SEAMLESS NETWORK FOR AERONAUTICAL FIXED SERVICE (AFS)

Presentation to: ICNS CONFERENCE

Date: May 1-3 2007

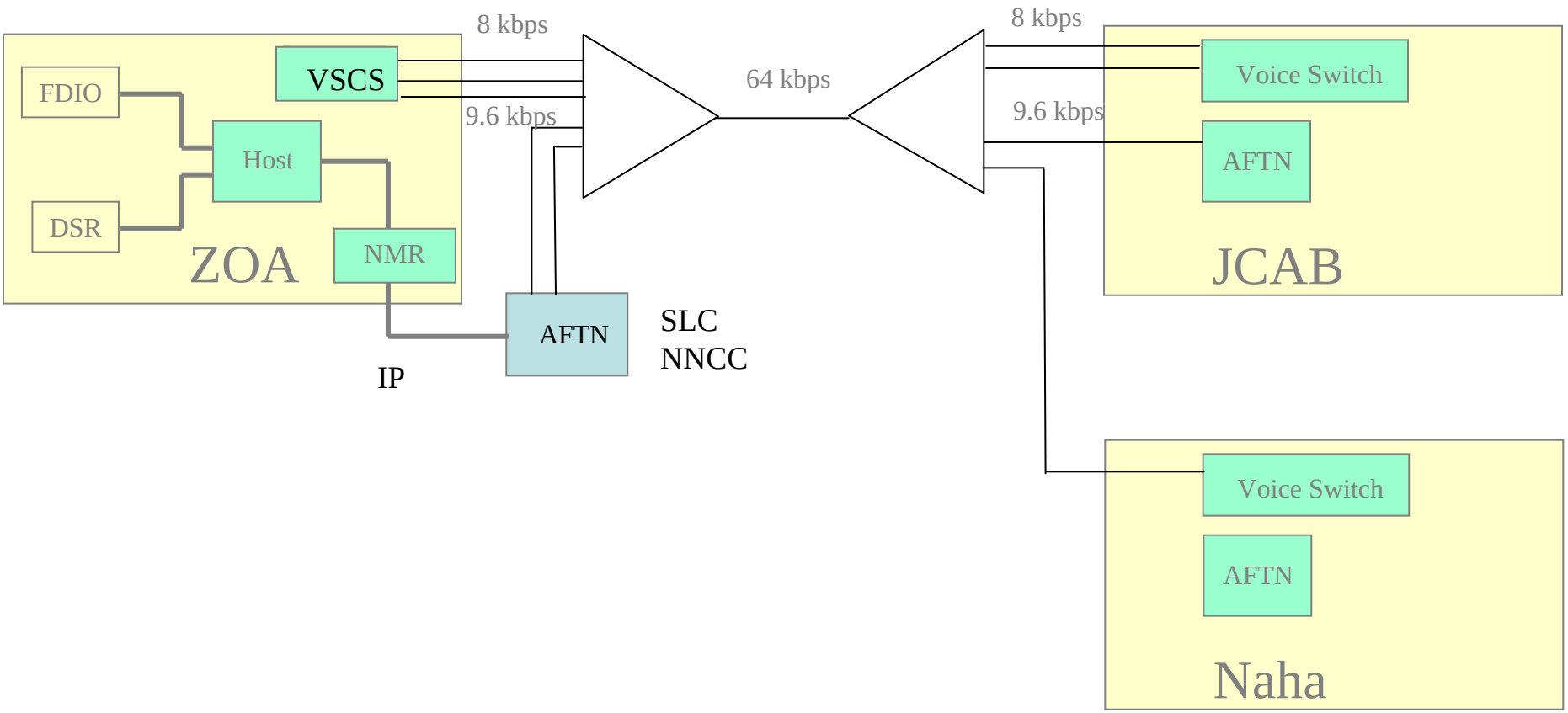
Topics

- **Aeronautical Fixed Service (AFS) Background**
- **Aeronautical Fixed Telecommunication Network (AFTN) Service**
- **Air Traffic Service Message Handling System (AMHS) Service**
- **Global Transition Plan**
- **Federal Aviation Administration (FAA) Plan**

Aeronautical Fixed Service Background

- **The AFS, as specified in International Civil Aviation Organization (ICAO) Annex X, is designed to provide communication links between member States to exchange flight plans, meteorological data, NOTAM, and other ATC related messages to support the flight transfers between FIRs.**
- **The AFS is divided into Air Traffic Control (ATC) voice and Aeronautical Fixed Telecommunication Network (AFTN).**
- **The ATC Voice service is compressed into 8 kbps per channel. It is combined with AFTN service into a voice/data multiplexer. For example, the service between US and Japan is comprised of a 64 kbps circuit with voice/data Multiplexer on each site. There are three 8 kbps voice channels and two 9.6 kbps channels for AFTN and AIDC.**
- **The ATC voice service will not be addressed in this presentation since there is no plan to update or replace this service.**

FAA/JCAB ATC Voice and AFTN Configuration



AFS Background
AFTN

- The AFTN was implemented in the 1970s and is based on ASCII which uses the “store and forward” function to distribute its messages.
- The AFTN network is based on dedicated circuits with a data rate of 50 Baud.
- In 1990s, the AFTN backbone was replaced by the X.25 network with dedicated circuits and data rates up to 9.6 kbps.
- Over the years, AFTN became the carrier for many more services such as Air Traffic Service Inter-Facility Data Communication (AIDC), Dynamic Oceanic Tracking System (DOTS), International Search and Rescue and many other messages to support ATC activities not covered in ICAO Annex X.

AFS Background
AFTN

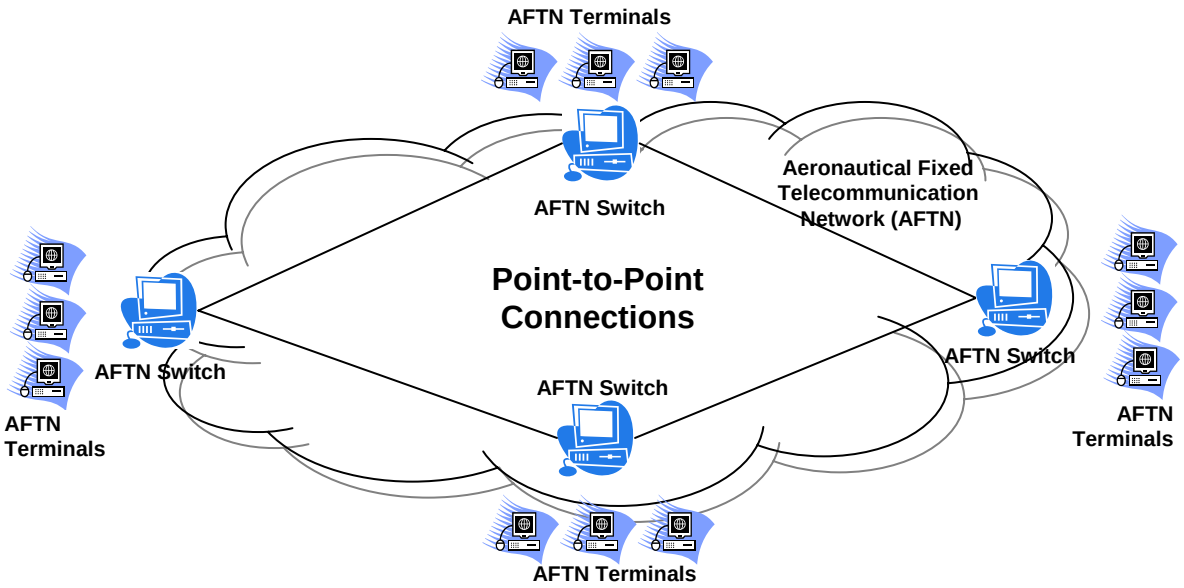
- **ICAO Annex X describes AFTN as a service based on the "store and forward" function for conveyance of text messages using character-oriented procedures. AFTN messages are forwarded on a hop-by-hop basis using pre-configured routes that are the most expeditious to affect delivery to the addressee. This means messages are routed by the application (AFTN switch) not by the network router. This operation is required so that messages exchanged between adjacent AFTN centers, including transit messages, are processed, stored and forwarded to the next AFTN center until the messages have reached their intended destination.**
- **AFTN has diversion routing lists agreed to by the administrations operating the communication centers where the AFTN switches reside. These lists are statistically configured and used to immediately reroute traffic in the event of a circuit outage in a fully automatic communication center or to manually reroute traffic within 10 minutes in a non-fully automatic communication center.**

AFS Background-AFTN

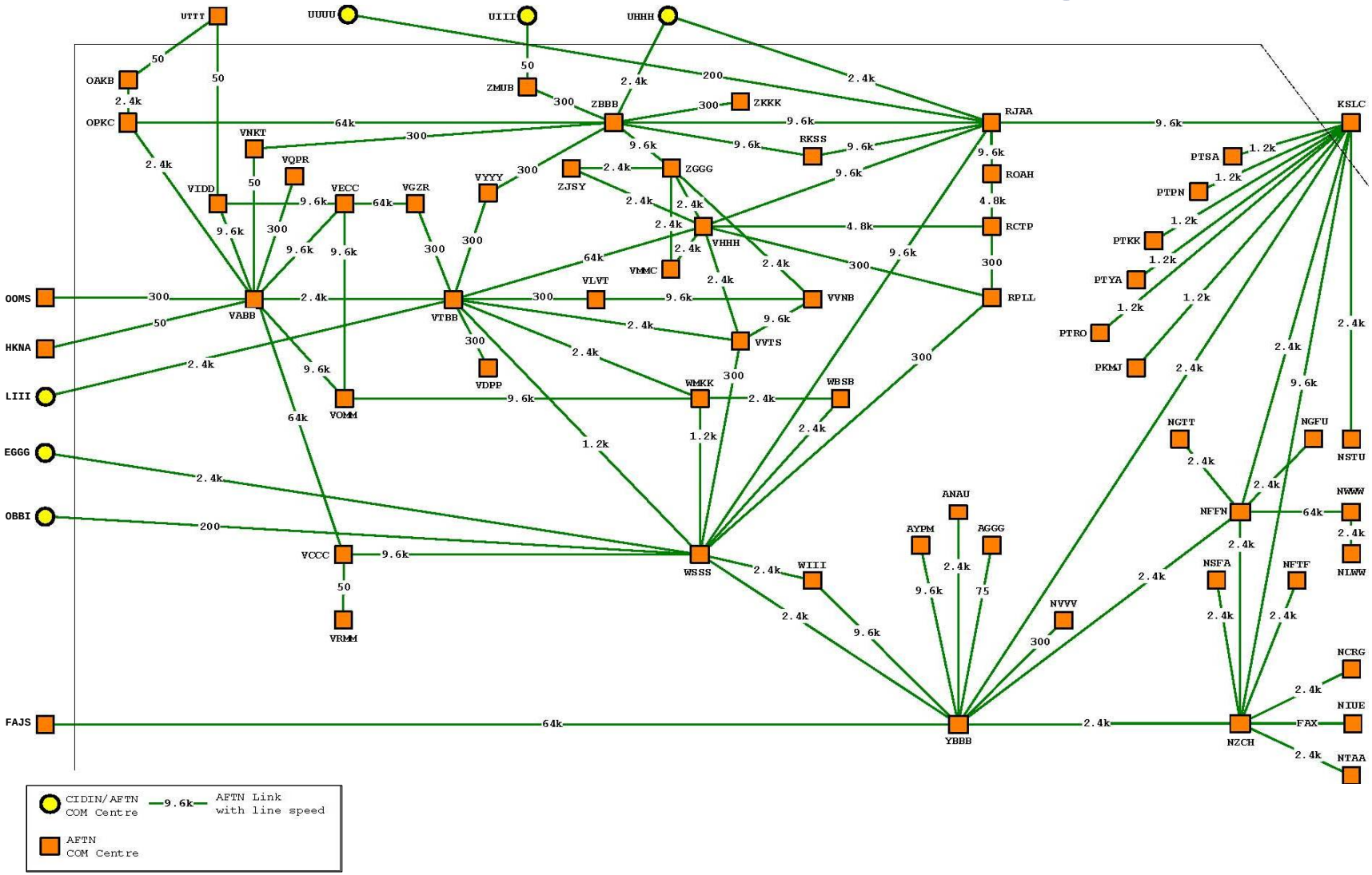
- Under AFTN procedures, the sending station will hold messages transmitted, and in the event that continuity of message traffic is not maintained, they are re-transmitted. Continuity of message traffic is supervised by using sequence numbers applied to all traffic over a particular channel.
- The procedure for tracking of unknown or lost messages has been refined over the years. It requires the AFTN centers to manually contact one another to resolve problems. These problems can be easily traced through the dedicated X.25 port to determine the source of the lost or unknown messages to either the sending or receiving AFTN center.
- The European region adopted a slightly different version of X.25 called CIDIN
- To accommodate the incompatibility between X.25 and CIDIN, European States adopted an X.25 interface with other ICAO regions

AFS Background-AFTN

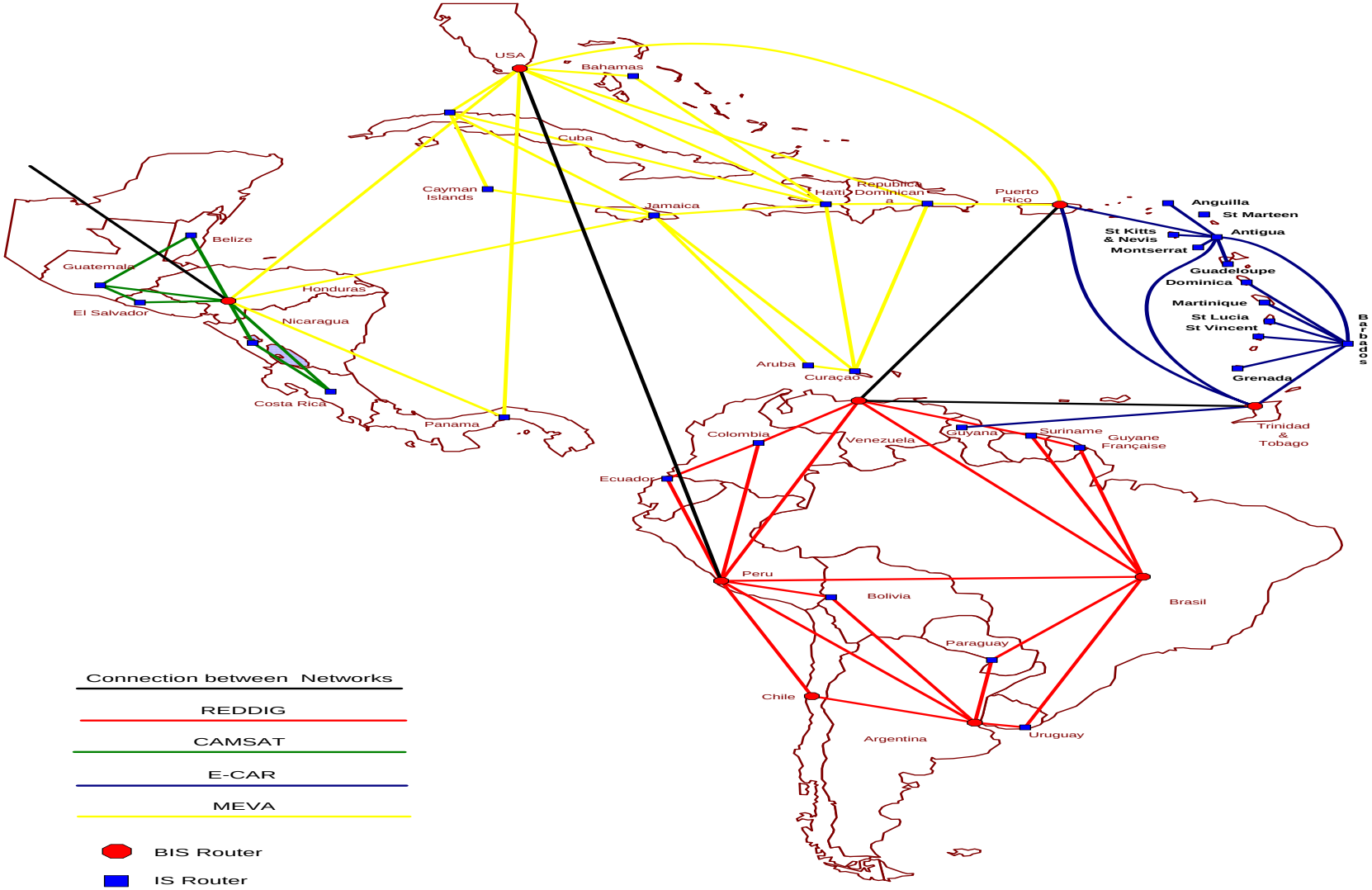
AFTN System



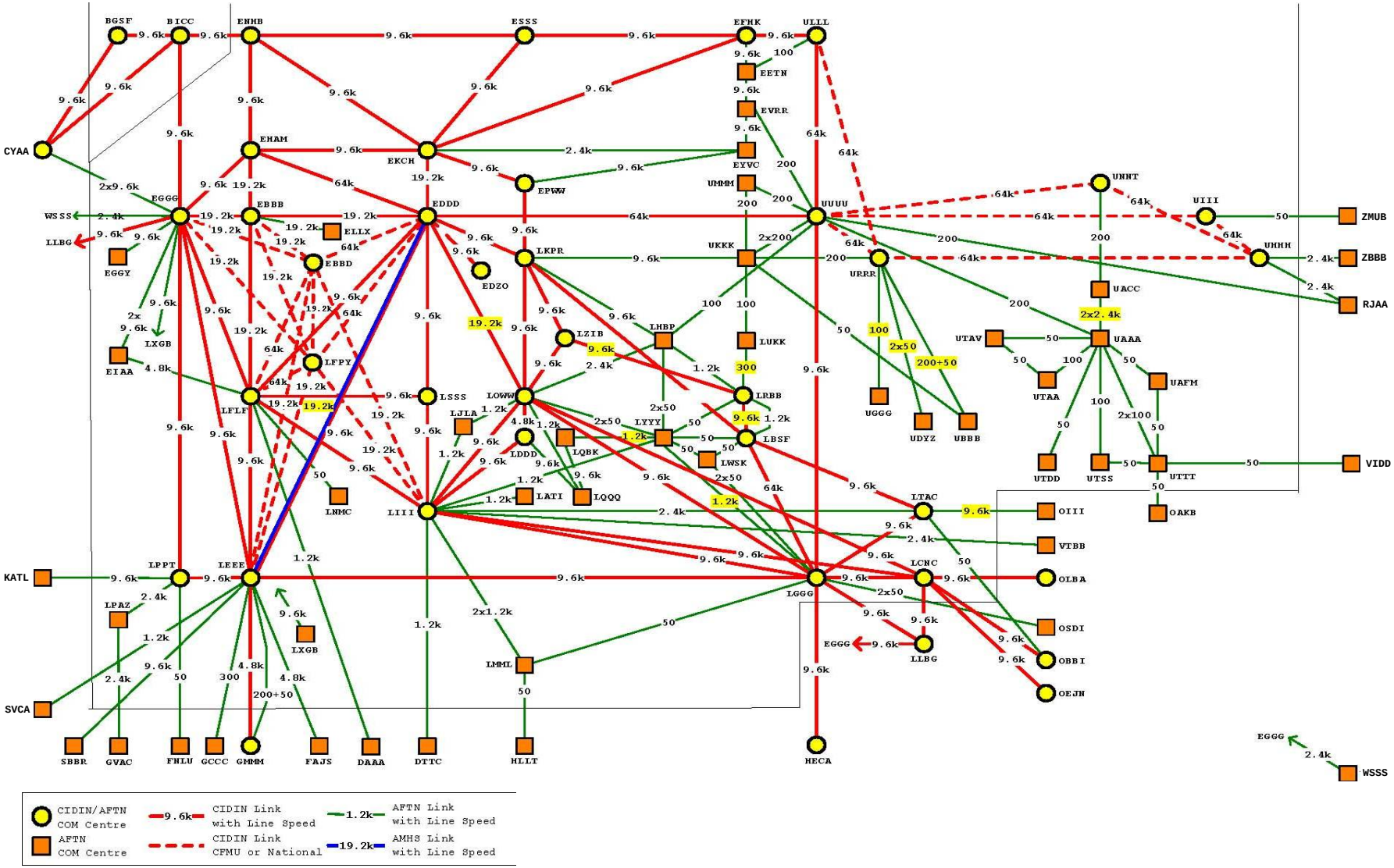
AFTN Asia/Pacific Region



CAR/SAM International AFTN Backbone



AFTN European/NAT Region



ATN AMHS Background

As defined by ICAO Doc. 9705, the ATN consists of two categories:

- **Networks**
  - **Air to Ground (A/G) Router Network and**
  - **Ground to Ground (G/G) Router Network**
- **Applications**
  - **Air Traffic Service (ATS) Inter-facility Data Communication (AIDC)**
  - **ATS Message Handling System (AMHS)**
  - **AMHS/AFTN Gateway**
  - **Controller Pilot Data Link Communication (CPDLC)**
  - **Directory Service**

AMHS Description

ICAO Doc 9705 distinguishes the service from the set of computing and communication resources implemented by ATS organizations to provide the ATS message handling service. The set of computing and communication resources is called the *AMHS*. For Basic ATS Message Service, the following AMHS entities are defined:

1.ATS Message Server (MS) - An X.400 Message Transfer Agent (MTA) and optionally one or more MSs

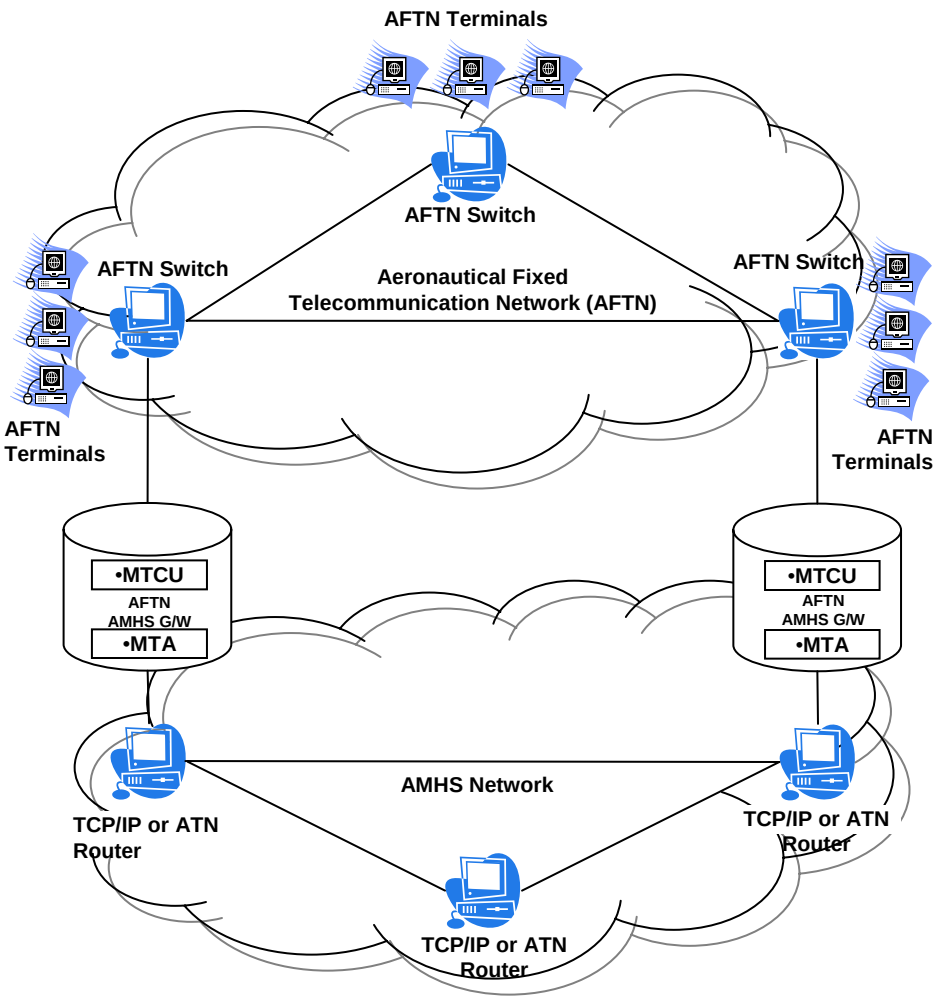
2.ATS Message User Agent (UA) – An X.400 UA designed to replace the AFTN Terminals

3.AFTN/AMHS Gateway – An MTA and an AFTN specific AU, called a Message Transfer and Control Unit (MTCU) with a corresponding Control Position.

4.CIDIN/AMHS Gateway – An MTA and a CIDIN specific AU, called a Message Transfer and Control Unit (MTCU) also with a corresponding Control Position. The European region has decided to adopt a different approach during the transition which uses the AMHS/AFTN Gateway.

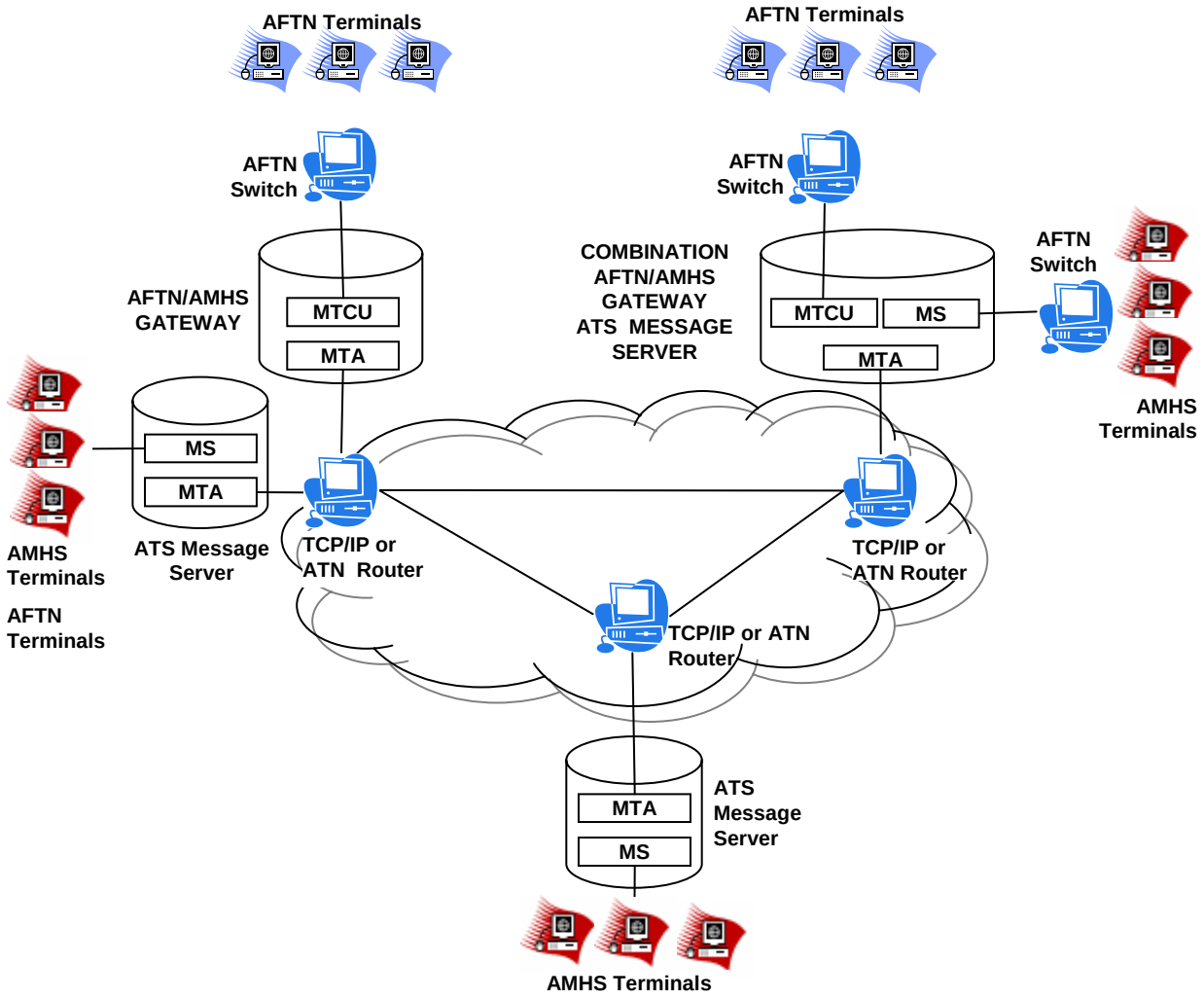
AMHS Description

Initial AFTN-AMHS Gateway System



AMHS Description

Evolving AMHS

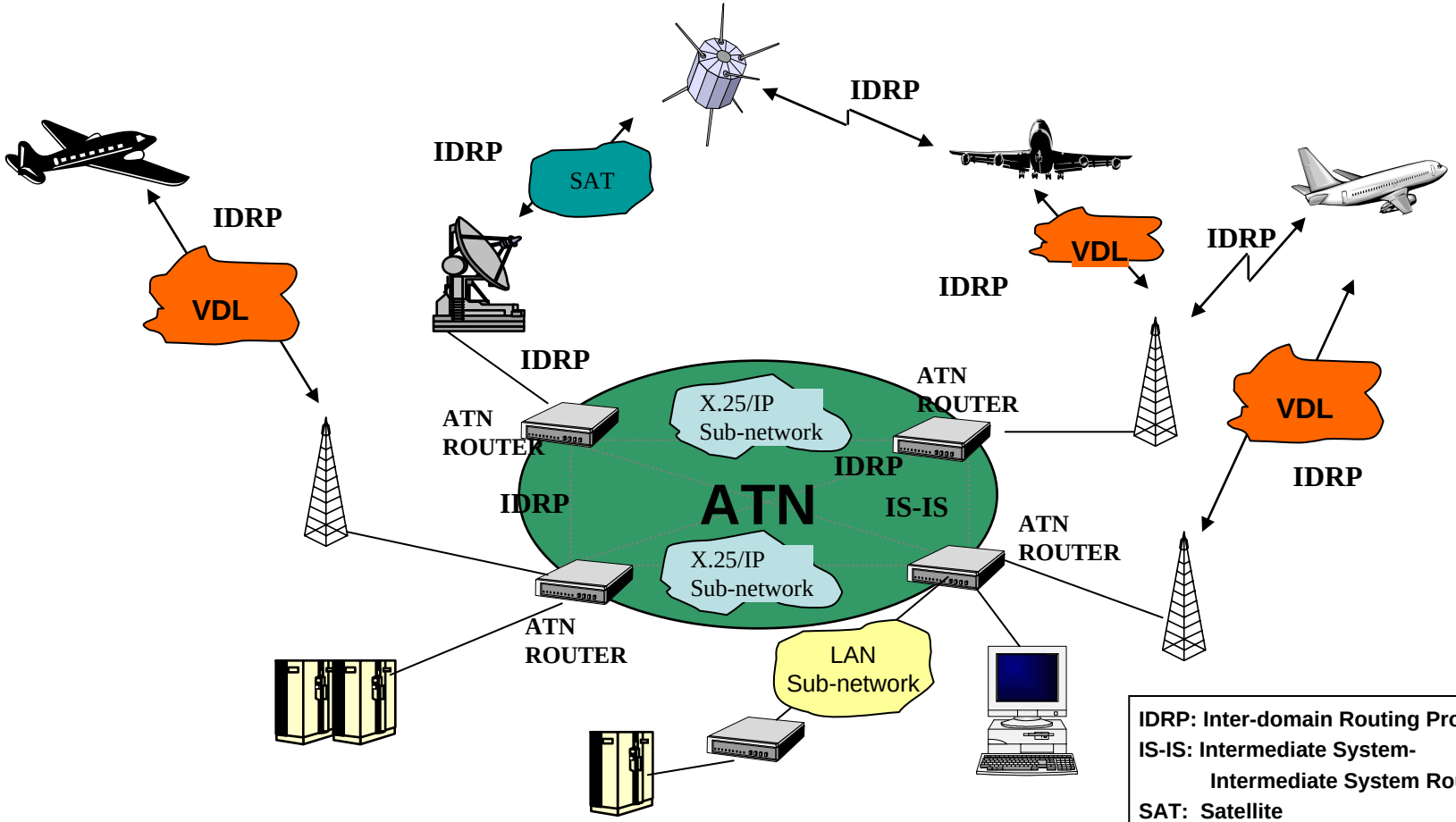


AMHS Network

- **The ICAO Doc. 9705 recommends two options for the establishing of an AMHS internet and the IPS SARPs recommend TCP/IP as another alternative.**

1. **IP Router that supports AMHS using RFC 1006/2126**
2. **ATN Router using X.25 subnet: ICAO Asia/Pacific has adopted this network protocol as their ATN Internet.**
3. **ATN Router using IP subnet (requires Sub Network Dependent Convergence Function (SNDCF): The ATN IP subnet will be able to utilize the Internet Protocol (IP) network (TCP/IP) but requires another ATN IP Subnet to receive the message due to Inter-Domain Routing Protocol (IDRP) encapsulated in the message.**

ATN Interconnection of Air/Ground and Ground/Ground Routers



IDRP: Inter-domain Routing Protocol
IS-IS: Intermediate System-Intermediate System Routing Protocol
SAT: Satellite
VDL: Very High Frequency (VHF) Data Link
LAN: Local Area Network

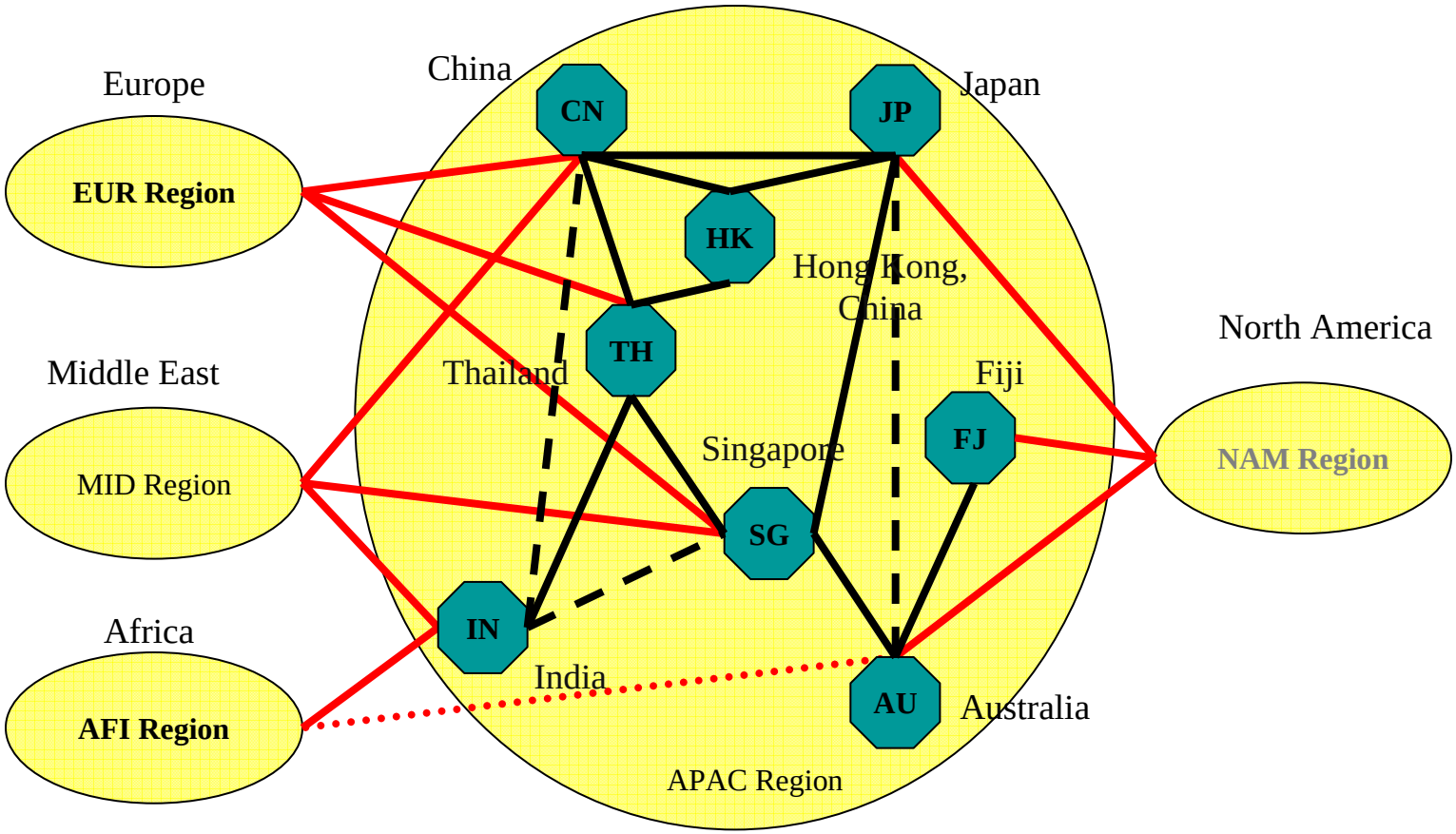
Aeronautical Communication Panel (ACP) Working Group N Planning

- The ACP has developed an Internet Protocol Suite (IPS) SARP for Ground-Ground network.
- This document recommends the use of IPv6 to replace the ATN X.25 network
- This IPS SARP is in the process of being adopted by ICAO.
- The IPS Transition Guidance Material is under consideration.

Asia/Pacific Regional Planning

- **The Asia/Pacific has adopted the ICAO Doc. 9705 to replace its AFTN service.**
- **In March 2005, the first AMHS service was established between Japan and USA**
- **The Asia/Pacific Regional Facilities and Services Implementation Document (FASID) plans for AMHS major backbone to be deployed by 2008.**

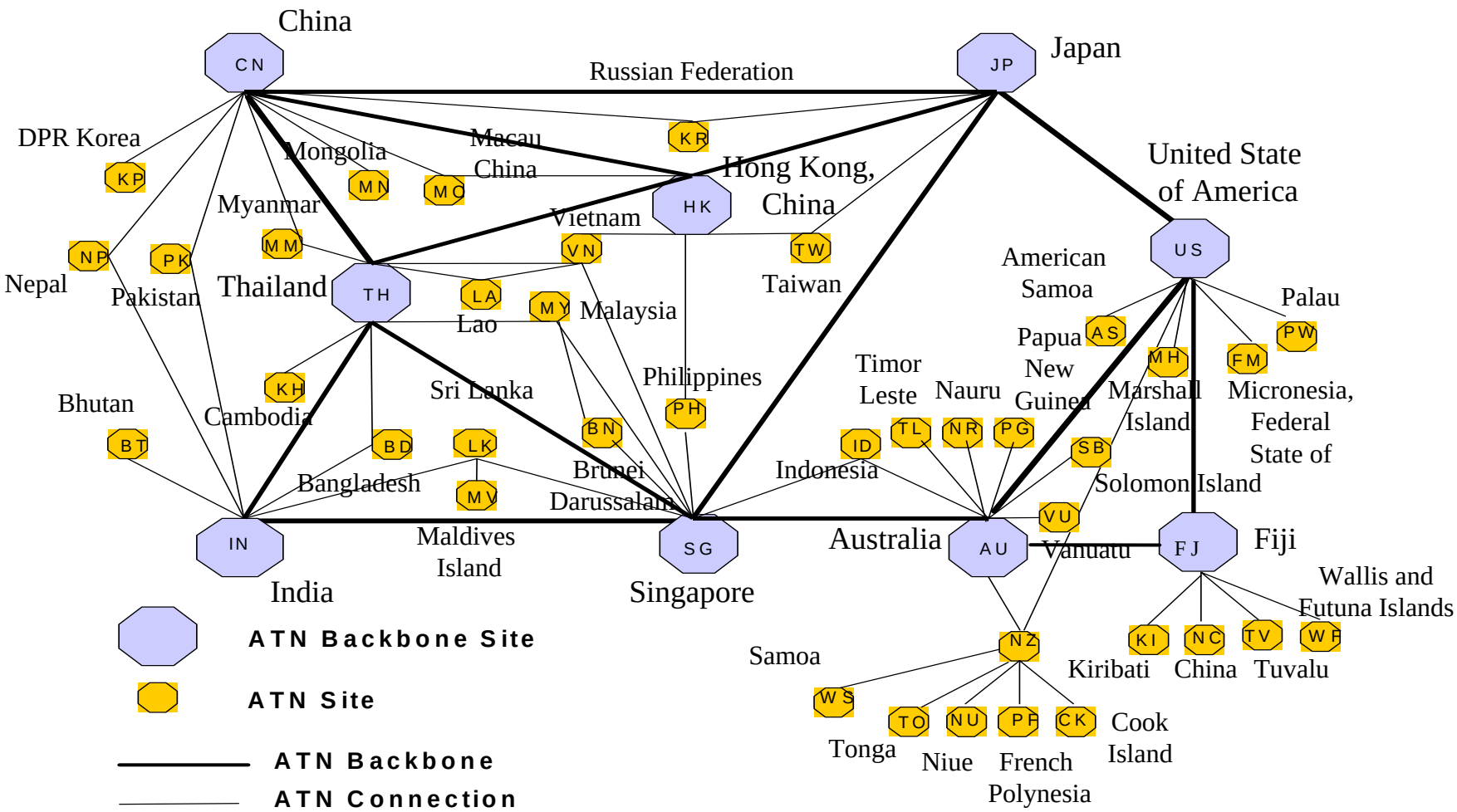
Asia/Pacific ATN Regional Backbone



Inter-Regional Trunk Connection
New Inter-Regional Trunk Connection
Intra-Regional Trunk Connection
New Intra-Regional Trunk Connection

- US is North America Backbone

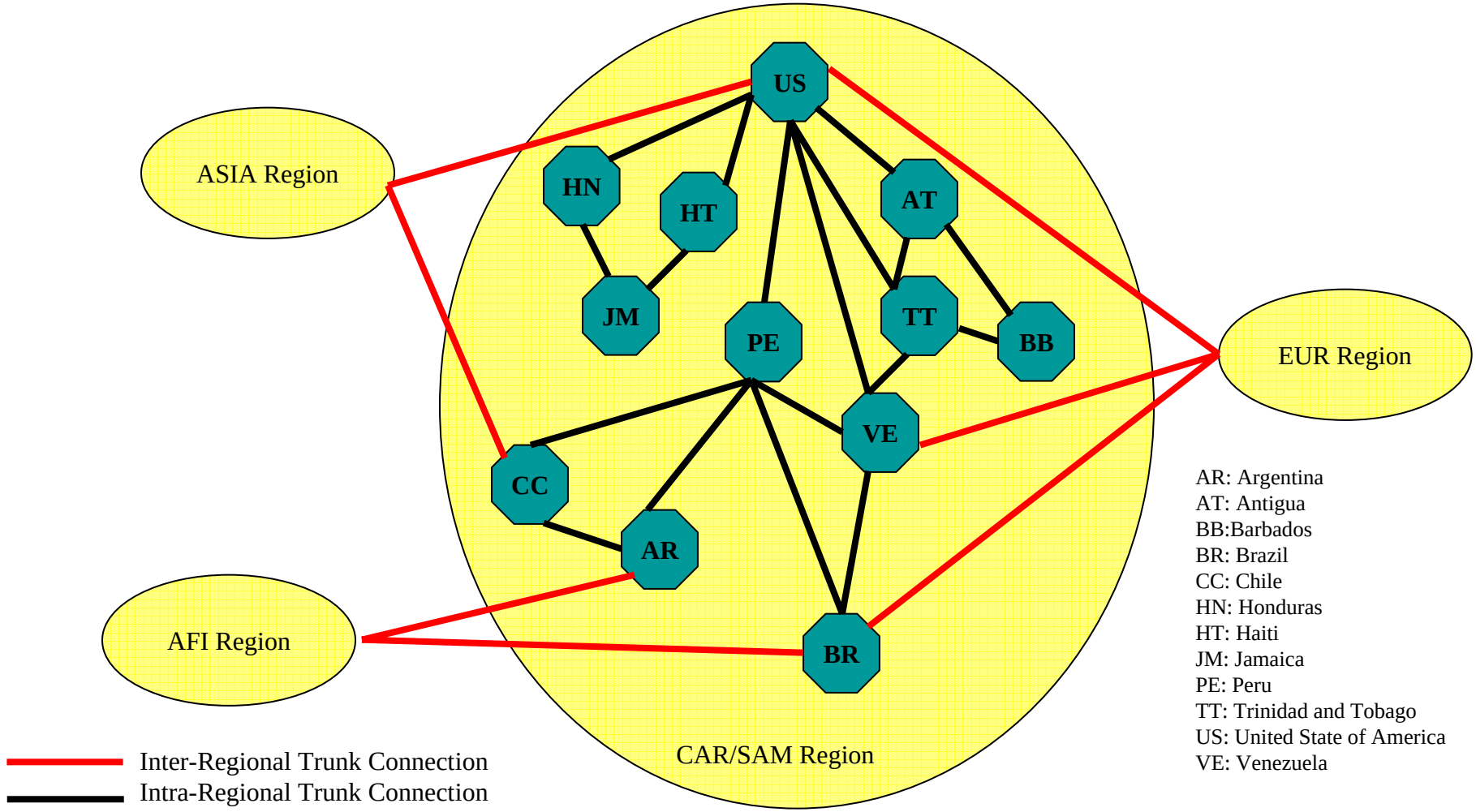
Asia/Pacific ATN Regional Router Plan



CAR/SAM Regional Plan

- **In 2006, the CAR/SAM region adopted the ICAO Doc. 9705 and the IPS SARP to replace its AFTN service.**
- **Its approach is to implement IP router with AMHS and AMHS/AFTN Gateway.**
- **Many States in this region have obtained the AMHS and AMHS/AFTN Gateway.**
- **This region is projecting the first AMHS service over IP will be in 2008.**

Notional CAR/SAM Regional ATN Backbone Architecture



AR: Argentina
AT: Antigua
BB:Barbados
BR: Brazil
CC: Chile
HN: Honduras
HT: Haiti
JM: Jamaica
PE: Peru
TT: Trinidad and Tobago
US: United State of America
VE: Venezuela

European Regional Plan

- **The European region adopted the ICAO Doc. 9705 and the IPS SARP to replace its AFTN service.**
- **The AMHS service between Germany and Spain has been established.**
- **The European region has been working closely with the CAR/SAM major backbone States to establish AMHS service.**

Transition Plan

- **Some ICAO regions have selected the ATN as the underlying AMHS network protocols (CLNP/TP4) while other regions have selected IPS-based networks for the AMHS.**
- **The use of different network protocols in different regions means that the direct communications between any MTA to any other MTA is not possible across all ICAO regions. Direct MTA to MTA communications is only possible where the MTAs are on networks using the same communication protocols.**
- **In those cases where different regions are using different network protocols, an AMHS MTA must act as the relay between the different networks.**
- **The dual operation of AMHS and AFTN will require global address coordination.**
- **A well coordinated upgrade of the circuit data rate will be needed to support alternative routing.**
- **The overhead of the AMHS address will require most of the existing AFTN circuits to be upgraded.**

Transition Plan

Routing Policy should be developed to address the followings:

1. **Intra-Region MTA routing during the AFTN/AMHS transition period: Specify the AMHS MTA address control policy during the transition between AFTN and AMHS**
2. **Intra-Region MTA routing at End-State Environment: Specify the AMHS MTA address control policy in the End-State Environment**
3. **Inter-Region MTA Routing during transition period: Specify the AMHS MTA address control policy during the transition of the AFTN/AMHS environment as well as different network protocols**
4. **Inter-Region MTA Routing at End-State Environment: Specify the AMHS MTA address control policy at the End-State environment. It is noted that due to network protocol incompatibility, the transition period may extend for a long period.**

Transition Plan-New Requirement

- The Binary Universal Form Representation (BUFR) code was developed by the ICAO OPLINK Panel.
- The BUFR code is used to provide graphic meteorological data.
- The BUFR code can only be distributed by the AMHS since the AFTN can not support binary based message.
- The BUFR code has been adopted by the WMO and the ICAO.
- The ICAO Regional Offices have been analyzing the BUFR code to determine the impact to AMHS (AMHS X.500 based Directory Service versus modifying the MTA).

Transition Plan-IP

Protocol Stacks for Current AMHS Applications

<table>
<tr><td colspan="2">AMHS
APPLICATION
(Message Transfer Agent)</td></tr>
<tr><td colspan="2">Presentation Layer</td></tr>
<tr><td colspan="2">Session Layer</td></tr>
<tr><td rowspan="3">TP4</td><td>TP0</td></tr>
<tr><td>RFC 1006</td></tr>
<tr><td>TCP</td></tr>
<tr><td>CLNP</td><td>IPv4</td></tr>
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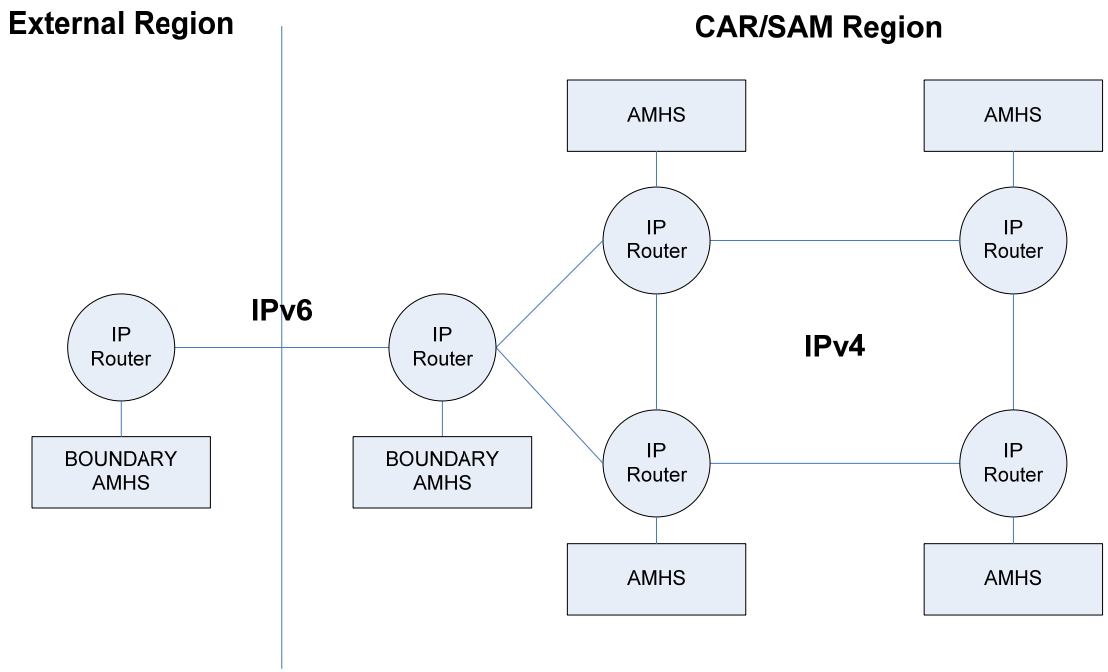
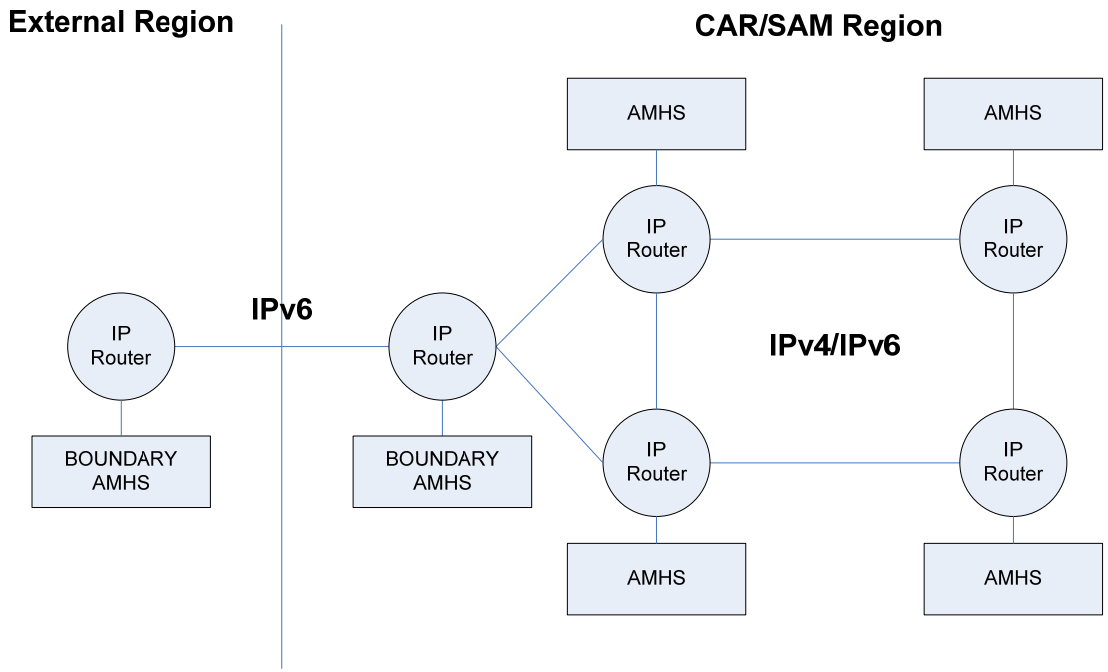
Transition Plan-IP

IPv4 Intra-Regional and IPv6 to External ICAO Regions



Transition Plan-IP

IPv4 and IPv6 Intra-Regional, and IPv6 to External ICAO Regions



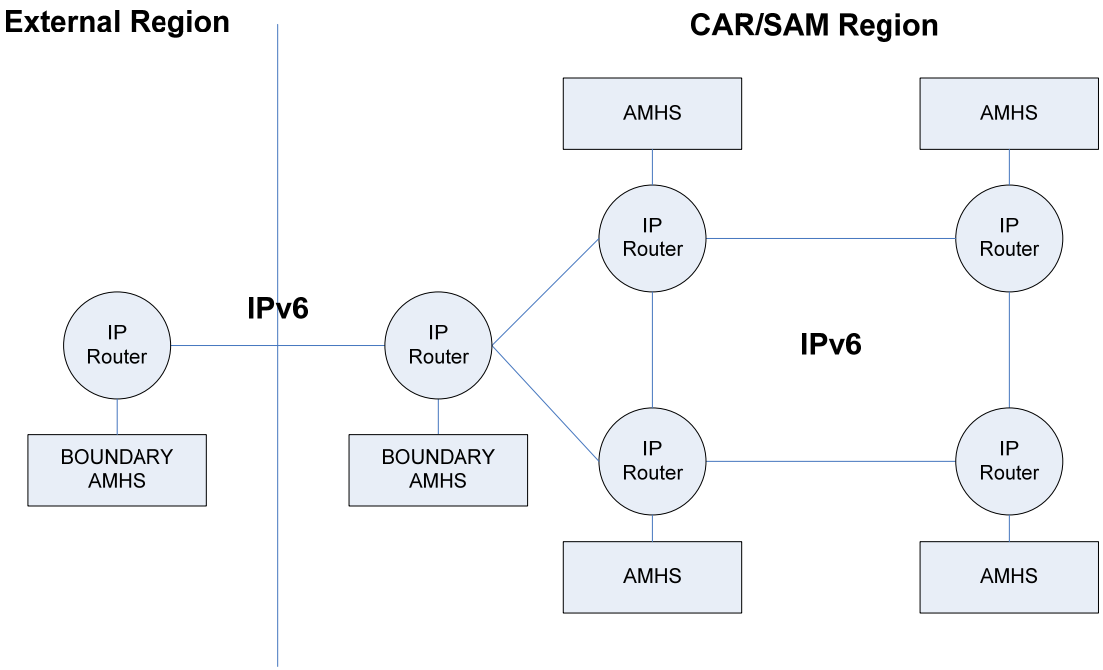
Transition Plan-IP

Protocol Stacks for Transition-Phase AMHS Applications

AMHS APPLICATION (Message Transfer Agent)	
Presentation Layer	
Session Layer	
TP0	TP0
RFC 1006	RFC 2126
TCP	TCP
IPv4	IPv6

Transition Plan-IP

End State IPv6 for Intra-region and Inter-region



IP Transition Issues

- The Technical Manual for the IPS will not be finalized by the Aeronautical Communication Panel (ACP) before 2008.
- The associated Guidance Material has not been developed by the ACP.
- Initial implementations in the ICAO European Region are using AMHS over IPv4 in separate sub-regions. Two of these sub-regions are interconnected via IPv6 using a network address and protocol translation technique whereby IPv4 messages are converted to IPv6 across the interface and then back to IPv4.
- The aeronautical communication industry (i.e., AMHS system providers) has not fully developed the MTA to support IPv6.
- Many CAR/SAM member States have already implemented the AMHS or will replace the AFTN service in the near future.
- The Asia/Pacific region needs to work out the network protocol with European and South American regions (ATN router or IP router).
- A global AMHS network coordination is required to ensure smooth operation.
- Implementing security measures.
- IPv4 address is not uniformed.

Implementation Documents Needed

ICAO Regional ATN/AMHS Implementation Documents

G/G Transition Plan

IP Router ICD

MTA Routing Policy

Test Procedures

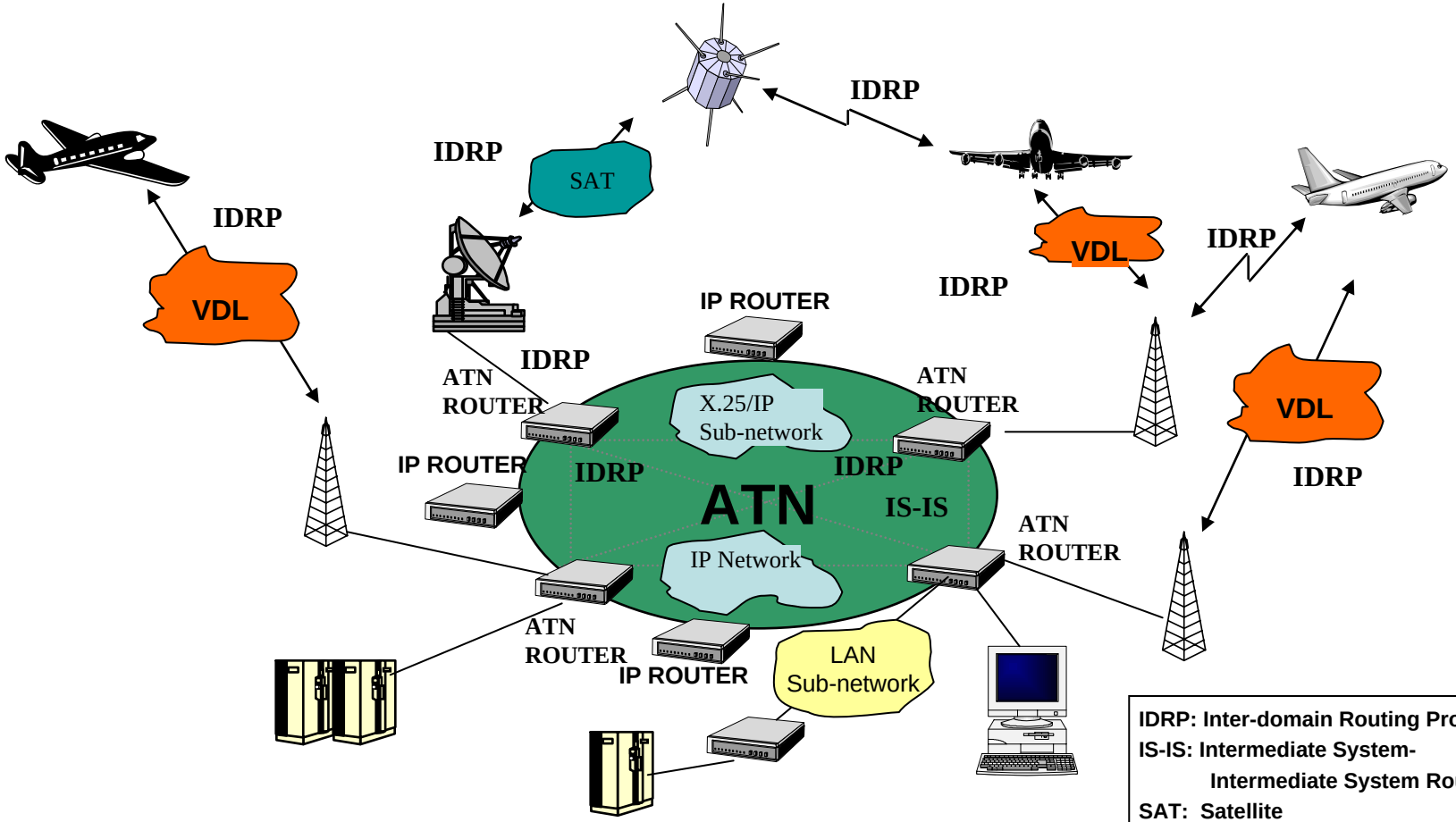
ATN Routing Architecture

ATN Addressing Plan

System Management

Directory Service

Evolving ATN Interconnection of Air/Ground and Ground/Ground Routers



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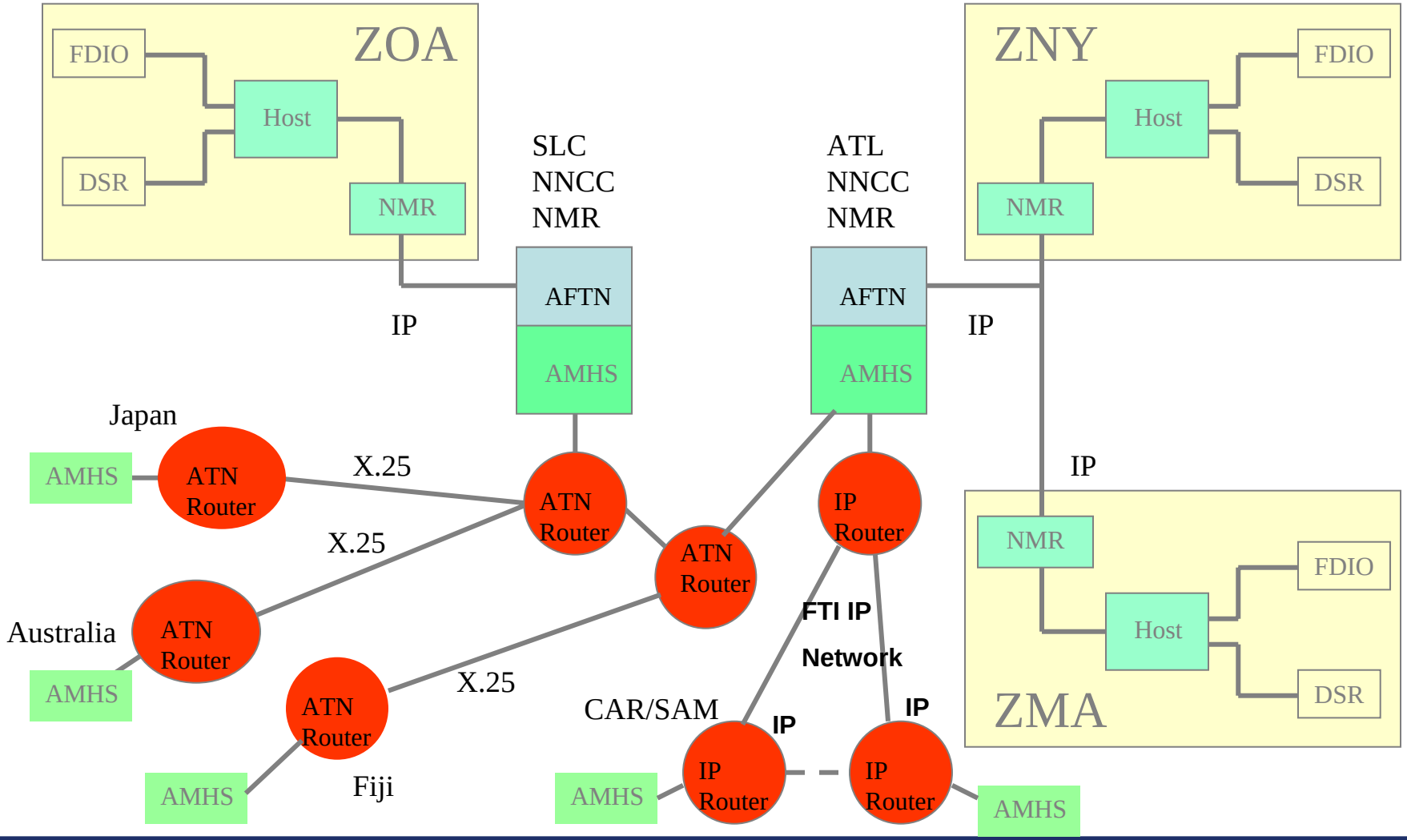
FAA ATN/AMHS Configuration



FAA Position

- **The FAA is supporting the development of Internet Protocol Suite (IPS) SARPS for ground to ground aeronautical data communication.**
- **The FAA is moving toward a ground-to-ground IPS for aeronautical data communications.**
- **The FAA will continue to support ATN Open Systems Interface (OSI).**
- **The FAA encourages the use of the IP router as its network converts from X.25 to IP.**

Acronyms

- AFS — Aeronautical Fixed Service
- ACP — Aeronautical Communication Panel
- AFTN — Aeronautical Fixed Telecommunication Network
- AIDC — Air Traffic Service Inter-Facility Data Communication
- AMHS — Air Traffic Service Message Handling System
- ATC — Air Traffic Control
- ATN — Aeronautical Telecommunication Network
- BUFR — Binary Universal Form Representation
- CIDIN — Common ICAO Data Interchange Network
- CLNP — Connection Less Network Protocol
- DOTS — Dynamic Oceanic Tracking System
- FASID — Facilities and Services Implementation Document
- FIR — Flight Information Region
- ICAO — International Civil Aviation Organization
- IDRP — Inter Domain Routing Protocol
- IP — Internet Protocol
- IPS — Internet Protocol Suites
- MTA — Message Transfer Agent
- MTCU — Message Transfer and Control Unit
- MTS — Message Transfer System
- NOTAM — Note to Air Men
- OSI — Open System Interface
- SARP — Standard and Recommended Practices
- SNDCF — Sub Network Dependent Convergence Function
- UA — User Agent
- WMO — World Meteorological Organization