3.4.3.6 ADS-B System Quality of Service

3.4.3.6.1 Required Monitoring Performance

A key concept in the definition of future ATS systems is that of Required Monitoring Performance (RMP). The term "Monitoring Performance" refers to capabilities of an airspace user to monitor other users and be monitored by other users and ATS at a level sufficient for participation of the user in both strategic and tactical operations. RMP is intended to characterize aircraft path prediction capability and received accuracy, integrity, continuity of service, and availability of a monitoring system for a given volume of airspace and/or phase of operation. Important monitoring system parameters such as state vector report received update rate can be derived from the primary RMP parameters.

Aircraft path prediction capability is defined by a 95 percent position uncertainty volume as a function of prediction time over a specified look ahead interval. Monitoring integrity (assurance of accurate, reliable information), where there is availability of service, must be defined consistent with the desired airspace application. Monitoring continuity of service and availability also must be defined consistent with the desired airspace application.

Development of the RMP concept is in progress by RTCA [Author's note - ????]. Companion concepts of Required Navigation Performance (RNP) and Required Communications Performance (RCP) have also been developed in order to provide the necessary characterization of Required System Performance (RSP) of aviation Communications, Navigation, and Surveillance (CNS) systems. RMP, RNP, and RCP are central to the future FANS/ATM system and the realization of Free Flight. ADS-B delivery technologies, data definition, and applications must conform to appropriate RMP specifications on an end-to-end basis.

3.4.3.6.2 Failure Mode and Availability Considerations

Navigation and radar surveillance in the horizontal dimensions are independent; this independence is beneficial under certain failure modes. Today, an aircraft with failed navigation capability may get failure mode recovery vectors from ATS based on SSR/PSR tracks. Today, an aircraft with a failed transponder may still report navigation based position information to ATS for safe separation from other traffic even if no PSR is available. On the other hand, a navigation capability failure in an ADS-B only surveillance environment results in both the aircraft and ATS experiencing uncertainty about the aircraft's location. The operational impact of such a failure depends upon the nature of the failure: i.e., a single unit failure, or an area wide outage. Additional factors include the duration of the failure, the traffic density at the time of the failure, and the overall navigation and surveillance architecture. Detailed treatment of these issues should consider the failure mode recovery process in the context of the service outage duration and the total CNS environment. Figure 3-9 suggests how such a failure mode recovery process depends upon the total ATS architecture. Different states may implement different ATS architectures.

It is anticipated that ADS-B will be used as a supplemental means of surveillance for some ATS-based airspace operations during a transition period leading to full ADS-B equipage. When used as a supplemental means of surveillance, ADS-B adds availability within a larger surveillance system. Primary means of surveillance is defined as a preferred means (when other means are available) of obtaining surveillance data for aircraft separation and avoidance of obstacles. Use of ADS-B as a sole means of surveillance presumes that aircraft can engage in operations with no other means of surveillance. If ADS-B were to be used as a sole means of surveillance, availability would be calculated using only ADS-B, aircraft sources, and applications. ADS-B is not expected to be used as a sole means of ATS surveillance for the near future in US domestic airspace.

Where the ADS-B System is used as a supplemental means of surveillance, the ADS-B system is expected to be available with a probability of at least 0.95 for all operations, independent of the availability of appropriate inputs to the ADS-B system. Where the ADS-B System is used as a primary means of surveillance, the system is expected to be available with a probability of at least 0.999 for all air-air operations.

If an ADS-B system is used as a primary means of surveillance, then a supplemental surveillance system, independent of the navigation system, is expected to be available. The overall surveillance system will need to satisfy fail-safe operation of navigation and surveillance, i.e., a failure of the navigation system will not result in a failure of the surveillance function. This will enable ATS to provide an independent means of guidance to aircraft losing all navigation capability. The overall requirement for the surveillance system is adequate availability of the surveillance function, independent of navigation system availability. Where this requirement cannot be satisfied in a system intended for primary means of surveillance, the avionics and support infrastructure should be designed such that the simultaneous loss of both navigation and surveillance is extremely improbable. The expected availability of the total surveillance system is at least 0.99999, independent of navigation system availability.

3.4.3.6.3 ADS-B Availability Requirements

Availability is calculated as the ADS-B System Mean-Time-Between-Failures (MTBF) divided by the sum of the MTBF and Mean-Time-To-Restore (MTTR). ADS-B equipage is defined to be available for an operation if the following conditions are met: (1) ADS-B equipage outputs are provided at the rates defined in Tables 3-4(a) through 3-4(e) and (2) the ADS-B reports have the integrity required by §03~~.3.6.5~~. For the purposes of calculating availability, an ADS-B transmission subsystem is considered to be one participant's message generation function and message exchange (transmission) function. An ADS-B receiver subsystem is considered to be one participant's message exchange (receiver) and one report generation function.

ADS-B availability **shall** (242AR3.35) be 0.9995 for class A0 through class A3 and class B0 through class B3 transmission subsystems. ADS-B availability **shall** (242AR3.36) be 0.95 for class A0 receiver subsystems. Class A1, A2, and A3 receiver subsystems **shall** (242AR3.37) have an availability of 0.9995. Specification of Class C receiver subsystem availability requirements are beyond the scope of this MASPS.

High transmission availability (0.9995) is required of all classes in order to support the use of ADS-B as a primary means of surveillance for ATS. The combination of 0.9995 availability of transmission and 0.9995 availability of receive for classes A1 through A3 results in availability of 0.999, allowing the use of ADS-B as a primary means of surveillance for some air-to-air operations. A lower availability is permissible for Class A0 receiver subsystems as ADS-B is expected to be used as a supplemental, rather than as a primary tool of separation, for this class.

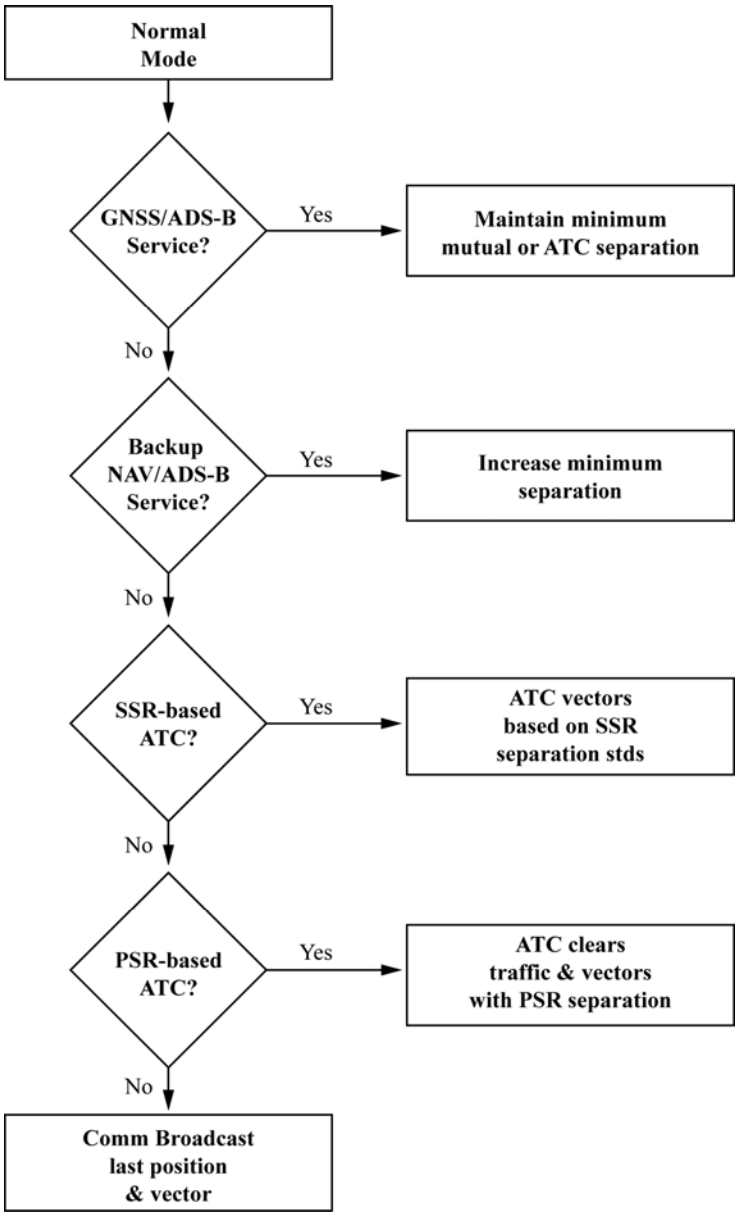

Figure 3-9 GNSS/ADS-B Surveillance/Navigation Failure Recovery Modes

3.4.3.6.4 ADS-B Continuity of Service

The probability that the ADS-B System, for a given ADS-B Message Generation Function and in-range ADS-B Report Generation Processing Function, is unavailable during an operation, presuming that the System was available at the start of that operation, **shall** (242AR3.38) be no more than 2×10^{-4} per hour of flight. The allocation of this requirement to ADS-B System Functions should take into account the use of redundant/diverse implementations and known or potential failure conditions such as equipment outages and prolonged interference in the ADS-B broadcast channel.

3.4.3.6.5 ADS-B Integrity – [Obsolete – refer to Link MOPS & Application MOPS & SPR's]

ADS-B integrity is defined in terms of the probability of an undetected error in a report received by an application, given that the ADS-B system is supplied with correct source data. The integrity of the ADS-B System **shall** (242AR3.39) be 10^{-6} or better on a per report basis. Appendix I contains information relevant to the development of high integrity end-to-end surveillance, conflict detection and management, and separation assurance applications using ADS-B.

Demonstration of compliance with ADS-B System integrity requirements will require a safety assessment to evaluate the System's implementation against known or potential failure conditions such as encoding, decoding and processing errors and interference in the ADS-B channel.

3.4.3.6.6 Subsystem Reliability

Each subsystem design should be capable of supporting ADS-B system Quality of Service (QOS) described in §03~~.3.6~~. Specifications of each subsystem implementation will define requirements necessary to support the QOS. The subsystem should provide reliability required for the intended service environment commensurate with the criticality levels supported. Requirements for single thread or redundant configurations will depend on the FAR category of the operator, the aircraft system approval requirements, and the airspace operations supported by the subsystems.

MOPS or other subsystem specifications should provide definitive allocation of reliability factors considering failure probabilities, detected and undetected failure effects and probabilities specifically applicable to acquiring/transmitting and to receiving/reporting ADS-B exchanged information. Reliability includes maintenance of integrity in the applicable broadcast exchange technology. Attributes of the subsystem and the specific exchange technology must be shown to meet the operational and system requirements of Sections **Error! Reference source not found.**~~2~~ and **Error! Reference source not found.**~~3~~ respectively. These requirements apply between all subsystems on a pair-wise basis. Assumptions pertaining to reliable exchange of data intended for use in separation support will be required to support certification and operational approval. All MOPS or other specifications governing implementations should define major design assumptions, system/subsystem allocations and means to validate the subsystem results.