different stages of a sound implementation process as follows:

Stage Number	Action A	Action B	Action C	Action D	Action E	Action F
1. PROJECT PLANNING	Identify the problem or improvement required	Assess applicability to operating environment and State regulations	Gather and review data related to the desired change	Assess economic feasibility and cost/benefit	Start the project, determine project budget and milestones	Plan tendering and maintenance contract process
2. DESIGN	Determine initial design of the desired change, including alternatives	Determine Key Performance Indicators and/or success criteria	Design backup and transition procedures/ steps, including reversion	Determine maintenance considerations	Refine and agree on final design	Define system validation and verification (FAT, SAT)
3. SAFETY	Form safety teams or engage relevant safety experts	Assess operational strengths and weaknesses, opportunities, and threats (SWOT)	Develop the safety case	Prepare and apply for regulatory approval or certification		
4. COMMUNICATION	Consult with key stakeholders	Coordinate Regionally and bilaterally	Conduct formal promulgation/ notification	Advertise and brief about the change		
5. TRAINING	Develop simulations and procedures	Source relevant training experts	Conduct simulation and relevant training	Assess competency and authorise		
6. IMPLEMENTATION	Conduct operational trials and testing	Assess stability and performance	Make a Go/No-Go decision	Implement and monitor		
7. POST - IMPLEMENTATION	Develop review -Lessons learnt -KPI achievement -Report	Monitor medium and long term performance and safety				

Procurement activities, as detailed further in the present document, should be seen as a particular process in the broader picture of the implementation, throughout the stage 1. Project planning.

Certification/surveillance of CNS/ATM systems activities relate to the Action D of the stage 3. Safety.

Another useful reference document is from CANSO which develops a CANSO Acquisition Excellence Manual that provides 11 Case Studies about the various different approaches of acquisition of ATM systems and services. This Manual can be accessed via the following link: -

<https://www.canso.org>

2. Complying with national regulations and procedures

2.1. Responsibility for acceptance, certification and surveillance

While different processes for acceptance, certification and surveillance exist across the Asia-Pacific Region, their common goal is to ensure that applicable requirements, as transposed from the ICAO provisions and other relevant standards, are continuously complied with.

In any case, the responsibility for acceptance, certification and surveillance shall rest with the State authority or the organization authorized by the State (ANSP) following established procedures.

2.1.1. CNS/ATM systems

Some States have adopted a regime of acceptance testing for their CNS/ATM systems, and some others a regime of certification. Other States combine these two approaches, relying on acceptance testing to grant the initial certificate.

Beyond the regime itself, what matters is that the demonstration that national rules, regulations and standards are complied with relies on scientific evidences. While the scope and depth of tests required can vary from one regulatory system to another, such evidences can only be obtained through an engineering approach relying on proper requirements and testing.



To go deeper

In a general manner, testing of CNS/ATM systems can be approached in a functional manner.

The ICAO Document 8071 (Manual on Testing of Radio Navigation Aids) volumes II and III address respectively the testing of radio-navigation aids and testing of surveillance radar systems and constitute a helpful guidance which can be analyzed and transposed by the State Authority into national guidance.

For ADS-B systems, the ADS-B Implementation and Operations Guidance Document (AIGD) (current version [is Edition 10.0, June 2017](#)) contains helpful guidance to approach testing of ADS-B function.

For AIDC, the AIDC Implementation and Operations Guidance Document (current version is [Edition 1.0 - July 2017](#)) contains helpful guidance to approach testing of AIDC function.

2.1.2. Particular case of the flight inspections

The ICAO Document 8071 volume II states in its paragraph 1.7 AUTHORITY FOR STATUS DETERMINATION that “the responsibility for determining procedure and facility status rests with the appropriate State authority or the organization authorized by the State.”

This explicitly means that even though flight inspections could be procured from a service provider, the appropriate State authority (usually the Civil Aviation Authority) has to issue the guidance (referencing the applicable rules and regulations, procedure, periodicity, etc) to the service provider, usually as part of the contract, to ensure that the service provider conducts flight inspections in compliance with the applicable rules and regulations.



To go deeper

Before award, a detailed assessment of the bids should be conducted as part of the procurement to ensure that the selected service provider will comply with the applicable rules and regulations of the recipient State, including in terms of process, quality assurance and validity.

It is also the State responsibility to make sure that inspections are conducted in such a way that there is no validity gap between inspections. If however, due to unforeseen circumstances or lack of planning, an inspection could not be conducted before the end of the validity period, an exemption could be granted, but based only on a safety assessment, evaluating that the risk to do so remains tolerable.

2.2. Acceptance process (factory and onsite, initial and upgrades) and safety assessment of changes

Most States use the acceptance process, relying on tests that cover the set of requirements.

Among the best practices, such tests are performed while the system/service is in factory, and then on site. For a COTS (Commercial off-the-shelf), it is usually a minimum to test the system as a black-box (testing the interfaces), for which the specific knowledge of the system internal structure is not required.

However, it is recommended that the level of testing be proportioned to the criticality of the system, and includes grey-box or white-box testing as deemed necessary.

A simple way to do that can consist in requiring “free tests” during factory and on-site testing stages, in addition to the test cases pre-established with the manufacturer. The advantage of such

approach is that these “free tests” may reveal non-compliances or defects that otherwise would have been overlooked. A drawback is however such an approach is unstructured.



To go deeper

In the same spirit, different levels of care can be applied to the processes of procurement, requirement, testing and maintenance:

Care in terms of traceability (between System and Software requirements, between Software requirements and Software Architectural Design, between Software Architectural Design and Detailed Design, and between Software Detailed Design and Executable Code);

- *Care in terms of coverage of testing; and*
- *Care in terms of independence of testing.*

In Europe for example, the level of care throughout the overall lifecycle of a software that forms part of an ANS system directly derives from the safety assessment and is determined by the SWAL (Software Assurance Level). The higher the criticality, the stronger the care. Standards like EUROCAE ED-153 Guidelines for ANS Software Safety Assurance (ED-109/DO-278 Software Integrity Assurance Considerations for Communication Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems) are based on the principles retained by ED-12B/DO-178 B for avionics.

2.3. Certification and surveillance processes, including safety assessment of changes

Some States have adopted this regime. For example, Republic of Korea has proposed some best practices in a paper to APANPIRG/27 ([APANPIRG/27 - WP/21](#)).

In particular, it is advised that processes to system certification & development include:

- Safety inspection of equipment
- Inspection of related matters such as requirement
- Inspection of the suitability for test procedure, and test results
- Inspection of software development and design assurance system
- Inspection of hardware development and design assurance system
- Inspection of user manual
- Inspection of education, training and data



To go deeper

Detailed guidance can be found in the Attachment A to the paper.

2.3.1. Re-use of existing compliance evidences

In the case of import/export of CNS/ATM systems, or donation of systems as developed in 2.4, it may be efficient to envisage reusing the evidences of compliance as initially established in the State of manufacture, when available.

However, since the effective implementation of ICAO provisions into national requirements varies from country to country as well as compliance processes, this should be done with great care.

It is recommended that such re-use be subject to a Memorandum of Understanding between States, after a careful comparison of national requirements and compliance processes.

Once the gap analysis has been conducted, the basis of compliance should be carefully complemented to comply with the national regulatory framework of the recipient State.

2.3.2. Some suppliers have a basis ready (product policy) – could be reused but must be carefully evaluated and complemented in the local operational context

As part of their product policy, some suppliers have a basis of compliance evidences ready. For example, it may comprise a catalogue of tests with results documented, a system (or “product”) safety assessment, etc.

However it is usually not free of charge and should be taken care of in the initial procurement.

The existing basis should also be carefully evaluated and complemented in the local operational context and against the national requirements, which will also have a cost.

2.4. Particular case of a gift or donation between Member States

In the case where a Member State A receives a gift from a Member State B, State B should undertake all efforts to ensure that State A is in the position to safely commission and maintain the

system. In particular, and before the gift occurs, a complete review of the implementation and post implementation processes, including maintenance activities, should be performed by States A and B against State A's capabilities.



To go deeper

The potential gaps are:

- *Lack of documentation (design, interfaces, operator handbook, etc), or documentation not available in the proper language;*
- *No or insufficient training delivered to State A;*
- *No or insufficient evidence of compliance with the national regulations and procedures of State A;*
- *No or insufficient support from State B for State A to perform its safety assessment;*
- *No or insufficient support from State B for State A to commission the system;*
- *No maintenance solution proposed or offered to State A.*

After the review and gap analysis, it is recommended that States A and B sign an agreement ruling the donation, with the objective to close the detected gaps within agreed timelines.

When a third party is involved, such as a manufacturer, service provider, training center, or other stakeholders, it is recommended that their roles and responsibilities be identified in the agreement, along with the terms and conditions ruling their interventions.

3. Procurement strategy and contract execution

3.1. E-Procurement

E-procurement, including electronic tendering, electronic quotations, and sourcing, proves to be efficient in terms of cost and time reduction in tendering and should be encouraged.

Traceability through a sound record management system can also contribute to reduce corruption in public procurement practices.

3.2. Benchmarking

3.2.1. *Market survey: features of systems/services available versus own needs, total cost of ownership*

Benchmarking --i.e. comparison-- is a critical activity supporting the Project Planning stage --right from the identification of the problem and improvement required, through intermediate activities and down to planning the tendering and maintenance contract process.¹ A brief revisit of the ICAO Global Air Traffic Management Operational Concept (GATMOC)², and supporting documents clarifies the role and criticality of benchmarking in the widest relevant context. The GATMOC points out that

- i. achieving an expected *performance* (at the level of the 11 Key Performance Areas³) requires *services*, which in turn need *assets*⁴; and that
- ii. managing the delivery of ATM services --ie ATM Service Delivery Management (ATM SDM)⁵ -- is about managing the *Performance, Services and Assets package* (PSAP) as a

¹ Actions A to F of Stage 1 in Table 2 of the 'APAC Seamless ATM Implementation Guidance Material' referred in the earlier section 0.

² ICAO Air Traffic Management Service Delivery Management (ATM SDM) Circular (Cir 335 AN/194), p.(iii).

³ The combined performance of what GATMOC Appendix D calls 'Expectations' (alphabetically: Access and equity; Capacity; Cost-effectiveness; Efficiency; Environment; Flexibility; Global Interoperability; Participation by the ATM Community; Predictability; Safety; and Security) and subsequent documents call Key Performance Areas (e.g. ICAO Global Air Navigation Plan 2016-2030, p.31).

⁴ Assets can be of the following types: *people, technology, information, procedures*, and/or a combination of them. Assets include, for example, aerodromes, airspace, radars, etc. The word 'system' as used in this document is a combination of assets of types technology, information and procedures as supplied by the vendor.

⁵ ICAO Air Traffic Management Service Delivery Management (ATM SDM) Circular (Cir 335 AN/194), p.(vii): "ATM SDM means analyzing and deciding what *assets* need to be deployed to deliver what required *services*, to obtain what expected *performance* [across the 11 Key Performance Areas], and to do so while thinking:

- a) across and within global concept components -- [i.e.] airspace organization, aerodrome operations, user operations, etc.;
- b) across and within time horizons -- from long-term planning through to tactical decisions; and
- c) end to end -- whether seen as gate to gate or en route to en route."

whole, getting the balance right, and demonstrating so by way of a system-wide performance case.⁶

Thus, in GATMOC terms, benchmarking is about understanding:

- iv. the current air traffic demand and PSAP;
- v. the forecasted air traffic demand and PSAP;
- vi. what assets are available in the market and the extent to which these could improve any gaps in the PSAP (current or forecasted) through the provision of related services.

In plain language, benchmarking is simply taking stock of

- a. how well the demand is being satisfied now, and by what services and assets;
- b. how well the demand would be satisfied in the future if nothing is done; and
- c. what assets are available in the market that could close any gaps in satisfaction now and in the future.

The basic examples below illustrate how to develop more complex ones, and why:

- Suppose that one of the *performance objectives* of the procurement is “Objective 1: *increase the en-route throughput which can be handled during typical busy hour.*”⁷
 - Then, *performance indicators* and corresponding *metrics* (units of measurement) would have to be chosen to describe the *performance baseline* (currently being delivered) and the *performance targets* expected to be satisfied by the procurement.
 - For example, *Throughput Demand* (performance indicator) could be chosen and measured as number of IFR movements per hour (metric); *Throughput Capacity* as number of IFR movements per hour; and *Number of Sectors* as number of sectors that are open in an airspace volume during a typical busy hour.
 - Actual measurements will establish the *performance baseline* (e.g. 40; 30; 10; respectively) and analysis of demand-forecasts and expectations will define the *performance targets* to be satisfied by the procurement (e.g. 50; 60; 5; respectively).
- Simultaneously with the above, another *performance objective* could be “Objective 2: *increase the number of aircraft that can be simultaneously accommodated in en-route airspace.*”⁸ *Peak Instantaneous Aircraft Count (PIAC) Demand* and *PIAC Capacity* could be the *performance indicators* measured as number of IFR flights simultaneously present in the

⁶ ICAO Air Traffic Management Service Delivery Management (ATM SDM) Circular (Cir 335 AN/194): p.1-2, §1.2

⁷ Example adapted from the ICAO *Manual on Global Performance of the Air Navigation System* (Doc 9883) (Part I, pp.15-16).

⁸ Example adapted from the ICAO *Manual on Global Performance of the Air Navigation System* (Doc 9883) (Part I, pp.15-16).

airspace volume at a given moment in time (metric). The measured *Performance Baseline* could be (100; 70); respectively) and the *Performance Target* expected to be satisfied (120; 140; respectively) –i.e. a demand increase of 20% and a capacity increase of 200% which would see demand satisfaction improve from -30% to +16.6%.

- Simultaneously with and similarly to the above, and for any procurement, *Performance Objectives, Indicators, Baselines and Targets* should be developed for all 11 Key Performance Areas and treated as a whole –e.g. see performance spider-web diagram—⁹ although it is highly advisable to first establish *Focus Areas* based on organizational experience in the Performance Based Approach.¹⁰

The above examples show that benchmarking is instrumental to demonstrating

1) that the following relevant ATM system requirements¹¹ are met:

- “ensure that performance forms the basis for all ATM system development [R97a];”
- “treat performance as whole, that is, considering all the ATM community expectations [i.e. KPAs] [R185];”
- “ensure the establishment of performance cases (safety, business, environmental, etc.) before implementing changes [R186];”
- “balance the expectations of the ATM Community [R188];” and
- “optimize system-level performance as [the] highest priority with individual component performance subject to that prioritization [R67];”¹²

2) the application of the three principles of the ICAO Performance Based Approach:¹³

- Strong focus on desired/required results;
- Informed decision making driven by the desired/required results; and
- Reliance on facts and data for decision making; and

3) the application of Key Air Navigation Policy Principles #1 and #4 of the Global Air Navigation Plan.¹⁴

⁹ ICAO Manual on Global Performance of the Air Navigation System (Doc 9883): Part I (Global Performance), Appendix C (Priorities, Trade-Offs and Risks), p.C-4, Figure 8.

¹⁰ ICAO Manual on Global Performance of the Air Navigation System (Doc 9883): Part I (Global Performance), p.14, §2.3.2 (Focus Efforts by Defining and Prioritizing Performance Objectives as Needed)

¹¹ The ICAO *Manual on Air Traffic Management System Requirements* (Doc 9882) together with the ICAO *Manual on Global Performance of the Air Navigation System* (Doc 9883) and their parent ICAO *Global Air Traffic Management Operational Concept* (Doc 9854), support the Key Air Navigation Policy Principle 4 of the ICAO *Global Air Navigation Plan* (Doc 9750).

¹² ICAO *Manual on Air Traffic Management System Requirements* (Doc 9882): p.2-1, p.2-24

¹³ ICAO *Manual on Global Performance of the Air Navigation System* (Doc 9883): Part I (Global Performance), p.3, §1.2.1

¹⁴ Principle #1: Commitment to the implementation of ICAO’s Strategic Objectives and Key Performance Areas. Principle #4: Global Air Traffic Management Operational Concept (GATMOC). See GANP 2016-2030: p.17, pp.29-31.

For further guidance, see: ICAO Air Traffic Management Service Delivery Management (ATM SDM) Circular (Cir 335 AN/194); ICAO Manual on Global Performance of the Air Navigation System (Doc 9883); ICAO Manual on Air Traffic Management System Requirements (Doc 9882); and ICAO Global Air Navigation Plan [GANP] 2016-2030 (Doc 9750).

3.2.2. Other ANSP: lessons learnt from acceptance, transition and operations

Projects are always challenging. Organizations should minimize risk by incorporating in their current project plans the lessons learnt by other ANSPs in previous, similar situations.

For example, organizations can compare their current project plans with previous ones by other ANSPs and with the difficulties the latter found during acceptance, transition and operations, to analyze differences, potential impacts and possible risk mitigations.

3.3. Different procurement strategies

3.3.1. Grouped procurement with other ANSP

One option that ANSPs could consider while planning for procurement of CNS/ATM system will be group procurement. This means a group of like-minded ANSPs with more or less similar requirements could band together to procure CNS/ATM systems. With such an approach, ANSP could benefit from economies of scale in term of cost of procurement as well as after-sale support. Examples of such group procurement are COOPANS¹⁵, iTEC and Co-Flight.

3.3.2. Collaboration with suppliers for joint development & production

For complex procurement such as for ATM systems and when ANSPs may want to be involved in development of the ATM system, ANSP may want to consider collaboration with potential system suppliers for joint development and production of the system. From involvement in its development process, ANSP will have better knowledge of the ATM system. Such development experience gained will be useful in subsequent maintenance and upgrading of the ATM system.

¹⁵ COOPANS is a partnership between air navigation service providers of Austria, Croatia, Denmark, Ireland and Sweden which had chosen Thales to be their industry partner to implement an unified air traffic control system among the 5 States

3.3.3 Proof-of-concept method, prior to award of procurement

For some new CNS/ATM features that have to be developed/customised and not available in the market, ANSPs may want to consider using the proof-of-concept method, prior to commitment of award of procurement. In this particular case, contractors will have to demonstrate successfully their understanding and capabilities of developing the new features, prior to award of procurement. This method will allow the ANSP to have better confidence of getting the new features that it wants, although the cost and time of procurement could be affected as a result.

3.3.4 Competitive process

3.3.4.1 Turn-Key

For a situation when ANSP does not have the expertise nor resources, it may want to consider the turn-key approach where the successful tenderer will undertake to design, supply, implement, test, train and certify the CNS/ATM system that it provides, even transition into operations.

3.3.4.2 Service Subscription

In circumstances when an ANSP wants to focus only on the availability of service, without being bogged down by maintenance and repair of asset or high capital expenditure, ANSP may consider the service subscription approach for procurement of CNS/ATM service. In this instance, ANSP will incur operational expenditure but not capital expenditure. Such an approach is useful when there is fluctuating demand for service.

3.3.5 Pre-qualification of suppliers using transparent criteria and careful evaluation

As discussed and exemplified earlier (3.2), benchmarking allows organizations to understand more accurately and objectively the overall problem (including the improvement required) and the market possibilities.

This understanding can be formalized in a broad set of explicit, transparent, and objective criteria (e.g. principles, indicators, metrics, ranges, etc.) against which potential suppliers can be carefully evaluated and a small subset formally pre-qualified as suitable to enter a subsequent tendering process.

3.4. Best value for money (weighted evaluation) and lifecycle cost considerations

In order to evaluate thoroughly so that all costs are accounted for, it is essential to carry out a total lifecycle cost evaluation in order to recommend a best-value-for-money proposal. So all the

costs involve in procurement and operation of the system/facility from birth to cradle, including mid-life upgrade, should be accounted for. To carry out the evaluation fairly and in a transparent manner, State should carefully consider its requirements and evaluation criteria to be used during assessment of tender proposals. For transparency reasons, evaluation criteria would have to be decided and approved before any assessment of tender proposals is carried out. As such requirements and evaluation criteria may be of different importance, they may be graded in percentage terms, etc to reflect their relative importance. To assist the resulting complex detailed evaluation, tool such as Analytical Hierarchy Process may be used

To facilitate overall evaluation of reasonableness of tender proposals received, State will have to carry out its own self-assessment. This can be done, for example, by comparing the tender proposals received or by carrying out a market survey of systems/services that may likely meet its requirements, taking into account real value of money over time. For evaluation of costs of software development, this can be done by breaking the works into estimated manhours required multiplied by manhour rates.

3.5. Establishing the requirements

Establishing the requirements for the CNS/ATM system or service is an essential part of the compliance process, since the bargaining power is with the buyer until the award of the contract.

This includes selecting applicable and relevant standards, assessing the future compliance during the bidding process, and obtaining from the vendor/manufacture all the evidences that will serve the safety, training and V&V processes during the execution of the contract.

3.5.1. Include applicable standards for the system/services purchased

In selecting the applicable and relevant standards, some States usually face a number of difficulties:

- How to select relevant standards from the mass of existing standards? (background)
- Should one select ICAO standards? national standards? How deep? (background)
- How to handle non or partial compliances reported by the industry?
- How to handle in the contract the evolution of those standards, and new standards (foreground)

3.5.2 Selection of relevant standards and initial compliance (background)

To select relevant standards, one should take care to select ICAO SARPS and their latest amendments, as well as guidance material (manuals etc). ICAO-NET is a useful resource (<https://portal.icao.int/ICAO-NET/Pages/default.aspx>). In most of the States, the technical librarian and/or ICAO point of contact has an access to ICAO resources.

The overarching documents will include at least the following, in their latest version:

- ICAO Annex 10 Volume I Radio Navigation Aids
- ICAO Annex 10 Volume III Communications Systems
- ICAO Annex 10 Volume VI Surveillance Radar and Collision Avoidance Systems
- ICAO Annex 11 Air Traffic Services
- ICAO Document 4444 PANS Air Traffic Management
- ICAO Document 8071 (Manual on Testing of Radio Navigation Aids)



To go deeper

It is a good practice to mention specifically the relevant provisions within ICAO annexes, but to avoid taking inadvertently some out, one should use “including”.

Example: inclusion of ADS-C capability into an ATM system for oceanic airspace:

*Refer to ICAO DOC 4444, **including** chapter 4.11.5 Contents of ADS-C reports*

The ICAO Asia/Pacific Seamless ATM Implementation Guidance Material

(<https://www.icao.int/APAC/Documents/edocs/Seamless%20ATM%20Implementation%20Guidance%20v5-0.pdf>) includes in its Table 3: Implementation Actions and Guidance of ICAO Asia/Pacific Seamless ATM Implementation Guidance Material the list of ICAO provisions and other standards that may be of interest.

Following on our example, the table 3 page 29 points out to Seamless item 280 ADS-C, CPDLC (BO-TBO) and mentions in the left column other documents that should be analyzed and referred to.

National requirements and standards with their latest amendments should also be included. It is also advisable to reference the differences of national provisions against the ICAO provisions in the procurement if they are of interest. However, one should assume that implementing these differences as part of a system or service will have a cost from industry perspective, since they will be seen as a deviation to standards.

3.5.3 *Require the detailed evidences of initial compliance of the design in the technical offer*

Usually, selection criteria consist in formal, technical and financial in nature. .

The initial compliance to standards should form a major component of the technical subset.

For this to be efficient, the instructions to tenderers should require a response sufficiently justified from bidders to allow for evaluation of their initial compliance.

The instructions to tenderers should also require from the bidders to indicate how and when non- or partial compliances reported will be covered during the execution of the contract. This can have financial ramifications that should be accounted for in the financial criteria. Doing so ensures a fair treatment of all bidders, as their actual level of compliance against national standards will be different at the time of bidding.

3.5.4 *Evolution of standards (foreground)*

Usually a contract is signed off for several years. Over the lifespan of the contract, standards will unavoidably evolve.

As a result, the contract signed should be clear at the time of signing off, and include a mechanism, such as an impact analysis, to promptly maintain the compliance against applicable standards. Depending on the product policy of the vendor, this may or may not be free of charge.



To go deeper

For systems, the impact analysis of the evolution could determine the size of the impact on the system: sub-system(s) or function(s), interface(s), and its nature: hardware, software and/or dataset.

It is noticeable that some software upgrades, whether stemming from evaluation of standards or not, will entail a hardware upgrade. There should be provisions in the initial procurement to cover this case as well.

To determine the corresponding cost, it is recommended to use a system of metrics as developed in O, since the impact determination a priori (at the time of the initial procurement) may not be possible.

For services, while the contract should require that the provision of services shall comply with applicable standards, the costs of evolution of standards will probably be borne by the provider. Provisions should

be in the contract to obligate the provider to notify with sufficient lead time a change to the interface(s), so that the customer can analyze the impact and, as required, conduct the preparation work.

It should also be noted that as Air Traffic Management evolves towards SWIM, the frequency of changes to models, formats or interfaces (such as AIXM, FIXM or IWXXM) may increase, which calls for sound version management practices in procurement and compliance processes.

3.5.5 User requirements

Requirements should be gathered from users such as ATCOs to facilitate their buy-in as well as from maintenance contractors to learn from problems encountered during existing operations. It is good also to scout the market to see what is new and available and consult with users about their suitability and adaptation for future local use. This will then form as future new requirements. Besides these, the need for interfacing of new systems/services to existing systems/services would also have to be catered for, so that appropriate costs and time for development of Interface Control Documents, etc would be factored in tenderers' proposals.

In determining availability, reliability and spares level of the new facility/service, States should consider the following:

- Review whether alternate means of provision of service are readily available;
- Review air traffic and its distribution;
- Discuss with ATC about expected level of service to be provided;
- Review conditions of the site and surrounding terrain such as accessibility;
- Review weather trends at the system site;
- Review expected turn-around time for repair of faulty items by OEM;
- Review philosophy or degree of repair of cards/modules to be carried out

3.5.5.1 Evolution of user requirements

It is a good practice not to change the user requirements after the bidding process. This would bring confusion on the baseline, including timelines and costs incurred.

As user requirements evolve, the State/ANSP should maintain a wish list. When the new requirements have matured, they can be shared with the vendor/manufacturer for impact analysis, as described in 0. If a procurement strategy was chosen as described in 3.3, then this list of requirements could be shared with partners.

3.5.5.2. Contribution of the vendor to the safety assessment process

During clarification with contractors who had bidden for tender of CNS systems, States could ask about common modes and conditions of failure of the CNS systems. Such information can then form the basis of a hazard list for the selected system should the contractor be successfully awarded the tender.

Agree on the responsibilities of ANSP (integrator) and supplier

The tender should clarify what the responsibilities of the ANSP and those of the supplier are. To perform the safety assessment as required by the Safety Management System established at the national level for safe transition of the new system/service, the ANSP will need to get tenderers to submit information such as the following during its tender bid:

- allocate information to be gathered from equipment supplier such as design philosophy and reliability considerations of the system such as assumptions made and procedures of design, levels of redundancies, testing), etc
- collect evidences regarding actual performance of the system such as Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR), etc.



To go deeper

To explore further the processes for system assessment and certification, one can take a look at Attachment A of Working Paper 21 as presented by the Republic of Korea at APANPIRG/27 meeting in September 2016. The link to this Attachment A is as follows:-

<http://www.icao.int/APAC/Meetings>

Then select Year 2016, select APANPIRG/27, then WP 21

3.5.6 Contributions of the vendor to the training process

Technology platforms available in the market are supplied with a baseline of technical and operational manuals (including related procedures, data, etc.) and corresponding training courses that are applicable to all customers. However, these always need adaptation to the customer needs, processes and location.

In particular, to training, the customer needs to keep in mind the following:

- The supplier's terminology needs to be mapped to that of customer to ensure clarity.
- The supplier's training process needs to be adapted or complemented by the customer's own to ensure that customer staff is trained to competency standards. It is not advisable to assume that supplier's training is competency based, or that the supplier's syllabi include all considerations needed by the customer.
- Given that the technology platform is new, there will be a need for new operating procedures and it is advisable that these be designed and tested in advance by a 'pioneer team'.

3.5.7 Contributions of the vendor to Validation & Verification (V & V) process

Verification and Validation activities are critical, require significant effort and need to be planned and understood by the customer from the very beginning of a project. The customer needs to develop a thorough idea of the V&V activities that it expects to be undertaken –e.g. depth, breadth, timing, applicable standards, evidences produced by, success criteria, recommended independence, amount auditing to be conducted, etc. —and which activities will be undertaken by the supplier and which by the customer.

There is a raft of different types of V&V activities/techniques suited to the various types and phases of projects and to the types of assets. There is plenty of suitable literature and the matter will not be discussed here any further beyond making the following points.

First, since the terminology can vary across a variety of industry standards, some jurisdictions provide adaptable guidance in the form of high-level common principles that are present in most.¹⁵

Second, it is important to emphasize an often forgotten aspect. The point is not simply to be confident that the assets behave as expected or specified. It is also to be confident that these do not behave in unexpected ways –confidence which is more difficult and nuanced to obtain since the 'absence of evidence' is not 'evidence of absence.' In this regard, for example, due attention should be paid to

¹⁵ E.g. Advisory Circular 'Software and its use in Aeronautical Telecommunication and Radio Navigation Services' (Civil Aviation Safety Authority. AC 171-04(0. <https://www.casa.gov.au/files/171c04pdf>)

negative testing, stress testing, free tests, subjecting a technical platform to a realistic input environment for a set period of time, etc.

Factory & Site Acceptance Tests, live trials , etc must have traceability to users' requirements.

3.5.8 Transition and on-site support

3.5.8.1 Readiness of operational and maintenance staff

As part of the Safety Management System process to introduce a new system/facility into service, both the operational and maintenance staff must be trained and be ascertained as being familiar and comfortable with the use of the new system/facility. This is important as it involves buy-in by the users of the system/facility. If they are not properly trained to either use or maintain the new system/facility confidently, they will not use/maintain the new facility/system safely and efficiently. Training can be done through various means or through different stages such as computer-based training, class-room lecture, hand-on training, shadow operations, etc. Following such training, attendees will have to be assessed to ascertain the level of competency attained which will be important in deciding whether to be able to go ahead with transition to the new system/facility. Aside from such initial training, continuous refresher training to ensure that attendees retain their skills in maintaining the new system/facility is essential.

3.5.8.2 Contingency planning during phasing in of new system/service

As with introduction of any new system/facility, there must be contingency planning in case things do not work out as what we have planned. This will minimize any impact to existing operations should the transition not turn out well. Also, as part of the contingency planning, the timing and date of the transition will also have to be carefully considered so as to minimize any impact to existing operations. Notifications of other stakeholders, curtailment of certain activities or operations would also have to be considered as part of contingency planning for transition/operationalisation of a new system/service.

3.5.8.3 Big bang approach or incremental phasing in of new system/service

As part of planning of transition to new system/facility, there is this dilemma of a Big Bang approach or an incremental phasing of new system/services. A Big Bang approach is cleaner in transition but carries high risk that the transition may not go as planned due to unforeseen or omitted considerations. It would involve a major change which affected parties may find it difficult to accept and react. On the other hand, incremental phasing in will take longer time for transition but as the changes

are in small bites, affected parties could be less affected and therefore find them easier to buy in and accept. Also, incremental phasing in carries lower risk since only certain parts/services are changed and not everything, in case problems are encountered during the transition. For complex system/service such as transition to a new ATM system, one effective way of transition is to have shadow operations whereby a part of the new system/service shadows the current system/service. This helps to ensure that affected parties get familiarized with the new system/service and this new system/service is working well. This helps to build up confidence of the affected parties in using the new system/service and facilitate their buy-in. With confidence, the scale of the shadow operations could increase and it could also run for longer period of time.

3.5.9 Supplier's on-site support during and after transition

Aviation is an unforgiving environment and things can go wrong even when the best project plans are well executed – example even if all V&V activities are successful, even if all staff is trained on time, etc.

Therefore, depending on the complexity of the assets and operations, and the fallback alternatives in place, the customer may still consider worthwhile availing itself of the supplier's on-site support during and after the critical transition-to-commissioning phase in order to respond effectively should any residual risk materialize.

3.5.10 Requirements regarding maintenance

Inspection of faults and escalation process

As part of the procurement, it is a good practice to lay down the requirements about how faults in the system or the services will be inspected and solved. In the particular case of COTS, even though the testing process is based on black-box principles, the inspection and resolution of faults should be done at the white box level, and reports should state what caused the fault(s) and what was done to avoid any further occurrence.



To go deeper

Timelines to diagnose and solve the faults should be established in the procurement.

In the same spirit, the escalation process should take into account the potential and actual impacts of the fault on the safety of operations, and these impacts should be agreed on by the State/ANSP.

Whenever the fault cannot be resolved within a timeline that is compatible with the potential or actual impact of the fault on the safety of operations, a workaround should be proposed by the vendor and its implementation agreed on by the State/ANSP after a minimal safety assessment.

Corrections/changes management – configuration management

Configuration management by the manufacturer, vendor and State/ANSP is an essential part of safety assurance.

Regarding services, the contract should require from the vendor that an impact assessment is made for any planned configuration change. The impact assessment shall address the safety impact and the change be coordinated with all the parties involved.

Regarding systems, the contract should require that the manufacturer implements a change management process of system configurations.

These requirements will in turn enable the State/ANSP to manage the configuration of its operational systems.



To go deeper

Contract wise and to better control the costs of evolution throughout the lifecycle, it is recommended to use metrics based on impact analysis of the change. For example, for a system, the metric could consist of the number of function(s)/interface(s) impacted, the depth of the impact (light, moderate, heavy) itself characterized in terms of manpower, and the level of care, as proposed in 2.2. A price could be negotiated during the initial procurement with the vendor/manufacturer for each component of the metric.

Example to follow-up on ADS-C, paragraph 3.5.1: inclusion of ADS-C capability into an ATM system for oceanic airspace:

Number of function(s)/interface(s) impacted:

4 functions (HMI, Flight Data Processing System, Datalink Server, Dataset Management),

Depth of the impact (light, moderate, heavy): HMI (light), Flight Data Processing System (moderate), Datalink Server (heavy), Dataset Management (light)

Level of care: equivalent to Software Assurance Level (SWAL) 3

This would allow to pick up the corresponding manpower or cost as initially negotiated.

3.6. Respect of the initial contractual terms and conditions

3.6.1 During execution of the contract, it is important that all parties should respect the contractual terms and conditions as well as spirit of the contract – namely to commission/operationalise the new system/service on prior agreed timeline and costs. Any deviation on one side may lead to disputes. But as with any procurement of goods/services, there are bound to be changes along the way, due to new requirements, changing circumstances, etc. What is important is that both parties should be open and transparent when problems/disputes arise, so as to seek out amicable solutions. For dispute settlement, it would be good to revert to what the contract has in place such as mediation, arbitration, with litigation as the last resort

3.7. Best practices can help States to guide their exporting industry

3.7.1 By adopting a systemic approach as recommended in this guidance, vendors/manufacturers are in a better position to export as they will have already complied with robust worldwide requirements

3.8. Assistance with procurement

3.8.1. Civil Aviation Purchasing Service by ICAO Technical Cooperation Bureau

As part of the procurement strategy, a need to be assisted in procuring the new system or services or certifying it may be identified.

The Civil Aviation Purchasing Service (CAPS) was established by ICAO in mid-1974 to assist countries in the procurement of aviation equipment. The assistance is provided in both the administrative aspects of a procurement and, when necessary, the technical aspects.

Any Government/Administration/Government Agency/Private Entity might become a Member of CAPS by completing the registration form and the Memorandum of Understanding.

CAPS is essentially a type of Trust Fund arrangement. The method of assessing administrative charges, however, departs from the traditional (across-the-board flat rate percentage), utilizing instead a progressively reducing scale of charges, according to the value of the purchase involved.

A feature of CAPS is the flexibility to offer a CAPS Member the options of either a complete procurement service (from specification of the equipment through to its commissioning) or participation in specific stages of the procurement process, e.g.

- (i) preparation of specification;
- (ii) invitation of tenders, evaluation of tenders and preparation of recommendations;
- (iii) negotiations and award of contract;
- (iv) supervision of contract awarded by ICAO or awarded directly by a CAPS Member, up to final acceptance.

In such case, the cost for each stage is developed and quoted to the CAPS Member once the tasks required of ICAO are clearly identified.

The nature of purchases already undertaken under CAPS is varied and has included the procurement of flight and ATC radar simulation equipment, aircraft, navigation aids, air traffic control radar equipment and complex, large-scale activities associated with complete airport development.



To go deeper

Technical services include:

- *preparation of detailed technical specifications;*
- *preparation of technical tender documentation;*
- *technical evaluation of tenders;*
- *technical contract negotiations;*
- *drafting of technical component of purchase order/contract document;*
- *review of system design document;*
- *site and equipment inspections;*
- *acceptance and commissioning activities, etc..*

Note. — It should be noted that in performing the services described herein, ICAO acts solely for and/or on behalf of the Government/Administration/Government Agency/Private Entity

3.8.2. Industry

Different companies can also provide valuable assistance in the different steps of the process up to the award of contract. Usually, their knowledge of the market allows for a solid benchmarking and establishment of robust requirements.

If such an option is retained, it is recommended to ensure in the assistance procurement that the same company will not contribute to the later stages of implementation, to avoid any conflict of interest.

3.9. Assistance with certification/surveillance

The ICAO Technical Cooperation Bureau, as well as industry, can assist with the certification and surveillance processes. In the case of TCB, OPAS may assist for short-term or long-term missions (OPS, AIR, PEL, ANS, AGA).

In the scope of this document, these experts will assist with the certification/surveillance of CNS/ATM systems or services.

4. Liability and Intellectual Property Rights

4.1. Liability

Contracts usually include liability clauses to protect the customer from losses due to the supplier breaching the contract provisions. Since such protection comes at a cost, the customer should tailor such clauses to reflect risks that are as realistic. Otherwise additional costs would be incurred without any corresponding real benefit.

4.2. Intellectual Property Rights (IPR)

The scope of ICAO does not extend over intellectual property rights (IPR), which falls under the purview of other international conventions and agreements.

Assets are subject to IPR generally (e.g. design of hardware or software, etc.), and their continued use and upgrade during the entire lifecycle is a common concern since the original suppliers may cease to be in business or may discontinue support for a particular product or line.

This concern is magnified for assets that are difficult to replace with equivalent ones readily available in the market, that have a long lifecycle with plenty of life left and that are bound to need remedial fixes and/or upgrades – as is usually the case with assets that are heavily dependent on software and/or information.

In such cases, the customer should consider reducing the risk through contractual arrangements allowing the transfer of IPR and necessary material to the customer under specific conditions. This can be done through a software escrow (sometimes also referred as technology escrow) which is a service that helps protect all parties involved in a software license by having a neutral 3rd party escrow agent holds source code, data, and documentation until a mutually-agreed-upon event occurs.
