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**(DRAFT)**

# MANUAL ON REQUIRED COMMUNICATION PERFORMANCE (RCP)

First Edition – 2006

International Civil Aviation Organization

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# Chapter 1

# INTRODUCTION

## 1.1 Background

1.1.1 In 1983, the International Civil Aviation Organization (ICAO) Council established the Special Committee on Future Air Navigation Systems (FANS). The FANS Committee was tasked with studying, identifying and assessing new technologies, including the use of satellites, and making recommendations for the future development of air navigation for civil aviation. The FANS Committee determined that it would be necessary to develop new systems that would overcome limitations of conventional systems and allow Air Traffic Management (ATM) to develop on a global scale.

1.1.2 In September 1991, 450 representatives from 85 States and 13 international Organizations gathered at the Headquarters of ICAO in Montreal, Canada at the Tenth Air Navigation Conference, to consider and endorse the concept for a future air navigation system as developed by the FANS Committees, that would meet the needs of the civil aviation community well into the next century. The FANS concept, which came to be known as the communications, navigation, surveillance/air traffic management (CNS/ATM) systems concept, involves a complex and interrelated set of technologies, dependent largely on satellites.

1.1.3 The endorsement of the CNS/ATM systems concept reached at the Tenth Air Navigation Conference signaled the beginning of a new era for international civil aviation and paved the way for the many activities related to planning and implementation of new systems around the world.

1.1.4 The fourth meeting of the Aeronautical Mobile Communications Panel (AMCP/4) (Montreal, April 1996) recognized the absence of objective criteria to evaluate communication performance requirements. This objective criteria was seen as a set of values for parameters, which would be based on the operational requirements for communication systems in the various phases of flight. The meeting agreed that there was an urgent need to assess the various technical options of communication systems against such a set values for these parameters. The term RCP type is used to denote a set of values for these parameters.

1.1.5 When reviewing the report of AMCP/4 in 1997, the Air Navigation Commission tasked the Automatic Dependent Surveillance Panel (renamed in 2000 as the Operational Data Link Panel — OPLINKP) to develop the operational concept of RCP.

1.1.6 In 2001, the OPLINKP completed its Concept of Required Communication Performance document. The Air Navigation Commission (ANC) solicited comments from ICAO Contracting States. The comments received indicated broad support for the RCP concept. In light of the comments received, in 2002, the ANC amended the OPLINKP work program to develop a Manual on Required Communications Performance (RCP) and, as necessary, SARPS and procedures relating to the use of RCP in the provision of air traffic services.

1.1.7 In 2003, the Eleventh Air Navigation Conference endorsed recommendations to:

a) Continue the development of Standards and Recommended Practices (SARPs), procedures and guidance material on RCP; and

b) Investigate areas for further work to determine the relationship of the RCP concept to separation studies and interoperability, the standardization of RCP types and allocations, the adequacy of air traffic service (ATS) functions and procedures for new CNS/ATM environments, as well as requirements for safety performance monitoring.

## 1.2 Purpose of manual

1.2.1 The purpose of this guidance material is to explain the concept of RCP, identify RCP requirements applicable to the provision and use of air traffic services, and provide a basis for the application of RCP in a specified airspace.

## 1.3 Explanation of terms

1.3.1 Development and explanation of RCP relies on the understanding of terms, which are included in Appendix A.

# Chapter 2

# REQUIRED COMMUNICATION PERFORMANCE

## 2.1 General

2.1.1 The continuing growth of aviation places increasing demands on airspace capacity and emphasizes the need for the optimum utilization of the available airspace. These factors, allied with the requirement for operational efficiency within acceptable levels of safety have resulted in the need for a performance-based airspace system.

2.1.2 The transition to a performance-based airspace system is a critical aspect of evolving to a safe and efficient global ATM environment. As ATM evolves, it will be necessary to ensure acceptable operational performance, taking into account the changing technologies and a changing environment.

2.1.3 ATM is the aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations.

2.1.4 ATM is achieved through the collaborative integration of humans, information, technology, facilities and services, and supported by communication, navigation, and surveillance capabilities that are dependent on each other. For instance, the communication and surveillance capabilities and performance required for a given operational capability, which in this document is referred to as an ATM function, will depend on the capabilities and performance of the available navigation and other air traffic management functions, including those on the aircraft. Therefore, to establish the capability and performance requirements of the ATM system, it will be necessary to consider it in its overall context, taking into account interdependencies.

2.1.5 To meet the demands on airspace capacity and operational efficiency, the operational communication capability is increasingly playing an essential role in air traffic management using a mixture of data and voice communication. For example, data link can provide for integration of air traffic management functional capabilities on the aircraft and at the ATS units, and more direct controller-pilot communications enabling user-preferred and dynamic rerouting, and intervention capabilities in reduced separation environments where alternative communications are more cumbersome.

2.1.6 The RCP concept provides a means to ensure the acceptable performance of communications within a complete ATM system.

## 2.2 The RCP Concept

2.2.1 The RCP concept characterizes the performance required for communication capabilities that support ATM functions without reference to any specific technology and is open to new technology. This approach is essential to evolving operational concepts using emerging technologies. An ATM function is an individual operational component of air traffic services. Examples of ATM functions include the application of separation between aircraft, the re-routing of aircraft, and the provision of flight information.

2.2.2 The RCP concept assesses operational communication transactions in the context of an ATM function, taking into account human interactions, procedures, and environmental characteristics.

2.2.2.1 The contribution of the human can be significant to RCP. Communication is the accurate transfer of information between sender and receiver, the content of which can be readily understood by both.

2.2.2.2 An operational communication transaction is the process a human uses to send an instruction, clearance, flight information, and/or request, and is completed when that human is confident that the transaction is complete.

2.2.3 The RCP concept is based upon "operationally significant" benchmarks to attain confidence that the operational communications supporting the ATM functions will be conducted in an acceptably safe manner.

2.2.4 The basis for the development of the RCP concept was the need for objective operational criteria, in the form of an RCP type, to evaluate a variety of communication technologies. Once these criteria have been set and accepted, a specific implementation, considering system technical and human performance, may be assessed for its viability against acceptable operational criteria.

2.2.4.1 An RCP type is a label (e.g., RCP 240) that defines a performance standard for operational communication transactions. Each RCP type denotes values for communication transaction time, continuity, availability, and integrity applicable to the most stringent operational communication transaction supporting an ATM function.

2.2.4.2 The RCP concept is technology independent. However, it is not intended to promote an unrestricted number of alternative communication technologies for one ATM function. Whilst RCP types will be prescribed on the basis of regional consultation within the ATM community, so too will be the aircraft equipage requirements for communications. Interoperability and cost considerations will be major items to contend with during such consultations.

2.2.5 Several factors may affect States decisions as to when an RCP type will be prescribed. These factors are based on the ATM functions that an air traffic services (ATS) provider chooses to implement within that airspace. In cases where a safety related change, including the implementation of a reduced separation minimum or a new procedure, are predicated on communication performance, an RCP type should be prescribed. The approval of this change should include showing that the requirements and assumptions defined by the RCP type have been met.

2.2.6 It is anticipated that most aircraft, operating in airspace for which RCP has been prescribed by States or on the basis of regional air navigation agreement, will carry a mixture of voice and data communication equipment. The carriage of voice and data communication equipment may even be required in some regions or States to perform certain ATM functions. In order to receive approval to operate in such environments, the combined communications equipment should be required to provide at least the capabilities and features (or their equivalents) applicable to the appropriate RCP type.

2.2.7 Data communication capabilities provide for the integration of air traffic management functional capabilities to exchange information between air traffic management facilities and aircraft. For some ATM functions, to comply with its performance requirements, it may be necessary to introduce data communication capabilities that allow for automatically loading flight and navigation information data into the aircraft's flight management system or an ATS provider's flight data processor.

2.2.8 Additionally, data communication capabilities that meet the prescribed RCP type can provide the capability to communicate clearances and instructions without the need for a voice read-back.

2.2.9 The application of data communication capabilities in various parts of the world has already been shown to provide a number of advantages over voice communication. Examples of these advantages include:

a) Reduced separations;

b) Routine in-flight re-routes;

c) Direct controller pilot communications;

d) Reduced frequency congestion and capping the need for additional spectrum; and

e) Automatic exchange of flight information between aircraft and the ATS unit.

2.2.10 There is a need to ensure consistent definition and use of communication capabilities to apply the RCP concept on a global basis to achieve the benefits that are advantageous to States, ATS providers and users.

2.2.11 The RCP concept applies to the performance of the communication capabilities required for an ATM function and therefore affects the air traffic service provision and the operator's use, including aircraft equipage. The RCP concept is intended to characterize the communication capability and its performance through a statement of the communication performance (RCP type) to be achieved in order to perform the ATM function.

2.2.12 The RCP concept seeks to manage the performance of communications supporting evolving ATM concepts and emerging technologies. This is achieved by

- Determining an RCP type for the communication capabilities supporting an ATM function, then
- Prescribing the RCP type(s) related to the communications system(s) supporting the ATM functions within that airspace, and
- Complying with the prescribed RCP type(s) through analysis, operational assessments, and performance monitoring of the communication systems.

## 2.3 Determining an RCP type

2.3.1 To enable ATM functions within a performance-based airspace, it will be necessary to characterize the performance required for the applicable communication, navigation and/or surveillance elements. RCP will be used in conjunction with RNP and other performance-based measures.

2.3.2 For a particular ATM function, an increase or decrease in the required performance for any single element (i.e., C or N or S) may allow a tradeoff in required performance of some or all of the other elements, provided the target level of safety is maintained.

2.3.3 It is important that the States harmonize RCP type for the same or similar ATM functions to reduce training requirements and errors resulting from confusion in operations across airspace boundaries.

2.3.4 ICAO Doc 9689, Airspace Planning Methodology, provides considerations for assessing the risk of collision when determining separation minima within an acceptable target level of safety. The risk of collision is a function of navigation performance, route configuration, traffic density, surveillance, communication and air traffic control (ATC). Determination of separation minima allows for trade-offs

among these considerations to ensure that the target level of safety is achieved. An RCP type can be used to specify the performance requirements for the communication capability to implement the separation minima.

2.3.5 Chapter 3 provides guidance for determining an RCP type for an ATM function.

## 2.4 Prescribing an RCP type

2.4.1 After an RCP type has been determined, it may be prescribed for an airspace based on the ATM functions that an airspace planner or authority chooses to implement within that airspace. Potential airspace to which RCP may be applied includes:

a) A defined airspace, such as North Atlantic minimum navigation performance specifications (MNPS) airspace;

b) A fixed ATS route, such as between Sydney, Australia and Auckland, New Zealand;

c) Random track operations, such as between Hawaii and Japan;

d) A volume of airspace, such as a block altitude on a specified route.

2.4.2 When an RCP type is prescribed based on the intended ATM function provided in a given airspace, the RCP type(s) will provide the requirements for qualification and approval of the procedures, aircraft equipage, and airspace infrastructure.

2.4.3 Ideally, airspace should have a single RCP type; however, multiple RCP types may be prescribed within a given airspace. An example would be to prescribe an RCP type appropriate for the controller's ability to intervene in a conflict situation given the separation minima, and another RCP type to perform a specific procedure, such as an in trail climb or dynamic reroute, within that airspace.

2.4.4 Different RCP types may be prescribed for different airspace depending on the ATM functions. As an example, an RCP type in terminal area airspace may be different from the RCP type for en-route or oceanic airspace.

2.4.5 Chapter 4 provides guidance for prescribing an RCP type for an airspace.

## 2.5 Complying with an RCP type

### State Requirements

2.5.1 Since RCP is a statement of operational communication performance, there is an obligation on the part of the State to provide the necessary equipment, procedures, and training to achieve and maintain the required communication performance.

2.5.2 The State must ensure that changes to services that rely on communication performance within a given airspace provide safe separation.

2.5.3 The State must ensure that aircraft operators intending to operate in airspace where an RCP type is prescribed are qualified and approved for RCP operations.

2.5.4 It should be noted that compliance with an RCP type can be achieved in many different ways and the State may provide guidance on acceptable means for the ATS provider and the aircraft operator to show how RCP is achieved.

**Aircraft Operator Requirements**

2.5.5 The concept of RCP is based on the expected communication performance of all relevant communication capabilities used within an airspace. This in turn places demands on manufacturers of aircraft and aircraft operators to achieve the communication performance required for a specific RCP type. The RCP concept may also require different aircraft functional capabilities for different RCP types. As an example, one RCP type may be related to functional requirements for automatic loading of flight data into the aircraft's flight management system, whereas another RCP type may only relate to ATC communications.

2.5.6 Since RCP is a statement of operational communication performance, there is an obligation on the part of the operator to provide the necessary procedures and training, and ensure that aircraft equipage and related communication services comply with the required communication performance.

**Monitoring communication performance**

2.5.7 Monitoring provides creditable operational data to determine that the ATM system continues to meet the RCP type. Monitoring includes data collection on a routine basis and as problems or abnormalities arise.

2.5.8 Monitoring is performed by organizations in control of or responsible for a part of the ATM system in operation and a data collection point resides within that part.

2.5.9 Chapter 5 provides guidance for complying with an RCP type.

## 2.6 RCP Application

A checklist to aid in determining, prescribing, and complying with an RCP type can be found at Appendix B.

# Chapter 3

# DETERMINING AN RCP TYPE

## 3.1 RCP type

3.1.1 In order to simplify RCP type naming convention and to make the required communication transaction time readily apparent to airspace planners, aircraft manufacturers and operators, the RCP type is specified by the value for the communication transaction time associated with the ATM function.

3.1.2 An RCP type comprises values assigned to the parameters: communication transaction time, continuity, availability, and integrity.

3.1.3 RCP type parameters

3.1.3.1 Communication transaction time - The maximum time for the completion of the operational communication transaction after which the initiator should revert to an alternative procedure.

3.1.3.2 Continuity - The probability that an operational communication transaction can be completed within the communication transaction time.

3.1.3.3 Availability - The probability that an operational communication transaction can be initiated when needed.

3.1.3.4 Integrity - The probability that communication transactions are completed within the communication transaction time with undetected error.

## 3.2 RCP types – general application

3.2.1 Table 3-1 specifies RCP types envisaged for general application.

**Table 3-1 Recommended RCP types**

| RCP type | Transaction time (sec) | Continuity (probability/ flight hour) | Availability (probability/ flight hour) | Integrity (acceptable rate/ flight hour) |
|---|---|---|---|---|
| **RCP 10** | 10 | 0.995 | 0.99998 | $10^{-5}$ |
| **RCP 60** | 60 | 0.99 | 0.9995 | $10^{-5}$ |
| **RCP 120** | 120 | 0.99 | 0.9995 | $10^{-5}$ |
| **RCP 240** | 240 | 0.99 | 0.9995 | $10^{-5}$ |
| **RCP 400** | 400 | 0.99 | 0.999 | $10^{-5}$ |

*Note 1— RCP types will be validated by a safety assessment, data collection, and/or other means prior to the first time they are used.*

*Note 2.— When a unit of measure other than the "per flight hour" is used to specify RCP type values for continuity, availability, and integrity, the conversion process will need to be validated. For example,*

*when data is analyzed on a "per transaction" basis, or on a "per sector" basis, the average number of transactions per flight hour or the average number of flight hours per sector hour, respectively, will need to be validated for the specific implementation.*

3.2.2 RCP types other than those provided in the table may be established as experience is gained in RCP implementation.

3.2.3 RCP 10 would be used for controller intervention capability supporting separation assurance in a 5 nm radius environment.

3.2.4 In combination with the RCP 10 in a 5 nm radius environment, RCP 60 may be applied to routine communications on a data link system to offload the voice communication system.

3.2.5 RCP 120 would be used for controller intervention capability supporting separation assurance in a 15 nm radius separation environment.

3.2.6 RCP 240 would be used for controller intervention capability supporting separation assurance in a 30/30 separation environment.

3.2.7 RCP 400 would be used for controller intervention capability supporting separation assurance in current environments where separations are greater than 30/30 and alternative technologies are planned for providing normal means of communication, e.g., Iridium voice or HF data link in lieu of HF voice.

*Note 1.— RCP types were derived from intervention capabilities that exist today, aircraft performance characteristics, conflict detection and resolution capability, ICAO Doc 4444, PANS/ATM, RTCA DO-290/EUROCAE ED-120, RTCA DO-284, and other factors.*

*Note 2.— An example of the process and results related to determining an RCP type can be found at Appendix C*

## 3.3 Assessing operational communication transactions in the context of the ATM function

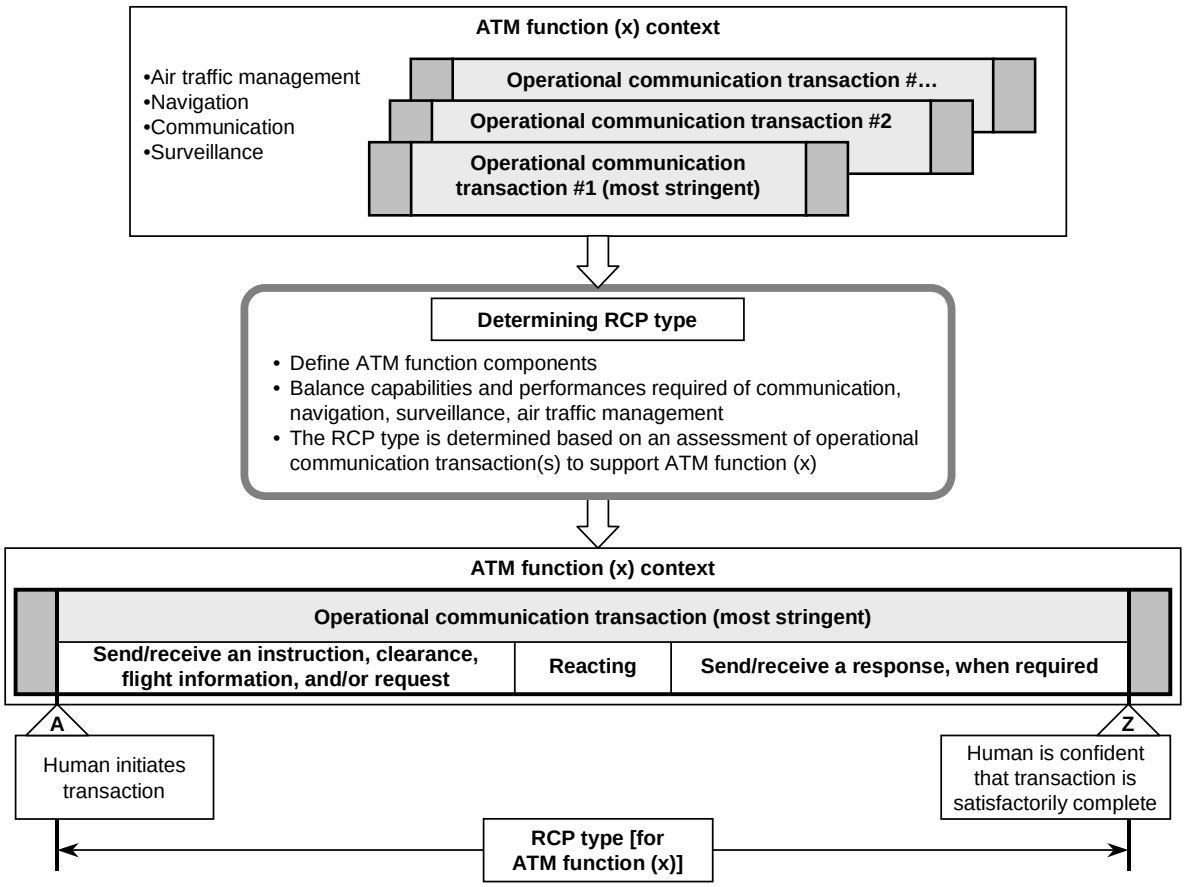



**Figure 3-1 Determining RCP type for an ATM function**

### Operational communication transaction in the ATM function context

3.3.1 Figure 3-1 provides an overview of determining RCP type for an ATM function. An RCP type is determined from an assessment of operational communication transactions in the ATM function context. The ATM function components include:

- Airspace characteristics, such as separation minima, spacing criteria, and capacity limits;
- Operational capabilities, such as a dynamic arrival procedure, crossing flight paths, or in trail climb/descent procedure; and

- CNS/ATM system performance, such as navigation, surveillance, flight management, flight data processing, and decision support tools for the controller and the flight crew.

3.3.2 It is important to note that the RCP type needs to be determined in the context of the relevant airspace characteristics, operational capabilities, and overall CNS/ATM system performance. Tradeoffs can be and are made to take advantage of existing fleet equipage and air navigation service provisions. For example, when implementing a 50/50 NM separation minima, if the operator/aircraft is qualified for RNP 4 operations, the interval for ADS-C periodic position reports is 32 minutes. If an operator/aircraft were only qualified for RNP 10 operations, the separation minima can still be implemented, but the interval for ADS-C periodic position reports is 27 minutes, which increases the number of position reports and associated costs, but the operator would not have to incur costs to upgrade to RNP 4 operations. The service provision would need to allow for variations in these performance tradeoffs.

3.3.3 Given the airspace characteristics and other capabilities and performances, the RCP type is used to characterize the communication capability and performance that needs to exist for the controller to intervene and resolve a potential conflict. It is not intended to imply that all communication needs to meet the RCP type. However, in addition to the RCP type determined for the intervention capability, other RCP types may be appropriate for specific operations that may have different performance characteristics. This dependency may be related to, for example:

- Functional differences in the means of communication, such as between voice, which provides an interactive capability, and data, which provides an air-ground automation integration capability;

- An increase in communications due to an increase in airspace capacity. For example, when increasing airspace capacity, the controller depends on a data link system to maintain an acceptable workload and suitable performance of the VHF voice communication to intervene in time-critical situations; and

- A contingency procedure in the event the primary communication system fails. For example, when implementing a 30/30 separation minima, the contingency procedure requires an alternate means of communication that enables the controller to establish communications with an aircraft after the normal means fails.

3.3.4 In such cases, it may be necessary to establish specific operational criteria using a different RCP type for the alternate means of communication to ensure that it performs as expected and to convey its performance characteristics to the controller and flight crew for proper use. This RCP type is different than the RCP type established for the communications capability the controller uses to intervene and resolve a potential conflict.

3.3.5 The specific operational criteria for a communication system may include an RCP type. In addition to the RCP type, the criteria may include other functional and performance criteria, for example:

- a specific message set or phraseology, transaction types, and intended use;

- the interactive capability of voice communication;

- the air-ground integration capability of data communication;

- times to indicate for contingency and non-compliant performance;

- positive assurance of the flight crew's receipt/understanding of an instruction, clearance, or request or the controller's receipt/understanding of a request/flight information; and

- Party-line and/or broadcast capability, multiple recipients of the same instruction, clearance, or information, e.g., such as transmitting and receiving on Guard frequencies.

**Communication transaction time**

3.3.6 There may be multiple operational communication transactions that support an ATM function. These transactions are assessed to determine the most stringent. The value for the communication transaction time parameter is based on the time needed to complete the most stringent transaction.

3.3.7 The assessment would take into consideration the time needed to safely execute the contingency procedure and can include simulations, demonstrations, operational trials, and analysis of empirical data applicable to the operational communication transaction times needed to support the ATM function.

3.3.8 Separation assurance is an ATM function for which the operational communication transaction time can be determined by collision risk modeling. Collision risk modeling considers the operational communication transaction times in the communications and controller intervention buffer supporting separation assurance. Figure 3-2 illustrates the operational communication transaction in the context of communications and controller intervention buffer.

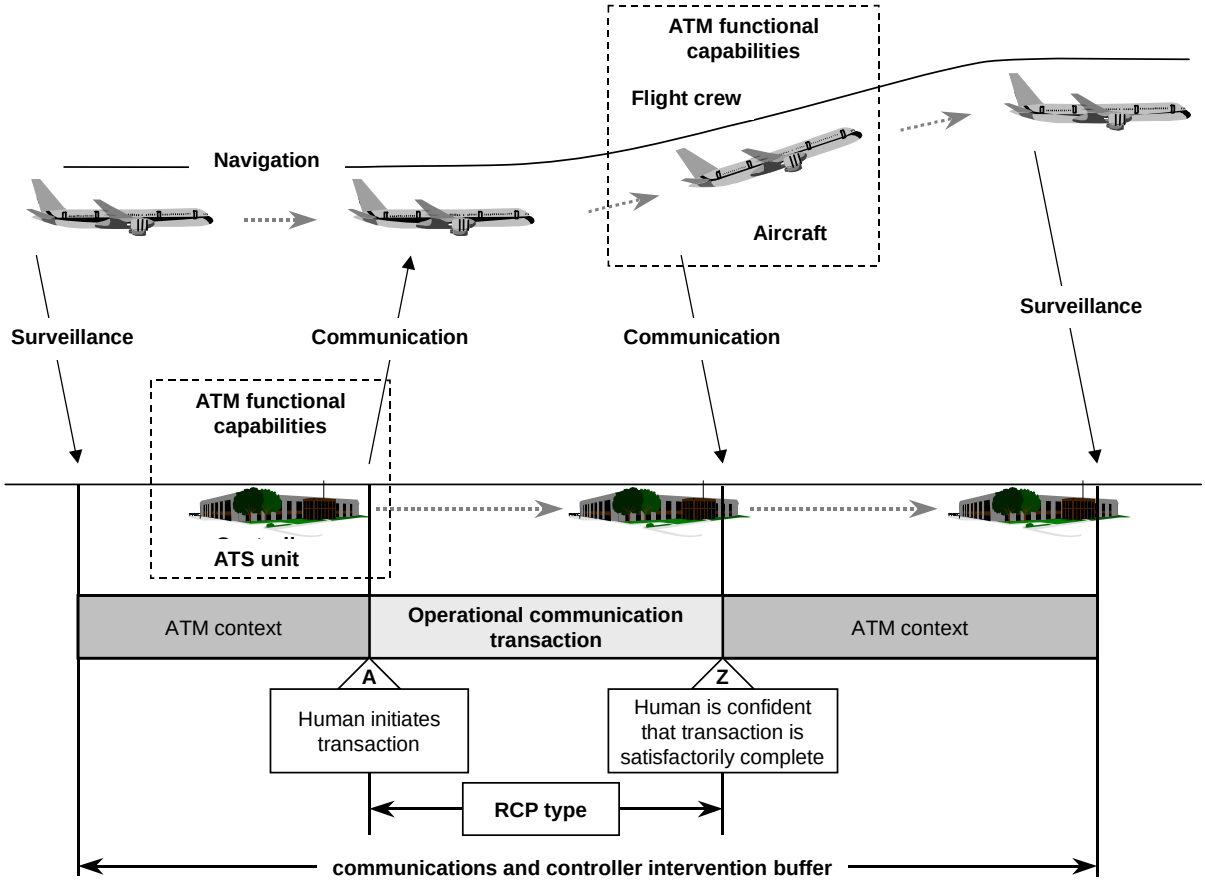



**Figure 3-2 Communications capabilities and performances related to separation assurance**

## Continuity

3.3.9 The value for continuity parameter is selected based on the results of an operational hazard assessment.

3.3.9.1 The operational hazard assessment should include a ***severity of effects analysis*** of detected errors within the communication transactions in the context of the ATM function. Detected errors include, but are not limited to:

- Detecting that the transaction has exceeded the communication transaction time;
- Detecting that one or more messages within the transaction are corrupted, misdirected, directed out-of sequence, or lost, and cannot be corrected to complete the transaction within the operational communication transaction time; and
- Detecting loss of the communication service or aircraft capability to use the service whilst transactions are pending completion.

3.3.9.2 An acceptable probability should be determined for the likelihood of occurrence of communication transactions with detected errors based on the severity of effects analysis.

3.3.10 The value for the continuity parameter is based on the acceptable probability of detected

anomalous behaviors of the communication transaction.

**Availability**

3.3.11 The value for the availability parameter is selected based on the results of an operational hazard assessment.

3.3.11.1 The operational hazard assessment should include a ***severity of effects analysis*** of the detected loss of the system prohibiting the initiation of a communication transaction needed to support the ATM function. Detected loss includes, but is not limited to:

- Detecting loss of the communication service, which affects multiple aircraft; and
- Detecting loss of the aircraft capability needed to use the communication service, which affects a single aircraft.

3.3.11.2 An acceptable probability should be determined for the likelihood of occurrence of inability to initiate a transaction based on the severity of effects analysis.

3.3.12 The value for the availability parameter is based on the acceptable rate of detected inability to initiate a transaction.

**Integrity**

3.3.13 The value for the integrity parameter is selected based on the results of an operational hazard assessment.

3.3.13.1 The operational hazard assessment should include a ***severity of effects analysis*** of communication transactions with undetected errors in the context of the ATM function. Undetected errors include, but are not limited to:

- Undetected corruption of one or more messages within the transaction ;
- Undetected misdirection of one or more messages within the transaction;
- Undetected delivery of messages in an order that was not intended;
- Undetected delivery of a message after the communication transaction time; and
- Undetected loss of service or interruption in a communication transaction.

*Note: Undetected loss of service is associated with integrity because it is "undetected." In some operational scenarios, it is conceivable that a network could have failed with no indication provided to the users of the system.*

3.3.13.2 An acceptable probability should be determined for the likelihood of occurrence of communication transactions with undetected errors based on the severity of effects analysis.

3.3.14 The value for the integrity parameter is the acceptable probability of communication transactions with undetected errors.

## 3.4 Selecting the RCP type

3.4.1 Once all the safety and operational requirements have been determined, the RCP type which meets these requirements is selected from Table 3-1.

3.4.2 Separate analyses of different ATM functions may result in a number of different RCP types being determined for the different ATM functions. See Chapter 4 for guidance on prescribing an RCP type in these situations.

# Chapter 4

# PRESCRIBING AN RCP TYPE

## 4.1 Determine Requirements

4.1.1 An RCP type may be used to prescribe operational communication requirements for an airspace based on the ATM functions that an airspace planner or ATS provider needs to implement within that airspace. However, in practice this is likely to be an iterative process and it is likely that, in defining the ATM functions to be used in a particular airspace, consideration will be given to the capabilities and avionics equipage of aircraft likely to use that airspace.

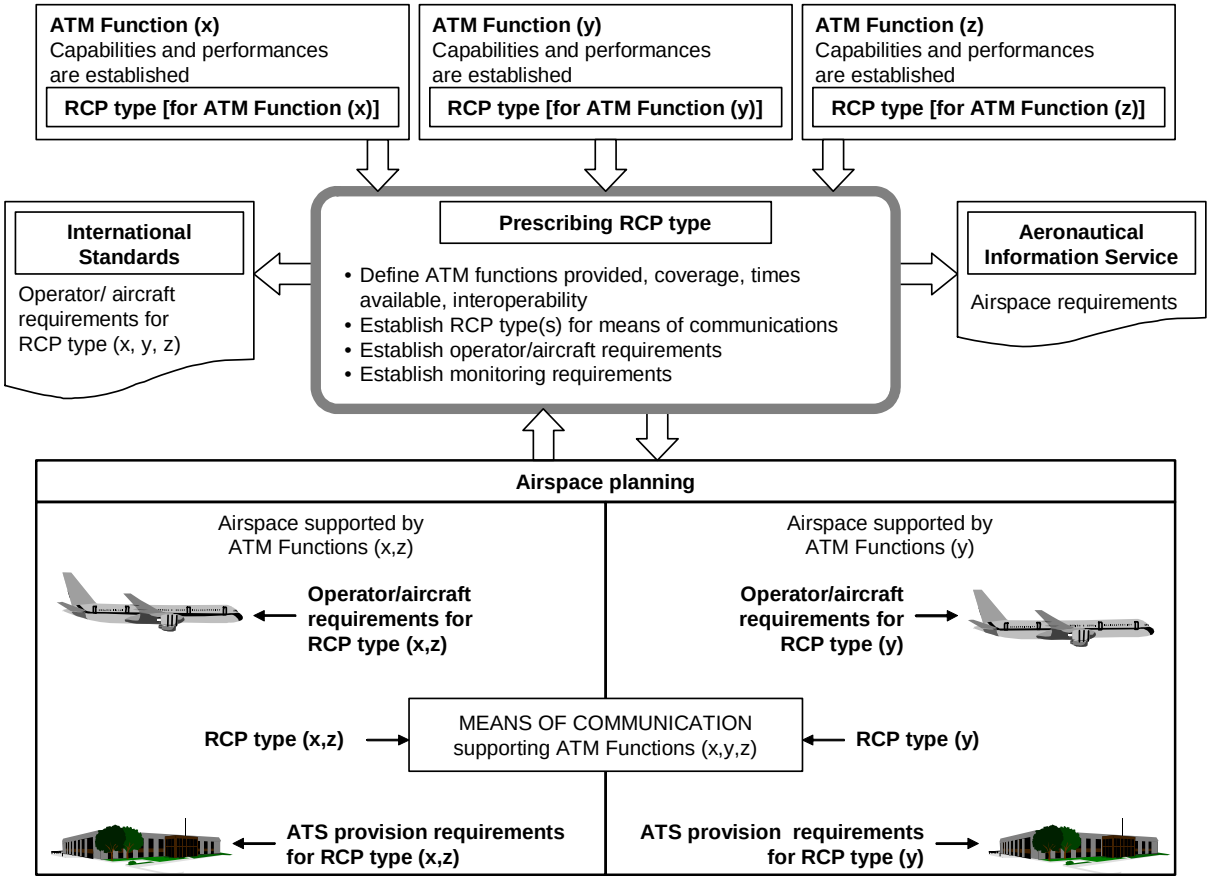



**Figure 4-1 Prescribing an RCP type within an airspace (single means of communication)**

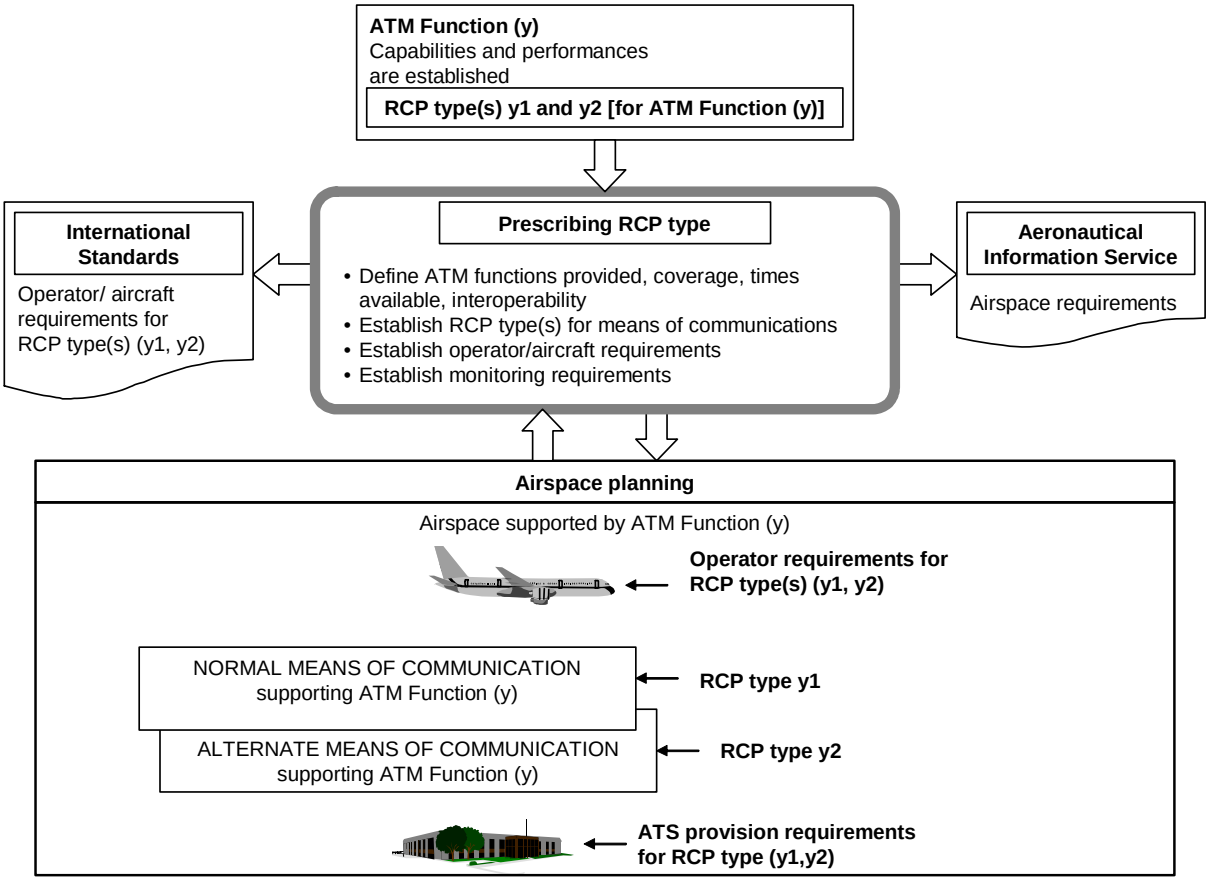



**Figure 4-2 Prescribing an RCP type within an airspace (normal and alternate means of communication)**

4.1.2 **Figure 4-1** provides an overview of a single means of communication that supports multiple ATM functions with different RCP types in multiple airspaces and within a single airspace. For example, the communication system may be used to provide for intervention to support implementation of a technology, such as Iridium, which is different than current HF voice requirements to maintain 100 nm/15 min separations, but meets RCP 400.

4.1.3 **Figure 4-2** provides an overview of a normal means of communication and an alternate means of communication with different performance characteristics, both support an ATM function in the same airspace. Each means of communication has an RCP type associated with it to ensure that each means of communication performs as expected and to convey its performance characteristics to the controller and flight crew for proper use. For example, VHF voice communication may be used to provide for more time critical communications, whereas data link communications may be used for more routine communication of a less time critical nature.

4.1.4 Other scenarios can be formulated using combinations of the two scenarios portrayed in **Figure 4-1** and **Figure 4-2**. For example, where separations are 30/30 nm, HF voice and/or data communication may provide an alternate means of communication to meet RCP 400, while controller pilot data link communications (CPDLC) may be the normal means of communication, using SATCOM, to meet RCP 240. Where separations are 5 nm radius, the same CPDLC, except using VDL Mode 2, may be the used for routine communications associated with RCP 60, while VHF voice is used for intervention and more time critical communications associated with RCP 10.

4.1.5 In order to prescribe an RCP type (or types) applicable to an airspace, it is first necessary to identify the functions that will be required to support ATM in any particular airspace. These functions will have been separately established and it is likely that separate RCP types will have been identified that are necessary to achieve particular performance levels of a function. For example, if aircraft separations are being considered it is likely that a more stringent RCP type will be needed to implement a 3 nm terminal area separation minima compared to that needed to implement a 30/30 nm oceanic separation minima.

4.1.6 Once the ATM functions and the associated RCP type(s) for a particular airspace have been established, these shall be published in the appropriate local documentation (e.g., AIP, regional Guidance Material, etc). Care must also be taken to ensure that any potential users of the airspace are provided with an unambiguous definition of the procedures, aircraft equipage and training requirements that will be necessary to operate in that airspace and performance monitoring criteria.

4.1.7 In order to ensure that problems do not arise when these requirements are introduced, it is recommended that early liaison in the appropriate forum should take place between ATS providers and operators.

4.1.8 When an RCP type(s) is prescribed in a given airspace, the RCP type(s) will provide the basis for qualification and approval of the procedures, aircraft equipage and airspace infrastructure. The basis for each type of approval is provided in the form of an RCP type allocation.

## 4.2 RCP type allocation

4.2.1 RCP type allocation is the process of apportioning the various RCP type values to the various parts of the system. The results of this process are RCP type allocations that are used to:

a) Assess viability of different technologies to meeting operational requirements;

b) Approve the provision of air traffic services supported by communication systems;

c) Determine when to initiate contingency procedures;

d) Design, implement, and qualify communication services;

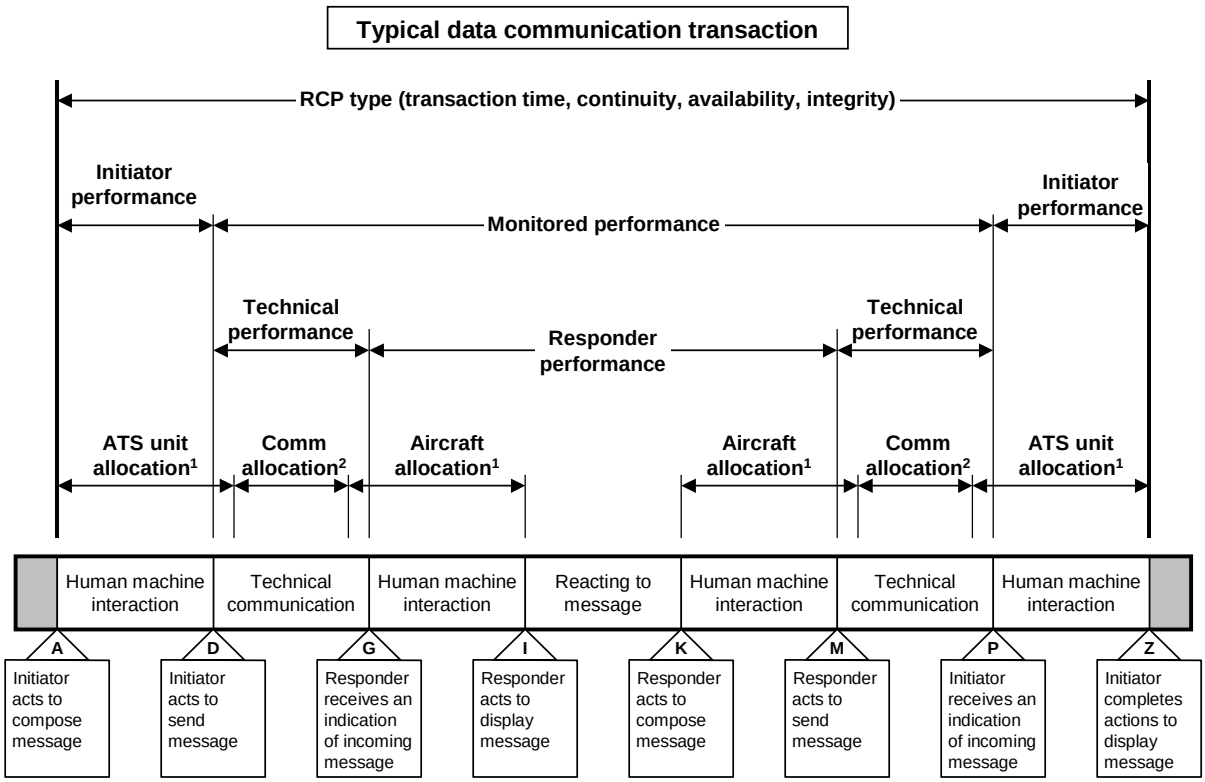
e) Design, implement, qualify, and approve aircraft type designs;

f) Approve aircraft operator’s for RCP operations; and

g) Operationally monitor, detect, and resolve non-compliant performance.

4.2.2 RCP type allocations may need to be established by States or on the basis of regional air navigation agreements. However, in such cases, States should initiate appropriate action to document the RCP type allocations appropriate for each RCP type in international standards.

4.2.3 RCP type allocations are documented in ICAO manuals or industry-developed minimum aviation system performance standards which specify allocations for various communication system elements. **Figure 4-3** and **Figure 4-4** provide templates for allocating capability and performance to data and voice communication, respectively.




Note 1: A controller initiated transaction is shown. ATS unit and Aircraft allocations are transposed for a pilot initiated transaction
Note 2: The aircraft and ATS unit allocations include HMI and a portion of the technical communication to provide a basis for the different types of approvals.

**Figure 4-3 Template for typical data RCP type allocation**

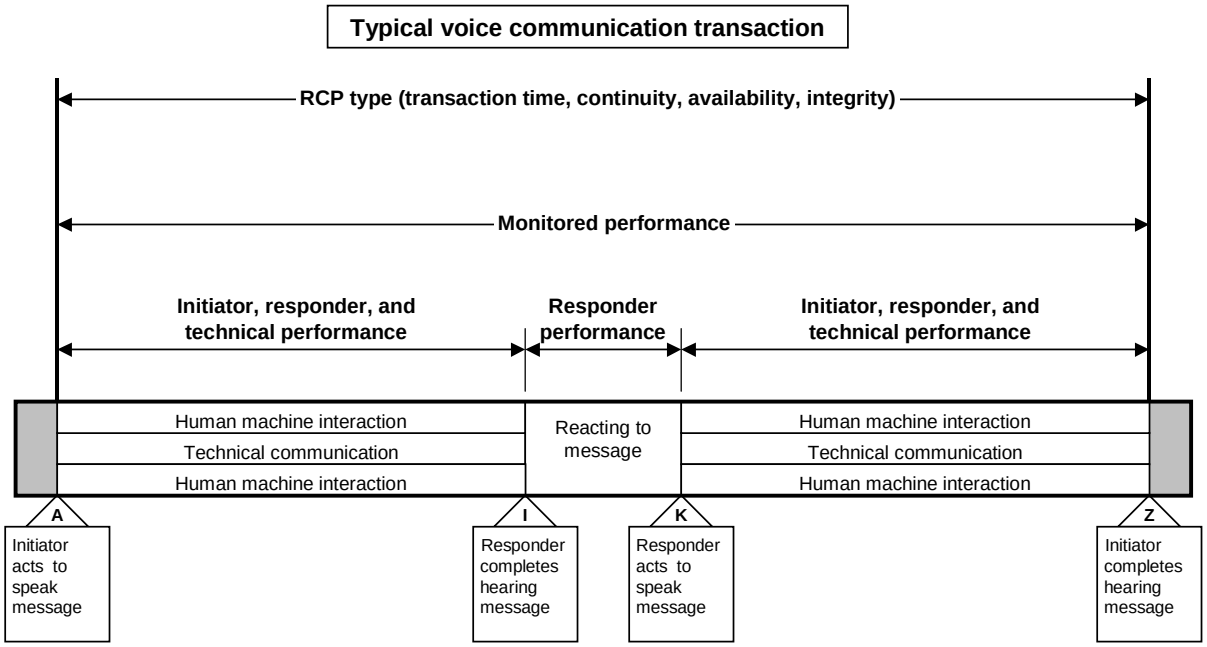



**Figure 4-4 Template for typical voice RCP type allocation**

# Chapter 5

# COMPLYING WITH AN RCP TYPE

## 5.1 Evidence of compliance

5.1.1 There is an obligation on the part of the State and the aircraft operator to show that the procedures, aircraft equipage and airspace infrastructure comply with the RCP type. This compliance is performed as part of different approval types. The different approval types are the ATS provider approval, aircraft operator approval, and aircraft type design approval. These separate and distinct types of approvals collectively define the conceptual "ATM system approval." In cases for which there is no regulatory basis for approval of a part of the ATM system, "approval" denotes the activities that take place to show compliance with the requirements allocated to that part of the ATM system.

5.1.1.1 Aircraft operator approval is the authorization granted to an aircraft operator to use the air traffic services, aircraft equipage, communication services procured by the aircraft operator, and related internetworks with the ATS provider's communication services. It is supported by information provided by the aircraft type design approval and ATS provider approval.

5.1.1.2 Aircraft type design approval is the approval granted to an aircraft manufacturer or modifier to indicate that the type design of the aircraft equipage complies with applicable airworthiness requirements. It includes information to support operator operational approval.

5.1.1.3 Approval is granted to an ATS provider for the provision of ATS within an airspace. It includes approval of the procedures, technical system and the communication services procured by the ATS provider.

5.1.2 Figure 5-1 provides an overview of complying with an RCP type. To comply with an RCP type, all communication systems that support the ATM function are considered. ACP is the dynamic assessment of the operational performance of the communication path, with human performance and technical performance included in the assessment. The human performance considers such factors as training, procedures and human-machine interaction. The technical performance is the installed communication performance operating together and is used to demonstrate that the technical part of the operational communication system meets the intended function. The actual communication performance (ACP) is assessed in the same terms and parameters as the RCP type.

5.1.3 Initially, for aircraft type design approval and ATS provider approval, the expected ACP is determined based on validating any assumptions and demonstrating with representative elements of the complete system to show that the aircraft's or ATS unit's actual performance complies with its RCP type allocation. For the operational approvals, the ACP is determined based on measurements of actual performance characteristics of a specific implementation of the ATM function, initially, and in continued operations.

5.1.4 The results of these activities are provided as evidence of compliance, which is used to qualify for the different types of approvals.

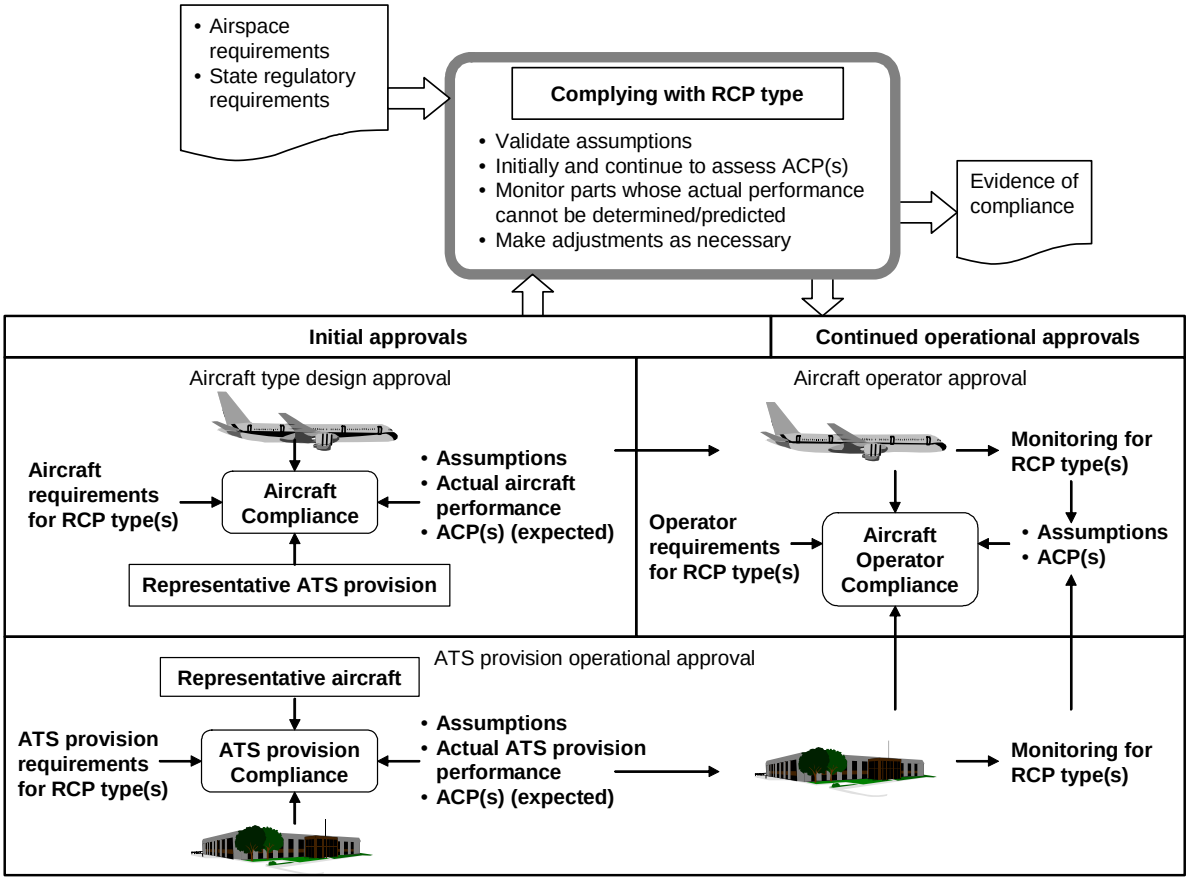



**Figure 5-1: Overview of complying with an RCP type**

## 5.2 Validate assumptions and analyze actual performance

### Communication transaction time

5.2.1 Allocation of the operational communication transaction time to the various parts of the system facilitates detection and resolution of anomalies during operations.

5.2.2 Design. Allocations of the operational communication transaction time can be used to provide indications or alerts in system design for the initiator or responder to perform contingency procedures. These allocations can also provide a basis for the design of the human-machine interaction (HMI) with respect to the time required by the human to complete the communication process.

5.2.3 Management of configuration of an operational system, including network and/or frequency management, priority selection criteria of subnetworks, and changes to the system expedites isolation and resolution of anomalies inherent in change activity.

5.2.4 Monitoring, measurement, & analysis of the normal time in which operational transactions are completed during demonstrations, operational trials, and in continued operations. Monitoring and

measurement is necessary when actual times can not be accurately predicted with an acceptable level of confidence and the potential variability is significant to the required performance.

a) The normal time target is typically defined as the time at which 95% of all transactions that are initiated are, in fact, completed. The normal time is related to the operational communication transaction time and continuity (probability of completing the transaction) only to the extent that the probability distribution function can be accurately predicted.

b) The normal time target is predetermined based on the operational communication transaction time requirement, the continuity requirement, and an analysis to determine the statistical distribution of the operational communication transaction time. Accuracy in predicting the distribution of transaction times and building an acceptable level of confidence can be attained through demonstrations, operational trials, and management of system configuration during continued operations.

c) Actual normal time may be determined based on analysis of statistical measures that include only portions of the operational communication transactions over a predetermined period of time. The portions that are measured and the period of time is determined, locally or regionally, based on analysis of the distribution and degree of variability determined from a sufficient sample of data collected.

*Note: The data collected need not include transactions that were initiated, but the initiating message was never sent, such as in data communication, or "disregarded" by the initiator, such as in voice communications. If the data excludes messages not delivered after the initiating message was sent, then additional targets need to be established to assess actual non-delivery rates.*

d) Analysis of data collected combined with assumptions of the portions not measured is used:

to support compliance for initial use, and

to detect anomalies for corrective action.

**Continuity**

5.2.5 Allocation of continuity to the various parts of the system facilitates to detection and resolution of anomalies during operations.

5.2.6 Design. Allocations of continuity can be used as a basis for ensuring that the design of a part of the system can meet its time allocation with an acceptable probability. These allocations can also provide a basis for the design of the HMI with respect to the continuity.

5.2.7 Management of configuration of an operational system, including network and/or frequency management, priority selection criteria of subnetworks, and changes to the system expedites isolation and resolution of anomalies inherent in change activity.

5.2.8 Monitoring, measurement, & analysis of actual probability that transactions meet the operational communication transaction time during demonstrations, operational trials, and in continued operations. Monitoring and measurement is necessary when actual continuity cannot be accurately predicted with an acceptable level of confidence and the potential variability is significant to the required performance.

a) Actual continuity may be determined based on analysis of statistical measures that include only portions of the operational communication transactions over a predetermined period of time. The portions that are measured and the period of time is determined, locally or regionally, based on analysis of the distribution and degree of variability determined from a sufficient sample of data collected.

*Note: The data collected need not include transactions that were initiated, but the initiating message was never sent, such as in data communication, or "disregarded" by the initiator, such as in voice communications. If the data excludes messages such as those not delivered in data communications after the initiating message was sent, then additional targets need to be established to assess actual non-delivery rates.*

Analysis of data collected combined with assumptions of the portions not measured is used:

1) to support compliance for initial use, and

2) to detect anomalies for corrective action needed to continue to meet the acceptable probability (continuity) at which the operational communication transaction is completed.

b) AIP's provide guidance primarily related to responsibilities of States, air traffic service providers, aircraft operators, and manufacturers and modifiers of aircraft for monitoring communication performance. The following types of monitoring should be considered;

1) *System self-monitoring*. For all RCP operations, communication systems should be designed to perform a continuous automatic self-test of continuity performance. Should performance fall below the required system use connectivity, the flight crew should be made aware in order that ATC may be informed.

2) *Communication equipment monitoring*. If a significant means of communication error is detected and automatic reconfiguration or fallback possibilities have been exhausted, a warning should be displayed to the flight crew and the equipment should ignore the communication performance derived from an out-of-tolerance source. Provision should be made to identify and deselect the discrepant source.

3) *Alert outputs.* For all RCP operations, alert outputs should be provided for equipment failures; reversion to supplementary or non-standard modes of communication; or loss of the capability to support a specified RCP type.

c) For continued operations, organizations must continually monitor to detect any deviations beyond the granted operational approval and coordinate timely and effective corrective action. Where changes are proposed beyond the original operational approval, an impact analysis is conducted to determine the extent to which the processes described in this document should be applied. The following monitoring objectives should be met:

1) Operations and procedures are continually evaluated;

2) Problem identification. Potential problems are identified early. Information concerning identified problems is disseminated to operators and ATS providers to raise awareness and facilitate problem resolution. Status reports and problem reports are generated on a periodic basis by each applicant and are based on data collected and analyzed, including the reason problems or abnormal events occurred.

3) Problem resolutions are identified, including interim operational procedures and operating constraints, which mitigate the effects of the problems until such time as a longer term solution is implemented. Problem resolutions are traced to the point at which the problem was encountered. Their operational implications and their resolution are identified and traceable.

4) Problems affecting safety or flight operations must be resolved in a timeframe acceptable to the approval authority. Problem resolutions may require re-training of system operators; revision of training procedures to ensure compliance with existing procedures or operational constraints; changes to operational data (including operator's operations specifications); and changes to systems including design, performance and interoperability.

5) System testing is authorized and coordinated. System performance is assessed; and ACP is monitored and the data is analyzed in regard to the RCP type.

**Availability**

5.2.9 Allocation of availability to the various parts of the system facilitates detection and resolution of anomalies during operations.

5.2.10 Design. Allocations of availability can be used as a basis for ensuring that the design of a part of the system supports the overall availability requirement.

5.2.11 Management of configuration of an operational system, including network management, priority selection criteria of subnetworks, and changes to the system expedites isolation and resolution of anomalies inherent in change activity.

5.2.12 Monitoring, measurement, & analysis of actual availability during demonstrations, operational trials, and in continued operations is necessary when actual availability cannot be accurately predicted with an acceptable level of confidence and the potential variability is significant to the required performance.

a) Actual availability may be determined based on analysis of statistical measures that include only portions of the operational communication transactions over a predetermined period of time. The portions that are measured and the period of time is determined, locally or regionally, based on analysis of the distribution and degree of variability determined from a sufficient sample of data collected.

*Note: Detected loss of the communication service whilst transactions are pending completion contributes to monitoring, measurement, and analysis for compliance assessment of the continuity.*

b) Analysis of data collected combined with assumptions of the portions not measured is used:

1) to support compliance for initial use, and

2) to detect anomalies for corrective action needed to continue to meet the acceptable probability that an operational communication transaction can be initiated when needed.

**Integrity**

5.2.13 Compliance to the integrity value of the RCP type is typically shown by analysis, design, and system architecture for the technical parts of the system. For the human, compliance to the integrity value of the RCP type is typically shown by evaluations of HMI, system design and capabilities, training/qualification, and operational judgment.

*Note: The integrity value of the RCP type is usually not monitored, although an analysis of operational data collected over large periods of time could reveal undetected errors and their effects.*

## Appendix A – Glossary of terms

| | |
|---|---|
| Actual Communication Performance (ACP) | The dynamic assessment of the operational performance of the communication path, with human performance and technical performance included in the assessment. |
| Air Traffic Control (ATC) service | A service provided for the purpose of:<br>a) preventing collisions:<br>1) between aircraft, and<br>2) on the maneuvering area between aircraft and obstructions; and<br>b) expediting and maintaining an orderly flow of air traffic. |
| Air Traffic Management | The aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations. |
| Aircraft | Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface. |
| ATM function | An individual operational component of air traffic services. Examples of ATM functions include the application of separation between aircraft, the re-routing of aircraft, and the provision of flight information. |
| Availability | The probability that an operational communication transaction can be initiated when needed. |
| Communication transaction time | The maximum time for the completion of the operational communication transaction after which the initiator should revert to an alternative procedure. |
| Continuity | The probability that an operational communication transaction can be completed within the communication transaction time. |
| Integrity | The probability that communication transactions are completed within the communication transaction time with undetected error. |
| Operational communication transaction | The process a human uses to send an instruction, clearance, flight information, and/or request, and is completed when that human is confident that the transaction is complete. |
| Qualification | The process through which a State, approval authority and applicant ensures that a specific implementation complies with applicable requirements with a specified level of confidence. |

| | |
|---|---|
| RCP type | A label (e.g., RCP 240) that represents the values assigned to RCP parameters for communication transaction time, continuity, availability, and integrity. |
| RCP type allocation | RCP type allocation is the process of apportioning the various RCP type values to the various parts of the system. |
| Required communication performance (RCP) | A statement of the performance requirements for operational communication in support of specific ATM functions. |

## Appendix B – Checklist for RCP Application

1. Establish RCP Implementation Team

   Identify all stakeholders: the regulator, air navigation technical department, air traffic service provider, airspace users, safety department, and communications service provider.

2. Develop an RCP plan

   Define the operational requirements.

   Develop an introduction plan and schedule for the introduction of RCP.

   Identify required regulator changes.

3. Define procedures, airspace and ATS requirements.

   Develop operational use policy, separation minima required, ATC procedures for RCP implementation.

4. Identify the ATM functions and environment.

   Determine what ATM functions will be performed in the airspace and either select predetermined RCP types or perform the analysis to determine the necessary RCP type.

   The evaluation of the ATM function will include the following:

   - Evaluate navigational and surveillance capability, route structure, airspace congestion in the area of implementation;

   - Identify the most stringent communication requirements;

   - conduct safety analysis and assess risk; and

   - select an RCP type that satisfies the communication requirement subject to the risk analysis.

5. Develop guidance material

   Develop procedures, including contingencies, covering the operational approval of RCP.

   Establish requirements for ATM/avionics approvals, pilot training and certification, ATS training and certification.

6. Develop a system of post implementation reviews and monitoring

   To ensure the safe and effective introduction of RCP operations, procedures must be developed for problem review and monitoring of the ongoing performance of the ATM system.

7. Prescribing the required RCP type.

   Publish the RCP type in the appropriate local documentation (e.g., AIP, regional guidance material, etc.)

8. Qualification/Certification/Operational Approval.

   Identify all involved parties and their association with the demarcation points within the communication system.

   Identify the performance requirement allocation for a given RCP type for all parties involved and conduct qualification test.

9. Execute the introduction plan

   Introduce the RCP operations including post implementation reviews and monitoring.

## Appendix C – Example of determining an RCP type

The ATM Function in this example is routine ATC communications on a data link system to offload the voice communication system, which is used to maintain separation assurance in the terminal control area (TMA).

Separation assurance is achieved by providing air traffic services necessary to maintain separation minima to an acceptably safe level. The separation minima that are implemented are based on many factors, including the quality of information available to ATC and the flight crew, flight planning and navigation capabilities, surveillance, and the ability of the controller to intervene when a loss of separation is detected.

In this example, it is desirable to allow in the TMA an increase in air traffic by 20 percent over current air traffic demand. However, to maintain separation minima to an acceptably safe level, the current air traffic demand is at a maximum when considering controller workload and congestion on the VHF voice communications. The air traffic demand could be increased by implementing an air-ground data link system, which can be used to perform some of the less time-critical ATC communications, thereby maintaining an acceptable intervention capability using the VHF voice communications. Additionally, with proper integration into the controller's workstation, the data link system will enable the controller to maintain an acceptable level of workload with the increase in air traffic.

RCP 10 is assumed for the intervention capability provided by the performance characteristics of the current VHF voice communication system in the TMA. Based on this assumption, we need to determine an RCP type for the data link system to ensure that when air traffic demand is increased, a sufficient amount of ATC communications is performed using the data link system to ensure that the VHF voice communication maintains a performance level (i.e., assumed to be RCP 10) that provides a capability suitable for the intervention capability in the TMA.

The transaction time for the data link system can be determined using an iterative process to determine the allowable increase in air traffic demand, the amount of ATC communications performed using the data link, and viable options offered by the enabling technologies and implementations. Analysis of empirical data and simulations can determine the types and volume of transactions. The continuity, availability, and integrity can be determined based on severity and effects analysis, using the criteria provided in Chapter 3 of this manual.

The scenario involves the use of data communications by the controller to ensure an acceptably safe separation minimum while increasing air traffic density. The choice of the medium that is used to communicate clearances is determined by the controller based on their training of the data link systems capabilities, how they would expect it to perform, and operational judgment of the time between recognition of the need to communicate and action taken to complete the maneuver associated with the clearance.

The tasks associated with the operational communication transaction for sequential communications (i.e., CPDLC) are described.

To determine the RCP type you must:

a) Define the ATM function components

   i) describe the environmental characteristics, operational capabilities, and other CNS/ATM system performance (i.e. communications, navigation, surveillance, traffic density, etc.) of the airspace in which the function will be performed;

   ii) describe the operational communication transaction associated with that function;

b) Balance capabilities and performances required of communication, navigation, surveillance, air traffic management

   i) determine the operational performance expectations associated with performing that function;

   ii) determine any safety requirements associated with the effects of failures arising during the performance of the function;

   iii) determine the values for the RCP parameters associated with performing the function; and

c) Select the RCP type based on the determined values.

**Define the ATM function components**

To describe the environmental characteristics of the airspace within which the function is to be applied, determine the following items:

**Environmental Characteristics**

| | **TMA** |
|---|---|
| **Airspace type** | Continental<br>Class A, B, C, D and E |
| **Communication capability** | VHF voice for intervention capability<br>data for routine ATC communications |
| **Surveillance capability** | 5 second updates |
| **Navigation capability** | RNAV/RNP 1 |
| **Horizontal Separation Minima** | 3 NM<br>2.5 to 6 NM on final approach |
| **Vertical Separation Minima** | 1000 ft |

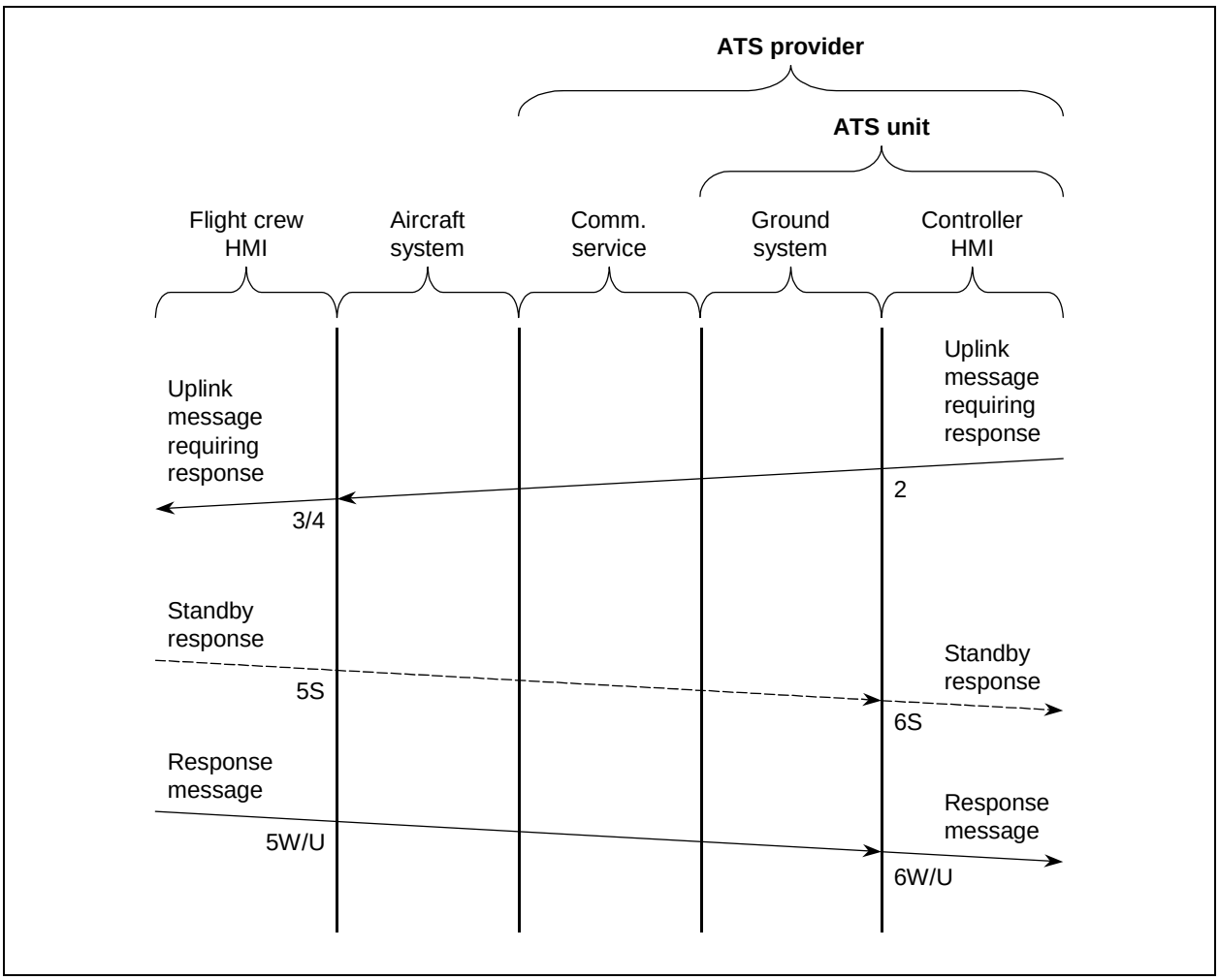
| | **TMA** |
|---|---|
| **Sector density**<br>**(with 70% aircraft data link equipped)** | 70 aircraft per hour<br>Maximum of 35 aircraft per controller at any given time |
| **Traffic complexity** | Predominately vectoring with a complex ATS route structure spaced less than or equal to 8NM between centerlines |

To describe the operational communication transaction, list the steps in which things occur to perform the function in the sequence they are performed. Include any items that occur outside the operational communication transaction for separation assurance in the TMA which may trigger the function to be initiated.

**Operational communication transaction**

| Step | Operating Steps |
|---|---|
| 1 | The surveillance or automation function provides information that requires the controller to initiate communications for assuring separation. |
| 2 | The controller sends a clearance message to the flight crew initiating the operational communication transaction. |
| 3 | The flight crew is notified when the aircraft system receives the message. |
| 4 | The flight crew accesses the message on a display and reacts to the message. |
| 5 | The flight crew may respond with a STANDBY, WILCO, or UNABLE. |
| 6S | Upon ATS unit receipt of the STANDBY the controller is notified.<br>***NOTE:*** *The STANDBY response does not close the communication transaction.* |
| 5W | The flight crew responds to the message with a WILCO and initiates the maneuver requested. |
| 6W | Upon ATS unit receipt of the WILCO the controller is notified.<br>The ATS unit updates the flight plan consistent with the clearance, if applicable.<br>***NOTE****: The WILCO response closes the dialogue.* |
| 5U | If the flight crew is unable to comply with the contents of the message, an UNABLE response is sent and the primary communications method is initiated. |
| 6U | Upon ATS unit receipt of the UNABLE the controller is notified.<br>***NOTE:*** *The UNABLE response closes the dialogue.* |
| 7 | The controller monitors execution of the maneuver to assure separation is maintained. |

The diagram below provides a pictorial reference of the time sequence that occurs during the steps used to complete the operational communication transaction for routine ATC communications using the data link system in the TMA. It is illustrated across the elements of the environment. When air-ground messages are exchanged, numbers shown in the diagram map to steps described in the table above.




**Balance capabilities and performances required of communication, navigation, surveillance and air traffic management**

In this example, the analyses considered that the only change to the existing environment was the introduction of the data link system to offload the VHF voice communication to enable an increase in sector capacity. Under these conditions and based on simulations and analysis, it was concluded that 70 per cent aircraft data link equipage and the transactions that needed to be completed by 60 seconds would enable a 20 per cent increase in capacity in the TMA.

The continuity, availability, and integrity was assessed based on severity and effects analysis, considering the operational hazards that can occur during the operational communication transaction for routine ATC communications using the data link system in the TMA and their effects. These operational hazards and their effects are shown in the table below. The hazards were generalized to the worst possible case to

determine the hazard level. Thus, any type of transaction for which the controller or pilot may use the data link system is considered for each hazard.

| Operational Hazard | Operational Effect | Hazard Classification |
|---|---|---|
| Loss of ability to provide the message. | The flight crew tries to send message and determines that CPDLC is unavailable prior to sending message; and/or<br>The ATS unit tries to send messages to several aircraft and determines that CPDLC is unavailable.<br>Slight increase in flight crew and/or ATS provider workload due to reversion to voice communication and procedures to re-establish CPDLC.<br>Slight reduction in air traffic control capability | minor |
| Detected late or expired message | Responder realizes received message is late or expired; aircraft system presents expired message as such or discards message and notifies sender.<br>Slight increase in sender and receiver workload due to reversion to voice communication. | minor |
| Detected misdirection of a message | Responder realizes message is not appropriate.<br>Message intent is not executed.<br>The aircraft or ATS unit that was supposed to receive the message does not receive it; equivalent to loss of the service.<br>Slight increase in flight crew and controller workload for the flight crew or controller receiving the detected misdirected clearance. | minor |
| Undetected misdirection of a message used for separation | A clearance, clearance response, or aircraft report is received by an unintended aircraft/ATS unit.<br>This can be equivalent to receipt and execution of an erroneous clearance.<br>The aircraft that was supposed to receive the message does not receive it; equivalent to loss of the service.<br>Possibly a significant increase in flight crew workload for both intended and unintended recipients.<br>Possibly a significant reduction in separation for both intended and unintended recipients.<br>Possible physical distress on passengers due to corrective maneuvers for both intended and unintended recipients. | major |
| Detected corruption of a message | Recipient realizes message is corrupted.<br>Message is discarded and sender informed<br>Slight increase in flight crew and controller workload due to reversion to voice. | minor |
| Undetected corruption of a message used for separation | If the corruption is in a clearance, this could result in the acceptance and execution of an erroneous clearance.<br>If the corruption is in a flight crew response to a clearance or report, results in the flight crew and ATS unit being out of synch.<br>Possibly a significant increase in flight crew workload.<br>Possibly a significant reduction in separation.<br>Possible physical distress on passengers due to corrective maneuvers. | major |
| Undetected out of sequence message used for separation | Flight crew could accept and execute an erroneous clearance.<br>Possibly a significant increase in flight crew workload.<br>Possibly a significant reduction in separation.<br>Possible physical distress on passengers due to corrective maneuvers. | major |

The following table presents typical safety objectives associated with the hazards classified in the table above for operational communication transaction for routine ATC communications in the TMA.

| Safety Objective |
|---|
| The likelihood of a loss of ability to provide messages for one or several aircraft shall be no greater than probable. |
| The likelihood of late or expired message delivery shall be no greater than probable. |
| The likelihood of misdirection of a message shall be no greater than probable. |
| The likelihood of undetected misdirection of a message used for separation shall be no greater than remote. |
| The likelihood of undetected corruption of a message used for separation shall be no greater than remote. |
| The likelihood of undetected out of sequence messages used for separation shall be no greater than remote. |

The following table presents examples of the safety requirements resulting from the hazard assessment performed on the sequential operational communication transaction for separation assurance in the TMA.

| Safety Requirement |
|---|
| When a clearance requires execution of more than one maneuver to be done in a specific sequence, the clearances shall be put in the order that they are to be executed in a single uplink message. |
| Each message shall be time stamped |
| The time stamp shall indicate the time that the message is released by the initiator for onward transmission. |
| Any processing (data entry/encoding/ transmitting/ decoding/ displaying) shall not affect the intent of the message. |
| The receiver shall reject messages not addressed to its end system. |
| The initiating system shall be capable of indicating to the user when a required response is not received within the required time. |
| When a received message contains a time stamp that indicates that the time has been exceeded, the receiving system shall either discard the message and inform the initiator or display the message to the receiver with an appropriate indication. |
| When the controller/flight crew is informed that a response has not been sent within the required response time, the controller/flight crew shall clarify the status of the message (e.g. using voice). |
| The ATS unit shall prevent release of a clearance without controller action. |
| The aircraft system shall prevent release of an operational response without flight crew action. |
| The recipient shall be capable of detecting a corrupted message. |
| Messages shall be transmitted/received in the order that they are sent. |

The performance objectives associated with operational communication transaction for separation assurance in the TMA is shown below. The performance objectives table only considers performance objectives for major hazards.

| **Performance Objective** | |
|---|---|
| **Description of parameter** | **Value** |
| Unexpected interruption of a transaction | $10^{-5}$ per aircraft per flight hour |
| Loss of communication transaction | $10^{-5}$ per aircraft per flight hour |
| Loss of service | $10^{-5}$ per aircraft per flight hour |
| Undetected corrupted transaction | $10^{-5}$ per aircraft per flight hour |

**Select the RCP type**

Based on the results of the simulations, empirical data and analyses, as indicated in Table 3-1, the RCP type applied to routine communications on the data link system in the TMA is RCP 60.

— END —