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Proposed ATN Internet Architecture for CNS/ATM Package 1 - Profile A (CNS/ATM/1-A)

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SUMMARY

This paper proposes an architectural approach for the first element of CNS/ATM Package 1, referred to as "Package 1-A" (CNS/ATM/1-A). This profile is intended to allow construction of initial ATN aircraft and ground-based equipment implementations for validation and pre-operational trials purposes that require a minimum of new technology, while retaining essential features of the ATN architecture, such as dynamic recognition of mobile routers. This profile is especially suited for early trials implementations, and has been accepted as the basis for the European contribution to the North Atlantic ADS trials. A companion paper (ATNP WG/2-WP/37) presents detailed protocol requirements lists to support this proposal.

REVISION HISTORY

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1. Introduction

1.1 Scope and Purpose

This paper proposes an architectural profile for the first element of CNS/ATM Package 1, referred to in this paper as “Package 1-A” (CNS/ATM/1-A). This profile is intended to allow construction of initial aircraft and ground-based Aeronautical Telecommunication Network (ATN) equipment implementations requiring a minimum of new technology, while retaining essential features of the ATN architecture), such as dynamic recognition of mobile routers.

This architecture is designed to allow implementations of airborne and ground-based ATN Boundary Intermediate Systems (BISs) and End-Systems (ESs) to proceed immediately, using currently available technology, in order to support ATN validation and pre-operational trials. This profile is especially suited for early trials implementations of both airborne and ground-based routers (i.e. BISs) and ESs, and has been accepted as the basis for the European contribution to the North Atlantic Automatic Dependent Surveillance (ADS) trials.

1.2 References

	Reference	Title
1	ATNP/1/WP-4	ATN Manual (2nd Edition)
2	ATNP WG/2-WP1	Draft ATN Standards and Recommended Practices (SARPs) and Guidance Material (GM): Version 0.0
3	ATNP WG/2-WP/37	Proposed ATN Protocol Requirements List (PRL) for CNS/ATM Package 1: Profile A

1.3 Conformance to Applicable Documents

The profile is in general compatible with requirements detailed in the ATN Manual (Reference 1) and in Draft 0.0 of the ATN SARPs and Guidance Material (Reference 2). A companion paper, ATNP WG/2-WP/37 (Reference 3), presents a detailed Protocol Requirements List (PRL) for this profile.

This paper focuses on the elements of the ATN provisions (i.e. the provisions documented in the ATN Manual) that are of particular significance in the context of Package 1-A, i.e. those elements directly related to the establishment of dynamic routing information exchange with mobile BISs where the implementation of IDRP in those mobile BISs is optional. As such, this paper details certain extensions to or constraints upon the ATN provisions as documented in the ATN Manual. Elements of ATN provisions not explicitly noted or discussed in this paper are assumed to be implemented in Package 1-A in the manner indicated in the ATN Manual.

2. Key Attributes of the Package 1-A Architecture

2.1 Objectives for CNS/ATM Package 1-A

In developing the proposed initial architecture for CNS/ATM Package 1-A, certain objectives were identified as being particularly important. These objectives are listed in Table 1, along with comments providing insight into either the rationale behind the objective, or the objective itself.

Table 1: Objectives for Package 1-A

	Description	Comments
1	Conformance to Key ATN Manual and ATN Draft SARPs Provisions	This objective is essential to support ATN validation. The Package 1-A proposal varies from ATN Manual provisions in only two areas: a) A new requirement is postulated for routing initiation with mobiles not implementing the ISO 10747 Inter-Domain Routing Protocol (IDRP) while maintaining compliance with those that do implement IDRP; and, b) Non-conformance with certain mandatory protocol requirements list elements is proposed when necessary to support the goals of practicality and timeliness while having minimal effect on the utility of validation results.
2	Dynamic Mobile Routing Support	As this is an essential element of the value-added aspect of the ATN, Package 1-A proposes a routing structure which allows dynamic discovery of mobile (i.e. aircraft) routers and routing domains. This is done in a manner which avoids the need for immediate implementation of IDRP in aircraft systems, but retains compatibility with future mobile systems hosting IDRP.
3	Ground Support for Distribution of Mobile Routes	While the loss of detailed knowledge of available ground routes by aircraft systems implied in the previous objective is deemed acceptable, the ground topology is more complex in general, and would benefit from early introduction of IDRP. Thus, this proposal for Package 1-A includes the implementation of IDRP in ground BISs for distribution of both air/ground and ground-based routes to peer BISs.
4	Practical for Near-Term Implementations in Ground Systems and on-board Aircraft	It is viewed as essential to create a Package 1-A profile which can be implemented in the near-term in both aircraft and ground environments. While this does not necessarily mean that all existing aircraft and ground-based hardware/software systems are capable of hosting Package 1-A, it is essential to take practical and transition considerations into account to ensure that a significant aircraft and ground equippage can occur.
5	Reasonable Efficiency of use of Mobile Data Links	This Package 1-A proposal includes the use of the ATN mobile SNDCF with local reference capability required, but with other forms of data compression remaining optional. This approach has been proposed to avoid the case where the combination of low air-ground throughput and uncompressed data flows create a situation that cannot realistically be used for ATN validation.
6	Support for Validation Activities	This is an essential goal of Package 1-A and its successors.
7	Support for Trials Activities	Since it essential to gain practical experience in order to complement certain more formal validation exercises, this proposal for Package 1-A is tailored to support near-term trials activities.

2.2 Assumptions and Constraints

Use of the proposed Package 1-A architecture requires an understanding of the underlying assumptions and constraints. The following sub-sections summarize these key assumptions and any associated constraints. It is important to note:

- that the assumptions are necessary in order to satisfy all objectives in Table 1; and,
- that none of the resulting constraints interfere with the attainment of the objectives in Table 1.

2.2.1 Evolutionary Path for the Communication Infrastructure

The primary assumption in the design of Package 1-A is that ATN validation and pre-operational trials can commence with systems that, while not meeting all requirements in the ATN Manual, are clearly on a evolutionary path to full compliance with ATN Manual and Draft SARPs and Guidance Material provisions regarding the ATN communication infrastructure.

2.2.2 IDRP (ISO 10747)

The use of IDRP in the context of Package 1-A differs in several ways from the provisions of the ATN Manual and the Draft SARPs and Guidance Material.

2.2.2.1 Non-Use of IDRP in the Air/Ground Environment

It is proposed that mobile BISs not be required to implement IDRP in Package 1-A. If a mobile BIS does not support IDRP, however, that BIS must then implement a network entitiy relying upon the ISO 9542 End-System to Intermediate System (ES-IS) protocol Intermediate System Hello (ISH) Protocol Data Unit (PDU) exchange to dynamically manage mobile connectivity to the ATN internet. This is proposed in a way that ensures compatibility with ground BISs conforming fully to ATN standards and that ensures compatibility when operating in the same environment with other aircraft operating fully-compliant ATN network entities.

2.2.2.2 Optional QOS/Security Attributes and Optional Route Aggregation

The proposed protocol requirements for the IDRP implementation in Package 1-A are less stringent than those specified in the ATN Manual, particularly in the area of path attribute support and route aggregation. The Package 1-A proposal does not require support for the quality of service (QOS) attributes or the security attribute, but rather leaves these as implementation options.

2.2.2.3 Non-Use of the IDRP CAPACITY Attribute

The Package 1-A proposal does not require support for the capacity attribute. Note that the absence of the capacity attribute (for which support is required according to the ISO 10747 standard) must not cause a protocol error in a Package 1-A implementation or in subsequent implementations intended to interoperate with Package 1-A.

2.2.3 Routing and Addressing

The assumptions and constraints related to routing and addressing may generally be derived from the approach to implementation of IDRP in Package 1-A. Note that these assumptions represent the most significant constraints placed on Package 1-A; however, these constraints do not prevent the attainment of the objectives noted in Table 1.

2.2.3.1 Identification of IDRP Operation

The presence or absence of IDRP in an airborne Package 1-A implementations is assumed to be inferred from the Network Selector (N-SEL) component of the Network Entity Title (NET). The N-SEL value

`<0x00>` indicates a network entity containing IDRP, while the N-SEL value **`<0xff>`** indicates a network entity that does not contain IDRP.

2.2.3.2 Policy Decision-Making

Since IDRP is not required to be operated over the air/ground path, it may not always be possible to communicate routing information between the aircraft domain and its attached ground domain for support of policy decision making. This, in combination with the reduced capability of the proposed IDRP implementation, means that in general, routing infomation utility is constrained to the knowledge and distribution of connectivity information. Local policies can be applied within each ground BIS based on connectivity and domain identity (derived from NET and address prefix information), however.

2.2.3.3 Aircraft Domain Knowledge of Ground Domain Reachability

Since IDRP is not required to be operated over the air/ground path, , it may not always be possible to communicate information to the aircraft domain regarding ground domain reachability. An aircraft Package 1-A BIS thus assumes that upon establishing connectivity to any ground ATN BIS, any ATN destination domain is reachable.

2.2.3.4 Identification of Routing Domains

Since IDRP is not required to be operated over the air/ground path, there is no mechanism available to explicitly convey aircraft Routing Domain Identifiers to ground ATN BISs. The identity of the airborne domain is thus inferred from the first 11 octets of the airborne BIS NET. Thus, all aircraft end-systems must share this prefix.

2.2.4 COTP (ISO 8073)

In general, operation of the ISO Connection-Mode Transport Protocol (COTP) within Package 1-A conforms to the requirements of the ATN Manual. The only significant constraint proposed is that transport user priority must not be invoked. This constraint implies that the mapping of end-user application priorities to transport priorities (and thus to network layer priorities) is not possible.

2.2.5 CLNP (ISO 8473)

Operation of the ISO 8473 Connectionless-Mode Network Protocol (CLNP) within Package 1-A conforms to requirements established in the ATN Manual.

It should be noted that in the implementation of the CLNP Forwarding Information Base (FIB) in an air/ground BIS, appropriate means must be provided to link FIB entry management to mobile connectivity information acquisition.

2.2.6 ES-IS (ISO 9542)

Operation of the ISO 9542 ES-IS Protocol within Package 1-A conforms to requirements established in the ATN Manual.

It should be noted that in the absence of IDRP operation over air/ground paths, ES-IS timers must be set in a manner to emulate the IDRP “update” and “keep-alive” functions. This subject is described in detail in Section 3.

2.2.7 ATN Mobile SNDCF

Operation of the ATN Mobile SNDCF within Package 1-A conforms to requirements established in the ATN Manual.

It is further required that Package 1-A air/ground BISs implement local reference compression; however, stream compression remains optional. This subject is described in detail in Section 3.

3. Package 1-A Architecture Requirements

3.1 General Requirements

The proposed CNS/ATM Package 1-A communication architecture is based on the following requirements:

a) Ground ESs must support the ISO 8073 Connection-Mode Transport Protocol (COTP) Class 4 , the ISO 8473 Connectionless-Mode Network Protocol (CLNP), the ISO 9542 End-System to Intermediate-System (ES-IS) protocol and any Subnetwork Dependent Convergence Facilities (SNDCFs) required to access chosen ground subnetworks (e.g. Ethernet LAN, X.25, etc.).

b) Ground BISs must support the ISO 8473 CLNP, the ISO 9542 ES-IS protocol, the ISO 10747 Inter-Domain Routing Protocol (IDRP), the ATN Mobile SNDCF, and any SNDCFs required to access chosen ground subnetworks (e.g. Ethernet LAN, X.25, etc.).

c) Airborne ESs must support the ISO 8073 COTP Class 4, the ISO 8473 CLNP and any SNDCFs required to access chosen airborne subnetworks (e.g. ARINC 429 Williamsburg).

d) Airborne BISs must support the ISO 8473 CLNP protocol, a minimal implementation of ISO 9542 ES-IS protocol (see Section 3.2.2), a minimal implementation of the ATN mobile SNDCF (see Section 3.2.3) and any SNDCFs required to access chosen airborne subnetworks (e.g. ARINC 429 Williamsburg).

e) All systems must support the ATN NSAP Addressing Plan (as specified in Appendix 7 of the ATN Manual).

3.2 Specific Requirements Placed on Airborne Systems

In addition, specific requirements are placed on airborne systems protocol architecture, in order to simplify their implementation while allowing for a growth architecture. These requirements are described in the following sub-sections.

3.2.1 Requirements related to Routing Functionality

Airborne BISs:

a) may optionally support quality of service (QOS) based routing decisions, but must not reject CLNP Network Protocol Data Units (NPDUs) with QOS maintenance parameters set;

b) may optionally support security-based routing decisions, but must not reject CLNP NPDUs with security parameters set;

c) may optionally support ISO 10747 (IDRP), but must indicate their level of routing service to ground peers as described in Section 3.2.2: and,

d) if not supporting IDRP shall accept NPDUs addressed to the airborne NSAP with an N-SEL set to **<0x00>** (i.e. addressed to a network entity containing IDRP), but shall ignore their content (i.e. an airborne router opting not to implement IDRP shall gracefully ignore any NPDUs containing IDRP PDUs that may be sent to the aircraft).

3.2.2 Requirements related to the Air/Ground Operation of ISO 9542

Airborne routers operating over an ISO 8208 subnetwork that provides connectivity information (refer to Section 6.1.2 of the ATN Manual) may optionally not support the full ISO 9542 (ES-IS) protocol, but must support as a minimum the capabilities described in the following sub-sections, based on the airborne BIS operating role.

3.2.2.1 Operation in the "Initiator Role"

The following procedures and requirements apply to an airborne BIS operating in the "initiator role" while connected to an ISO 8208 subnetwork that provides connectivity information (e.g. the aeronautical satellite subnetwork), as specified in Section A6.1.2 of the ATN Manual.

Airborne BISs must provide the following capabilities:

a) Accept any incoming Intermediate System Hello (ISH) PDU from the ES-IS protocol and update the local router Forwarding Information Base (FIB) accordingly (i.e. with NET/DTE/SNPA address mapping information).

b) Upon reception of a join-event notification from the local subnetwork interface unit (e.g. the notification of successful GES logon from a Data-3 SDU), generate an ISH (as per ISO 9542, and the ATN Manual, Section A6.1.2.2.1) containing the NET of the local airborne router to all appropriate remote ground routers, as qualified below:

   i) The routers with which an ISO 9542 dialog takes place (i.e. the "appropriate routers") must be locally known, based on static, dynamic, or configurable procedures. In the case of the satellite subnetwork, the routers reachable via the connected GES are known by means of a table containing a list of reachable router Data Circuit-Terminating Equipment (DTE) and Subnetwork Point of Attachment (SNPA) addresses associated with a particular Satellite, Satellite Beam and GES ID. The ID of the connected GES (including the satellite ID and beam ID) provides an index into that table, and the receipt of a join-event allows the tagging of the associated entries in that table as "reachable".

   ii) The local NET value reported to the remote (i.e. ground) BIS must have an N-SEL field set to **`<0x00>`** when the airborne router supports ISO 10747 (IDRP) and an N-SEL value set to **`<0xff>`** when the airborne router does not support IDRP. The ground router is expected to adapt to the mode of operation offered by the airborne router.

   iii) The holding time in the ISH PDU should be set to an infinite value in the case where IDRP is operated over the air/ground path, as recommended in the ATN Manual. If the airborne router does not support IDRP, the holding time must be set to a value of **<3>** minutes.

c) If the airborne router does not support IDRP over the air/ground path, these ISH PDUs must be sent periodically, with the format and content described above, at a rate compatible with the holding time specified in the initial ISH PDU. Note that this is counter to the recommendation in the ATN Manual, Section A6.1.2.2.1, but is required in the absence of the air/ground operation of IDRP. In this situation, the periodic ISH PDUs function in the manner of the IDRP keep-alive functionality.

3.2.2.2 Operation in the "Responder Role"

The following procedures and requirements apply to an airborne BIS operating in the "responder role" while connected to an ISO 8208 subnetwork that provides connectivity information (e.g. the Mode S subnetwork), as specified in Section A6.1.2 of the ATN Manual.

Airborne BISs must provide the following capabilities:

a) Accept any incoming Intermediate System Hello (ISH) PDU from the ES-IS protocol and update the local router Forwarding Information Base (FIB) accordingly (i.e. with NET/DTE/SNPA address mapping information).

b) Upon reception of an incoming ISH PDU from the BIS acting as the "initiator" (i.e. in this case, the ground BIS), generate an ISH (as per ISO 9542, and the ATN Manual, Section A6.1.2.1.1) containing the NET of the local airborne router to that ground router, as qualified below:

    i) The local NET value reported to the remote (i.e. ground) BIS must have an N-SEL field set to **`<0x00>`** when the airborne router supports ISO 10747 (IDRP) and an N-SEL value set to **`<0xff>`** when the airborne router does not support IDRP. The ground router is expected to adapt to the mode of operation offered by the airborne router.

    ii) The holding time in the ISH PDU must be set to an infinite value in the case where IDRP is operated over the air/ground path. If the airborne router does not support IDRP, the holding time must be set to a value of **<3>** minutes.

c) If the airborne router does not support IDRP over the air/ground path, these ISH PDUs must be sent periodically, with the format and content described above, at a rate compatible with the holding time specified in the initial ISH PDU. Note that this is counter to the recommendation in the ATN Manual, Section A6.1.2.1.1, but is required in the absence of the air/ground operation of IDRP. In this situation, the periodic ISH PDUs function in the manner of the IDRP keep-alive functionality.

3.2.3 Requirements related to the ATN Mobile SNDCF

Airborne BISs:

a) must support the local reference compression mechanism defined for use in the ATN mobile SNDCF (refer to Section A10.6.4.3.2 of the ATN Manual; and,

b) may optionally support one or more of the stream compression mechanisms defined for use in the ATN mobile SNDCF (refer to Section A10.6.4.3.2 of the ATN Manual), but must, as a minimum, support negotiation of the use or non-use of these compression mechanisms.

4. Package 1-A Protocol Conformance Requirements

Protocol conformance requirements proposed for Package 1-A are documented in Protocol Requirements List format in a companion paper, ATNP WG/2-WP/37.

5. Example of Package 1-A Operation

The purpose of this section is to describe the operation of the system, based on the specific implementation requirements described above. This description is presented in the context of an aircraft-initiated join/leave procedure operating over the aeronautical satellite subnetwork, with connectivity possible to three ground domains.

5.1 Elements of the CNS/ATM Package 1-A Architecture

A topology illustrating key elements of the proposed Package 1-A architecture is given in Figure 1. This topology assumes one airborne routing domain (RD), referred to as RD/A, and three ground RDs, referred to respectively as RD/1, RD/2 and RD/3. The notation for ESs and BISs located in a particular routing domain uses the RD number as the first digit of the reference, and the system number as the second digit. Thus, for example, the second ES in RD1 is known as “ES/1.2”. Other key elements include the Aircraft Earth Station (AES) Satellite Data Unit (SDU) avionics, and the Ground Earth Stations (GESs). Also, within each ground domain, a local area network (LAN) is indicated by the bold bar to which the ESs and BISs are connected, while a wide area network (WAN) or direct connection is indicated by a curved line between two systems. Between the satellite and the SDU and GESs, an air/ground radio link is shown as a bold dashed line.

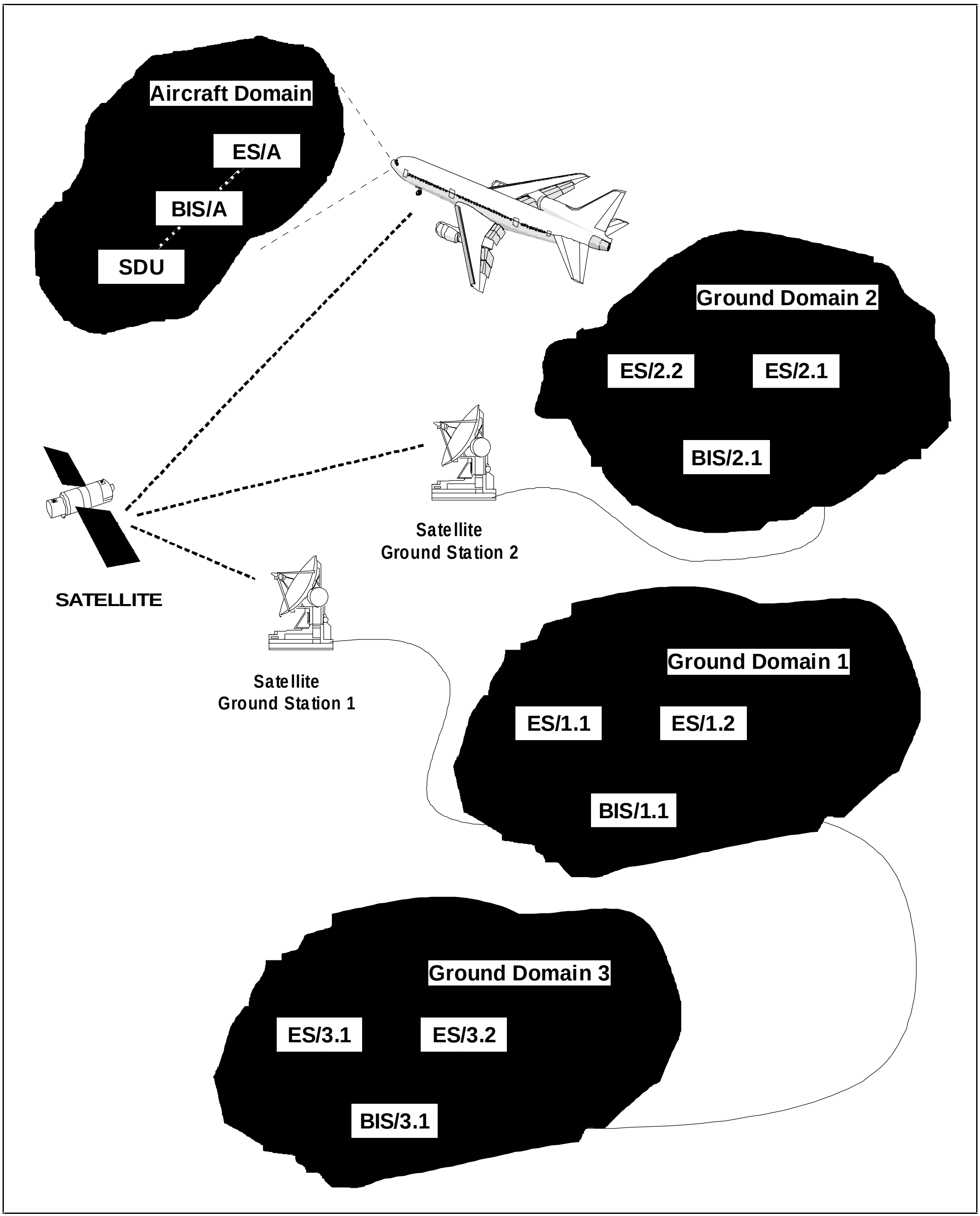

Figure 1: CNS/ATM Package 1-A Topology using Satellite Air/Ground Connectivity

Note that this topology assumes that RD1 and RD2 (i.e. Ground Domains 1 and 2) have air/ground connectivity through the satellite subnetwork (i.e. through direct connectivity to a ground earth station), while RD3 (i.e. the third ground domain) can only reach aircraft through RD1.

Note also that in the figure, the aircraft BIS, ES and SDU are illustrated as separate devices connected via an on-board subnetwork (e.g. an ARINC 429 data bus); however, this is not a necessary aspect of the example topology. In early trials equipment, it is likely that the ES and the BIS would be hosted in the same hardware unit, and thus require no data bus between them. Likewise, internal details of ground domains may vary, particularly in the area of local area networking and wide area network connectivity.

5.2 Aircraft Acquisition (Join Event Processing)

A typical sequence of operation for aircraft acquisition in the topology shown in Figure 1 would be as follows:

a) When the airborne AES/SDU logs on to a GES, the GES identity is reported to the airborne router as specified in the ATN Manual (i.e. a fast select call request contining the appropriate user data field). This constitutes the join event, reporting connectivity establishment between a particular GES and a particular AES, via a particular satellite/beam.

In this example, the sole logon is assumed to be with GES/1.

b) Upon receipt by BIS/A of the subnetwork Join Event containing the identifier (ID) of the reachable GES (for example, GES/1), the airborne router opens a virtual circuit with each DTE specifed as reachable via that GES in the DTE table (described above), and sends an ISH PDU, as specified above.

In this example, the sole ground DTE destination address would be that of BIS/1.1, and the airborne N-SEL set in the ISH PDU send to BIS/1.1 would be `<0xff>`, indicating that BIS/A does not support IDRP.

c) Upon receipt of the airborne ISH PDU, the ground router (BIS/1.1) will update its FIB accordingly and will send an ISH with its own NET and an infinite holding time to BIS/A. Then the following process would commence:

i) Based on the SEL value of the received airborne NET (i.e. from BIS/A), the ground router will either establish an IDRP BIS to BIS connection, in the case of an IDRP-equipped aircraft, or will update the IDRP Routing Information Base (RIB) and the FIB directly through local management action, in the case of a non IDRP-equipped aircraft. In the case of an IDRP-equipped aircraft, the RIB will be updated by IDRP directly.

In this example, an IDRP BIS to BIS connection would not be attempted by BIS/1.1 with respect to BIS/A, as the received N-SEL value was `<0xff>`, indicating that BIS/A does not support IDRP. The N-SEL value transmitted from BIS/1.1 to BIS/A would be `<0x00>` in this case, indicating to BIS/A that BIS/1.1 supported IDRP; however, what BIS/A does with this information is a local matter.

ii) In all cases, updating the ground RIB will trigger the local routing decision process and allow route propagation to other connected ground-based IDRP-equipped BISs.

In this example, route propagation would occur between BIS/1.1 and BIS/3.1 if the administrators of RD/1 and RD/3 had authorized this mode of operation; and if this took place, systems in both RD/1 and RD/3 would then be capable of reaching systems connected to BIS/A. Thus, traffic generated by ESs in RD/3 and destined for RD/A would be forwarded by BIS/3.1 to BIS/1.1 for relay to RD/A. Traffic generated by ESs in RD/1 would be relayed directly to RD/A by local BIS/1.1.

On the other hand, BIS/2.1 would remain ignorant of RD/A, due to its lack of connectivity with either RD/1, RD/3 or RD/A, and would not attempt to

foward traffic destined for RD/A toward any external domain. This traffic, were it to be generated by an ES within RD/2, would be discarded internal to RD/2, probably by BIS/2.1.

d) Upon receipt of the ground ISH PDU, the airborne router will update its FIB. The routing decision process for downlink transmissions is local to each airborne router, but must assume complete ATN connectivity on the ground.

In this example, this means that any BIS/A will believe that traffic can be forwarded to any ground destination via the router NET identified in the FIB, i.e. via BIS/1.1. Thus, traffic destined for RD/1 or RD/3 would be forwarded to BIS/1.1, which is capable of relaying that traffic toward the destination ESs. Note, however, that traffic originating in RD/A that is destined for RD/2 (or any other RD for that matter) would be forwarded to BIS/1.1, and then discarded by that BIS.

e) The airborne router continues sending ISH PDUs to the ground BISs in the DTE table at a rate compatible with the ISH holding time specified above. The ground router (BIS/1.1) tracks receipt of these PDUs against the prescribed holding time interval.

In this example, the periodic ISH PDUs would be sent to BIS/1.1.

Once the previous set of actions have been performed, routes now exist from the aircraft routing domain point of view (i.e. RD/A) to all ground ATN routing domains via any ground BIS whose NET is now in the airborne FIB.

In this example, the only ground BIS known to BIS/A is BIS/1.1; thus, any ATN ground domains with which communication is desired by an RD/A ES would be assumed reachable through BIS/1.1.

Also, routes now exist from certain ground routing domains to the aircraft routing domain based on IDRP information propagation on the ground. This information reflects existing connectivity status only, with no QOS or Security contraints applied. At this point, and in consideration of the constraints noted above, air/ground communication can commence.

5.3 Detection of Aircraft Leaving Coverage (Leave Event Processing)

A typical sequence for aircraft leave detection would be as follows:

a) When the aircraft loses connectivity and/or logs off with the GES, a leave event is generated from the AES/SDU to the airborne router as specified in the ATN Manual.

In this example, the information indicates that GES/1 is no longer reachable.

b) Upon receipt of the leave event, the airborne router clears the FIB entries associated with the GES DTEs. At this point, no more communication via the associated ground routers is possible from aircraft systems. If the aircraft is IDRP equipped, the airborne router terminates IDRP connections with these routers.

In this example, BIS/A will now assume that only destinations internal to RD/A are reachable, and that all externally-addressed traffic should be discarded.

c) On the ground, certain housekeeping actions will commence upon loss of air/ground connectivity:

i) In the case of a non IDRP equipped aircraft, the ground router(s) will clear the FIB entry for the airborne NSAPs and NET and will update the RIB accordingly, based on the lack of receipt of an ISH PDU from the airborne router within the appropriate interval.

ii) In the case of an IDRP equipped aircraft, the ground router will automatically update the FIB and RIB, based on lack of reception of the airborne KEEPALIVE IDRP PDUs within the appropriate interval.

iii) In all cases, the RIB update will be propagated to adjacent ground BISs using IDRP, thus informing other ground domains that the previously existing route to the aircraft no longer exists.

In this example, BIS/1.1 will detect the loss of periodic ISH PDUs from BIS/A, and will purge the BIS/A connectivity information from the its RIB and FIB. This will in turn trigger the local IDRP decision process, resulting in the removal of the route to RD/A from the routes advertised to RD/3. BIS/3.1 will then adjust its own RIB and FIB, declaring RD/A to be now unreachable. Any traffic destined for RD/A via either BIS/1.1 or BIS/3.1 will thereafter be discarded.

5.4 Summary of Information/Status following Join/Leave Sequences

Following the sequences described above, the following situation exists, after completion of either join or leave event processing:

1 An airborne BIS is aware of the presence or lack of connectivity to a ground BIS via a specific GES and satellite/beam.

2 The ground BIS (connected to that specific GES) is aware of connectivity to the airborne BIS.

3 Link availability is continually monitored based on the issuance by the airborne BIS of ISH PDUs to that ground BIS.

4 Other ground BIS(s) may be made aware of a route to that airborne BIS, via the IDRP protocol, and based on ground connectivity and administrative arrangements.

6. Conclusions and Recommendations

This paper has presented a detailed proposal for an initial ATN internet architecture profile for CNS/ATM Package 1, referred to herein as “Package 1-A”, along with the rationale for its design and and example of its use. In order to support the commencement of ATN validation using the Package 1-A ATN internet architecture, certain actions are required from ATNP Working Group 1 and Working Group 2. Thus, this paper is presented to both groups, with the respective proposed actions detailed below.

6.1 Working Group 1 Proposals

It is proposed that Working Group 1:

1. endorse the scope and purpose of CNS/ATM Package 1-A as described in Section 1.1;
2. endorse the objectives for CNS/ATM Package 1-A as described in Section 2.1; and,
3. endorse the assumptions and constraints for CNS/ATM Package 1-A presented in Section 2.2.

6.2 Working Group 2 Proposals

It is proposed that Working Group 2:

1. endorse the detailed requirements for CNS/ATM Package 1-A presented in Section 3;
2. endorse the conformance requirements as referenced in Section 4 (detailed in the companion working paper ATNP/WG2-WP/37); and,

3. develop the necessary change proposals for the Draft SARPs and Guidance Material document.