

# **Next Generation Data Communications**

**AIM Global Consortium Conference**

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# Topics

- Aeronautical Telecommunication Network (ATN)
  - Original, Evolving, Planned
- Aeronautical Fixed Telecommunication Network (AFTN) Service
- Air Traffic Service Message Handling System (AMHS) Service
- Web Services over the ATN

# The Aeronautical Telecommunication Network

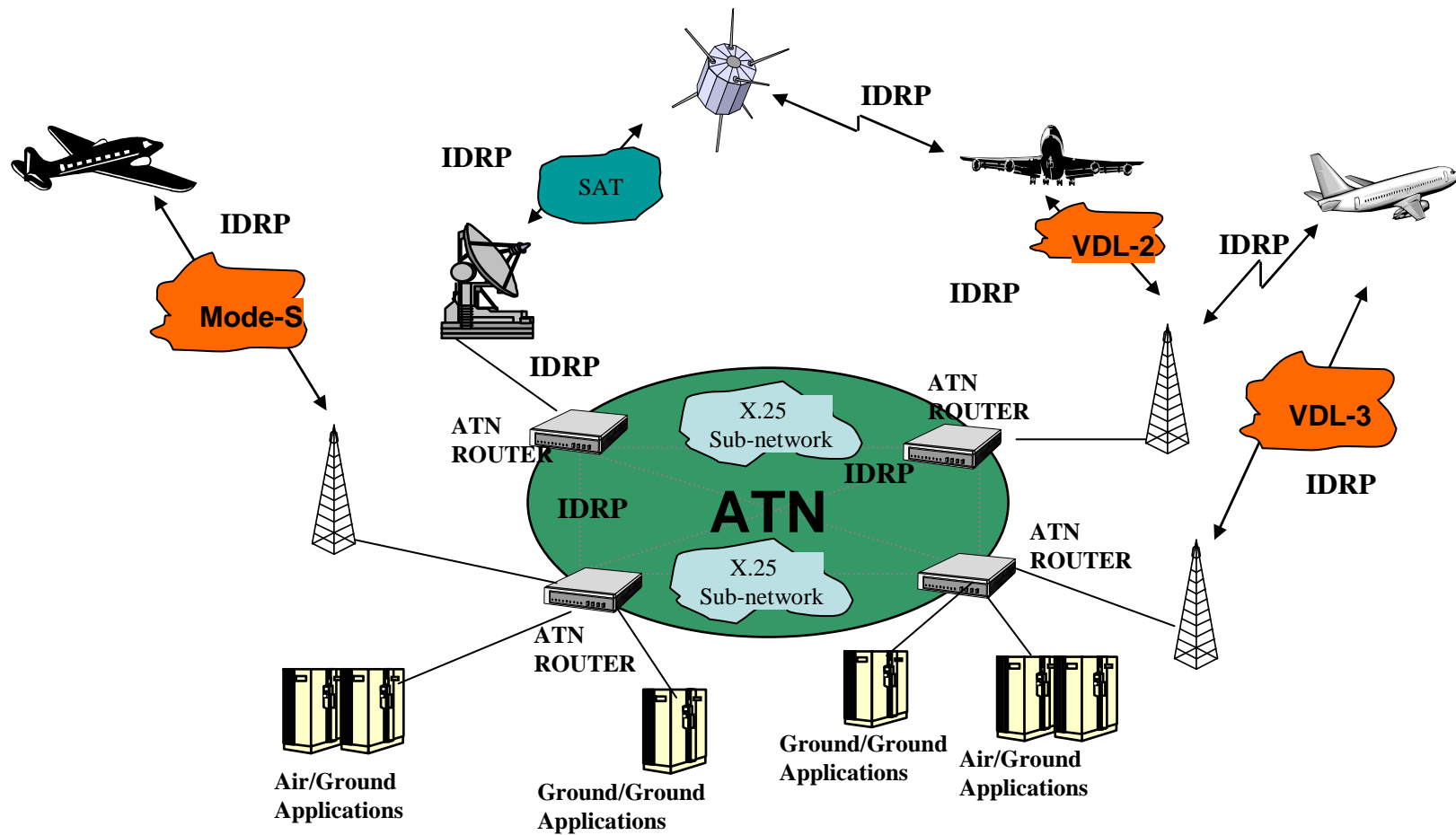
As originally defined by ICAO in Doc. 9705, the ATN consists of Applications and the ATN Internetwork.

- Applications
  - Air-Ground Applications
    - Controller Pilot Data Link Communication (CPDLC)
    - Automatic Dependent Surveillance – Contact (ADS-C)
    - Flight Information Service (FIS)
    - Context Management (CM)
  - Ground-Ground Applications
    - ATN Message Handling Service (AMHS)
    - ATN Interfacility Data Communications (AIDC)

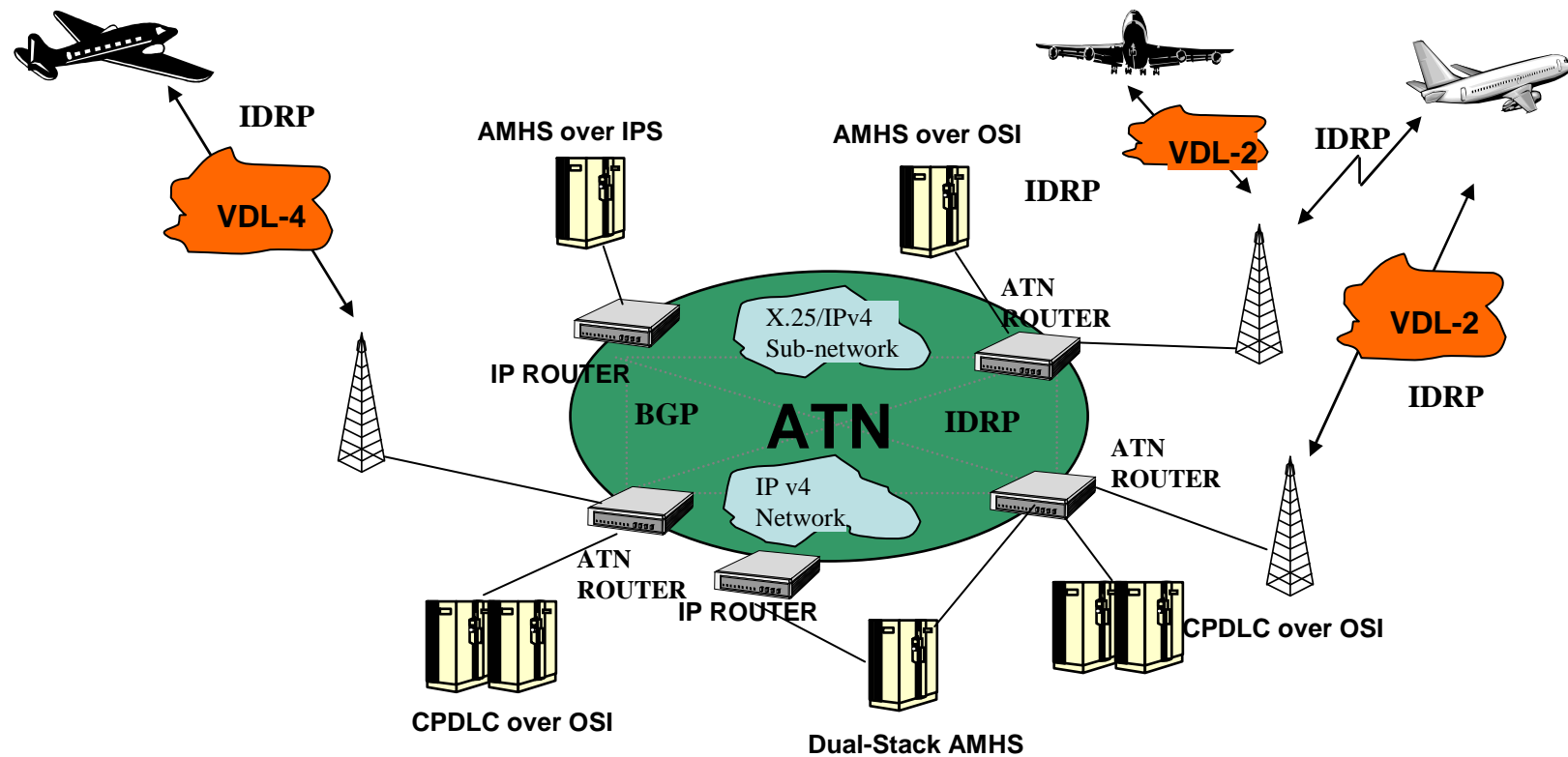
# The Aeronautical Telecommunication Network

- ATN Internetwork
  - An internetwork of Ground/Ground, Air/Ground and Airborne ATN Routers
  - Uses the ISO Connectionless Network Protocol (CLNP) for forwarding
  - Uses the ISO Inter-Domain Routing Protocol (IDRP) for distributed adaptive routing
    - IDRP is used air/ground to provide mobility
- Air-Ground Subnetworks
  - VDL-2, VDL-3, Satellite, Mode-S
  - *Specified in other ICAO Manuals*
- Ground-Ground Subnetworks
  - (initially) X.25

# Initial ATN – “the plan”



# Evolving ATN – “the reality”



# The Evolving ATN

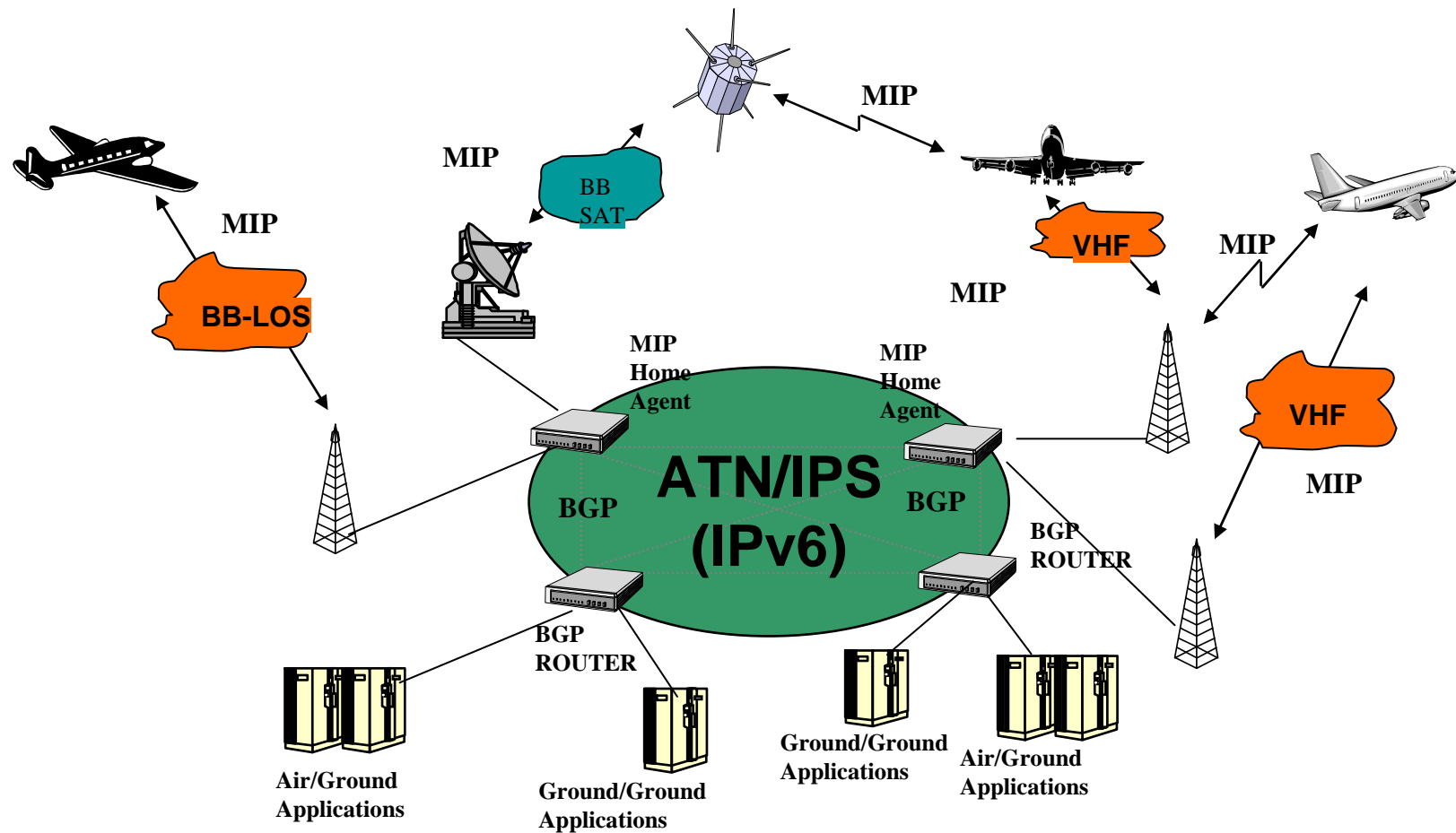
- Application Changes
  - CPDLC was enhanced with a “Protected Mode” version (PM-CPDLC) to prevent misdirection of air-ground messages
- Air-Ground Subnetworks
  - VDL-2 has emerged as the primary air-ground network for ATC
  - VDL-2 also supports ACARS over AVLK (AOA) for AOC traffic
  - The FAA stopped development of VDL-3
  - VDL-4 in limited use
- Ground-Ground Subnetworks
  - IPv4 is being used as a subnetwork for Air/Ground traffic
  - The Internetworking technology (for AMHS) is OSI in certain regions and IPv4 in other regions
    - *This means we do not have a global ATN Internetwork*

# ATN/OSI Specifications

- Several enhancements for the ATN were developed in Edition 3 of Doc 9705 which provides:
  - Formal specification of PM-CPDLC
  - Formal specification on the use of IP subnetworks
  - Several enhancements to the Internet Communications service
  - Security and Directory services
    - The security solution uses an enhanced CM application and Upper Layer Communication Service
    - The directory service is based on X.500
- ICAO is currently publishing a new version of the ATN/OSI standards in Doc 9880
  - Doc 9880 is being produced to capture corrections to the ATN implementations and only Edition 3 features in use or planned for actual implementation



# Next Generation ATN – “the new plan”



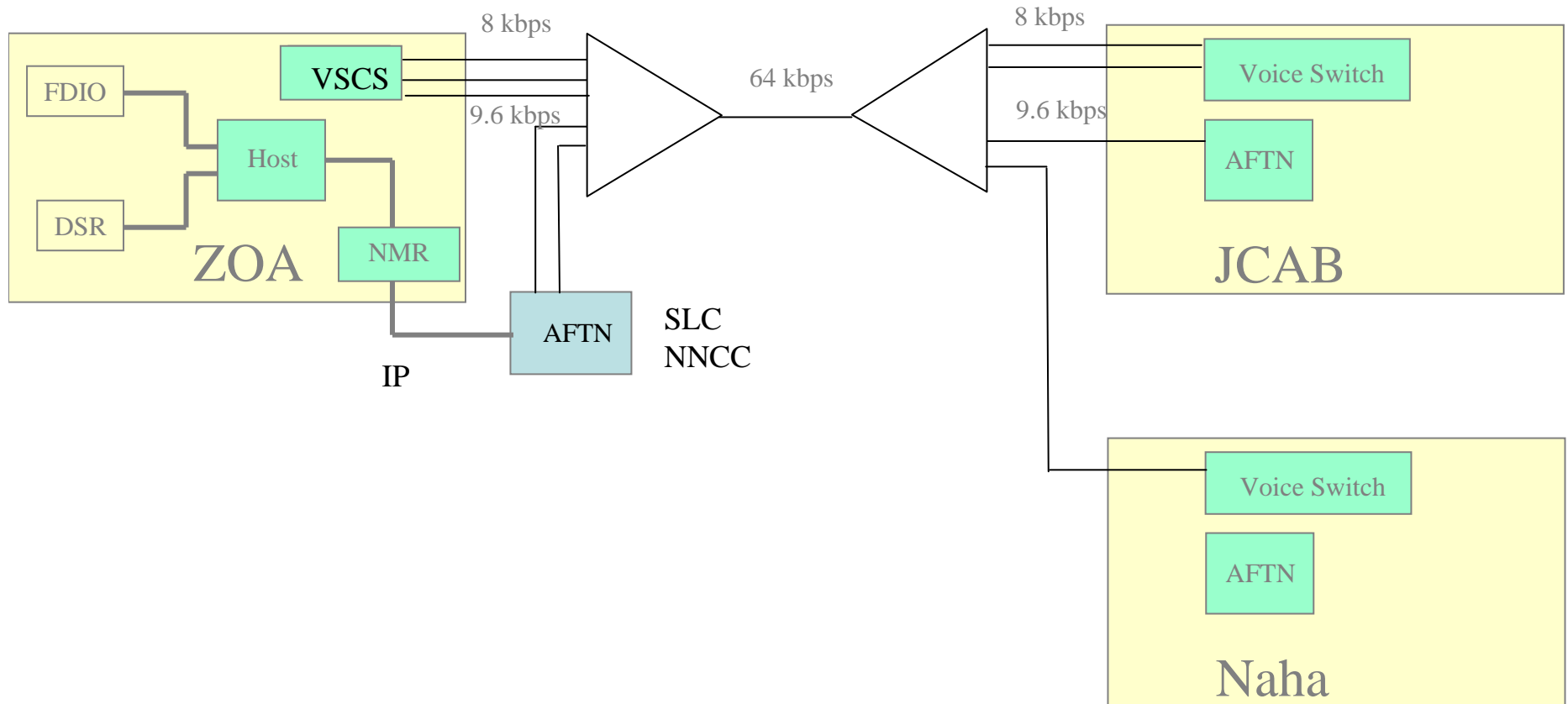
# The ATN/IPS

- ICAO has defined a new technical manual (ICAO Doc 9896) which specifies ATN operation over the Internet Protocol Suite (IPS)
- The ATN/IPS internetwork is based on IPv6
  - The Border Gateway Protocol (BGP) is used for distributed adaptive routing
  - Mobile IP (MIP) is selected as the base mobility solution
  - IPsec and IKEv2 selected for security
- Broad-band (BB) Air-Ground Subnetworks are expected to be available
- A method of converging OSI Air/Ground Applications has been specified

# Aeronautical Fixed Service

- The AFS, as specified in International Civil Aviation Organization (ICAO) Annex 10, 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.

# FAA/JCAB ATC Voice and AFTN Configuration



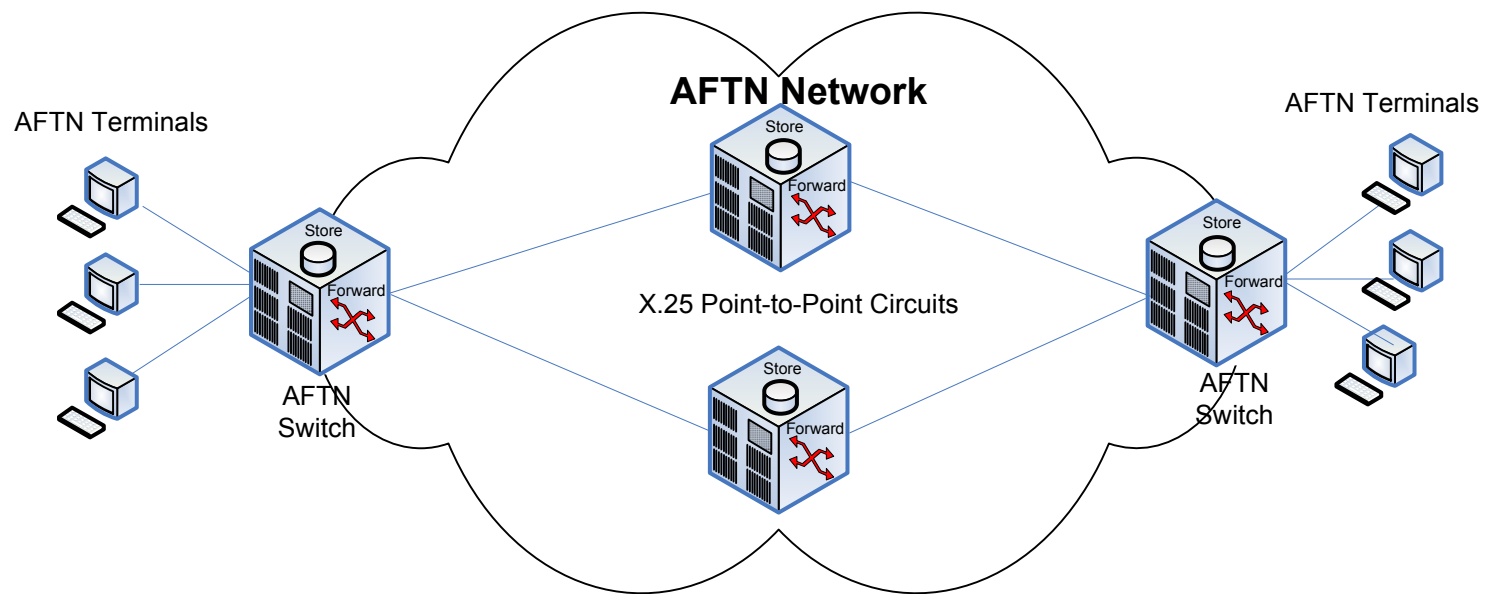
# Aeronautical Fixed Telecommunication Network (AFTN)

- The AFTN was implemented in the 1970s
  - It is text-based
  - It uses the “store and forward” function to distribute its messages.
- The AFTN network was initially based on dedicated circuits with data rates as low as 50 Baud.
- In 1990s, an AFTN backbone was formed using an 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
  - Air Traffic Service Inter-Facility Data Communication (AIDC),
  - Dynamic Oceanic Tracking System (DOTS),
  - International Search and Rescue
  - Other messages for ATC activities not covered in ICAO Annex 10.

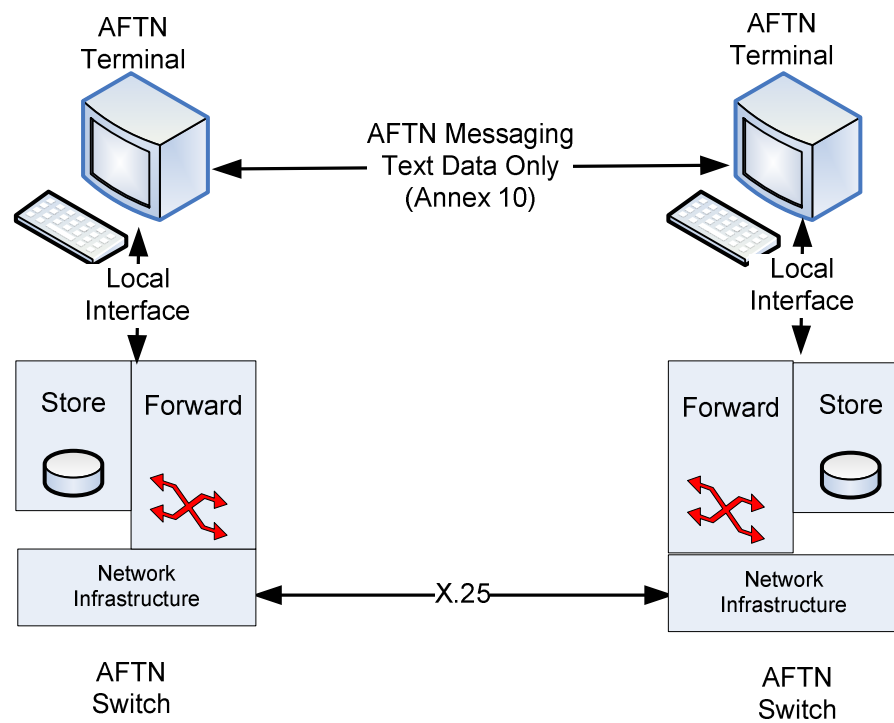
# Aeronautical Fixed Telecommunication Network (AFTN)

- ICAO Annex 10 describes AFTN as a service based on the “store and forward” function for conveyance of text messages using character-oriented procedures.
  - the sending station will hold messages transmitted, and in the event that continuity of message traffic is not maintained, they are re-transmitted.
- 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.
  - Messages are routed by the application (AFTN switch) and not by a network router.
  -
- AFTN has manually configured diversion routing lists agreed to by the administrations of AFTN communication center
  - 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.

# AFTN

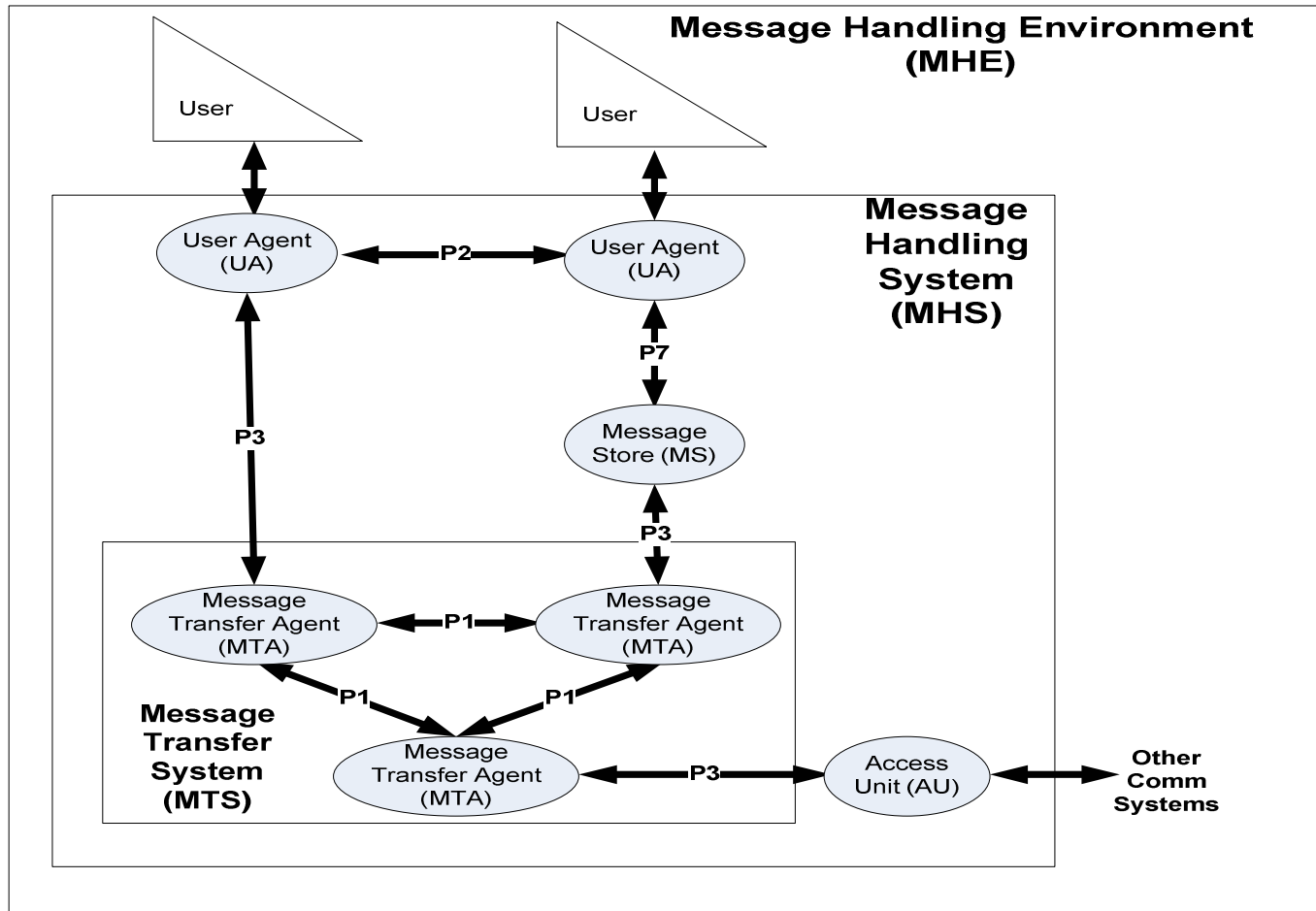


# AFTN





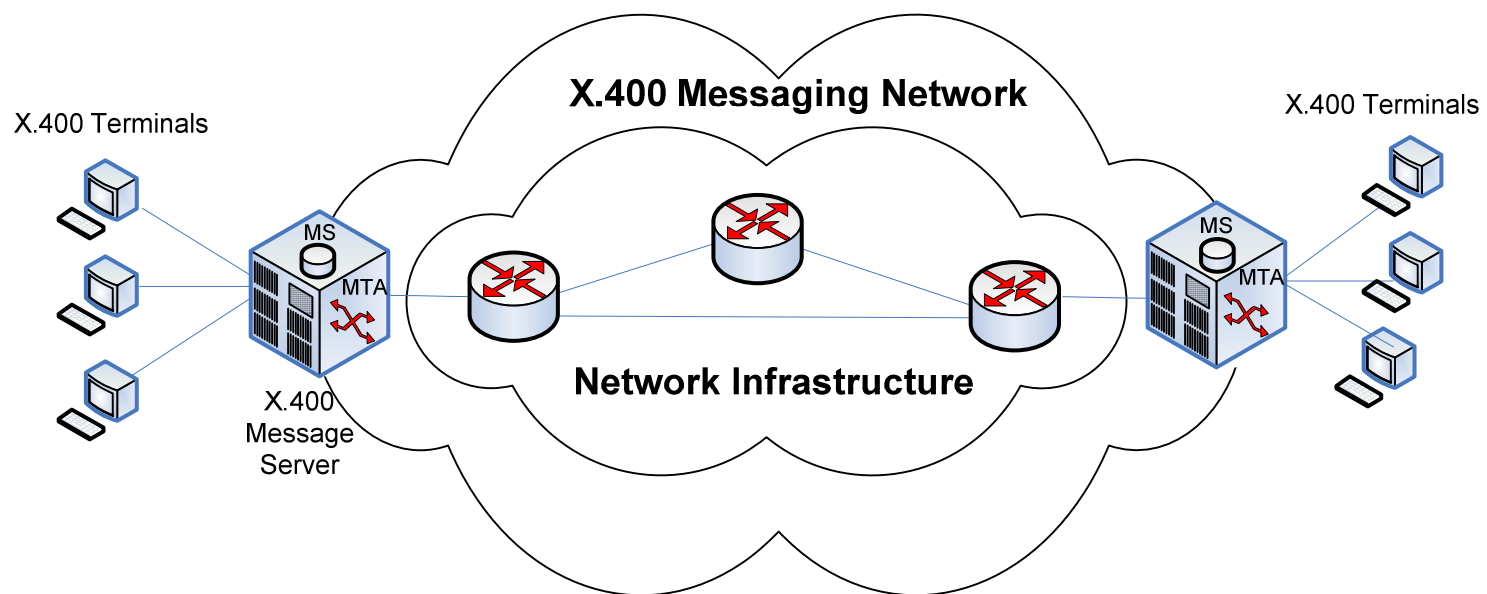
# AMHS Background – X.400 Protocols



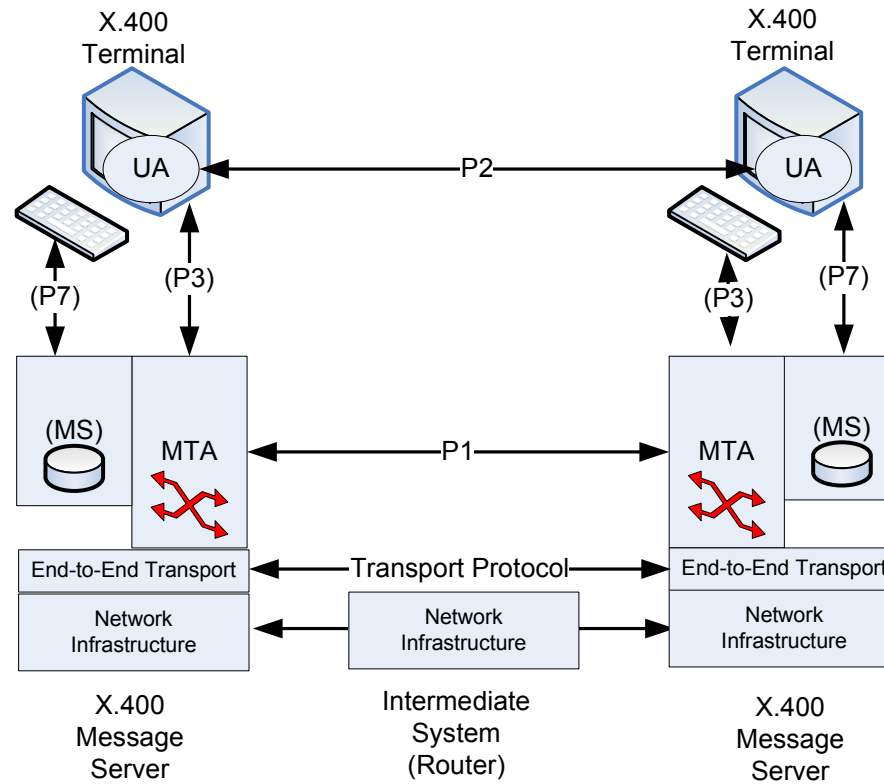
# AMHS – Background X.400

Protocol	Name	Protocol Specification	Abstract Service Specification	PICS/ISP
P2	Interpersonal Messaging	X.420 (ISO/IEC 10021- 7)		AMH21 X.481 (ISO/IEC 12062- 2)
P1	MTS Transfer Protocol	X.419 (ISO/IEC 10021- 6)	X.411 (ISO/IEC 10021- 4)	AMH11 X.482 (ISO/IEC 10611- 3)
P3	MTS Access Protocol	X.419 (ISO/IEC 10021- 6)	X.411 (ISO/IEC 10021- 4)	AMH12, AMH14 X.483 (ISO/IEC 10611- 4)
P7	MS Access Protocol	X.419 (ISO/IEC 10021- 6)	X.413 (ISO/IEC 10021- 5)	AMH13,AMH15 X.484 (ISO/IEC 10611- 5, ISO/IEC 10611-6)

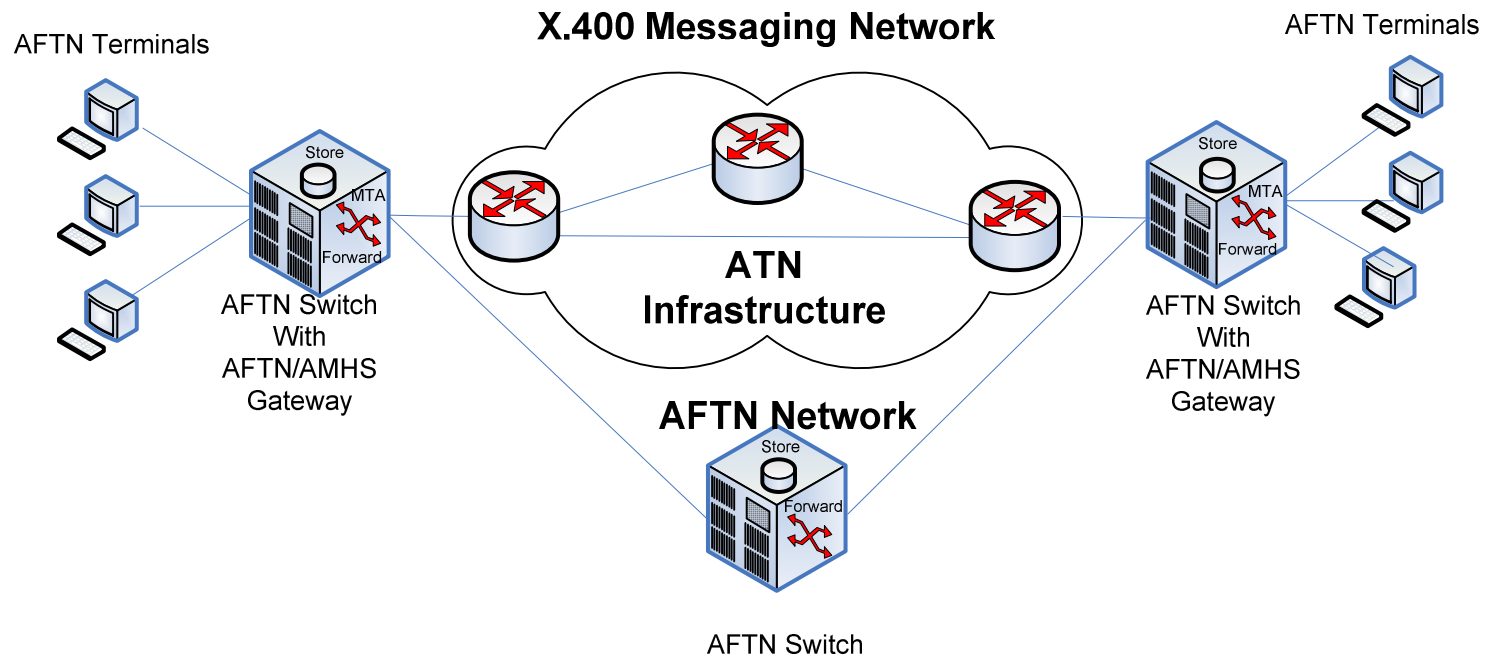
# AMHS – X.400 Only



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# AMHS and AFTN



# AMHS Description

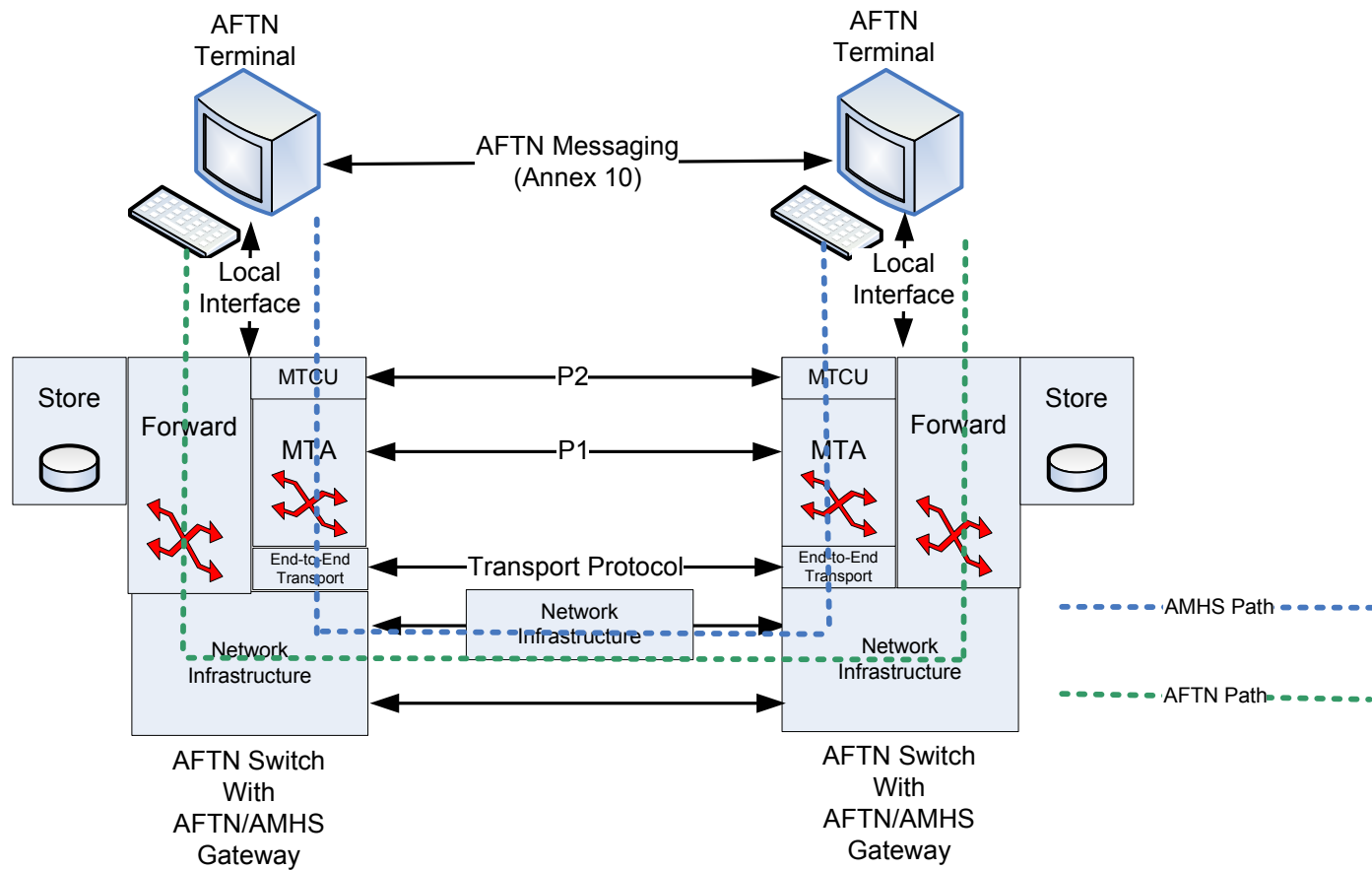
**ICAO Doc 9705 distinguishes the service from the set of computing and communication resources implemented by ATS organizations to provide the ATS message handling service. The set of computing and communication resources is called the *AMHS*. For Basic ATS Message Service, the following AMHS entities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

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

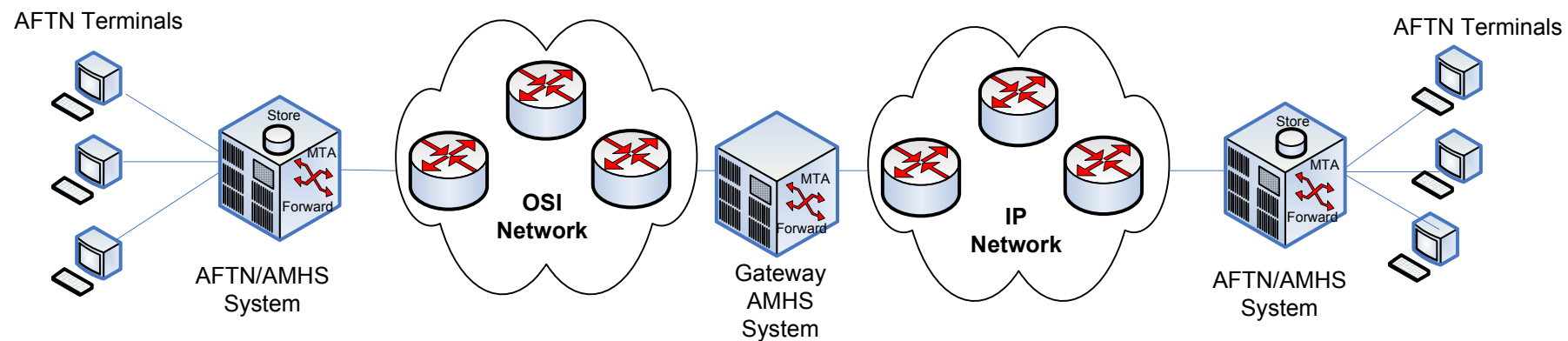
**2.ATS Message User Agent (UA) – An X.400 UA designed to replace the AFTN Terminals**

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

# AMHS and AFTN

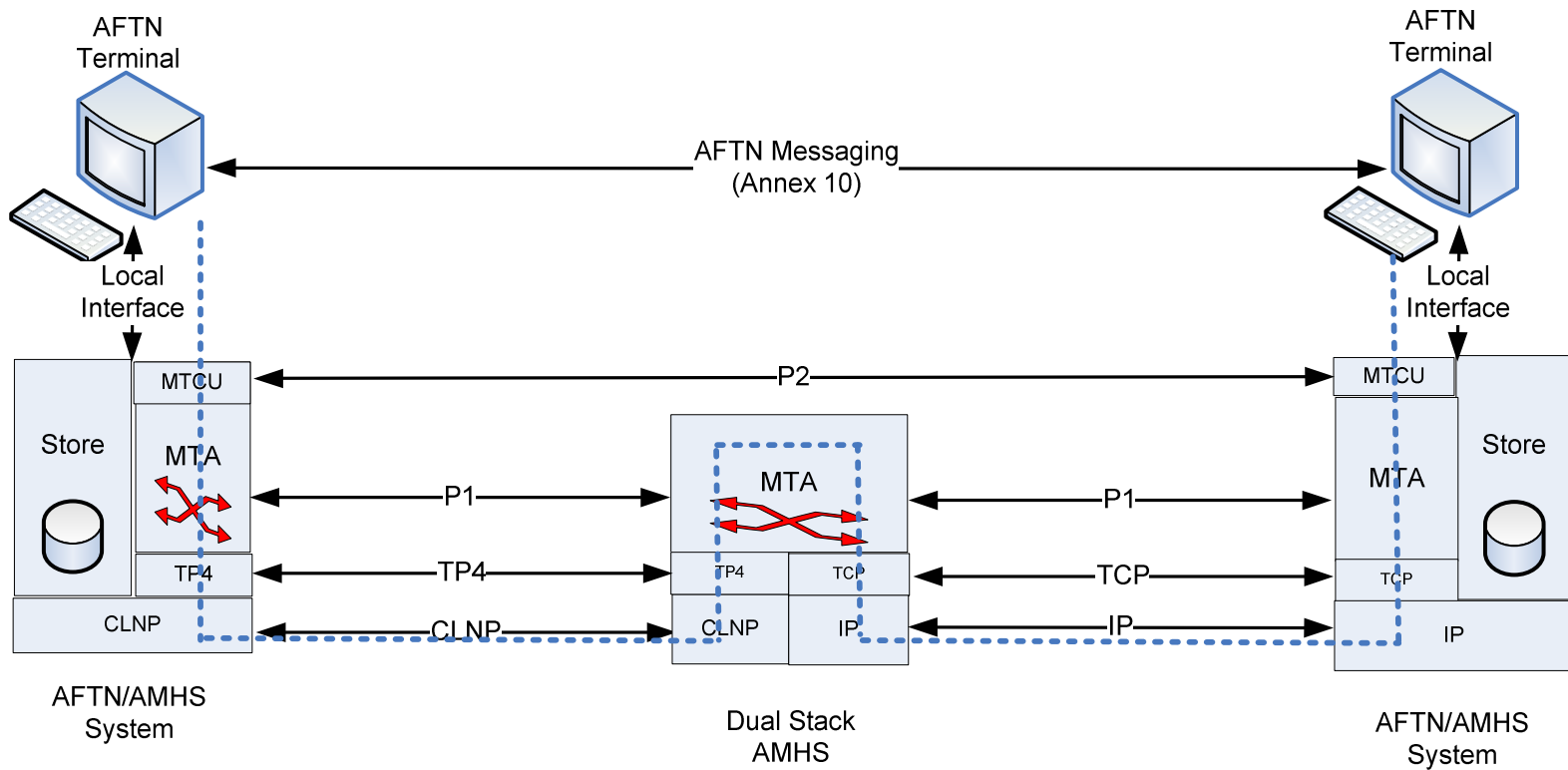


# AMHS over OSI and IPS





# AMHS



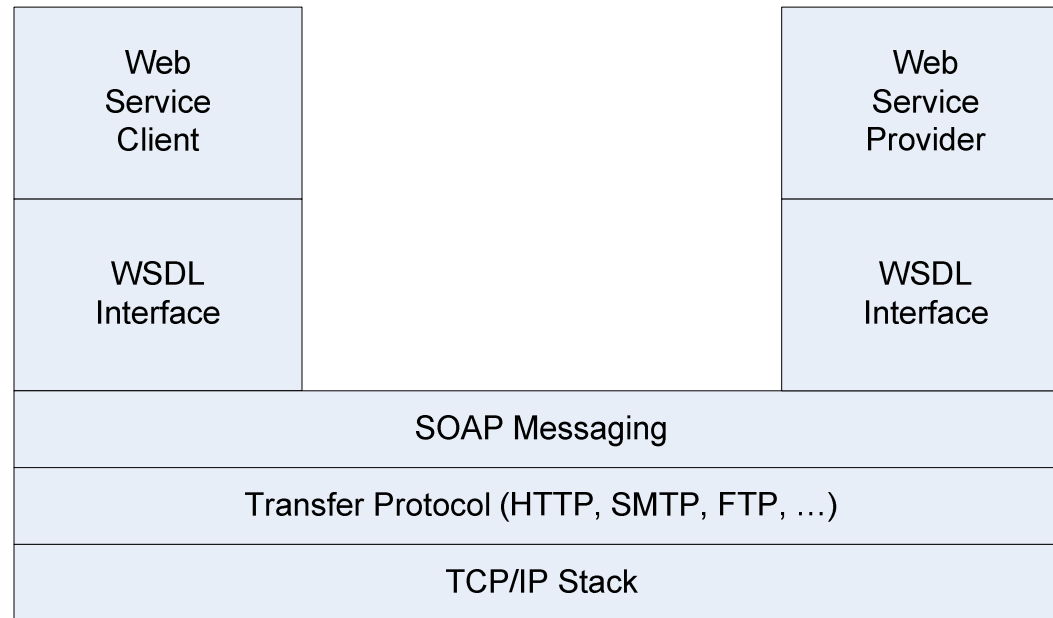
# Web Services over the ATN

- What is the service mechanism?
  - Simple Object Access Protocol (SOAP) is a logical choice from a standardization perspective
- How should binary data be carried?
  - One option is in SOAP messages using for example Message Transmission Optimization Mechanism (MTOM)
  - Another is to transmit binary data separately
    - FTP
    - AMHS X.400 File Transfer Body Part

# Web Services over the ATN

- Discussion item: How to carry Web Services over the ATN Services?
  1. Use ICAO ATN/IPS Global IPv6 Network
    - Would enable use of standard bindings such as HTTP
    - Not available globally in near term
  2. Use SOAP Intermediaries at regional boundaries
    - Permits different bindings in different regions
    - Intermediaries are new infrastructure elements
  3. Define a SOAP binding over AMHS
    - Permits use of AMHS infrastructure

# Typical Web Services Communications



# WSDL

**<definitions>**: Root WSDL Element

**<types>**: What data types will be transmitted?

**<message>**: What messages will be transmitted?

**<portType>**: What operations (functions) will be supported?

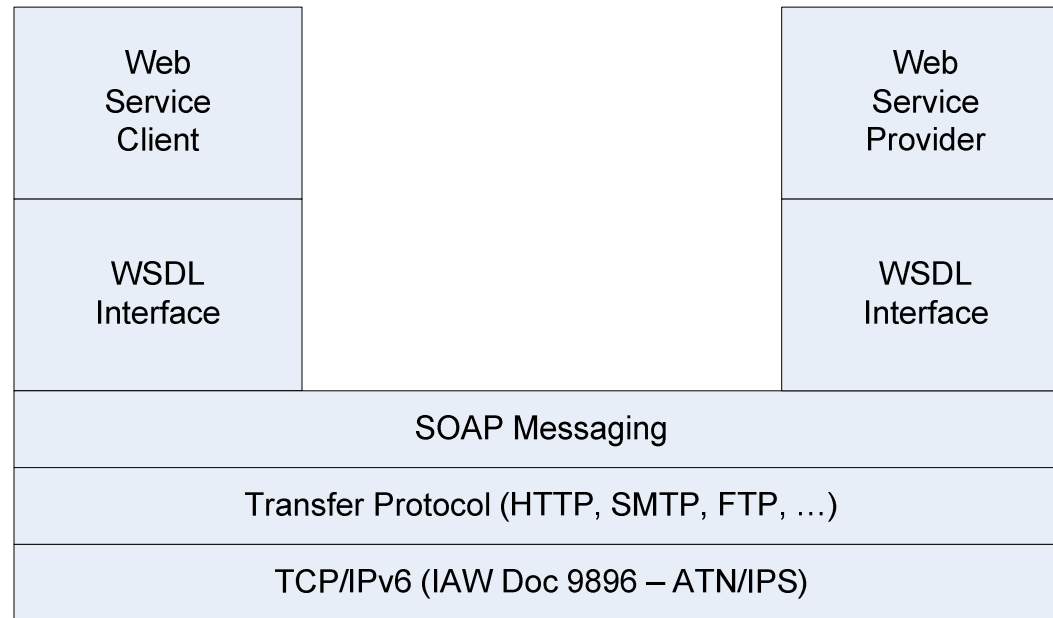
**<binding>**: How will the messages be transmitted on the wire?  
What SOAP-specific details are there?

**<service>**: Where is the service located?

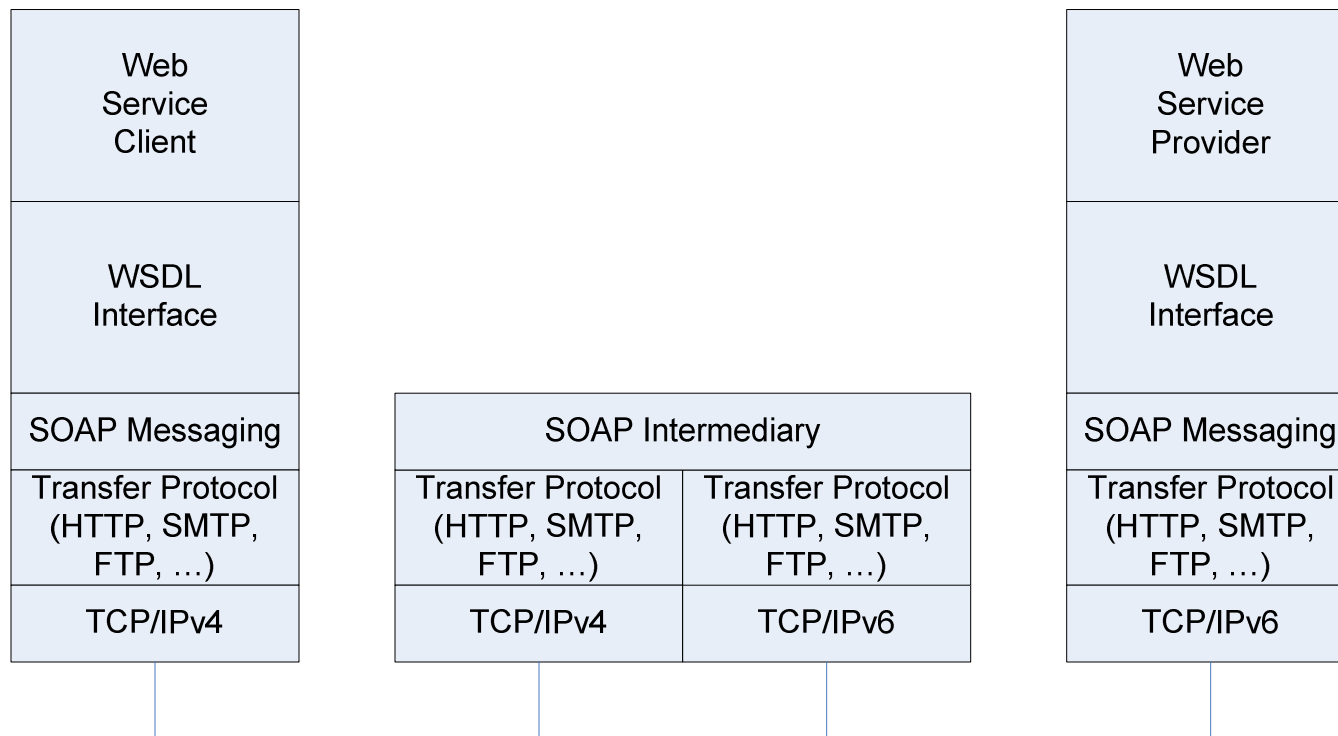
Other WSDL elements include:

a *documentation* element to include human-readable documentation,  
an *import* element to import other WSDL documents or XML schemas

# Option 1 Web Services over Global ATN/IPS



# Option 2 Web Services with SOAP Intermediaries



# Option 3 Web Services over AMHS

