2.1.5.3 *Adaptive acquisition*

2.1.5.3.1 For acquiring the last of the aircraft in a garble zone, an adaptive technique using II = 0 operates as follows:

a) all of the acquired aircraft in the beam dwell of the garble zone containing the unacquired aircraft are discretely interrogated and locked out to II = 0;

b) during the following scan, all-call interrogations are transmitted using II = 0, without lockout override; and

c) transponders will unlock to II = 0, 18 seconds after the last lockout command.

2.1.5.3.2 The reduced garble density will lead to rapid acquisition of the unacquired aircraft, or a determination that it is not Mode S-equipped. Since lockout is used only temporarily and selectively, only a minimum of coordination is required with neighbouring interrogators using lockout override to avoid conflict in the use of lockout to II = 0.

2.2 MODE S PASSIVE ACQUISITION

2.2.1 Need for passive acquisition

2.2.1.1 From the initial design to the present day, all Mode S scanning-beam interrogators have used an active approach (all-calls plus lockout) to acquire Mode S aircraft as described in 1.1 to 1.5 of this Appendix. This approach has two disadvantages:

a) it results in unnecessary all-call replies from aircraft beyond the interrogator's operating and lockout range; and

b) active acquisition requires the assignment of an II or SI code selected to permit non-conflicting lockout operation with all neighbouring Mode S interrogators that have overlapping coverage.

Passive acquisition's ability to provide significant reduction in all-call fruit (especially in areas where many Mode S interrogators are installed) and its ability to operate a Mode S interrogator without the need for an assigned interrogator code are both reasons for considering the use of this technique. The following paragraphs provide more detail on the advantages of operating without an assigned interrogator code.

2.2.1.2 The initial Mode S design had a total of 15 assignable interrogator codes (II Codes). As Mode S was implemented, it became necessary to increase the number of assignable interrogator codes, so a revision was made that added an additional 63 interrogator codes (SI Codes) for a total of 78 interrogator codes.

2.2.1.3 In the highest interrogator density in Europe, even this increased number of codes requires careful assignment in order to meet surveillance requirements that all overlapping coverage areas be assigned to different interrogator codes.

2.2.1.4 Mobile interrogators create a special challenge for the assignment of interrogator codes. These interrogators in particular can benefit from the use of passive acquisition of Mode S aircraft due to the ability to operate without an assigned interrogator code.

2.2.1.5 This section provides guidance on the use of passive techniques to acquire Mode S aircraft. Note that the passive acquisition system will develop information on aircraft being acquired that will have to be input and processed by the serviced Mode S interrogator. Mode S interrogators equipped with an interface for cluster operation can be

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interfaced with a passive acquisition system with little or no modification. More extensive modification will be required for existing Mode S interrogators without a cluster interface. (See the Explanation of Terms and 1.5 of this Appendix for more details on cluster operation.)

2.2.2 Mode S transmissions available for passive acquisition

Mode S transponder transmissions from airborne aircraft that can serve as the basis for passive acquisition are the following:

a) Mode S Acquisition Squitter: This 56-bit Mode S waveform is spontaneously transmitted approximately once per second by all Mode S transponders. This squitter is the principal means of Mode S acquisition by ACAS systems. It contains the 24-bit ICAO address as data and is protected by error detection and correction coding. The acquisition squitter has the same format as the Mode S-only all-call reply. See Annex 10, Volume IV, Figure 3-8 for the data format of this transmission.

b) Mode S Extended Squitter (ES): 112-bit ES transmissions are spontaneously generated by Mode S aircraft equipped for ES ADS-B. For airborne aircraft, the basic ES transmissions consist of 2 ES Airborne Position and 2 ES Airborne Velocity Squitters per second, plus one ES Identity and Category squitter per five seconds for a total of 4.2 per second as a minimum for ES-equipped aircraft. As per the acquisition squitter, the 24-bit ICAO address (as well as the ADS-B data) is protected by error detection and correction coding. See the *Technical Provisions for Mode S Services and Extended Squitter* (Doc 9871) for details of the data content of ES transmissions.

c) Mode S Replies to Addressed Interrogations: Mode S replies to addressed interrogations elicited from ACAS or nearby ground Mode S interrogators can also be used for passive acquisition. The 24-bit ICAO address is not contained in the message data but must be derived from the address/parity field. An error in the decoding of the message will result in a modified 24-bit address. Special processing is required to confirm a 24-bit address reception based on address correlation with future reply receptions. See Annex 10, Volume. IV, Figure 3-8 for the data formats of the replies to addressed interrogations.

2.2.3 Independence requirement for passive acquisition

A technique for passively acquiring a Mode S aircraft's 24-bit ICAO address and its position must have the same independence as active acquisition. For example,

a) ADS-B extended squitter can provide passive reception of the 24-bit address and position, but this technique is dependent on the ES reported position for successful acquisition. If the reported position is accidently (or intentionally) incorrect, the Mode S interrogator would not be able to acquire the aircraft. Aircraft not equipped with ES would also not be able to be acquired. Hence, ES is not an acceptable primary acquisition technique for a Mode S interrogator.

b) A wide area multilateration (WAM) system can provide a very accurate position estimate in addition to the 24-bit address based on acquisition or extended squitters. However, using such WAM data for Mode S acquisition would mean that the Mode S interrogator could not be considered independent of the MLAT system for system availability purposes. That is, a failure of the MLAT system would result in a failure of the Mode S interrogator. Therefore, a WAM system is not a suitable primary acquisition technique for a Mode S interrogator.

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2.2.4 Information requirements for passive acquisition

2.2.4.1 Using active acquisition, a Mode S interrogator obtains the range, azimuth and 24-bit ICAO address from aircraft replies to Mode S-only all-call interrogations. On a subsequent scan, the interrogator includes discrete interrogations addressed to the newly acquired aircraft at the azimuth and range obtained from the previous all-call replies. As shown in Figure H-4, discrete interrogations are formed into a tightly packed schedule to efficiently use the available dwell time.

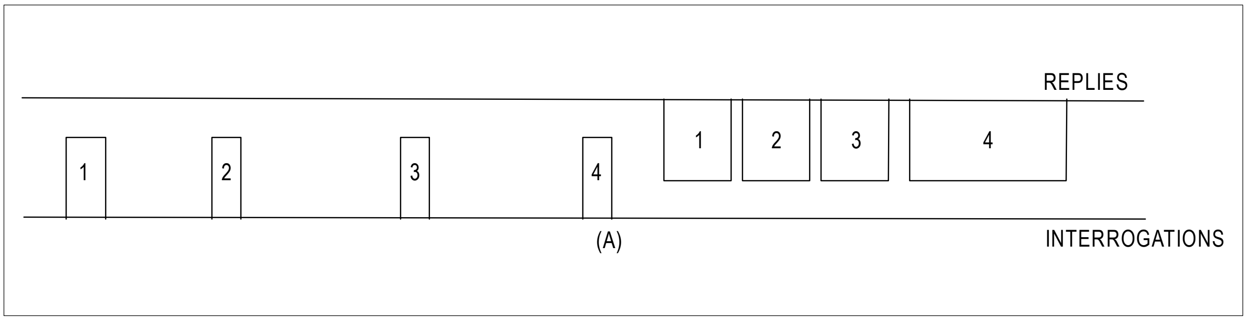

Figure H-4. Mode S discrete interrogation and reply scheduling

2.2.4.2 Efficient scheduling requires knowledge of the range of the newly acquired aircraft. Efficiency is important in order to make the best use of the available dwell time. After a successful initial discrete interrogation, regular roll call surveillance is performed using all-call lockout so that all-call replies from other aircraft entering the coverage area are not garbled by all-call replies from already acquired aircraft.

2.2.4.3 A passive system for Mode S acquisition must as a minimum provide the 24-bit ICAO address and an azimuth estimate. The azimuth estimate must be accurate enough to place the acquired aircraft in one or two beamwidths of the Mode S interrogator so that subsequent addressed interrogations can be made over a limited angle to reduce interference. The typical beamwidth for a Mode S interrogator is nominally 2.4 degrees.

2.2.4.4 The recommended technique for passive Mode S acquisition is a short-baseline multilateration (MLAT) system installed and operated near the interrogator. General details of MLAT system are provided in Chapter 5, 5.3.5 and Appendix L.

2.2.4.5 In cases where an MLAT array is not feasible (e.g. on a ship) an alternative technique that can be used is an omnidirectional antenna with angle of arrival (AOA) capability. This omni antenna can be placed at the centre of an electronically scanned antenna or placed near a scanning beam Mode S interrogator.

2.2.4.6 The above techniques can provide the 24-bit ICAO address and accurate azimuth but cannot provide accurate range without augmentation. Accurate range is very useful since it results in very efficient interrogation scheduling as shown in Figure H-4.

2.2.4.7 A description and expected performance of the short baseline MLAT system and the AOA approach are provided in the following sections. This is followed by sections on augmentation techniques to obtain range so that normal interrogation scheduling can be used, and also scheduling techniques if range is unknown.

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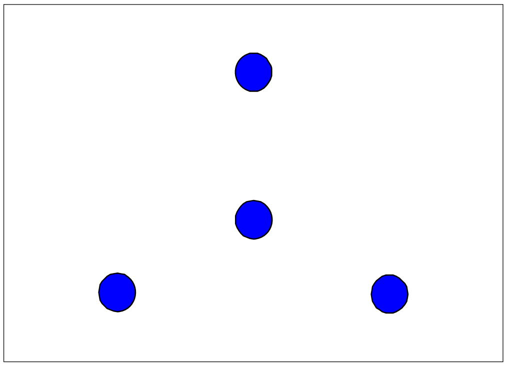

Figure H-5. Short baseline MLAT receiver configuration

2.2.5 Short baseline MLAT system for passive acquisition

2.2.5.1 Configuration: Figure H-5 shows the configuration for a 4 receiver 3D multilateration system with a 100 m baseline. The interrogator would be located near the central receiving station.

2.2.5.2 Error characteristics: Multilateration errors are normally expressed in terms of x and y but if they are expressed in terms of range and azimuth a useful characteristic of a multilateration system becomes apparent that is directly applicable to its use for passive Mode S acquisition. As will be shown, the azimuth error is relatively small but the error in range increases significantly once the target is outside the area of the receivers.

2.2.5.3 Azimuth error: Figure H-6 shows how the error of a 4 receiver 3D multilateration system varies for a 100 m baseline system. It can be seen that the bearing accuracy is accurate to a fraction of a bearing error in degrees. This shows excellent accuracy, typically 0.2 to 0.3 degrees. The error in Figure H-6 is based on a simulation result with 1 ns timing error. A timing error mainly depends on signal corruption (i.e. signal to noise ratio), quantization error and synchronization error. A nominal timing error in a real environment is expected to be about 30 ns.

2.2.5.4 Performance evaluation: The measured error of a short baseline MLAT with 100 m baseline in a real environment was based on Mode S signals transmitted by a traffic of opportunity. During short baseline MLAT performance evaluations in a real environment, bearing error of the targets was 4.6 degrees (1 σ) and the timing error of the targets was 23 ns (1 σ). The measured performance is sufficient to locate the aircraft to within the required two beamwidths for a Mode S interrogator. Note that this technique by itself provides no range information.

2.2.5.5 Range error: Figure H-7 shows a slice through the area indicating how the range accuracy changes throughout the region. Note that the range accuracy degrades rapidly outside the area enclosed by the receiver stations. It is seen that the range error exceeds 1 NM very rapidly outside the coverage area. For this 100-m baseline scenario the range error caused by a nominal (1 ns) timing error exceeds 1 NM beyond 3 km from the centre.

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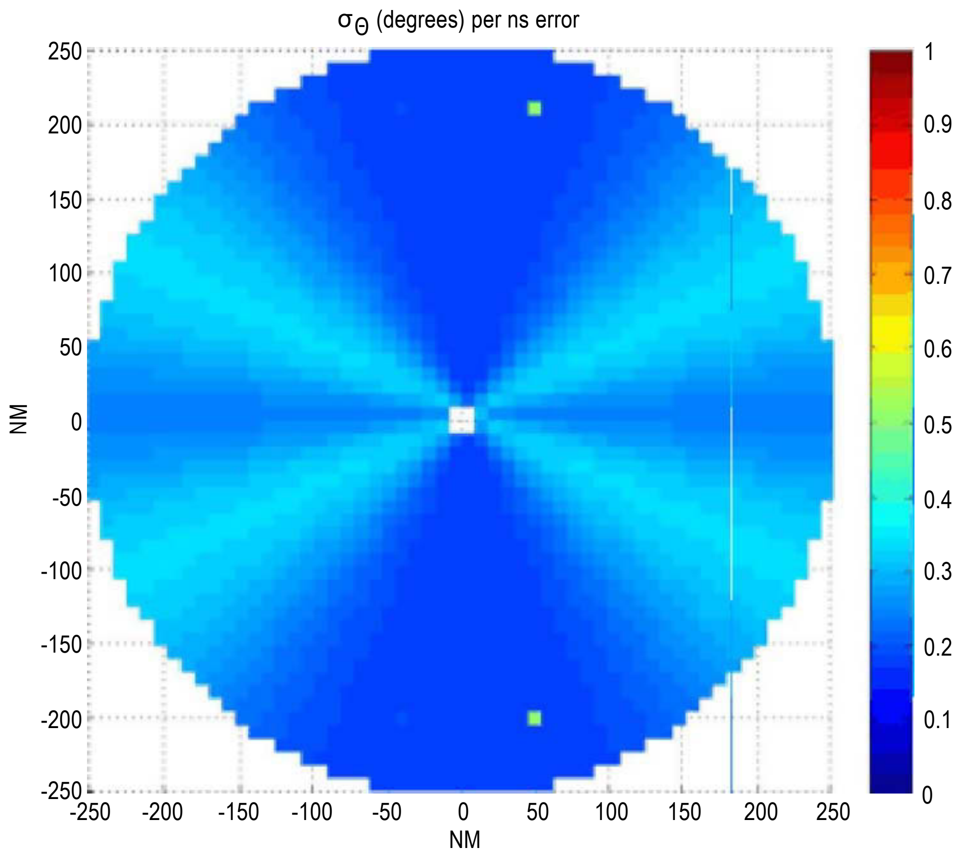

Figure H-6. Azimuth accuracy of a 100 m baseline multilateration system

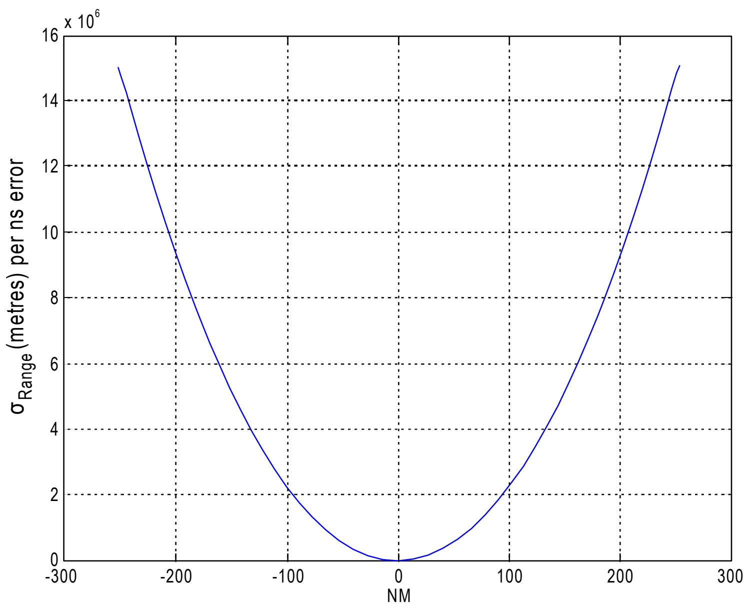

Figure H-7. Range and azimuth accuracy cuts for a 100 m baseline multilateration system

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2.2.6 Angle of arrival antenna (AOA) for passive acquisition

2.2.6.1 Configuration: For passive acquisition, a six-sector omnidirectional antenna will be used with a receiver and Mode S reply processor attached to each sector giving continuous 360 degree coverage. AOA is performed by using a monopulse technique based on the relative amplitude of the received signal on adjacent beams.

2.2.6.2 Detailed antenna characteristics: Antenna and physical specifications for the six-sector antenna are as follows:

Azimuth coverage:	60° Nominal for each lobe.
Peak of beam gain:	> 16 dBi.
Gain:	> 13 dBi throughout 60° sector including edges.
Size:	2.5 m high by 0.6 m in diameter.
Weight:	Approximately 115 kg.
Physical design:	Six radiating arrays backed by six reflector elements. Entire RF portion is protected by a radome.

2.2.6.3 AOA measurement technique: To measure the AOA performance for this antenna system, the squitters from two aircraft that were at a range of more than 200 NM were received and recorded. One of the aircraft (the target) was used to derive a direction-finding calibration curve, defining the azimuth offset of the target aircraft as a function of the difference in the power received by the two adjacent antenna channels for each squitter. Then the power levels in the two adjacent antenna channels of the squitters received from the other aircraft were used to evaluate the use of this calibration curve to measure its azimuth.

2.2.6.4 Measured AOA results: Using this calibration curve to estimate the azimuth of the target aircraft from the power differences in the two adjacent channels, the RMS error was 3.2 degrees. In a more realistic test, when the calibration curve is applied to the power differences of the squitters received from the other aircraft, the RMS error was 4.2 degrees. However, if 7-point smoothing is applied to the power differences before using the calibration curve to estimate azimuth, the RMS error reduces to 1.9 degrees.

2.2.6.5 Performance evaluation: The measured AOA performance was based on a once-per-second transmission for aircraft at long range. When used on a single one-second measurement, the AOA performance was 4.2 degrees. With smoothing this error was reduced to 1.9 degrees. Smoothing could be used on the higher squitter rate for aircraft equipped with ES to further reduce this error. Even without any smoothing, the measured AOA performance is sufficient to locate the aircraft to within the required two antenna beamwidths. Note that this technique by itself provides no range information.

2.2.7 Augmentation techniques to obtain range

2.2.7.1 *Mode S interrogator transmitter*

2.2.7.1.1 A technique can be employed to measure the range of aircraft to augment the azimuth-only information obtained from the short baseline MLAT or AOA systems. This approach is particularly attractive if the Mode S interrogator is equipped with an interface for clustered interrogator operation. (See the Explanation of Terms and 1.5 of this Appendix for more details on cluster operation.) When so equipped, a Mode S interrogator can be used to provide active range augmentation without any modification to the Mode S interrogator. The passive acquisition system will measure the azimuth of Mode S targets within radar coverage and maintain a track list of targets. Any measurement with

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a 24-bit address not on the track list is a newly acquired aircraft. The cluster interface will be used to instruct the radar to roll-call the aircraft being acquired at the correct azimuth but with a nominal range. In parallel the passive acquisition system will receive the interrogation and record the interrogation and reply times for this 24-bit address and calculate the range to the target. The cluster interface will then be used again to provide the correct position for the aircraft allowing the radar to acquire it using roll-call. This technique could also be used by modifying Mode S interrogators that do not have a cluster controller interface.

2.2.7.1.2 Note that the use of this technique requires a 1 030 MHz receiver, a Mode S interrogation processor and accurate time tagging of the interrogation and reply.

2.2.7.2 *Stand-alone transmitter*

2.2.7.2.1 For AOA-based passive acquisition systems the alternative exists to use a single transmitter that can be switched to any of the six sectors to make range measurements independent of the collocated Mode S interrogator. The system will transmit an interrogation to the aircraft to be acquired and measure its range. The 24-bit address, bearing and range will then be input to the Mode S interrogator for roll-call surveillance.

2.2.7.2.2 Note that this technique requires a 1 030 transmitter and a Mode S interrogation processor plus accurate time tagging of the interrogation and reply.

2.2.7.2.3 ES reported position: Available ES position can be used to obtain range for a short baseline or AOA system with or without active range augmentation. In the case that active range augmentation is used, the ES position will reduce the frequency of active interrogations and thereby reduce interference effects. In order to guard against acceptance of incorrect ES position data, the bearing derived from the ES data must be compared to that measured by the short baseline MLAT or AOA systems. If there is a discrepancy, the ES data will be discarded.

2.2.7.2.4 WAM position: Available WAM positions can be used to obtain range for a short baseline or AOA system with or without active range augmentation. In the case that active range augmentation is used, the WAM position will reduce the frequency of active interrogations and thereby reduce interference effects.

2.2.8 Scheduling addressed acquisition interrogations

2.2.8.1 Scheduling with a range estimate: If range is available in the acquisition information provided to the Mode S interrogator, the standard technique for interrogation and reply scheduling can be used (as shown in Figure H-4).

2.2.8.2 *Scheduling without a range estimate*

2.2.8.2.1 If no range estimate is available, a different approach to scheduling is required to avoid garble of addressed acquisition replies due to the unknown time at which the reply will be received. An interrogator using active surveillance separates the channel timeline into distinct periods for roll call and combined Mode A/C and Mode S all-call periods as shown in Figure H-8. An interrogator using passive surveillance will only perform Mode A/C surveillance in these periods. This presents an opportunity to use the Mode A/C periods for acquisition of Mode S aircraft whose range is unknown.

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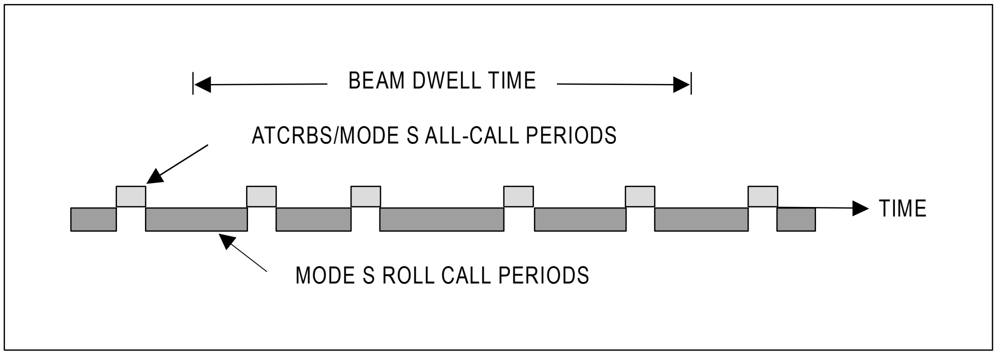

Figure H-8. Mode S interrogator channel periods

2.2.8.2.2 The approach is to schedule one or more addressed acquisition interrogations at the beginning of the Mode A/C period. Since the short P4 pulse will be used with Mode A/C interrogations, only non-Mode S aircraft will reply. This will ensure a low probability of addressed reply loss due to Mode A/C replies overlapping the addressed Mode S reply. If only one addressed interrogation is transmitted in a Mode A/C period, then the reply should be received with high probability since the Mode S error correction coding is optimized for decoding in the presence of a single Mode A/C overlap. In some cases it may be necessary to attempt acquisition of more than one Mode S aircraft in a single Mode A/C period (e.g. recovery of the track files after a period of interrogator failure). In this case, it is possible to have occurrences of overlapping Mode S replies. Successful decoding of overlapping Mode S replies is a much lower probability event.

2.2.8.2.3 The receipt of a Mode S reply that cannot be error corrected is an indication of a garble condition of two or more Mode A/C replies with the Mode S acquisition reply, or two (or more) overlapping Mode S replies. If this condition happened during normal all-call processing, the remedy would be to use the stochastic acquisition feature to command a reply probability of less than one to obtain a reply from only one of the aircraft of the garbling set. Reply probability cannot be commanded for an addressed interrogation, but scheduling another acquisition interrogation in the next Mode A/C period using a different relative interrogation time will achieve the same effect.

2.2.8.2.4 Once a successful reply is received to an acquisition interrogation, future addressed interrogations can be incorporated into the normal roll-call schedule.

2.2.9 Summary

2.2.9.1 This section has described a concept for passive acquisition of Mode S aircraft by a scanning beam Mode S interrogator. The benefit of passive acquisition is reduced all-call fruit and the ability to operate without an assigned interrogator code. Two techniques were described for obtaining the aircraft 24-bit ICAO address and bearing; a short baseline MLAT and an AOA antenna system. These systems can be augmented with active interrogation together with ES or WAM position to obtain range data. Two techniques for acquisition interrogation scheduling were described for the cases with or without range data.

2.2.9.2 The described technique for using the Mode S interrogator to obtain range is most attractive for adding passive acquisition to an interrogator with a cluster interface. The availability of this interface makes it possible to integrate passive acquisition capability with little or no modification to the Mode S interrogator.

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3. SURVEILLANCE PROTOCOL

3.1 The ground station's surveillance protocol should routinely elicit Mode C altitude in the Mode S surveillance reply. An additional interrogation to elicit the aircraft Mode A code should also be sent:

a) when the Mode S aircraft is acquired;

b) after a prolonged coast period; and

c) in the case of temporary or permanent alert.

3.2 An alert condition is reported in the FS field of every surveillance and Comm-B reply to indicate a change in Mode A code. If the new code is an emergency code (7500, 7600 or 7700), the alert condition remains active (i.e. it does not time-out). If the new code is not an emergency code, the alert condition resets after 18 (plus or minus 1) seconds. The interrogator should continue to elicit a Mode A response for one to two scans after the alert condition clears to ensure steady state reliability.

3.3 Knowledge of the current value of the transponder Mode A code is important to the ATC system since:

a) the code is used to signal emergency conditions; and

b) it is needed to identify an aircraft in handoffs to non-Mode S facilities.

3.4 Provision is therefore made in the FS field to notify the ground station when the Mode A code is changed during the flight.

4. UPLINK SLM DATA LINK PROTOCOL (COMM-A)

Note.— Comm-A interrogations are used for the ground-to-air transmission of SLMs. Before any such transfer is initiated, the interrogator has knowledge (from a previous capability report usually obtained when the aircraft is first acquired) of the Comm-A capability of the addressed aircraft.

4.1 COMM-A protocol precautions

4.1.1 If the transponder cannot pass the uplink SLM to the data link processing unit, it may not reply to that Comm-A interrogation. Some transponders are designed not to accept an interrogation if they cannot output the uplink message. However, a transponder in this state will continue to respond to short surveillance interrogations. In the event of loss of contact with an aircraft when using only Comm-A interrogations, a ground station should transmit one or more short interrogations to determine whether interface failure is preventing the transponder from replying. A change of data link capability is announced by the broadcast Comm-B message.

4.1.2 If separate transponder interfaces are used for ACAS and ADLP, the transponder must route selectively addressed Comm-A messages to the appropriate interface based on information in the Comm-A interrogation. Comm-A messages intended for ACAS are identified by DI = 1 or 7, TMS = 0 and the first eight bits of the MA field equal to 05 {HEX}. Messages identified for ACAS (including air-air MU messages) should be delivered to the ACAS interface but not to the ADLP interface. Messages that are not identified for ACAS should be delivered to the ADLP interface but not to the ACAS interface.

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4.2 COMM-A broadcast messages

Comm-A broadcast messages are intended for the transfer of a message to all aircraft within an azimuth sector. Depending upon operational needs, this sector can be as small as one beamwidth, or as large as a complete antenna rotation. Because of the absence of a transponder reply, the interrogator will not have positive confirmation that this message was received by a particular aircraft. For this reason, broadcast messages should be restricted to information that is retransmitted periodically in order to ensure a high probability of successful delivery. Comm-A broadcast messages should be transmitted at a rate that allows at least three transmissions within each azimuth sector corresponding to the antenna 3 dB beamwidth. This minimum transmission rate ensures a reasonable probability of delivering the broadcast Comm-A message in one antenna scan.

5. DOWNLINK SLM DATA LINK PROTOCOL (COMM-B)

5.1 Ground-initiated transfer of Comm-B messages

5.1.1 The GICB protocol allows for the immediate transfer of data required by the ground and the extraction of information stored in the transponder. This information (if available) is contained in the reply to an interrogation specifying the address (BDS code) of the storage location containing that information. Examples of information obtainable using the GICB protocol are “data link capability report” and “aircraft identification”. An example of a GICB message delivery is presented in Table H-4.

5.1.2 Airborne applications providing downlink data via the GICB protocol will update specific registers at a rate that is consistent with maintaining current information in those registers. A minimum rate of approximately 5 seconds is used to provide for recovery of the GICB register data in the event of a failure that causes the transponder to lose GICB data. If an interface used to load the GICB registers fails, the data in the registers will become invalid with no indication given to users of these messages. Transponder action in this case should be to clear those GICB registers being updated by this interface, with the exception of the data link capability Register (10_{16}). This register has a special protocol for failure detection. Upon recovery of this interface, the airborne applications will resume loading data into these registers. Recovery will be completed in approximately 5 seconds.

Table H-4. Example of GICB delivery of Register 35_{16}

Interrogation[a]	*Reply*[a]	*Relevant fields*	*Significance*
S or A		RR = 19[b]	GICB message with BDS1 = 3
		DI = 7	SD field contains RRS
		RRS = 5	BDS2 of requested Comm-B message
	B	MB	GICB message

Notes:
a) *S = surveillance (UF = 4, 5), A = Comm-A (UF = 20, 21), B = Comm-B (DF = 20, 21).*
b) *RR code value equals 16 plus the decimal value of BDS1.*

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5.1.3 If the transponder interface used to load the AIS in GICB Register 20_{16} fails, the transponder should clear the AIS and the AIS bit in the data link capability report. This will cause the transponder to broadcast a change in aircraft ID and a change in data link capability. This action can be independent from the general clearing of the GICB registers if a separate interface is used to load the GICB Register 20_{16}. The transponder will ensure that the BDS code 2,0 (bits 33–40) is set in the resulting Comm-B broadcast message.

5.1.4 ACAS will normally be provided with a separate transponder interface. The same protocol for clearing GICB registers in the event of an interface failure should be applied separately to the ACAS interface.

5.1.5 The transponder action, in the event of an interface failure, is a function of the type of data transferred by that interface. For example, if GICB and SLM data use separate interfaces, the transponder will be able to provide GICB data even in the event of an SLM interface failure. Since the SLM interface is used by the ADLP to load the data link capability report, failure of the SLM interface will cause this report to indicate zero data link capability even though the transponder is still capable of supporting the transfer of GICB data.

5.1.6 The readout of a GICB can occur at any time, since it is governed by the transmission time of the interrogators. These interrogations involve an access to the GICB registers. A second asynchronous activity involving register access is the process of updating the information in the GICB registers. It is important that safeguards be provided to ensure that a register update cannot occur during an access due to a received interrogation. This will avoid the error of providing data from a partially updated register in the reply to a GICB request.

5.2 Air-initiated transfer of COMM-B messages

5.2.1 COMM-B message announcement and closeout

5.2.1.1 An air-initiated Comm-B message waiting for delivery causes the DR code of every surveillance or Comm-B reply to be set to a value that indicates that an AICB message is waiting. To extract the Comm-B message, the ground station will transmit a request for a Comm-B message reply in a subsequent interrogation (RR = 16 and if DI = 7, RRS = 0). Reception of this request code will cause the transponder to transmit the Comm-B message. The Comm-B reply will continue to contain a DR code equal to ONE. The message will be cancelled and the DR code belonging to this message will be removed once a Comm-B closeout has been received.

5.2.1.2 This protocol can result in the reception of more than one Comm-B closeout instruction for a particular message if the interrogation containing the closeout is received by the transponder, but the ground station does not receive the reply. The absence of the expected reply will cause the ground station to repeat the interrogation at the next opportunity.

5.2.1.3 If the transponder has a second AICB message waiting to be transferred, it indicates its presence to the ground station by sending the appropriate DR code in its reply to the interrogation that delivered the Comm-B closeout acknowledgement to the previous message. Every effort should be made to deliver this closeout within the same beam dwell period as the message delivery in order to permit the announcement of subsequent messages waiting to be delivered. Note that the avionics must not permit a message to be closed out until after it has been read at least once. This prevents the multiple clears that can be received due to a downlink failure from closing out a second waiting message that has not as yet been transferred to the ground station. The possibility of downlink failure also prohibits the ground station from both reading and closing out a Comm-B message in the same interrogation because multiple delivery of such an interrogation could result in the loss of an undelivered Comm-B message.

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