International Civil Aviation Organization

ATN Seminar and Third ATN Transition Task Force Meeting

Singapore, 26-30 March 2001

Agenda Item 4: ATN Air-Ground Application

CONTROLLER PILOT DATA LINK COMMUNICATION (CPDLC) CONTEXT MANAGEMENT (CM) OVERVIEW

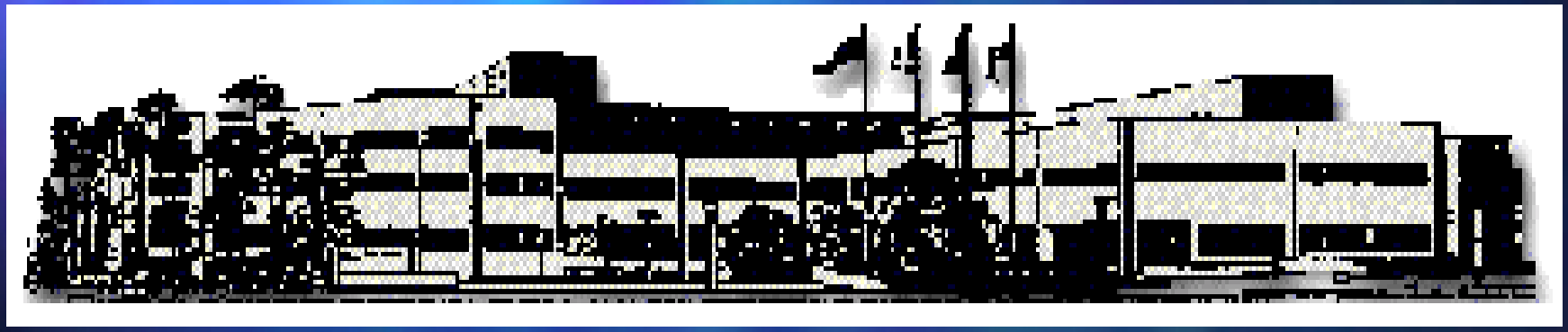
(Presented by Vic Patel, USA)

Federal Aviation Administration (FAA)

~ ATN Seminar - CPDLC ~

Singapore

March 2001



Federal Aviation Administration (FAA) William J. Hughes Technical Center (WJHTC)

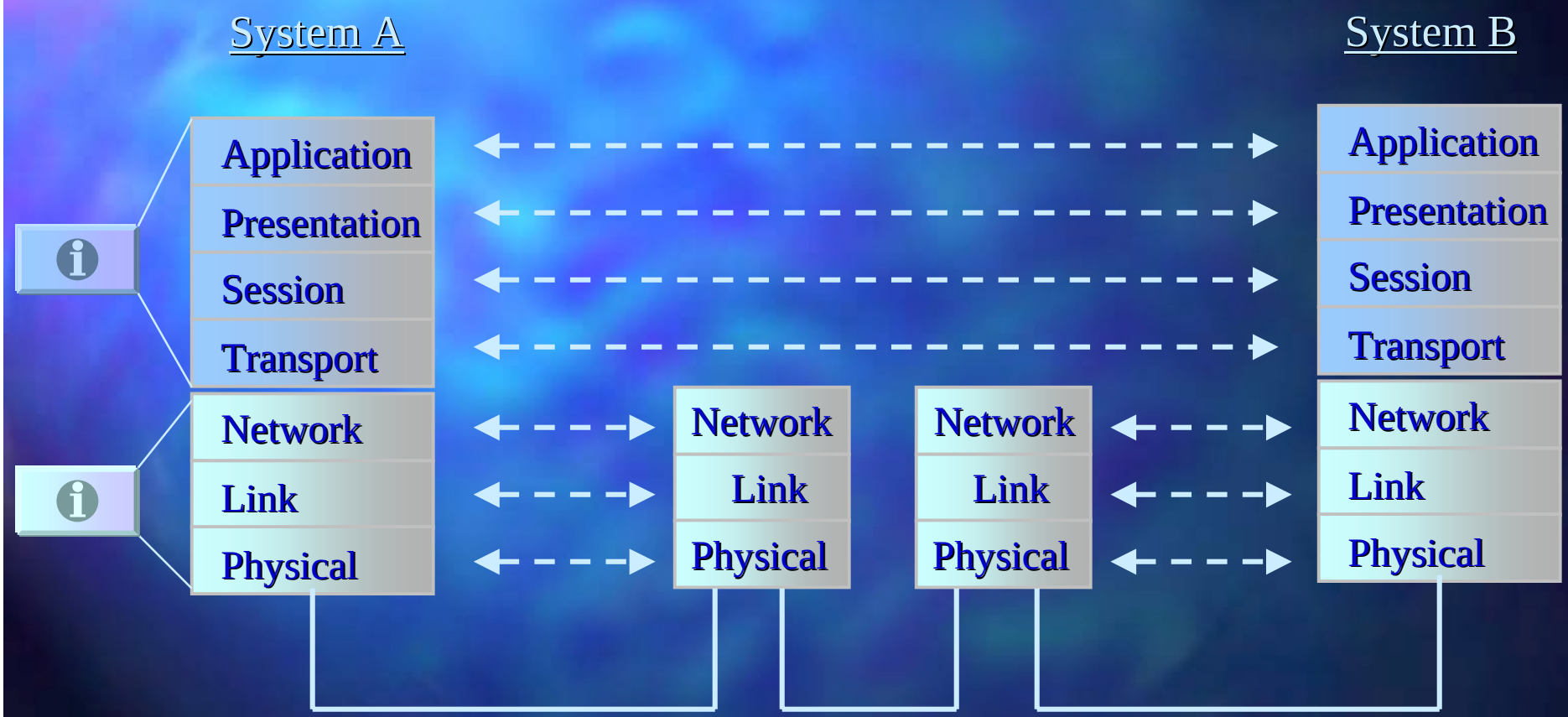
Vic Patel, FAA/ACT-350

ATN Technical Lead

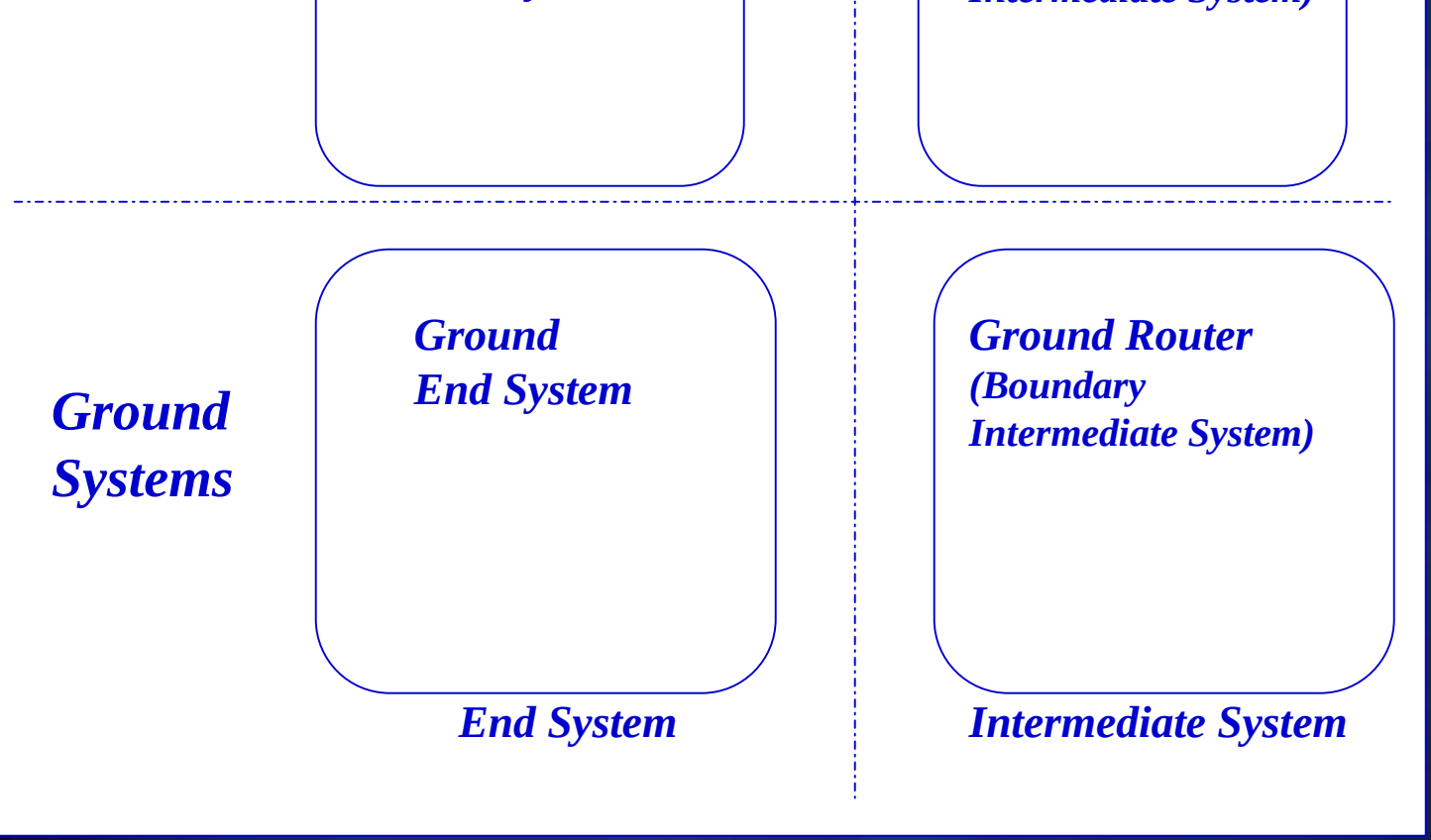
AGENDA

- ATN Communication overview
- ***Controller Pilot Data Link Communication (CPDLC) overview***
- ***Context Management (CM) overview***
- ***FAA/U.S. CPDLC implementation phases***
- ***Current status***
- ***Future Activities***

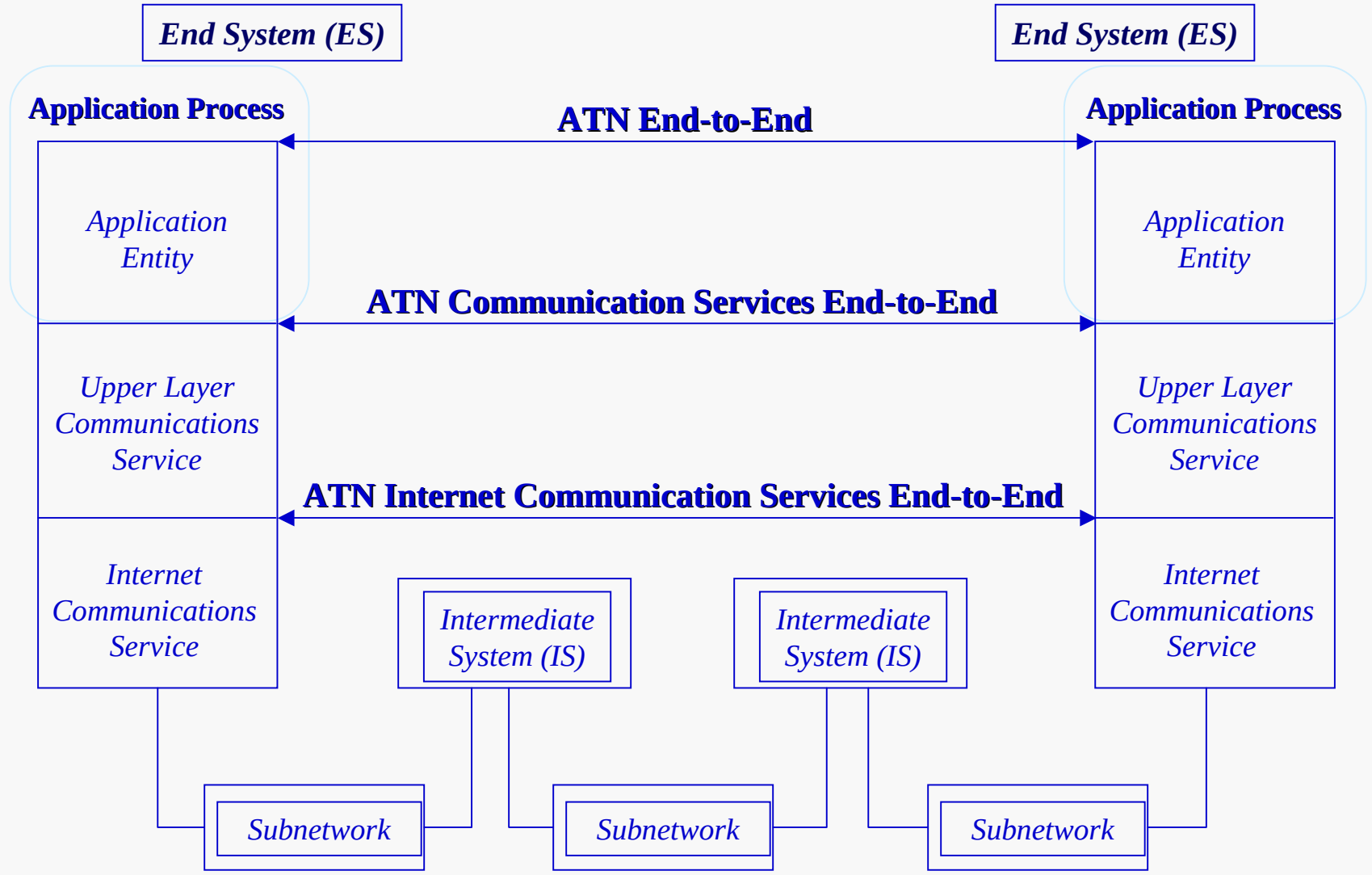
Open Systems Layer Structure



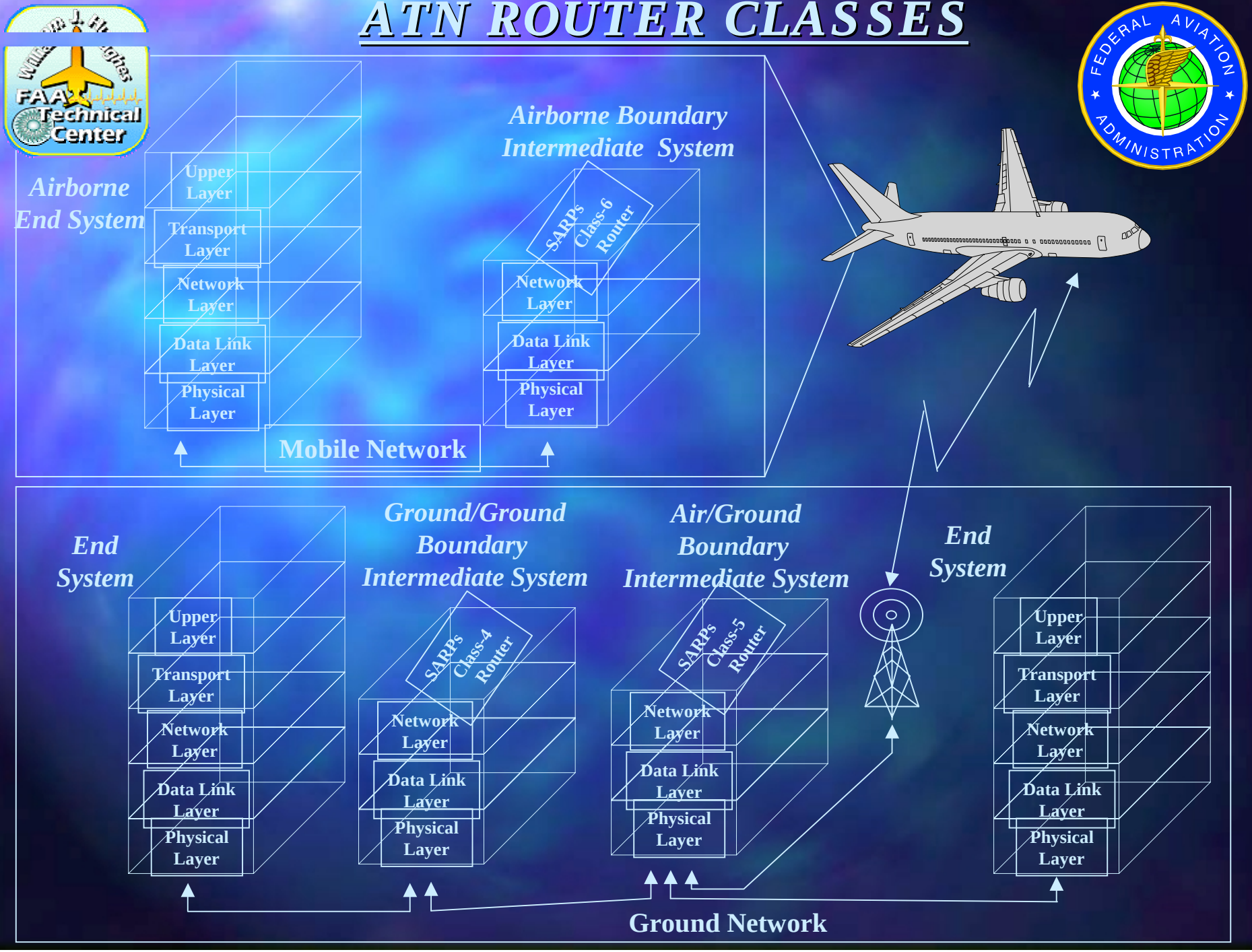
ATN ROUTER PACKAGES



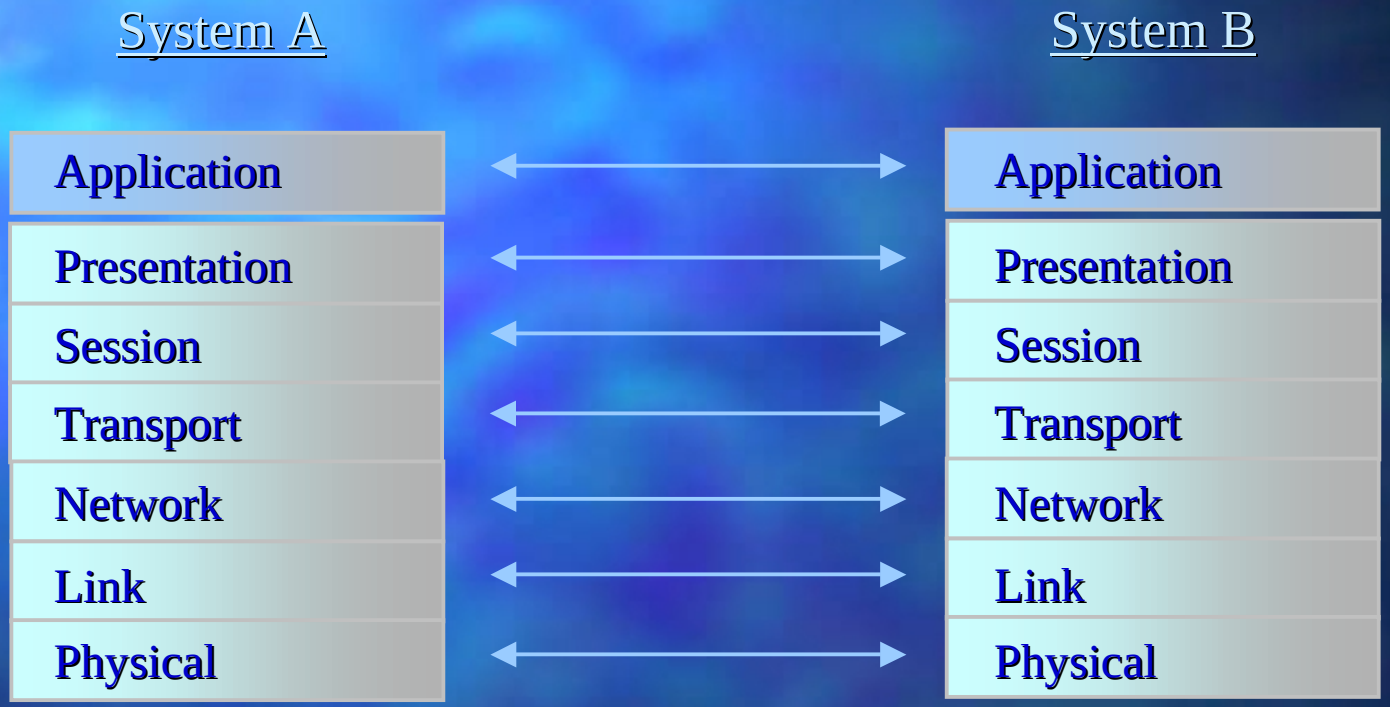
CONCEPTUAL MODEL OF THE ATN



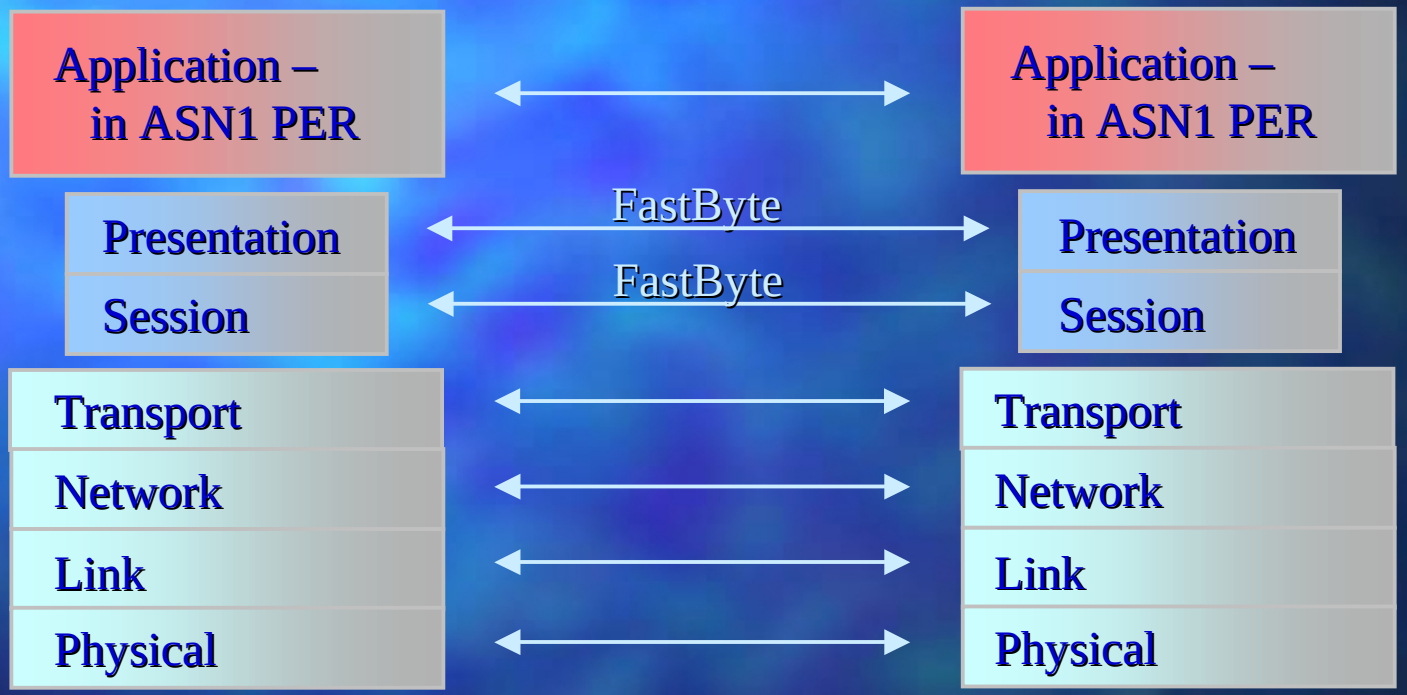
ATN ROUTER CLASSES



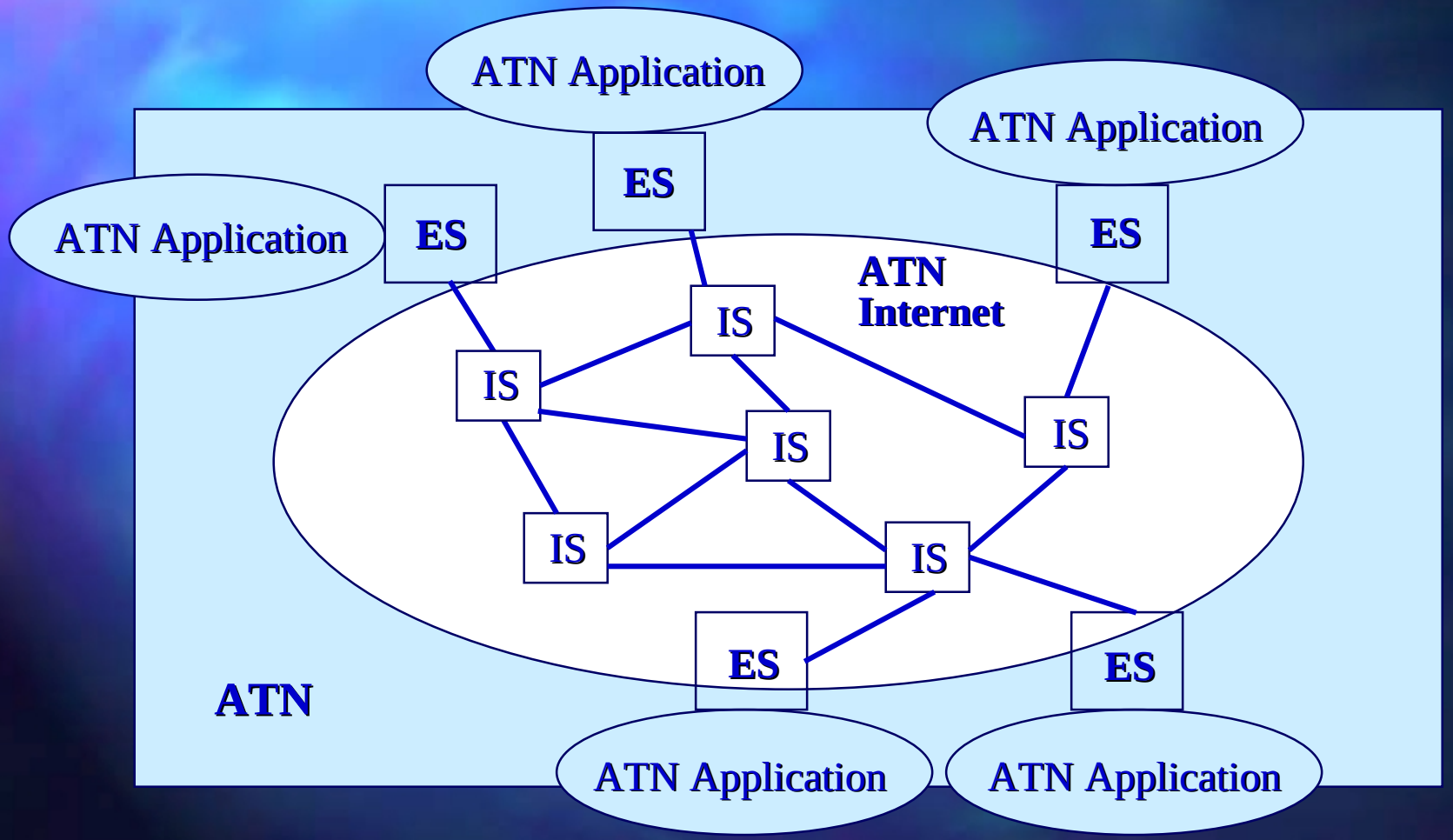
Application Layer



ATN FastByte Protocol Stack



ATN building components



The Internetworking

- Different Services
  - Reliable Connection oriented (e.g. X.25)
  - Unreliable Connection Mode (e.g. Frame Relay)
  - LAN Connectionless (e.g. Ethernet)
- Different Addressing Plans
  - X.25 DTE Addresses (X.121 - decimal digits)
  - IEEE LAN Addresses (A.B.C.D - 48 bits)

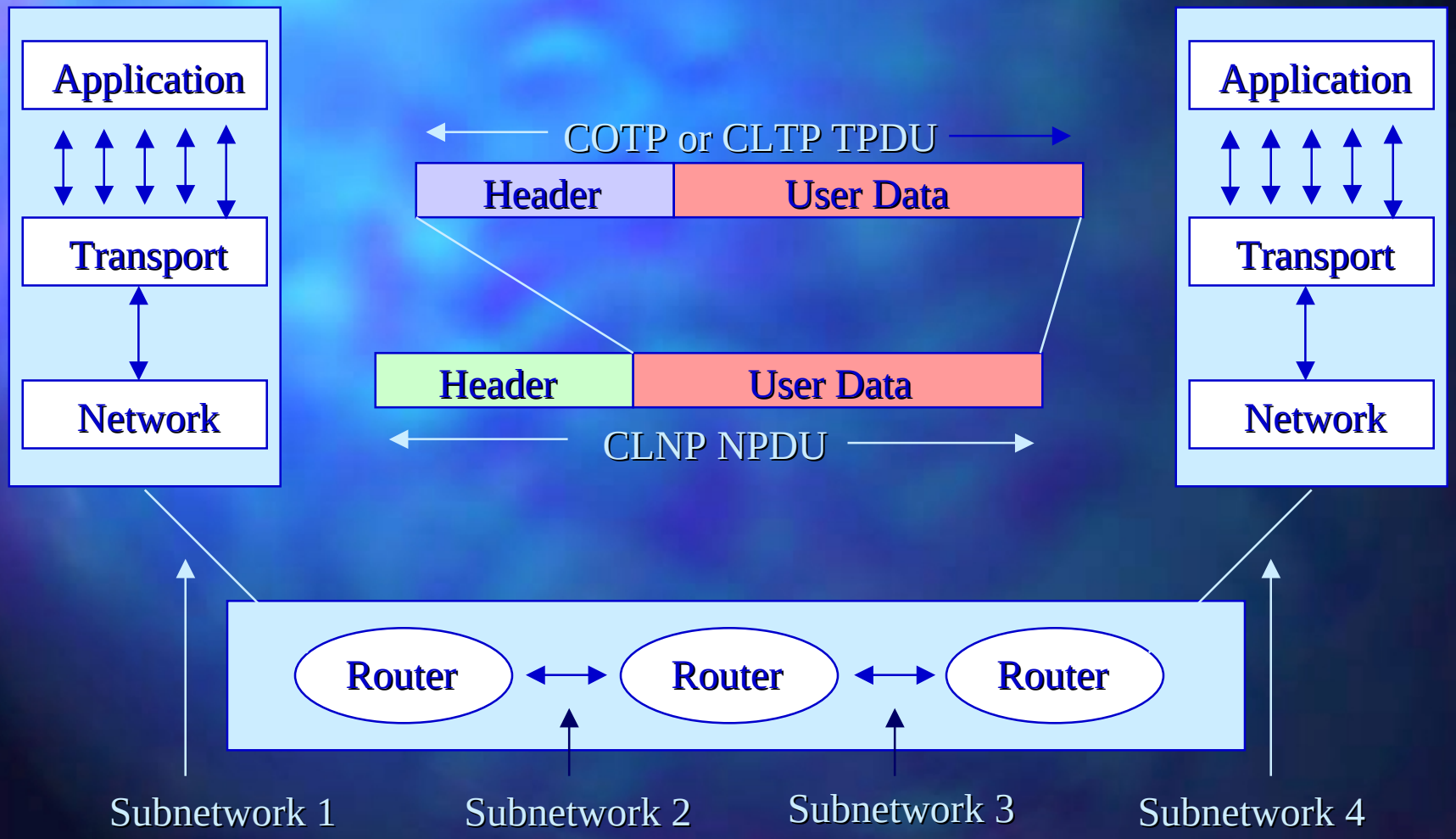
End-to-End Internetworking

- Requires an Internetwork Protocol
  - Universally known Packet Format
  - Created by End System
  - Forwarded by Router
  - Received by Destination End System
- Requires an Addressing Plan
  - Gives a Unique Address to every End System
  - Used by Routers when forwarding

ATN Internet Protocols

- ISO-8073 Class 4 Transport Protocol (TP4)
- ISO-8602 Connectionless Transport Protocol
- ISO-8473 Connectionless Network Protocol (CLNP)
- ISO-10747 Inter-Domain Routing Protocol (IDRP)
- ISO-10589 Intra-Domain Routing Protocol (IS-IS)
- ISO-9542 End System to Intermediate System Routing Protocol (ES-IS)

ATN Communications Model



End System Protocol Architecture

ATN End System Support

- Application ASEs
  - CPDLC, CM, ADS, FIS
- Fast BYTE Session & Presentation Layers
- CO and CL Transport Layer
- CL Network Layer
- ES-IS Routing

Intermediate System Protocol Architecture

IS can be

- Air/Ground
- Ground/Ground
- Airborne

ISs Support

- CL Network Layer
- Mobile SNDCF
- IDRP
- ES-IS Routing

Intermediate System
(ATN Router)

IDRP / CLNP	ES-IS / CLNP
SNDCF	SNDCF-Mobile
SNAcP	SNAcP
Data Link	Data Link
Physical	Physical

Subnetwork — Mobile Subnetwork

ATN End Systems

- Protocols Required
  - TP4 (with mandatory checksum support)
  - CLNP
- Protocols Recommended
  - ES-IS

ATN Routers

- CLNP Required by all ATN Routers
- IDRP Required by all Inter-Domain Routers
  - Air-Ground Data Links
  - Between Organizations
- ES-IS Required by Air-Ground Routers
- IS-IS and ES-IS Recommended within an organization

TP4 Functions

- Connection Mode Protocol
- Ensures end-to-end Reliable Delivery
- Provides a Checksum on each Packet
- Retransmits on Packet Loss or Corruption
- Provides End-to-End Flow Control

Connectionless Network Protocol (CLNP)

81h	Len		Dest	Source	Options & User Data

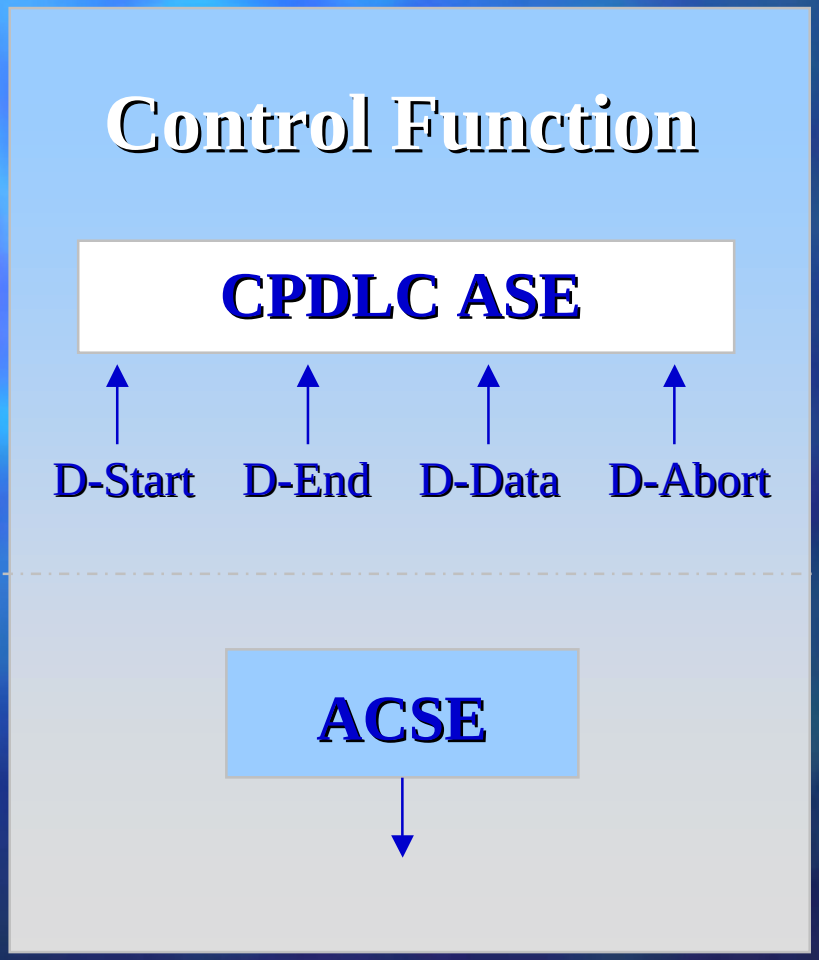
- Created by Sender
- Sender sends it and forgets it
- Interpreted by Routers
- Delivered to Destination System

CLNP Functions

- Simple Datagram Format
- Message Header Identifies
  - Source and Destination
  - Priority
  - Traffic Type
  - AOC Routing Requirements
  - ATSC Class

CPDLC Service Provision –

Use of the ATN



CPDLC Functions

- Controller-Pilot Message Exchange Function
- Transfer of Data Authority Function
- Down Stream Clearance Function
- Ground Forward Function

CPDLC Services

- CPDLC-start service
- DSC-start service
- CPDLC-message service
- CPDLC-end service
- DSC-end service
- CPDLC-forward service

Sample CPDLC Messages

- Roger (No Parameters)
- WILCO (No Parameters)
- Affirm (No Parameters)
- AT [time] EXPECT CLIMB TO [level]
- CLEARED [route clearance]
- SQUAWK MODE CHARLIE
- REPORT REMAINING FUEL AND PERSONS ON BOARD

Context Management Users

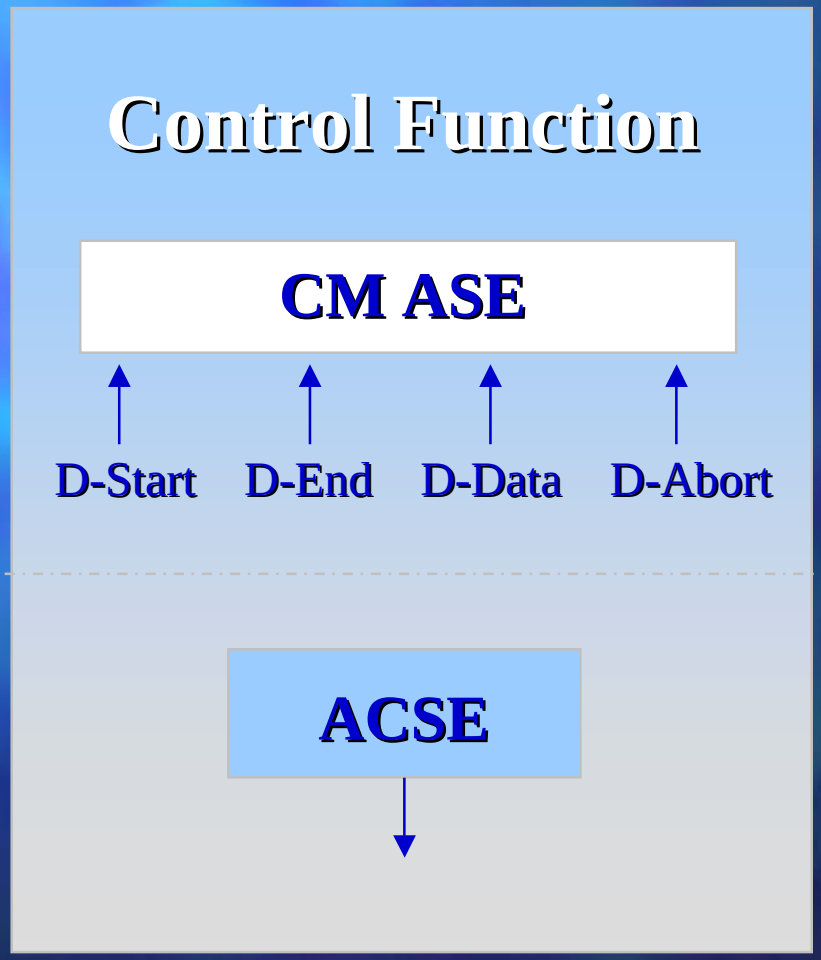
- CM Users are:
  - Aircraft ATN Communications System
  - ATC ATN Communications Systems
- In preparation for:
  - The ADS Application
  - The CPDLC Application
  - The FIS Application

Context Management Services –

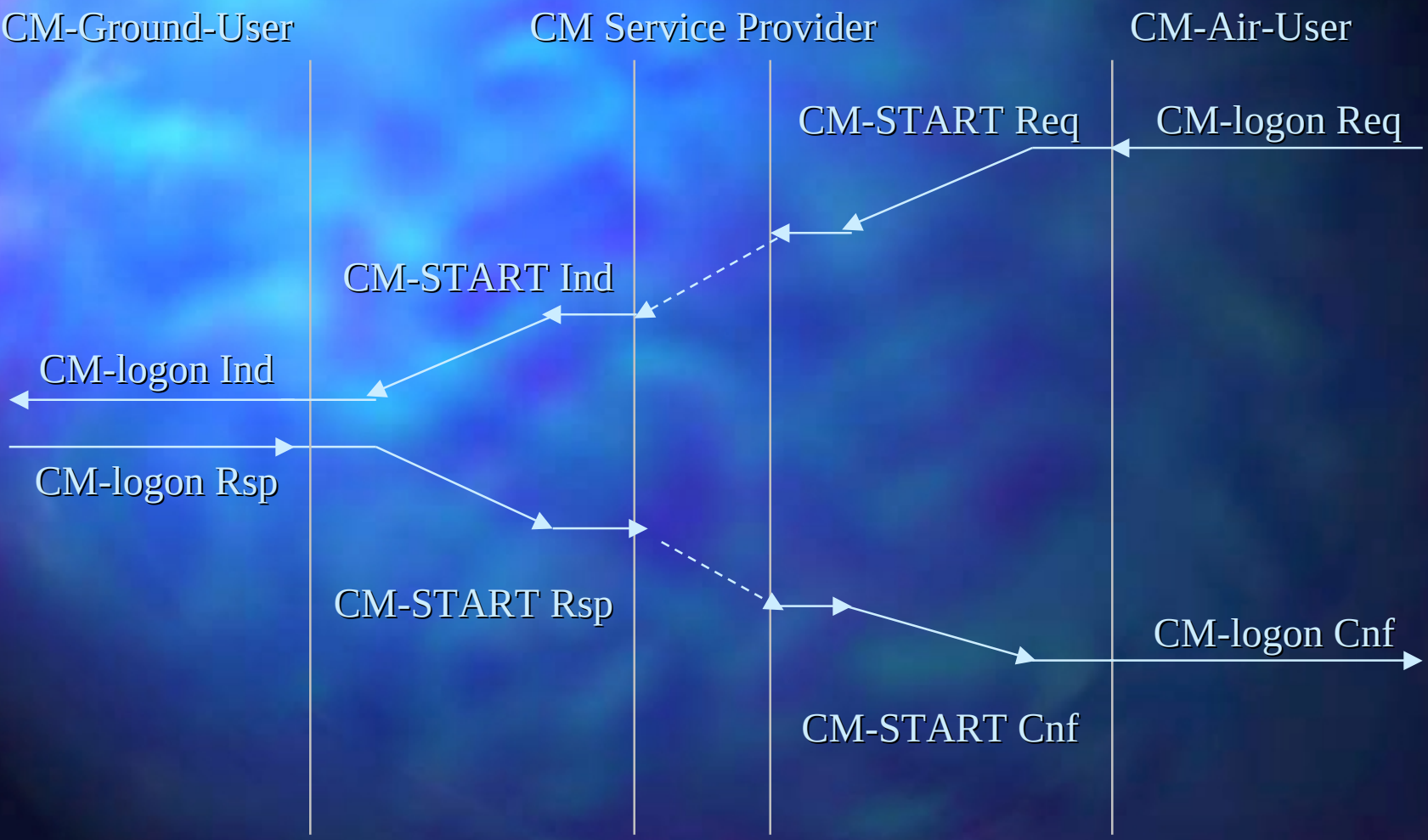
Getting To Know You

- CM-logon service
- CM-update service
- CM-contact service
- CM-end service
- CM-forward service
- CM-user-abort service
- CM-provider-abort service

CM Service Provision



CM Logon Protocol



FAA CPDLC Program Requirements

- Reduce voice congestion on individual frequencies
- Provide for more dynamic and efficient Air/Ground information exchange mechanism, thereby increasing productivity
- Reduce operational error resulting from misunderstood instructions and read-back errors
- Enable alternate method of communication in event of stuck microphone or other voice problem

FAA CPDLC I/ATN Architecture

- **Three Major Infrastructures:**
  - Ground - Ground Infrastructure
    - FAA G-BIS to ARINC G-BIS
    - FAA - ARINC Activities
    - FAA Domain integration
  - VDL2 Subnetwork Infrastructure
    - ARINC Ground ATN/VDL2 Service provider
    - Rockwell-Collins avionics provider for American Airlines
  - End-to-End Infrastructure
    - All of the above plus CPDLC, CMA, Host, and DSR
    - American Airlines with ES (CPDLC, CMA) and display

Ground - Ground

Key Components:

- FAA's Two G-BIS (ATN Back Bone Routers) - CPDLC/ATN traffic
- FAA's One ATN Router for Maintenance - Remote access from TC,
- using Packet Assembler Dissembler (PAD)
- FAA's Two HID/NAS LAN CISCO Routers – Data Link Application Processor (DLAP) & ATN Router communication
- ARINC's Network - Allows access to ATN Ground routers
- ARINC's GBIS - Exchange ATN routes between FAA and ARINC domains
- FAA's NADIN II - PSN for backbone and connections between FAA and ARINC domains

FAA CPDLC Program

- Build 1 (Domestic CPDLC) - ground initiated only
  - ATN complaint version of Transfer of Communication (TOC), Initial Contact (IC), Altimeter Settings (AS) and free text messages
  - Use VDL Mode 2 as Air/Ground Subnetwork
  - Key site IOC in Miami, FL: June 2002
- Build 1A (Enhanced CPDLC)
  - ATN compliant speed, heading, altitude assignment, and route clearance messages, Standby/Deferred/Unable Message
  - Use VDL Mode 2 as Air/Ground Subnetwork
  - Key site IOC: June 2003
  - National deployment (all 20 domestic ARTCCs) complete by Dec-2004

FAA CPDLC Program

- Build 2 (Domestic/International CPDLC)
  - ATN complaint services (~ 114 operational messages)
  - Includes Oceanic message support
  - Will define the beginning of transition from FANS 1/A to ATN
  - Use VDL Mode 2 as Air/Ground Subnetwork
  - Integrate in Free Flight Phase II
  - Include ATN Security (SARPS Sub-Vol. VIII)
  - Key site IOC: 2006
  - National deployment complete by Dec-2006
- Build 3
  - Expanded ATN message set
  - Integration with Decision Support Systems
  - Use NEXCOM as Air/Ground Subnetwork
  - National deployment

FAA CPLDC I/ATN OPERTAIONAL TESTING

Objectives

a. Ensure that US National Air Space (NAS) functionality, as existed prior to the installation of the CPDLC I capability, is not degraded.

b. Verify that CPDLC I can be integrated with the ATN in a VDL-2 environment.

c. Evaluate the CPDLC I system functionality/usability/maintainability from an Air Traffic (AT) and Airway Facilities (AF) perspective.

d. Evaluate the CPDLC I system functionality/usability from controller and flight crew perspective.

e. Evaluate CPDLC I system from complete end-to-end perspective.

FAA CPLDC I/ATN OPERTAIONAL TESTING (cont'd)

Objectives

- OT will verify that Critical Operational Issues (COIs) have been resolved, and specifically will ensure that that the modified HCS and DLAP are suitable for and can effectively be used in their intended environment and that the modified HCS and DLAP meet their required levels of performance.

- Suitability, effectiveness and performance with respect to COIs will be determined against specific Measures of Suitability (MOSs), Measures of Effectiveness (MOEs), and Measures of Performance (MOPs) described in OT plan.

FAA CPLDC I/ATN OPERTAIONAL TESTING

(cont'd)

Phase I

- Evaluated the CPDLC functionality in a simulated operational environment with field users (Miami air traffic controllers). The users had an opportunity to see, play and feel CPDLC using the DSR glass.

- Controllers received and evaluated the training that has been prepared for training the entire center. All of their recommendations, concerns and PTRs encountered during OT have been addressed.

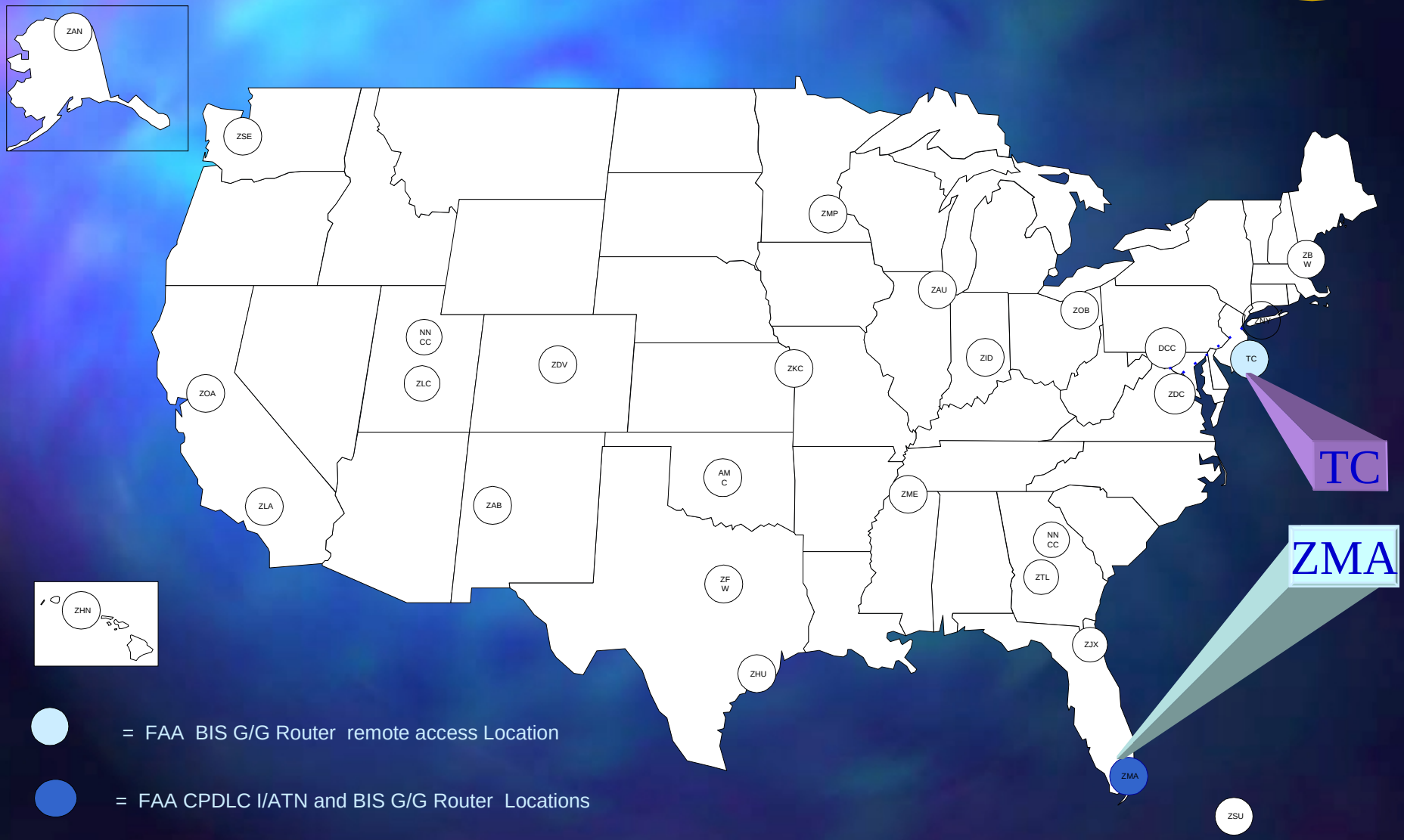
FAA CPLDC I/ATN OPERTAIONAL TESTING

(cont'd)

Phase II

- Goal is to evaluate the CPDLC functionality in a REAL end-to-end environment. Other category that will be evaluated are: Security, Service Certification, Menu Build, Supervisory functions, Training materials for AF and Suitability aspects of the system.
- For this go around we don't have plans to bring controllers from Miami. We will have Supervisors and AF personnel from Miami participating in OT.

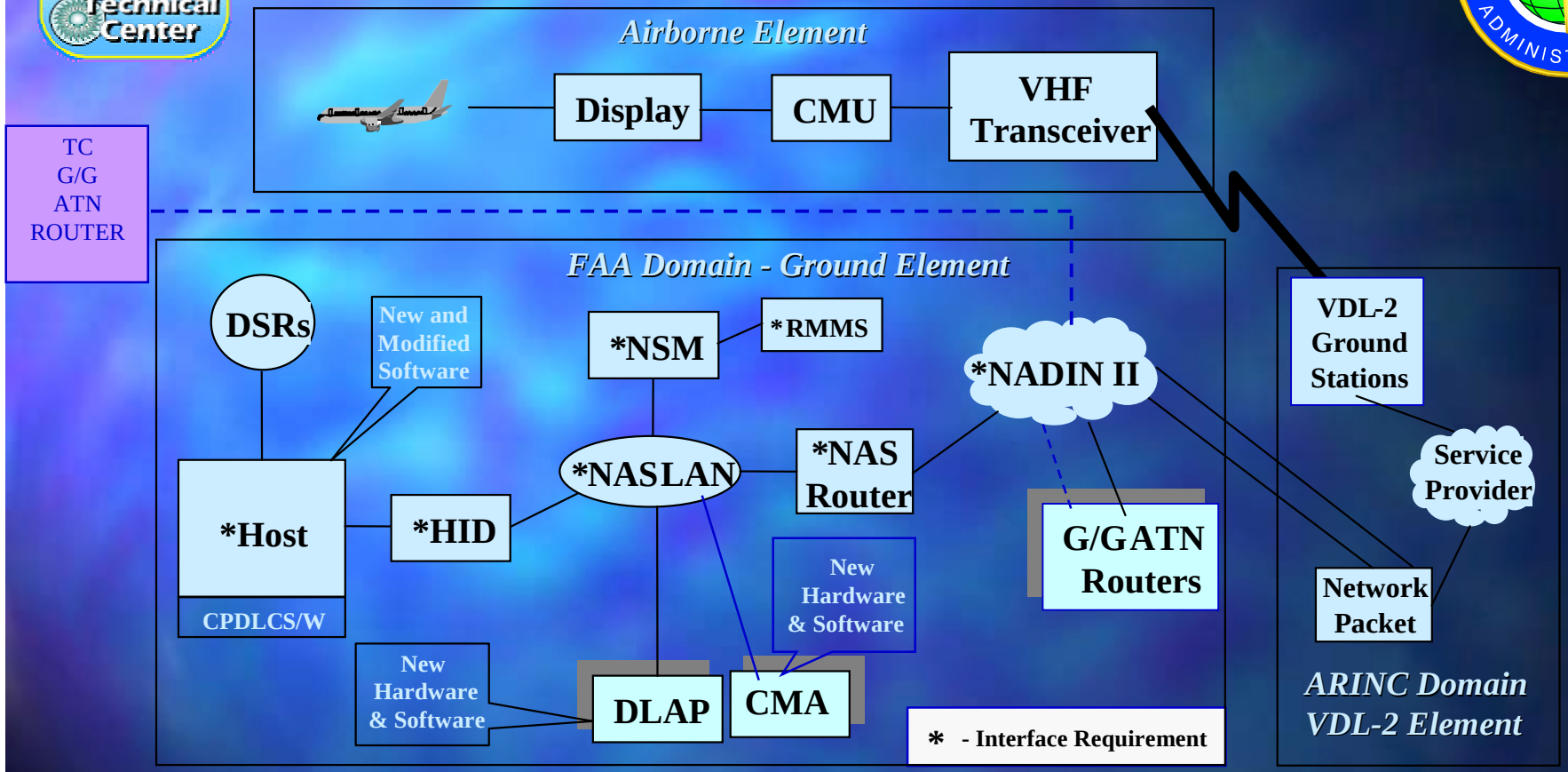
FAA ATN Ground Service Locations during CPDLC I



= FAA BIS G/G Router remote access Location

= FAA CPDLC I/ATN and BIS G/G Router Locations

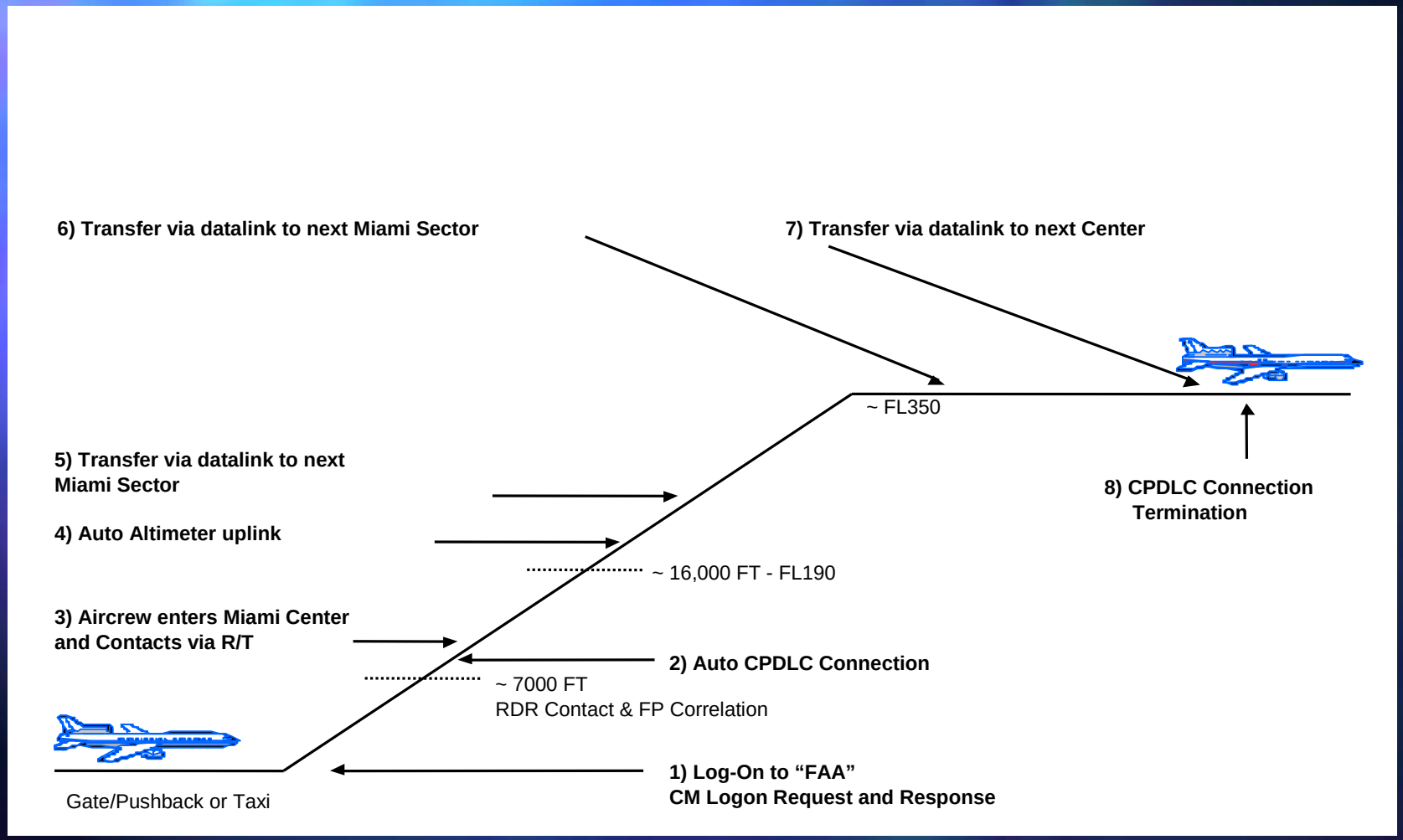
FAA CPDLC I End-to-End Connectivity



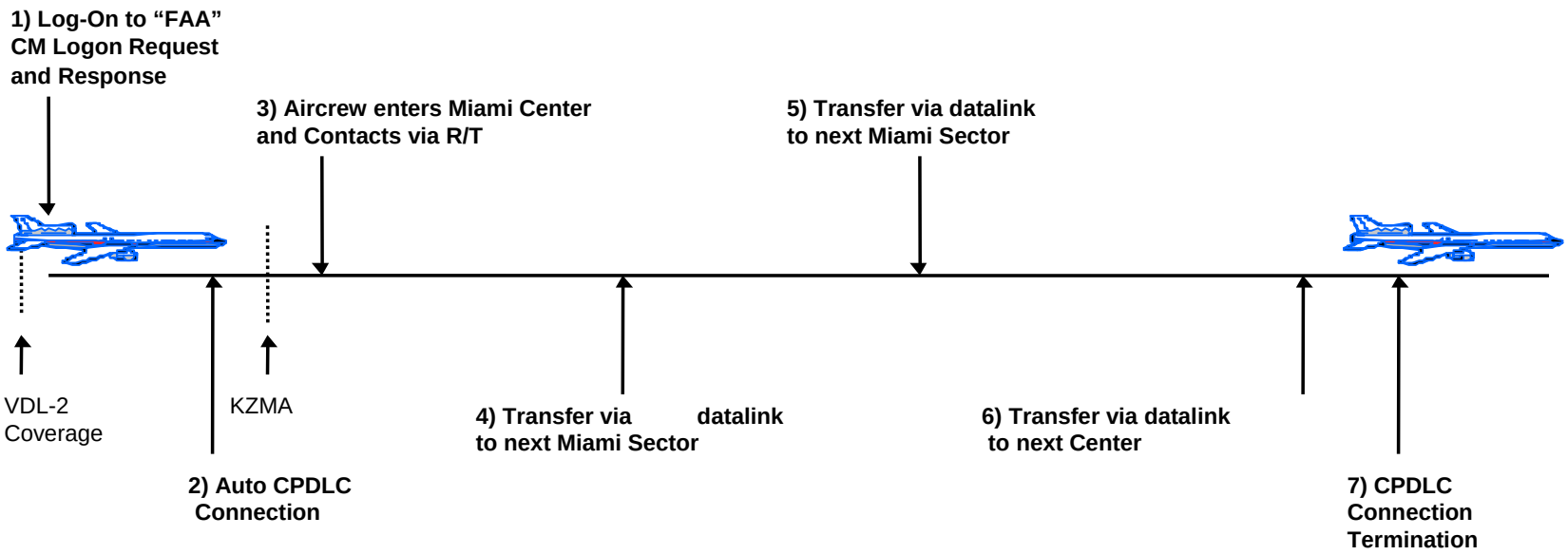
KEY:

DSR - Display System Replacement
HID - Host Interface Device
NAS - National Airspace System
LAN - Local Area Network
NSM - Network System Manager
RMMS - Remote Maintenance Monitoring System
DLAP - Data Link Application Processor
CMA - Context Management Application
NADIN - National Airspace Data Interchange Network
ATN - Aeronautical Telecommunication Network
CMU - Communications Management Unit

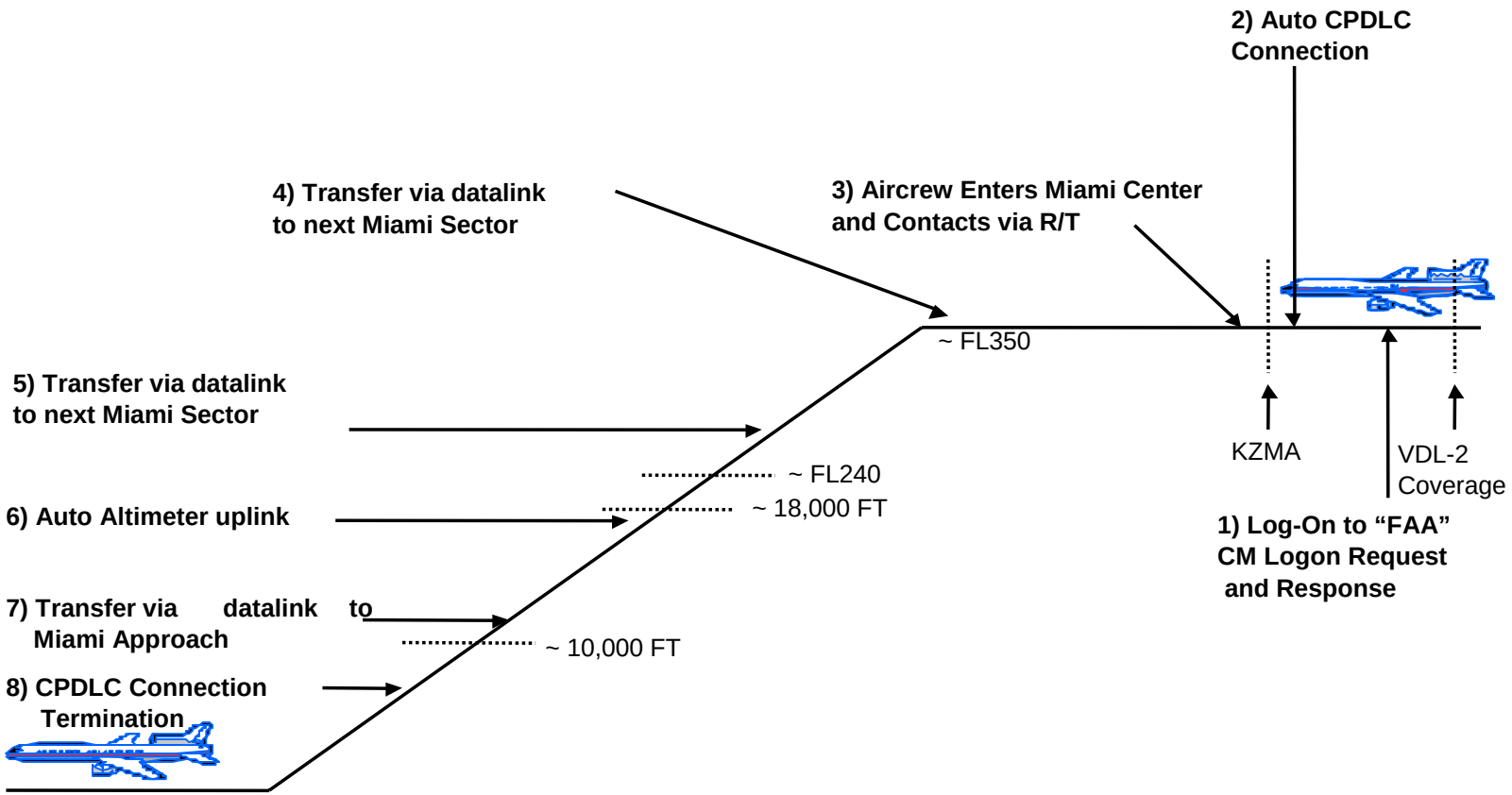
Vertical Profile for CPDLC Build I Miami Departure



Flight Profile for CPDLC Build I Miami Over-Flight



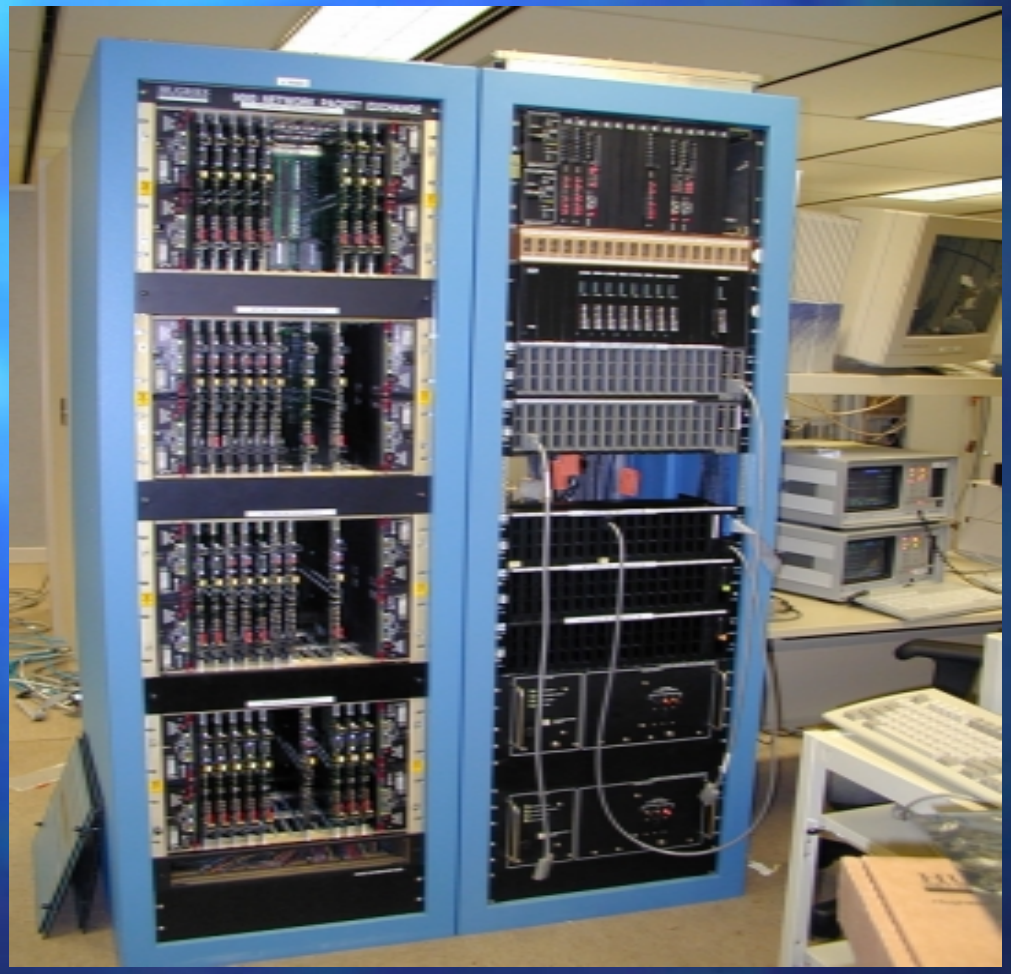
Vertical Profile for CPDLC Build I Miami Arrival



CPLDC I & CMA

HID/NAS LAN

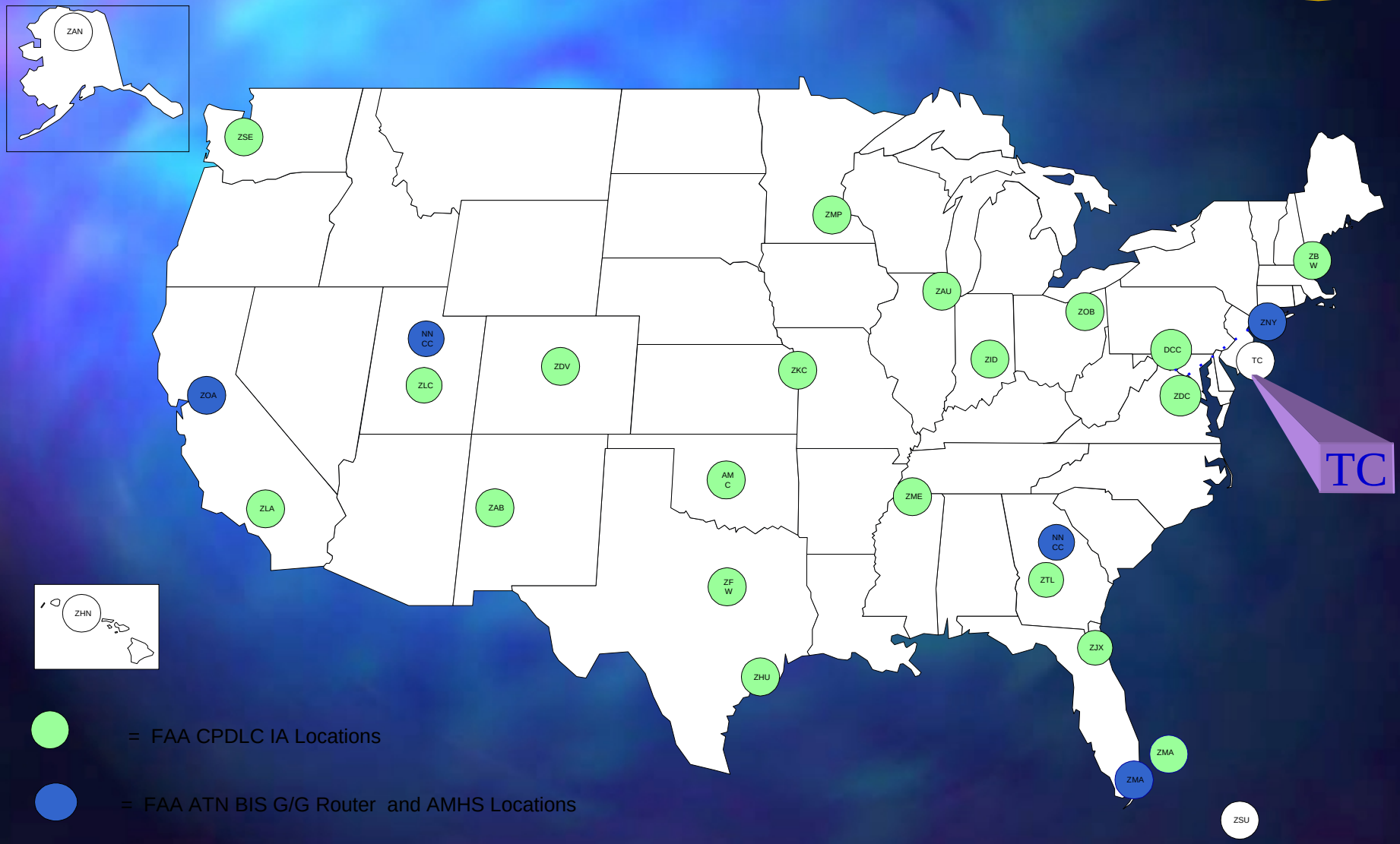
NADIN II



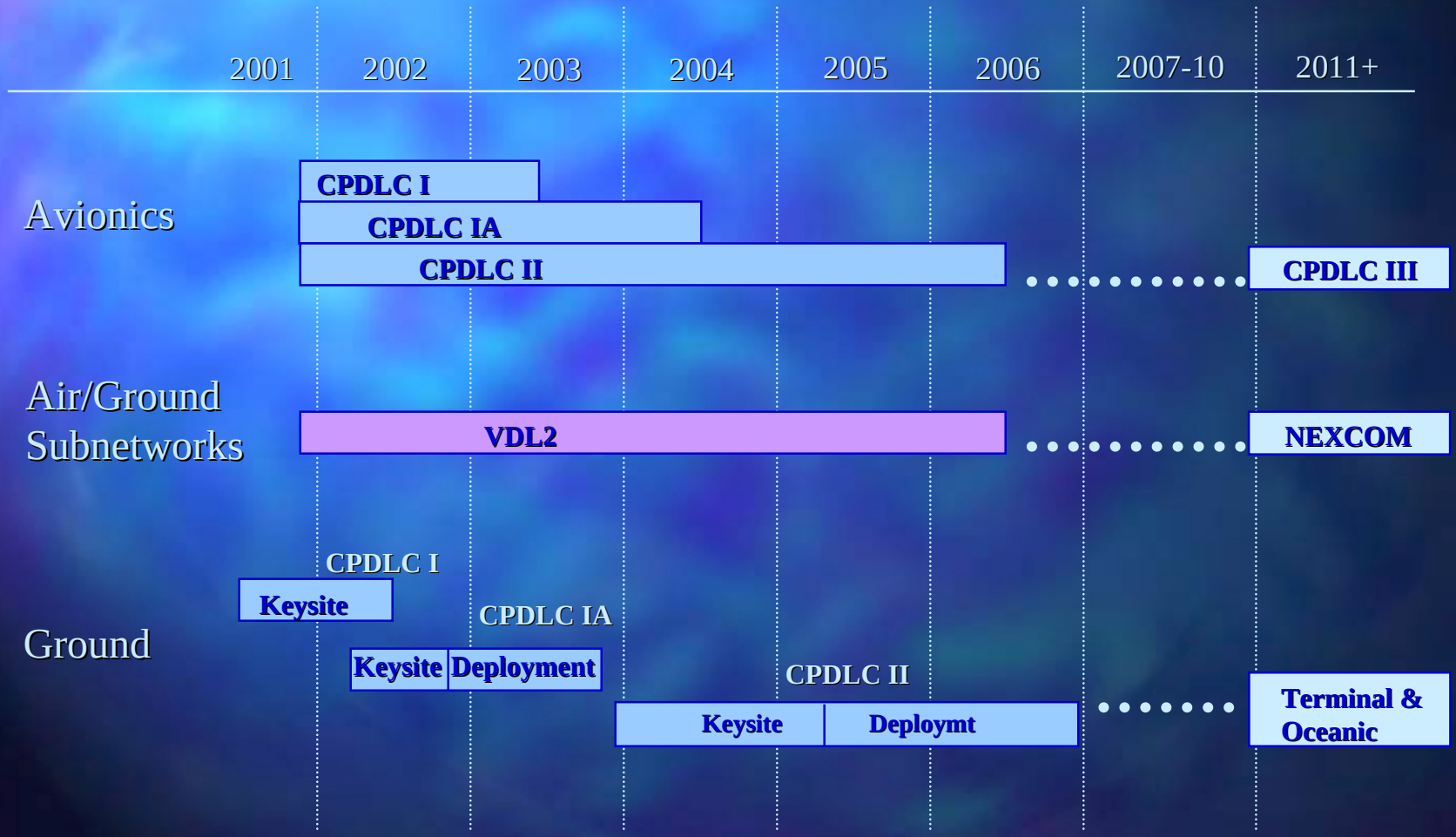
G/G BIS (ATN ROUTER)

CPLDC I & CMA RACK

FAA ATN Ground Service Locations during CPDLC IA and II



FAA CPDLC Implementation Program



FAA Technical Center

FEDERAL AVIATION ADMINISTRATION

QUESTIONS

?

Open Systems Layer Structure

Each layer provides a standard communications service to the layer above and below, and embodies one or more standard protocols to support that service. Within each 'layer', the lower layer service is enhanced by means of local functionality and the layer protocol to provide a richer service to the next higher layer.

The **Physical Layer** service and protocol is determined by the technology of the telecommunications link being used. The physical layer defines actual physical connections. E.g. EIA-530, RS-232. Ethernet, FDDI

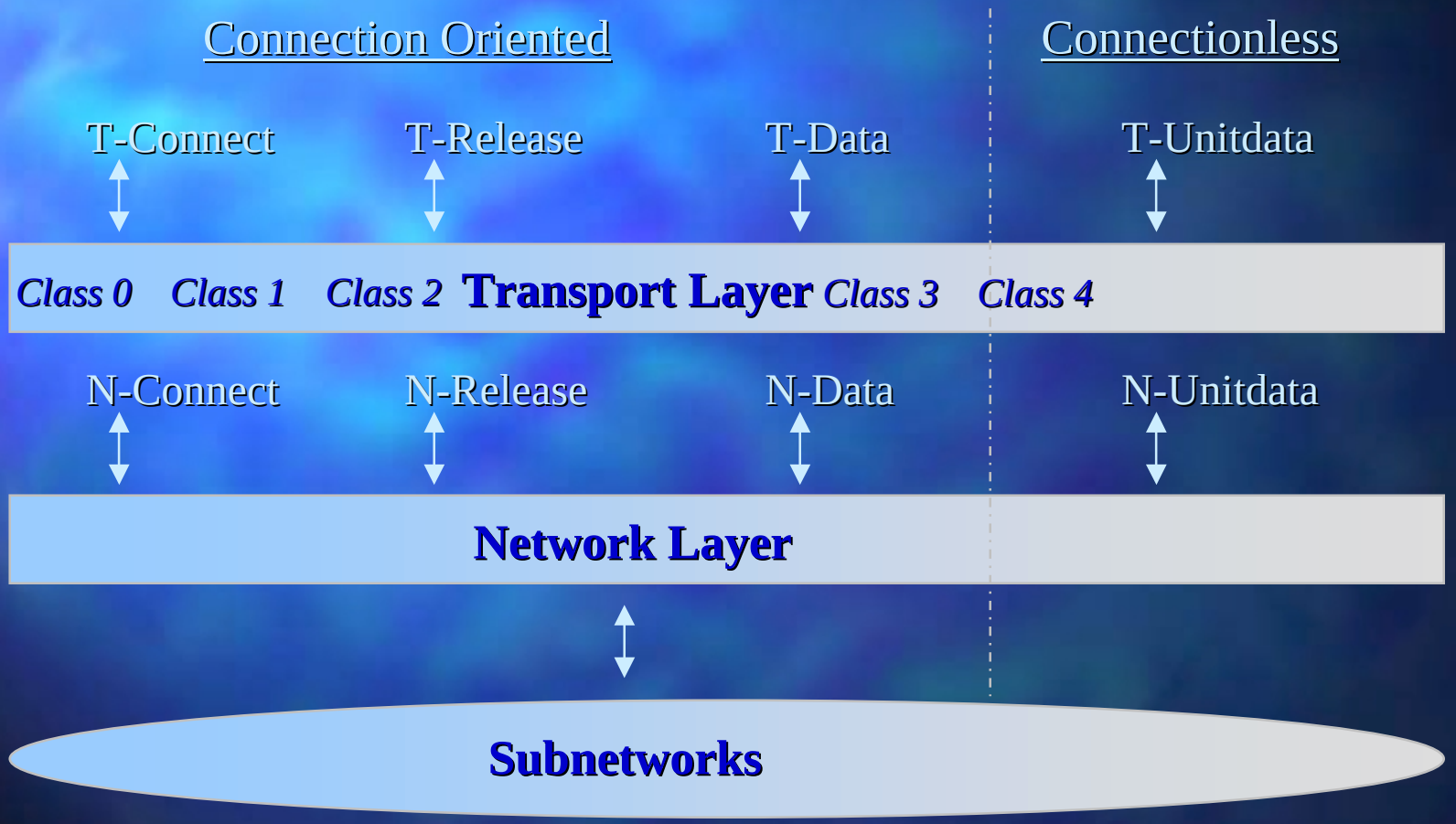
Open Systems Layer Structure
(cont'd)

The **Link Layer** standardizes the way in which data is transferred across a particular type of physical connection to overcome errors introduced into the data stream by the Physical Layer. There are different link layer standards for different physical media. E.g SDLC, HDLC MAC etc.

Open Systems Layer Structure
(cont'd)

The **Network Layer** is basically concerned with controlling network connections depending on the type of communications network used. It is concerned with establishing, for example, X.25 switched virtual circuits between systems and providing an error corrected, flow controlled data transfer service to the Transport Layer. The Network Layer is very complex since it must also include functionality to deal with end to end data connections which may need to extend across one or more different types of network, including connection oriented and connectionless.

Transport & Lower Layers



Session Layer

Presentation Layer