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Agenda Item 7: Develop IP Routing Policy, Review Addressing Plan

ASIA/PACIFIC IP ROUTING POLICY

VERSION 1.0
(INITIAL DRAFT)

(Presented by the USA)

SUMMARY

This paper presents a set of recommended routing policies for the Asia/Pacific Region Aeronautical Telecommunications Network (ATN) using the Internet Protocol Suite (IPS).

Executive Summary

The Asia/Pacific Region strategy is to eventually migrate to using IPv6 as the underlying communication infrastructure for the ATN. In order to route AMHS messages between States and Organizations in the Region, BGP-4 recommended as the dynamic routing protocol. This document presents the definition of routing policies that should be enforced between BGP-4 routers within the Region.

1 Introduction

The ASIA/PAC ATNICG has developed a strategy for implementing ATN applications throughout the Region. The strategy includes an eventual migration to an IPv6 network layer. This document describes the network routing protocols and policies that would support IPv6 network routing.

1.1 Objective

This document is meant to describe the Regional routing protocols and policies that are to be used for the ATN. Supporting the ATNICG regional strategy, this document focuses on the specification of routing protocols and policies based on the use of an IPv6-based network for exchanging ATN application messages.

1.2 Scope

This document is limited to describing the IPS routing protocols and policies to be used between States and Organizations (inter-domain) within the Region.

1.3 References

[1]	ICAO Doc 9705-AN/956	Manual of Technical Provisions for the ATN
[2]	TBD	Strategy for Implementation of the Aeronautical Telecommunication Network in the ASIA/PAC Region
[3]	RFC 4271	BGP-4 Specification
[4]	RFC 4272	BGP Security Vulnerabilities Analysis
[5]	RFC 4360	BGP Extended Communities Attribute
[6]	RFC 4384	BGP Communities for Data Collection
[7]	RFC 4451	BGP MULTI_EXIT_DISC (MED) Considerations
[8]	RFC 4456	BGP Route Reflection: An Alternative for Full Mesh Internal BGP (IBGP)
[9]	RFC 4486	Sub codes for BGP Cease Notification Message
[10]	RFC 4724	Graceful Restart Mechanism for BGP
[11]	RFC 4760	Multiprotocol Extensions for BGP-4
[12]	RFC 2385	Protection of BGP Sessions with the TCP MD5 Signature Option
[13]	ICAO Doc 9896	Manual for the ATN using IPS Standards and Protocols
[14]	TBD	Draft ASIA/PAC IPv6 Addressing Plan
[15]	ICAO Doc 9880	Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI standards and protocols

1.4 Terms Used

Administrative Domain	–	An administrative entity in the ATN/IPS. An Administrative Domain can be an individual State, a group of States, an Aeronautical Industry Organization (e.g., an Air-Ground Service Provider), or an Air Navigation Service Provider (ANSP) that manages ATN/IPS network resources and services. From a routing perspective, an Administrative Domain includes one or more Autonomous Systems.
Autonomous System	–	A connected group of one or more IP prefixes, run by a single Administrative Domain, which has a single, clearly defined routing policy.
Intra-domain (interior gateway) routing protocol	–	Protocols for exchanging routing information between routers within an AS.
Inter-domain (exterior gateway) routing protocol	–	Protocols for exchanging routing information between Autonomous Systems. They may in some cases be used between routers within an AS, but they primarily deal with exchanging information between Autonomous Systems.
Routing Domain	–	A collection of systems that are administered by a single administrative authority that is regulated by a particular set of administrative guidelines. A routing domain is an OSI concept. Routing domains are called autonomous systems in an IPS environment.

1.5 Acronyms

ATN	–	Aeronautical Telecommunications Network
AMHS	–	ATN Message Handling System
BBIS	–	Backbone Border Intermediate System
BG	–	Border Gateway
BGP	–	Border Gateway Protocol
BIS	–	Border Intermediate System
CLNP	–	OSI Connectionless Network Protocol
IDRP	–	OSI Inter-Domain Routing Protocol
ICS	–	ATN Internet Communication Service
ES	–	End System
IANA	–	Internet Assigned Numbers Authority
IPS	–	Internet Protocol Suite
IS	–	Intermediate System
NSAP	–	Network Service Access Point
RFC	–	Internet Engineering Task Force Request For Comment
RIR	–	Regional Internet Registry

1.6 Overview of IPS Specification Issues

The following subsections present issues that need to be considered regarding the routing policy document.

1.6.1 BGP-4 Specification

The BGP-4 RFC [3] presents the overall definition of the protocol and its operation. However as in any complex protocol specification, there are options and methods of operation that require users of the protocol to make a more detailed selection. Since BGP-4 is designed to use IPv4, a separate specification [11] is also needed to specify BGP-4 over IPv6.

The set of documents describing BGP-4 includes several that define optional/extended parameters (see [5] and [6]). The use of optional parameters needs to be carefully defined. The set of documents describing BGP-4 includes several that define optional/extended mechanisms (see [7], [8], and [10]). The use of optional mechanisms needs to be carefully defined.

1.6.2 Use of TCP

BGP-4 uses TCP connections for the exchange of information. As a part of the use of BGP-4, a specification of TCP parameters and timers for use in the region is needed.

1.6.3 Use of TCP MD5

For the authentication of BGP-4 peers, there is an option to use TCP MD5 [12]. However, this requires the generation, distribution, and management of keys. The administrative aspects of the use of MD5 need to be defined.

1.6.4 Autonomous System Number Assignment

In order to operate as a BGP-4 router, each router must be assigned an AS number. Public AS numbers are be obtained from a Regional Internet Registry (RIR). It is recommended that Private AS numbers be used within the region. Doc 9896 [13] contains an assignment of private AS numbers for all ICAO member states.

1.6.5 IPv6 Address Architecture

The Draft ASIA/PAC IPv6 addressing plan [14] defines an IPv6 addressing structure for the ASIA/PAC region

1.6.6 Security

Security vulnerabilities of BGP have been analyzed within the IETF [4]. The selection of mitigating options and/or procedures has to be decided.

2 Background

The ASIA/PAC ATN is based upon the use of the ATN ICS and utilizes the OSI transport protocol, CLNP, and IDRP for the exchange of messages across the network as originally defined in the Manual of Technical Provisions for the ATN (Doc 9705) [1] and currently defined in the Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI standards and protocols (Doc 9880) [15]. ICAO has also an IPv6 ATN Internetwork in the Manual for the ATN using IPS Standards and Protocols [14]. The ASIA/PAC Region has adopted a strategy to eventually migrate to an IPv6 ATN using IPS Standards and Potocols [2].

2.1 Routing Domain Fundamentals

2.1.1 Domains

Using the terminology of the ICAO/ATN, the ATN consists of a set of End Systems (ESs) and a set of Intermediate Systems (ISs). End systems are typically the computers that contain the applications and are not involved with routing packets to other systems. Intermediate systems are typically routers.

The ESs and ISs are organized into *Routing Domains*. Routing Domains are used to define sets of systems (that typically operate together) into clusters.

2.1.2 Intra-Domain Routing

Intra-domain routing is the routing of packets from the source to destination where both are in the same domain. Intra-domain routing implies two or more ISs capable of exchanging routing information with one another. Protocols for the exchange of routing information within a domain are called Intra-Domain (or Interior Gateway) routing protocols. Examples of intra-domain routing protocols are IS-IS and OSPF.

2.1.3 Inter-Domain Routing

The central definition of routing in the ATN is concerned with inter-domain routing. Inter-domain routing is the routing of packets from source to destination where each are in different domains. Inter-domain routing involves two or more boundary or border ISs exchanging routing information with one another. Protocols for the exchange of routing information among domains are called Inter-Domain (or Exterior Gateway) routing protocols. IDRP is the Inter-Domain Routing Protocol used in OSI networks. As described herein, the Border Gateway Protocol version 4 (BGP-4) is the Inter-Domain Routing Protocol used in IPS networks.

2.1.4 IPS Autonomous Systems and Routing

The terminology between ATN/OSI and the IPS is somewhat different. In the context of the IPS documentation, the term Autonomous System (AS) is introduced to define a network or set of networks that managed by a single Administrative Domain. For the purposes of describing routing using IPS, an AS can be considered equivalent to an ATN/OSI routing domain.

2.2 Router Fundamentals

All routers specified by ICAO Doc. 9705 and Doc. 9880 are called Boundary Intermediate Systems (BISs). Using the IPS terminology, these would be called "Border Gateway (BG)" routers that communicate between Autonomous Systems. Since BGP-4 is the inter-domain routing protocol selected for the region, the routers in this specification are simply called "BGP-4 routers."

The ASIA/PAC OSI network distinguishes among backbone and non-backbone sites; however for the purpose of routing policy it is not necessary to differentiate backbone from non-backbone routers. Rather the policy depends on the type of connectivity the BGP-4 router has, i.e., inter-regional, intra-regional, or local connectivity as defined in section 4 below.

2.3 Internet Protocol Suite Routing Protocols

Several routing protocols have been defined for the IPS. For intra-domain routing typical protocols are RIPv2 and OSPF. For inter-domain routing, BGP-4 is the most prevalent. For that reason and its close relationship with the ATN IDRP, BGP-4 is recommended as the Regional Inter-domain protocol.

3 BGP-4

The Border Gateway Protocol (BGP) is the routing protocol used to exchange routing information across the Internet. It makes it possible for ISPs to connect to each other and for end-users to connect to more than one ISP. BGP is the only protocol that is designed to deal with a network of the Internet's size, and the only protocol that can deal well with having multiple connections to unrelated routing domains.

3.1 BGP-4 Requirements

In order to use BGP-4 for routing within the Region, each BGP-4 router must meet the following minimum requirements:

1) Each Administrative Domain must obtain an AS number for BGP-4 routers which connect to other Administrative Domains. Private AS numbers may be used within the region. Doc 9896 [13] contains an assignment of private AS numbers for all ICAO member states.

2) Each BGP-4 router must have an appropriate MD-5 key assigned and managed.

Note: The procedures for generating, managing, distributing MD-5 keys are TBD.

3.2 Policy Based Routing

3.2.1 Types of Policy

The BGP-4 decision process (and thus routing policy) is conditioned by three types of policy concerns.

- *Route Aggregation* policies permit BGP-4 routers to reduce the amount of routing information propagated.

- *Route Preference* policies determine which routes will be installed in the Forwarding Information Base. Route preference policies thus determine which path a router will select to forward IP packets on.

- *Route Distribution* policies determine which routes a BGP-4 router will advertise to other BGP-4 routers. Route distribution policies are a key aspect of an AS's transit policy in that they determine which routes will be permitted in a domain. A BGP-4 router will not propagate a route, which it does not wish to support. By selective advertisement of routing information BGP-4 routers control the use of their own resources since other routers cannot choose a route they do not know about.

4 AMHS BGP-4 Routing Policy

4.1 Routing Policy Goal for BGP-4 routers

The ASIA/PAC ATN infrastructure must support a consistent set of routing policies to provide paths to application systems at an inter-regional, intra-regional and local level without an inordinate number of routing protocol updates. Accordingly, the detailed policy requirements and recommendations specified in section 4 are derived from the following general routing policy goal:

a. Asia/Pacific region IP routers will provide global shortest path connectivity with a minimal exchange of routing information.

4.2 Network Organization for Routing to Ground Systems

The IP ground infrastructure may be partitioned into various levels of organization. The ATN IPv6 Addressing Plan [14] provides an IP address structure that partitions the address space to include NLRI prefixes that vary according to the level of organization.

a) Autonomous Systems at the highest level are associated with an ICAO region.

Note. – In order to facilitate shortest path routing across inter-domain boundaries, the Asia, Pacific, and North America regions are combined under a single region identifier.

b) Within the ASIA/PAC Region, Autonomous Systems are next associated with a particular state or organization. Accordingly the addressing plan defines a field within an IPv6 address that can be uniquely assigned to the state or organization.

c) Finally, within a particular state or organization there may be multiple local sub-networks (which may or may not be visible outside of the particular state or organization). The addressing plan defines a Subnetwork ID field which may be assigned to particular sub-networks.

Within this framework, BGP-4 ground routers may be characterized and their policy requirements specified according to the type of connectivity they have to adjacent BGP-4 ground routers.

d) BGP-4 routers connecting to adjacent routers in another region are said to have "inter-regional" connectivity.

e) BGP-4 routers connecting to adjacent routers in another state or organization within the ASIA/PAC Region are said to have "intra-regional" connectivity.

f) BGP-4 routers connecting to adjacent routers within a particular state or organization are said to have "local" connectivity, i.e. intra-state or intra-organizational connectivity.

4.3 Policy for BGP-4 Routing

The policy requirements for BGP-4 routers in the ASIA/PAC Region for routes to application systems are specified in this section. The following sub-sections specify the policies according to the classification:

1. the general policy for routes to ground systems;

2. the policy for inter-regional connectivity;

3. the policy for intra-regional connectivity; and

4. the policy for local connectivity.

4.3.1 General Policy

a) If a backbone router receives multiple routes to an aggregate or specific destination, the route with the shortest path ([i.e., shortest list of AS)] shall be selected.

b) All BGP-4 routers in the Region shall authenticate the identity of peer ATN routers.

Note. *– Authentication may be accomplished via the TCP MD-5 option.*

4.3.2 Policy for Intra-Regional Aggregate Routes to Ground Systems

Inter-regional route aggregation permits advertisement of a single aggregate route which identifies all of an ICAO region. Aggregation at an inter-regional level refers to aggregating NLRI fields in the IPv6 address prefix up through the complete Regional Prefix field [14].

4.3.2.1 Inter-Regional Route Aggregation Policies

a) BGP-4 routers with inter-regional connectivity shall be configured with aggregate routes to systems at an inter-regional level.

4.3.2.2 Intra-Regional Route Preference Policies

a) BGP-4 routers with inter-regional connectivity shall accept inter-regional aggregate routes to systems from adjacent BGP-4 routers.

Recommendation. BGP-4 routers with inter-regional connectivity should only accept inter-regional aggregate routes on these connections.

4.3.2.3 Intra-Regional Route Distribution Policies

a) BGP-4 routers with inter-regional connectivity shall distribute inter-regional aggregate routes to adjacent BGP-4 routers.

b) BGP-4 routers with intra-regional connectivity shall distribute inter-regional aggregate routes to adjacent BGP-4 routers.

c) BGP-4 routers with local connectivity shall distribute inter-regional aggregate routes to adjacent BGP-4 routers.

4.3.3 Policy for Intra-Regional Aggregate Routes to Ground Systems

Intra-regional route aggregation permits advertisement of a single aggregate route which identifies all systems in a particular State or Organization. Aggregation at an intra-regional level refers to aggregating NLRI fields in the IP address prefix up through the complete State/Organization field [14].

4.3.3.1 Intra-Regional Route Aggregation Policies

d) BGP-4 routers with intra-regional connectivity shall be configured with aggregate routes to systems at an intra-regional level.

4.3.3.2 Intra-Regional Route Preference Policies

a) BGP-4 routers with intra-regional connectivity shall accept intra-regional aggregate routes to systems from adjacent ATN routers.

Recommendation. BGP-4 routers with intra-regional connectivity should only accept inter-regional or intra-regional aggregate routes on these connections.

4.3.3.3 Intra-Regional Route Distribution Policies

e) BGP-4 routers with intra-regional connectivity shall distribute intra-regional aggregate routes to adjacent BGP-4 routers.

f) BGP-4 routers with local connectivity shall distribute intra-regional aggregate routes to adjacent BGP-4 routers.

4.3.4 Policy for Local Aggregate Routes to Ground Systems

Local aggregation permits advertisement of a single aggregate route which identifies all systems in a specific subnetwork of a particular State or Organization of an ICAO region. Aggregation at this level refers to aggregating NLRI fields in the IP address prefix up to the Subnet ID field. BGP-4 routers connecting to adjacent routers within a particular state or organization, i.e., with

intra-state or intra-organizational connectivity, are said to have “local” connectivity. Since local aggregate routes are not visible to other states and organizations in the region the associated policies are considered a local matter. Therefore there are only recommendations in this section.

4.3.4.1 Local Route Aggregation Policies

Recommendation. BGP-4 routers with local connectivity should be configured with aggregate routes to all systems on their sub-network.

4.3.4.2 Local Route Preference Policies

Recommendation. BGP-4 routers with local connectivity should accept local aggregate routes from adjacent BGP-4 routers within the same state or organization.

4.3.4.3 Local Route Distribution Policies

Recommendation. BGP-4 routers with local connectivity should distribute local aggregate routes to ground systems only to adjacent BGP-4 routers within the same state or organization.

4.3.5 Additional State/Organizational Routing Policies

Individual states/organizations may have additional routing policies consistent with the above policies for routes to ground systems. Such policies may include various local preferences or Quality of Service based routing, e.g., routing based on line error rates, expense, delay, etc.