International Civil Aviation Organization

Fourth ATN Transition Task Force Meeting

Mumbai, India, 8 - 12 April 2002

Agenda Item 3: Review ATN technical documents and transition issues

ATN ROUTING POLICY FOR ASIA AND PACIFIC REGION

(Presented by USA)

SUMMARY

This paper is an update to the initial version of the ATN Routing Policy for the Asia and Pacific region, which was presented at the previous meeting of the ATN Transition Task Force (ATNTTF) Ad Hoc Working Group B in Chiang Mai, Thailand in December 2001. This document incorporates general comments from the Chiang Mai meeting, input from a related working paper, and further analysis of the initial set of policy requirements.

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Executive Summary

This document provides global policy for Aeronautical Telecommunication Network (ATN) routers operating in the Asia Pacific Region in support of Air Traffic Services Message Handling Services (ATSMHS) and other ATN services.

Background

The ATN Transition Task Force (ATNTTF) has been assigned a number of tasks to prepare the region for the introduction of the ATN. At the third meeting of the ATNTTF Working Group B meeting held in Bangkok, Thailand on 27 through 30 August 2001, a specific action item was identified to develop documentation on Routing Policy. This document is in response to that action.

Overview

This document presents relevant background information on routing and provides a general discussion of policy-based routing. With this background, policy is specified for backbone routers in support of inter-regional, intra-regional and local connectivity.

1. INTRODUCTION

The Aeronautical Telecommunication Network Transition Task Force is preparing a series of documents, which will govern the introduction of the ATN into the Asia and Pacific region. This document is to be the basis of ATN routing policy for the region.

1.1 OBJECTIVES

The objective of this document is to specify global policy for Aeronautical Telecommunication Network (ATN) routers operating in the Asia and Pacific Region in support of Air Traffic Services Message Handling Services (ATSMHS) and other ATN services.

1.2 SCOPE

The scope of the document includes:

- an introduction to relevant routing concepts;
- an overview of the Inter-domain Routing Protocol (IDRP) and the rational for its use in the ATN
- a summary of the ATN Routing Architecture for the Asia and Pacific Region; and,
- routing policy requirements for backbone routers in the Asia and Pacific Region.

1.3 REFERENCES

Reference 1 Manual of Technical Provisions for the ATN (Doc 9705-AN/956) Second Edition 1999.

Reference 2 ATN Routing Architecture Plan for the Asia and Pacific Region

Reference 3 ISO/IEC TR 9575, Information technology – Telecommunications and information exchange between systems – OSI Routeing Framework

Reference 4 ISO/IEC 10747, Information technology – Telecommunications and information exchange between systems – Protocol for Exchange of Inter-domain routeing Information among Intermediate Systems to Support Forwarding of ISO 8473 PDUs.

Reference 5 ATN Addressing Plan for the Asia and Pacific Region

2. ROUTING

2.1 ROUTING CONCEPTS

In this document the primary concern is routing through the ATN at the network layer. In order to establish a common framework within which routing may be examined, certain fundamental concepts are described. See Reference 3 for more detailed information.

The routing process in any network involves a forwarding function and a route maintenance function. Forwarding refers to those actions, which result in actual relaying of network packet data units (NPDUs) through nodes in the network. Route maintenance refers to the update of the Routing Information Base. Route maintenance may be static, in which case, it is performed through management operations in either an on-line or off-line mode, or it may be dynamic (also generally referred to as adaptive routing). Dynamic route maintenance involves the exchange of routing packet data units (RPDUs). RPDUs may be received from a single source such as a Network Control Center, in which case, routing is said to be centralized. Alternatively, RPDUs may be exchanged among the nodes in a network, in which case routing is said to be distributed. See Figure 2-1. In the ATN a distributed adaptive routing procedure is adopted.

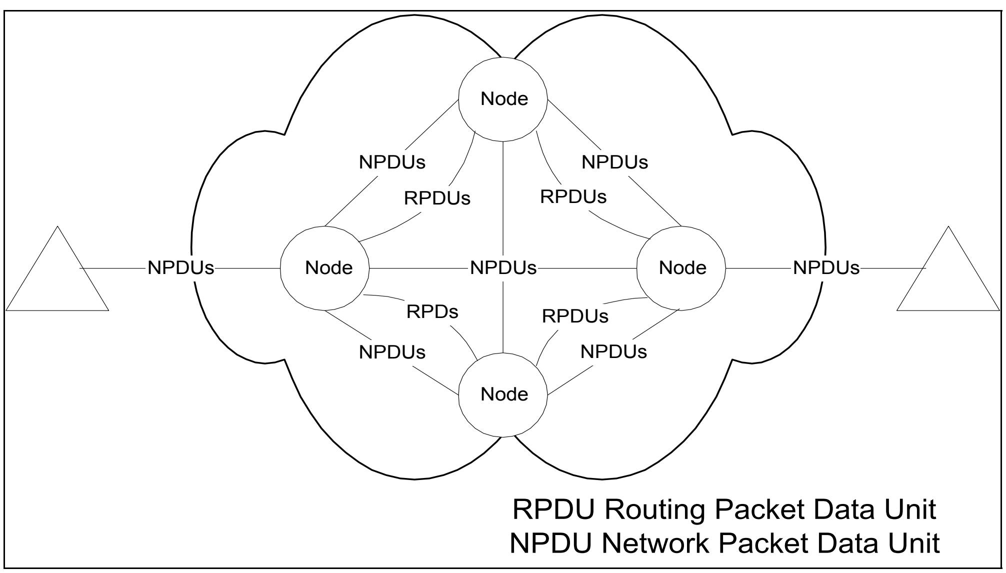


Figure 2-1. Exchange of NPDUs and RPDUs in Generic Network Environment

The route maintenance and forwarding functions are conceptually connected through a decision process as depicted in Figure 2-2. The decision process determines which routes are accepted into the routing information base, which routes are placed into the Forwarding Information Base in support of the forwarding function, and which routes are to be advertised to other nodes in the network. As will be described in more detail below, the decision process is affected by policy.

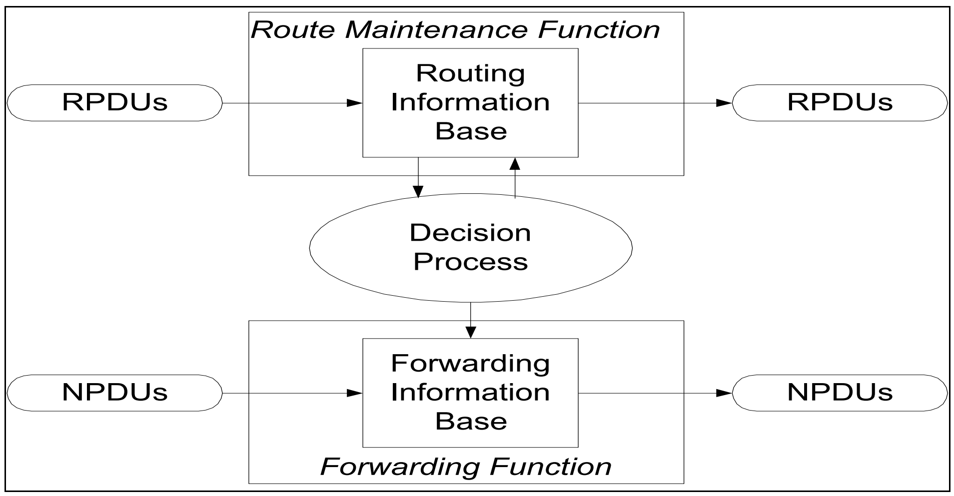


Figure 2-2 Routing Functions

2.2 INTER-DOMAIN ROUTING PROTOCOL (IDRP)

In this section the rational for the use of IDRP in the ATN is summarized. The three general reasons for using IDRP are support for mobility, support for policy-based routing, and support for secure exchange of routing information.

2.2.1 SUPPORT FOR MOBILITY

A fundamental objective of the ATN is to maintain connectivity from ground-based ATSC and AOC end systems to the airborne counterpart. This is to be accomplished over multiple subnetworks, that is, over the various VHF Digital Links, over Mode_S and over AMSS. This objective is essentially a routing problem. If we consider the general approaches to routing, it is immediately obvious that static routing would not work. As indicated previously, aircraft traverse multiple subnetworks and within each subnetwork they traverse multiple ground stations. Thus we are left with some type of adaptive routing. A centralized approach to adaptive routing has the problem that the central control center where changes would be reported becomes a bottleneck, especially in a global environment. Even if enough capacity could be provided, there are associated timing considerations, that is, a reported change in an aircraft's location must be available to communicating ground end systems in real time. There are also administrative considerations with centralized adaptive routing. These considerations include determining which administration (a particular CAA, service provider, etc.) would operate the central control center and what are the liabilities associated with such an operation. Therefore, since neither static routing nor centralized adaptive routing would be appropriate, we are led to some type of distributed adaptive routing approach as the solution to mobility.

There are two general approaches to distributed adaptive routing. The first is called *link state* routing. Under link state routing, each change in the network topology (in connectivity to an aircraft in the context of support for mobility) is broadcast to every other node in the network. Upon receipt of each change message, each node updates its image of the network topology and calculates the complete (shortest) path to the destination in the change message. The problem with this approach is that number of messages required to report changes in network topology becomes quite large in a global environment. Thus we arrive at the second distributed adaptive routing approach, which is *distance vector* routing. Under distance vector routing, a change in connectivity is propagated (i.e., advertised) to affected ATN routers throughout the network. The RPDU consists of a vector containing a destination prefix and a distance metric, which is generically a measure of the cost associated with the path being advertised to a particular destination.[1] The difference however (from link state routing) is that not all routers need

[1] In the context of the OSI Routeing Framework (Reference 3) IDRP would be classified as a distance vector routing protocol. However, in the technical literature, IDRP is often called *path vector* routing protocol. This is because IDRP can advertise multiple metrics called path attributes associated with a particular route to a destination rather than a single distance metric.

be affected. In other words, not every router needs to know about every change. Particular changes need only be propagated to a point where a choice of routes is to be made. Beyond that point either an aggregate route may be advertised to other routers or these routers may be configured with a default path to that point. For example, a service provider with a ground-ground router connected to a CAA's backbone router on one side and with connections to multiple service provider air-ground routers on the other side may not need to advertise a new route each time an aircraft connects to a new air-ground router. The service provider ground-ground router may rather only advertise an aggregate route to the backbone router when the aircraft connects with the first air-ground router and withdraw the aggregate route when the aircraft is no longer connected to any air-ground router. At the same time, non-backbone routers belonging to the CAA need not receive routes to individual aircraft but rather may be configured to forward all aircraft NPDUs to the backbone router.

2.2.2 SUPPORT FOR POLICY-BASED ROUTING

2.2.2.1 IDRP Model of Operation

ATN routers execute a particular distributed adaptive routing protocol for route maintenance. The protocol is labeled IDRP which stands for Inter-domain Routing Protocol (Reference 4). Figure 2-3 depicts a simplified model of IDRP route maintenance and CLNP forwarding.[2]

In the context of IDRP, an ATN router is a Boundary Intermediate System (BIS), and accordingly the routing PDUs exchanged are called BISPDUs. Similarly, in the context of CLNP, the forwarded NPDUs are called CLNP PDUs. As depicted in the figure and described in the following section, the IDRP decision process is conditioned by a policy base.

[2] The model of routing components in this document is a simplified form of the IDRP model. The IDRP specification (Reference 4) contains a more detailed model involving the concept of a multiple local RIBs for combinations of path attributes.

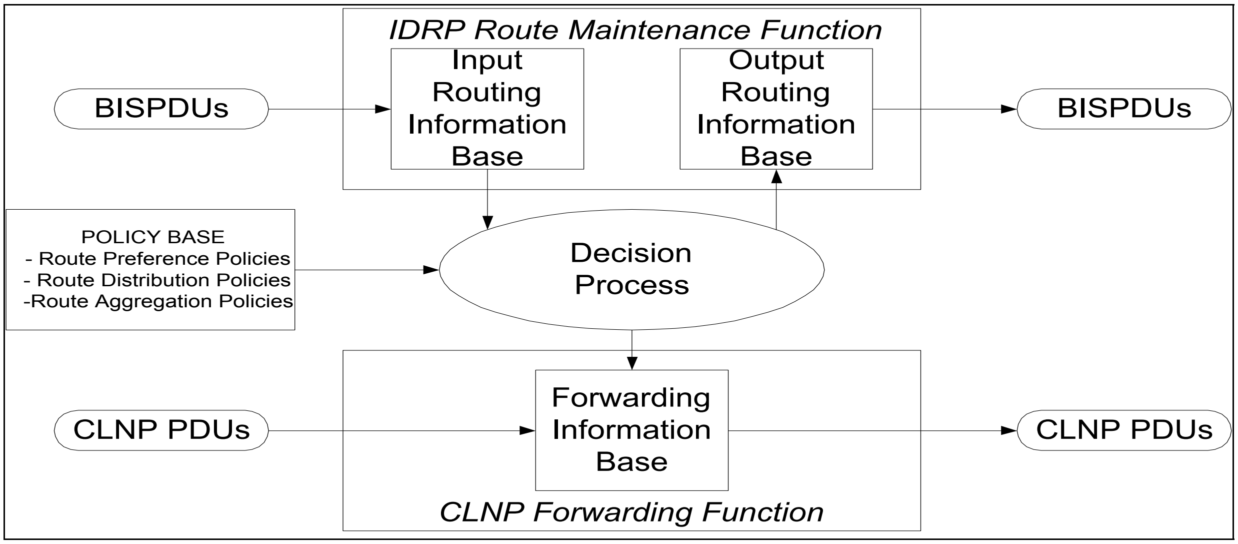


Figure 2-3. IDRP Route Maintenance and CLNP Forwarding

2.2.2.2 Types of Policy

The IDRP decision process (and thus ATN routing policy) is conditioned by three types of policy concerns.

- *Route Preference* policies determine which routes received in BISBPUs will be installed in the Forwarding Information Base. Route preference policies thus determine which path an ATN router will select to forward CLNP NPDUs on.
- *Route Distribution* policies determine which routes an ATN router will advertise to other ATN routers. Route distribution policies are a key aspect of a domain's transit policy in that they determine which routes will be permitted in a domain. An ATN router will not propagate a route, which it does not wish to support. By selective advertisement of routing information ATN routers control the use of their own resources since other routers can not choose a route they do not know about.
- *Route Aggregation* policies permit ATN routers to reduce the amount of routing information propagated throughout the ATN.

2.2.3 SUPPORT FOR SECURE EXCHANGE OF ROUTING INFORMATION

A final general advantage of using IDRP in the ATN is that it has a mechanism for the secure exchange of routing information. The mechanism takes advantage of a transport protocol built in to IDRP operation. When an IDRP connection is established (through the exchange of OPEN BISPDUs), the type of security to be applied to subsequent BISPDUs is signaled. In Edition 3 of the SARPs, procedures for performing *Type 2* authentication are specified. With type 2 authentication, each ATN router can be assured that the routing updates it receives are from a peer ATN router whose identity has been confirmed using strong (cryptographic) authentication.

3. ATN ROUTING ARCHITECTURE

This section contains a summary of the Asia and Pacific Region ATN routing architecture. See Reference 2 for more detailed information.

3.1 BACKBONE ROUTER SUPPORT FOR AIR-GROUND AND GROUND-GROUND APPLICATIONS

The ATN infrastructure and each region of the infrastructure must support both the air-ground and ground-ground applications that will operate over the ATN.

For air-ground applications each region should minimally support connectivity to the ground end systems which reside in the region. The regions should also support local connectivity to airborne end systems. Connectivity to airborne end system is generally expected to be provided by Air-Ground Service Providers operating in the region; however, in some cases Civil Aviation Authorities may operate their own air-ground subnetworks. Local connectivity to airborne end systems will generally be sufficient for ATSC applications. For AOC applications, it may be necessary to provide ground end systems outside the region connectivity to airborne end systems in the region. Connectivity to external ground end systems for AOC applications is generally expected to be provided by Service Providers but may be provided through bilateral agreement by appropriate operating agencies.

For ground-ground ATSC applications each region should support connectivity among ground end systems within the region and external to the region.

3.2 BACKBONE ROUTER SUPPORT FOR INTER-REGIONAL TRAFFIC

Figure 3-1 depicts those proposed ATN Backbone Routers in the Asia and Pacific Region, which support inter-regional traffic.

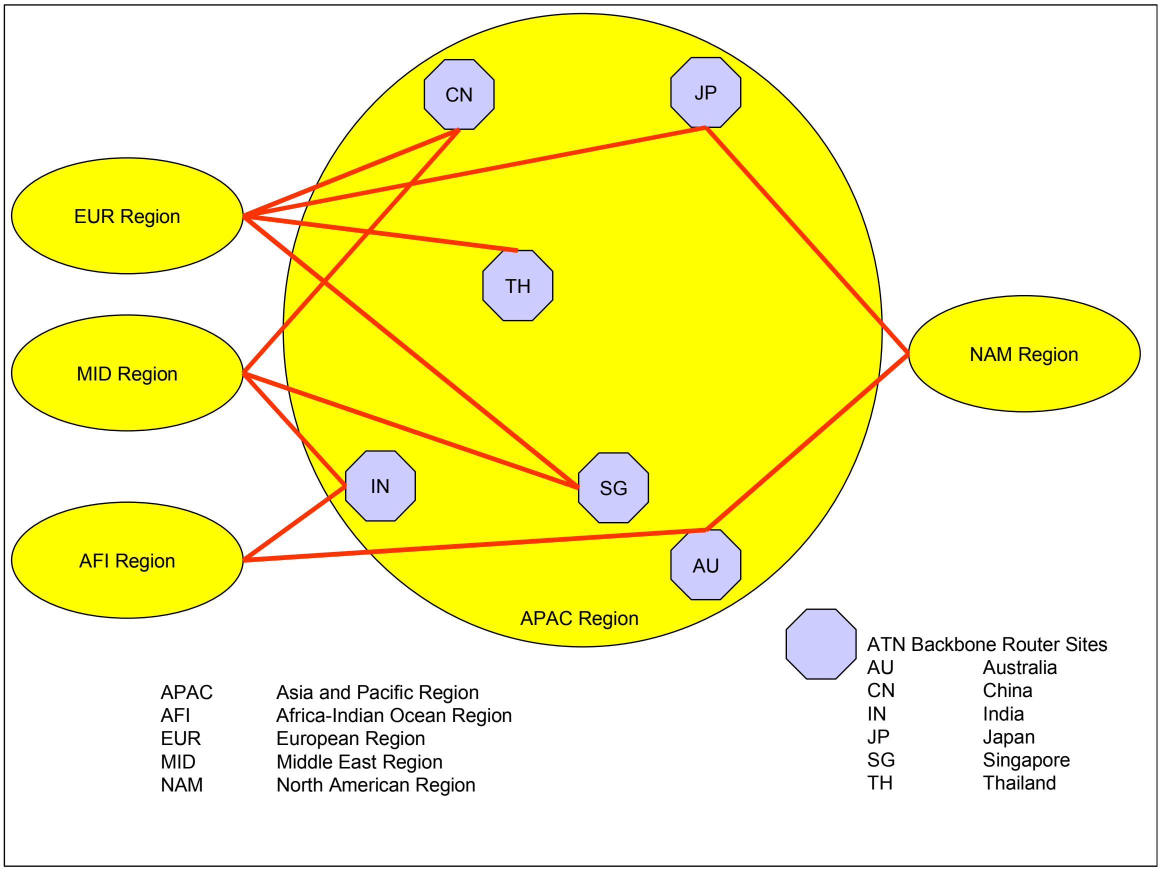
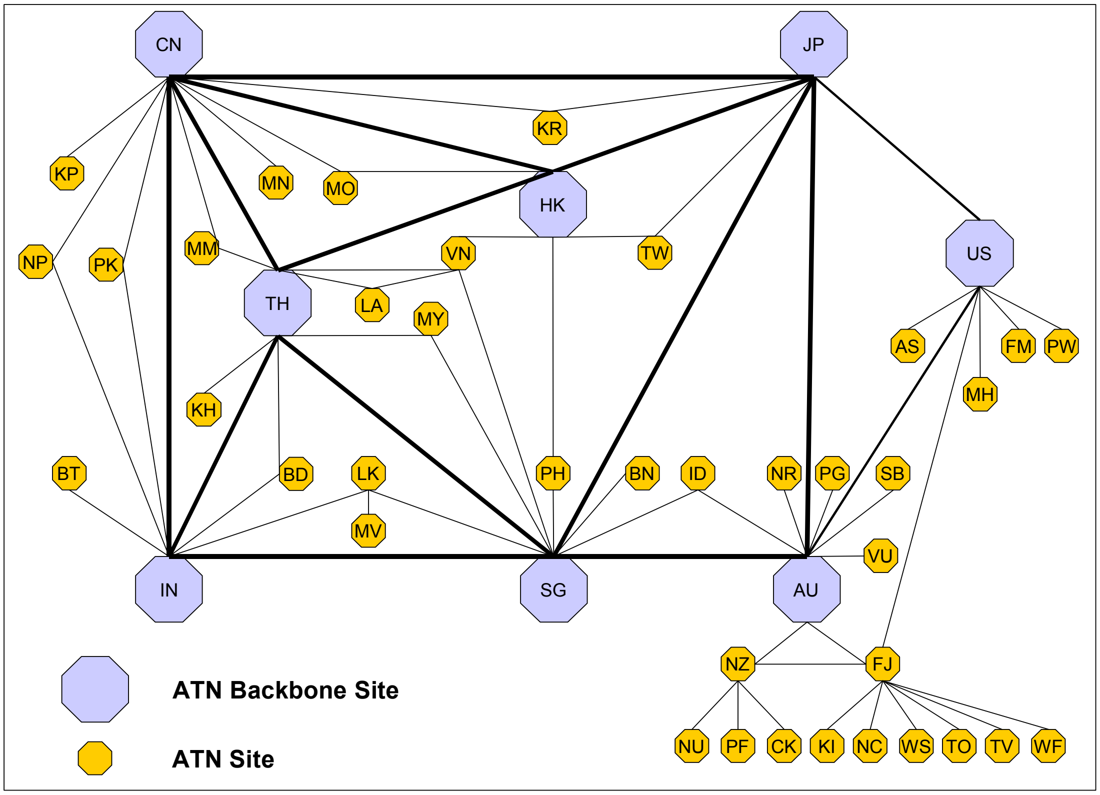


Figure 3-1 Backbone Router Inter-Regional Connectivity

3.3 BACKBONE ROUTER SUPPORT FOR INTRA-REGIONAL AND LOCAL TRAFFIC

Figure 3-2 depicts all proposed ATN Backbone Routers in the Asia and Pacific Region and their intra-regional and local connectivity. The routing policy specified herein assumes that all intra-regional connectivity is through the Backbone BISs depicted in Figure3-2.



Country	ISO Code	Country	ISO Code
American Samoa	AS	Mongolia	MN
Australia	AU	Myanmar	MM
Bangladesh	BD	Nauru	NR
Bhutan	BT	Nepal	NP
Brunei Darussalam	BN	New Caledonia	NC
Cambodia	KH	New Zealand	NZ
China	CN	Niue	NU
Cook Islands	CK	Pakistan	PK
Fiji	FJ	Palau	PW
French Polynesia	PF	Papua New Guinea	PG
Hong Kong China	HK	Philippines	PH
India	IN	Samoa	WS
Indonesia	ID	Singapore	SG
Japan	JP	Solomon Islands	SB
Kiribati	KI	Sri Lanka	LK
Korea, Democratic People's Republic of	KP	Taibei	TW
Korea, Republic of	KR	Thailand	TH
Lao	LA	Tonga	TO
Macau China	MO	Tuvalu	TV
Malaysia	MY	United States	US
Maldive Islands	MV	Vanuatu	VU
Marshall Islands	MH	Viet Nam	VN
Micronesia, Federated States of	FM	Wallis and Futuna Islands	WF

Figure 3-2 Backbone Router Intra-Regional and Local Connectivity

4. POLICY REQUIREMENTS FOR BACKBONE ROUTERS

The policy for backbone routers in the Asia and Pacific region is specified in terms of the types of policy concerns identified in section 2.2 relative to air-ground and ground-ground routes as applied to inter-regional, intra-regional connectivity, and local connectivity.

4.1 POLICY RELATIVE TO INTER-REGIONAL CONNECTIVITY

4.1.1 INTER-REGIONAL ROUTE PREFERENCE POLICIES

a) Backbone routers with inter-regional connectivity shall accept inter-regional aggregate routes to ground end systems for Air-Ground ATSC traffic from adjacent inter-regional ATN routers.

b) Backbone routers with inter-regional connectivity shall accept inter-regional aggregate routes to ground end systems for Air-Ground AOC traffic from adjacent inter-regional ATN routers.

c) Backbone routers with inter-regional connectivity shall accept inter-regional aggregate routes to ground end systems for Ground-Ground ATSC traffic from adjacent inter-regional ATN routers.

Note – Acceptance of non-aggregate routes to ATSC ground systems and routes to individual aircraft is a matter of bilateral agreement between states operating inter-regional backbone routers.

4.1.2 INTER-REGIONAL ROUTE DISTRIBUTION POLICIES

a) Backbone routers with intra-regional connectivity shall distribute inter-regional aggregate routes to ground end systems for Air-Ground ATSC traffic to adjacent inter-regional ATN routers.

b) Backbone routers with intra-regional connectivity shall distribute inter-regional aggregate routes to ground end systems for Air-Ground AOC traffic to adjacent inter-regional ATN routers.

c) Backbone routers with intra-regional connectivity shall distribute inter-regional aggregate routes to end systems for Ground-Ground ATSC traffic to adjacent inter-regional ATN routers.

Note – Distribution of non-aggregate routes to ground systems and routes to individual aircraft is a matter of bilateral agreement between states operating inter-regional backbone routers.

4.1.3 INTER-REGIONAL ROUTE AGGREGATION POLICIES

a) Backbone routers with inter-regional connectivity shall aggregate routes to ground end systems for Air-Ground ATSC traffic at an inter-regional level.

Note – Aggregation at an inter-regional level generally refers to aggregating NLRI fields to an NSAP prefix up through the ADM field. (Reference 5)

b) Backbone routers with inter-regional connectivity shall aggregate routes to ground end systems for Ground-Ground ATSC traffic at an inter-regional level.

4.2 Policy Relative to Intra-Regional Connectivity

4.2.1 Intra-Regional Route Preference Policies

a) Backbone routers with intra-regional connectivity shall accept inter-regional aggregate routes to ground end systems for Air-Ground ATSC traffic from adjacent intra-regional ATN routers.

b) Backbone routers with intra-regional connectivity shall accept inter-regional aggregate routes to ground end systems for Air-Ground AOC traffic from adjacent intra-regional ATN routers.

c) Backbone routers with intra-regional connectivity shall accept inter-regional aggregate routes to ground end systems for Ground-Ground ATSC traffic from adjacent intra-regional ATN routers.

d) Backbone routers with intra-regional connectivity shall accept intra-regional aggregate routes to ground end systems for Air-Ground ATSC traffic from adjacent intra-regional ATN routers.

e) Backbone routers with intra-regional connectivity shall accept intra-regional aggregate routes to ground end systems for Air-Ground AOC traffic from adjacent intra-regional ATN routers.

f) Backbone routers with intra-regional connectivity shall accept intra-regional aggregate routes to ground end systems for Ground-Ground ATSC traffic from adjacent intra-regional ATN routers.

4.2.2 Intra-Regional Route Distribution Policies

a) Backbone routers with intra-regional connectivity shall distribute inter-regional aggregate routes to ground end systems for Air-Ground ATSC traffic to adjacent intra-regional ATN routers.

b) Backbone routers with intra-regional connectivity shall distribute inter-regional aggregate routes to ground end systems for Air-Ground AOC traffic to adjacent intra-regional ATN routers.

c) Backbone routers with intra-regional connectivity shall distribute inter-regional aggregate routes to end systems for Ground-Ground ATSC traffic to adjacent intra-regional ATN routers.

d) Backbone routers with intra-regional connectivity shall distribute intra-regional aggregate routes to ground end systems for Air-Ground ATSC traffic to adjacent intra-regional ATN routers.

e) Backbone routers with intra-regional connectivity shall distribute intra-regional routes to ground end systems for Air-Ground AOC traffic to adjacent intra-regional ATN routers.

f) Backbone routers with intra-regional connectivity shall distribute intra-regional aggregate routes to end systems for Ground-Ground ATSC traffic to adjacent intra-regional ATN routers.

4.2.3 INTRA-REGIONAL ROUTE AGGREGATION POLICIES

a) Backbone routers with intra-regional connectivity and local connectivity to multiple routing domains shall aggregate routes to ground end systems for Air-Ground ATSC traffic at an intra-regional level.

Note – Aggregation at an intra-regional level generally refers to aggregating NLRI fields to an NSAP prefix up through the Network Group ID sub-field of the ARS field. (Reference 5)

b) Backbone routers with intra-regional connectivity and local connectivity to multiple routing domains shall aggregate routes to ground end systems for Ground-Ground ATSC traffic at an intra-regional level.

4.3 POLICY RELATIVE TO LOCAL CONNECTIVITY

4.3.1 LOCAL ROUTE PREFERENCE POLICIES

a) Backbone routers with local connectivity shall accept routing domain level aggregate routes to ground end systems for Air-Ground ATSC traffic from adjacent ATN routers serving one or more routing domains.

b) Backbone routers with local connectivity shall accept routing domain level aggregate routes to ground end systems for Ground-Ground ATSC traffic from adjacent ATN routers serving one or more routing domains.

Note – Acceptance of non-aggregate routes to ground systems and routes to individual aircraft is a local matter for states operating backbone routers.

4.3.2 LOCAL ROUTE DISTRIBUTION POLICIES

a) Backbone routers with local connectivity shall distribute routing domain level aggregate routes to ground end systems for Air-Ground ATSC traffic to adjacent ATN routers serving one or more routing domains.

b) Backbone routers with local connectivity shall distribute routing domain level aggregate routes to ground end systems for Ground-Ground ATSC traffic to adjacent ATN routers serving one or more routing domains.

Note – Distribution of non-aggregate routes to ground systems and routes to individual aircraft is a local matter for states operating backbone routers.