



# **Open Communications Standards/Protocols for Weather Dissemination\***

**Robert D. Grappel  
M.I.T. Lincoln Laboratory  
May 23, 2000**

\* This work was sponsored by NASA under Air Force contract #F19628-95-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the author and are not necessarily endorsed by NASA.



# Outline

- **Why use “open standards”?**
- **System Architecture**
- **Open Communication Standard selection criteria**
- **Open Communication Standard Candidates**
  - **Aeronautical Telecommunications Network (ATN)**
  - **Internet (TCP/IP)**
- **Why choose TCP/IP?**
- **VHF Data Link Mode 2 (VDL-2/IP)**
- **Summary**



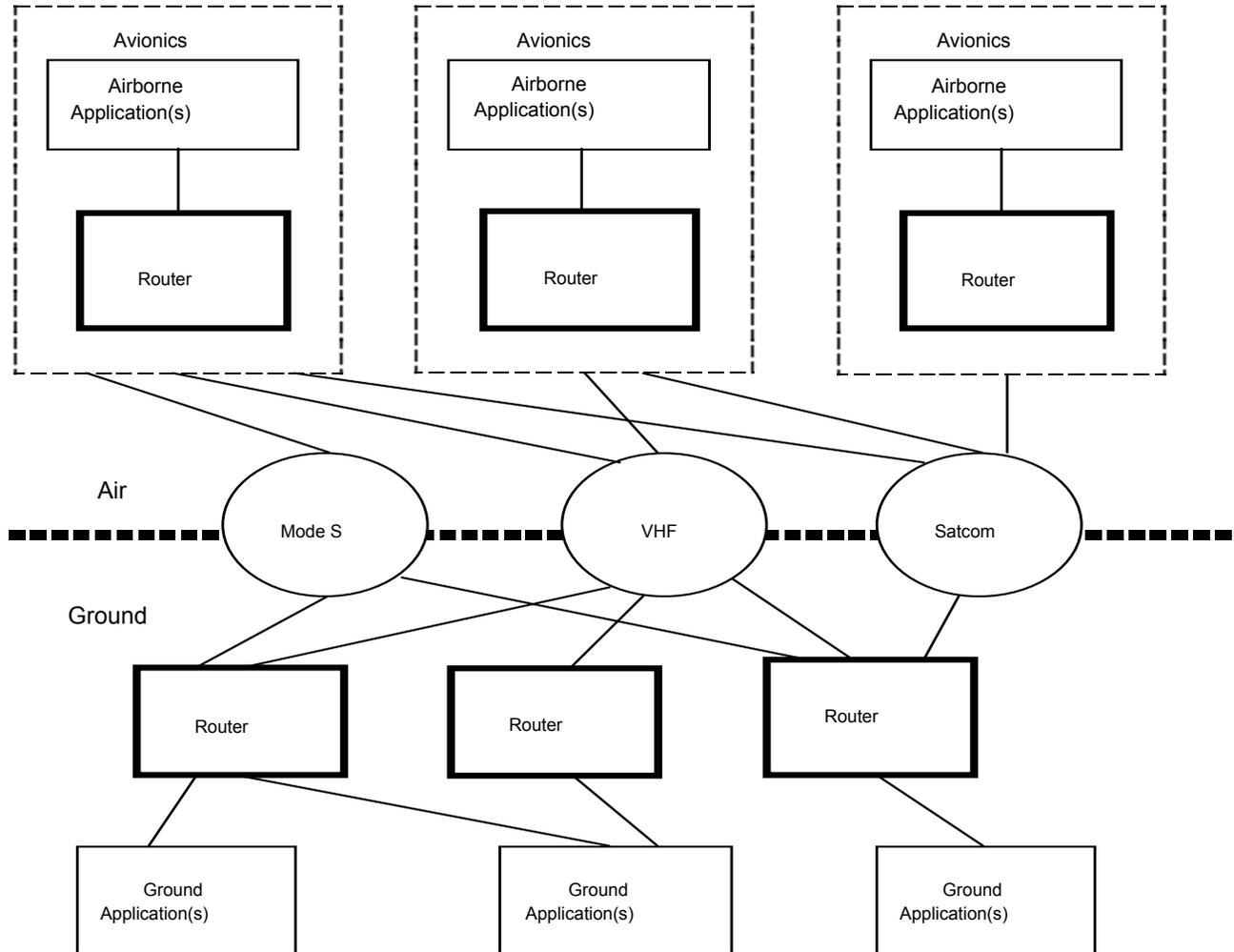
# Why Use Open Communications Standards/Protocols?

---

- **COTS software/hardware**
- **Well-defined and tested implementations**
- **Readily-available documentation and support**
- **Infrastructure Support may be already available**

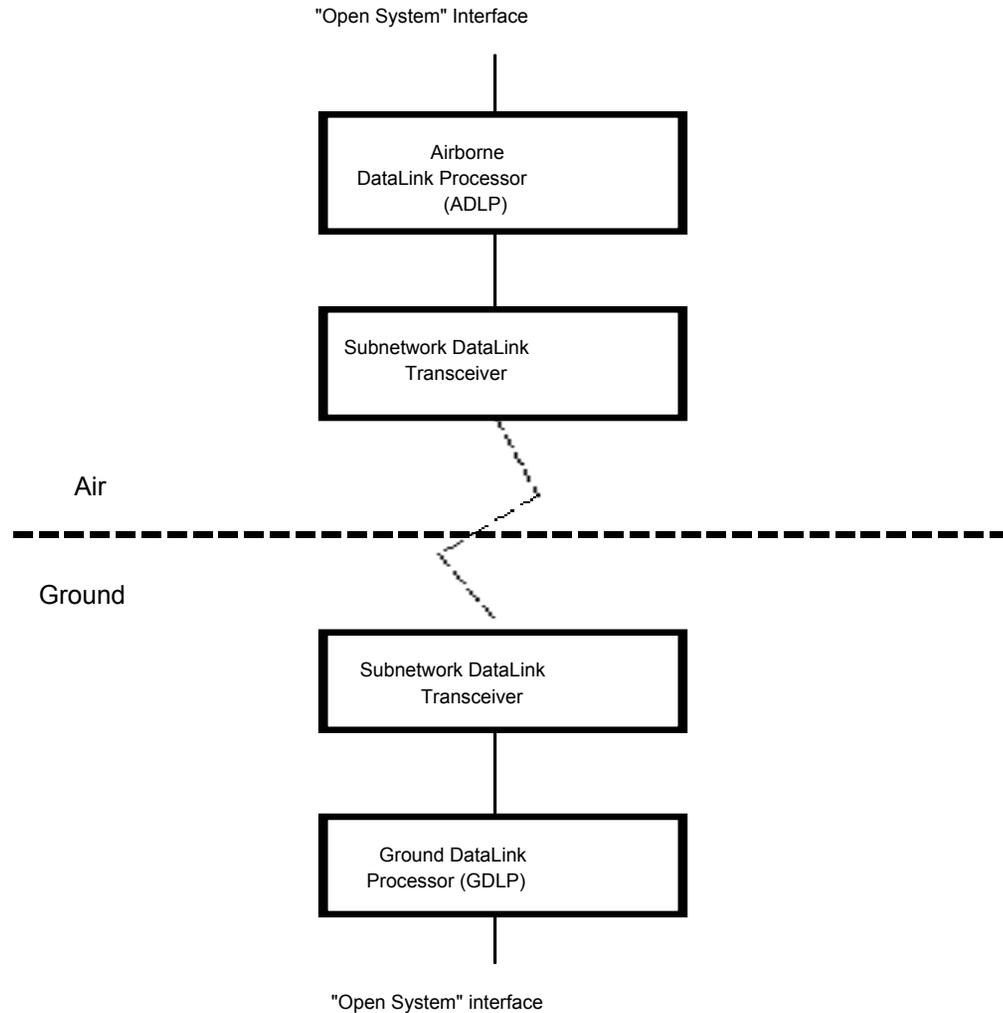


# Overall Aviation Communications System Architecture





# “Open System” Subnetwork Architecture





# Open Communication Standard/Protocol Requirements/Features

- **Open Standard**
- **Efficient for long and short messages**
- **Support Broadcast / Multicast**
- **Support Reliable Addressed Messaging**
- **Support priority-based Messaging**
- **Provide Mobile Routing**
- **Provide Link-independent Routing**



# Aeronautical Telecommunications Network (ATN)

- Tailored / modified OSI 7-layer protocols
- Developed specifically for aviation datalink
- Standards maintained by ICAO, RTCA, etc.
- Complex design, high link overhead
- Very large addressing range (>20 bytes)
- Transparent support for multiple communications links simultaneously
- Provides up to 16 levels of message priority



# ATN - Continued

- **Subnetwork protocol standard is “connection-oriented” ISO 8208**
- **ISO 8208 does not provide “broadcast”**
  - **ATN has subnetwork-specific broadcast modes**
- **ISO 8208 a reliable end-to-end protocol**
- **ATN handles mobile nodes via “Interdomain Routing Protocol” (IDRP)**



# TCP/IP

- **Base protocol of the Internet**
- **Has both a broadcast/multicast (UDP) and reliable end-to-end (TCP) mode**
- **Simple protocols, bandwidth efficient**
- **Mobile nodes handled by “Mobile IP” routing**
- **Current IP (IPv4) has limited address range (32 bits)**
  - **IPv6 expands addressing to 16 bytes**



# TCP/IP - Continued

- **Current IP (IPv4) routers may not support message priority capability**
  - IPv6 fully implements message priority
- **Mobile IP not configured for multiple subnetworks to same application**
  - May require a “policy-routing” driver



# Protocol Selection Factors

- **Open Standard (TCP/IP, OSI\*)**
  - TCP/IP is foundation of the Internet
  - ATN/OSI specific to aviation
- **Long / Short Messages (TCP/IP\*, OSI)**
  - IP “datagrams” have upper bound of 65,508 bytes
- **Broadcast / Multicast (IP, OSI\*)**
  - OSI “broadcast” is “subnetwork-specific”
- **Reliable-Addressed (TCP/IP, OSI)**
- **Priority-based (TCP/IP\*, OSI)**
  - Many current TCP/IP routers do not support priority “Type of Service” (TOS)
- **Mobile Routing (TCP/IP, OSI)**
- **Link-independent routing (TCP/IP\*, OSI)**
  - TCP/IP may require “policy-routing” module



# Select TCP/IP For Weather Dissemination

- **TCP/IP most “open” of standards**
- **Internet ground infrastructure world-wide**
- **TCP/IP COTS implementations**
- **TCP/IP supports broadcast/multicast**
- **TCP/IP drawbacks have low impact on weather dissemination**
- **TCP/IP “extensions” (e.g. policy routing) need be added only to ADLP/GDLP (not entire network)**

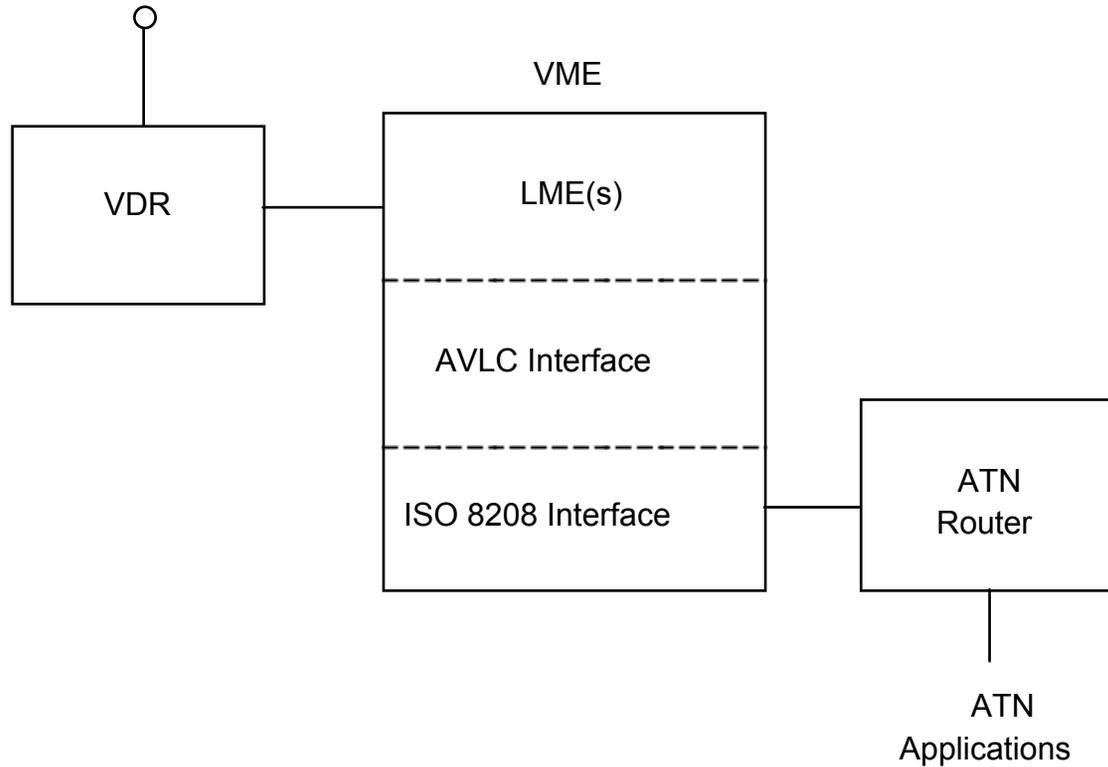


# Example of VHF Data Link Mode 2 - IP (VDL-2/IP)

- **VDL-2 is a high-capacity (31.5 kbs) replacement for current ACARS (2.4 kbs)**
- **VDL-2 is designed as an ATN Subnetwork**
- **VDL-2 supports high-reliability, binary messaging**
- **VDL-2 has distributed architecture with link-level management protocols**
- **VDL-2 link-layer interface is a modified standard HDLC protocol**



# VDL-2 Standard Architecture





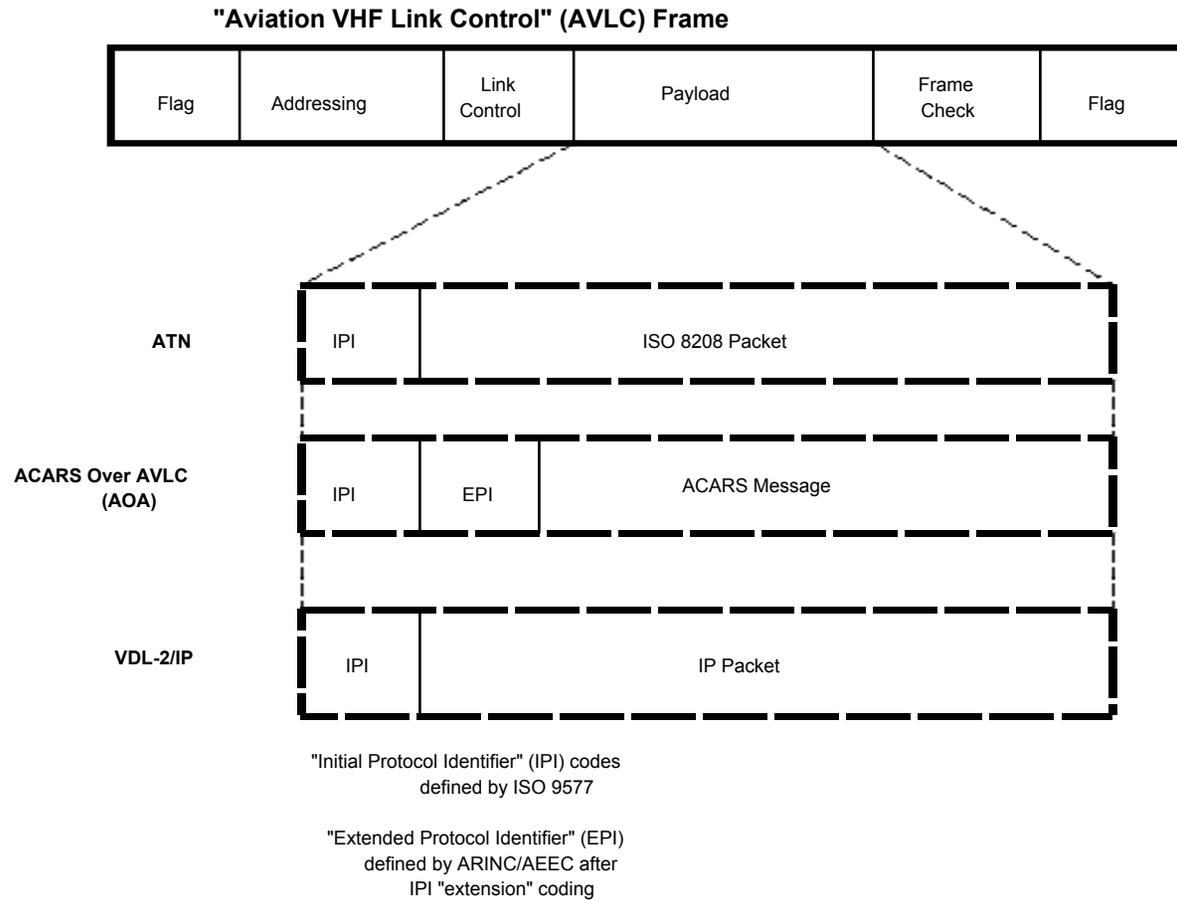
# Aviation VHF Link Control (AVLC) Frame

ISO 3309  
Address  
Format

| Description                     | BYTE | BIT NUMBER |     |     |            |     |     |            |   |
|---------------------------------|------|------------|-----|-----|------------|-----|-----|------------|---|
|                                 |      | 8          | 7   | 6   | 5          | 4   | 3   | 2          | 1 |
| FLAG                            | --   | 0          | 1   | 1   | 1          | 1   | 1   | 1          | 0 |
| Destination<br>Address<br>Field | 1    | D22        | D23 | D24 | D25        | D26 | D27 | <b>A/G</b> | 0 |
|                                 | 2    | D15        | D16 | D17 | D18        | D19 | D20 | D21        | 0 |
|                                 | 3    | D8         | D9  | D10 | D11        | D12 | D13 | D14        | 0 |
|                                 | 4    | D1         | D2  | D3  | D4         | D5  | D6  | D7         | 0 |
| Source<br>Address<br>Field      | 5    | S22        | S23 | S24 | S25        | S26 | S27 | <b>C/R</b> | 0 |
|                                 | 6    | S15        | S16 | S17 | S18        | S19 | S20 | S21        | 0 |
|                                 | 7    | S8         | S9  | S10 | S11        | S12 | S13 | S14        | 0 |
|                                 | 8    | S1         | S2  | S3  | S4         | S5  | S6  | S7         | 1 |
| Link Control                    | 9    |            |     |     | <b>P/F</b> |     |     |            |   |
| User<br>Data                    | 10   |            |     |     |            |     |     |            |   |
|                                 | --   |            |     |     |            |     |     |            |   |
|                                 | N-2  |            |     |     |            |     |     |            |   |
| Frame<br>Check                  | N-1  |            |     |     |            |     |     |            |   |
|                                 | N    |            |     |     |            |     |     |            |   |
| FLAG                            | --   | 0          | 1   | 1   | 1          | 1   | 1   | 1          | 0 |

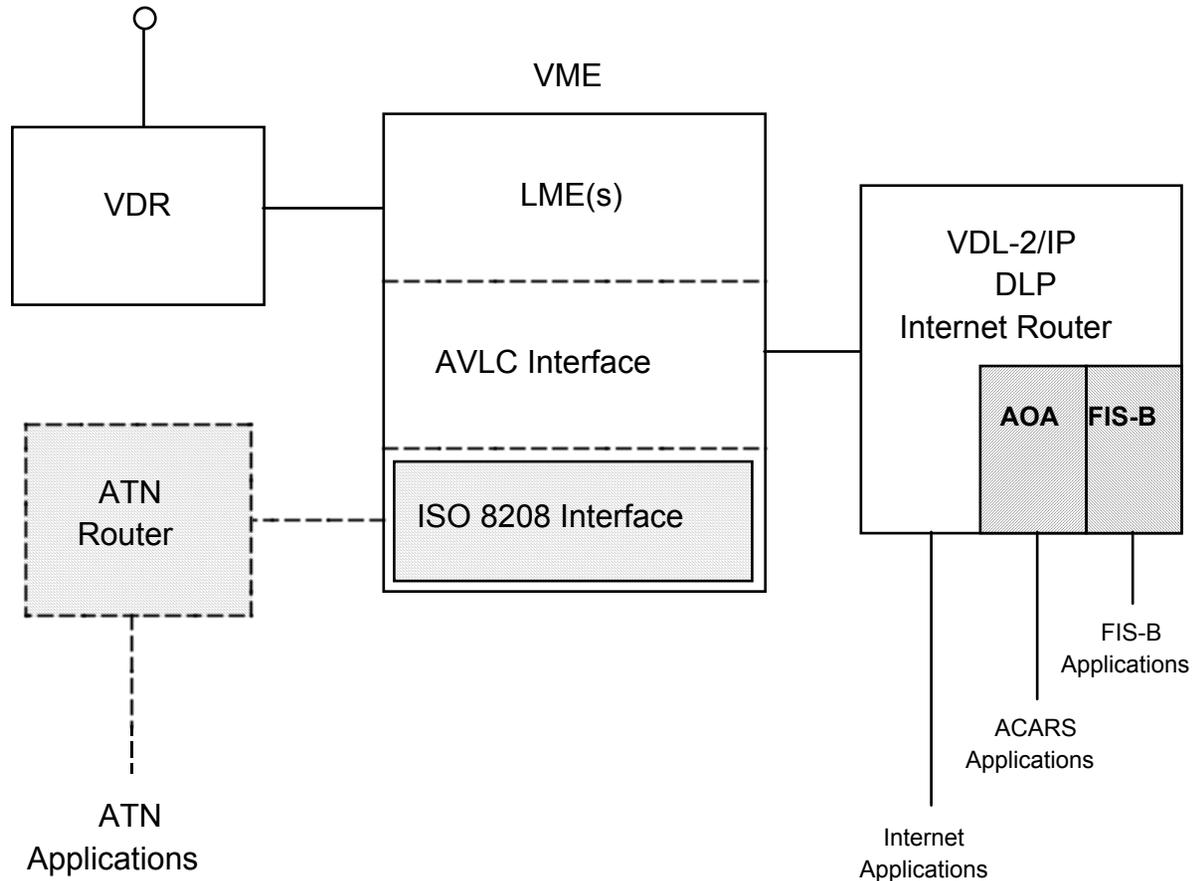


# “Encapsulation”





# VDL-2/IP Architecture





# VDL-2/IP Design Overview

- **ADLP/GDLP start out as standard Internet IP routers (IPv4 for now)**
- **Modify Internet “Point-to-Point Protocol” (PPP) interface to match AVLC**
- **Modify Internet “Address Resolution Protocol” (ARP) for VDL addressing**
- **Support “Mobile IP” routing**



# Summary

- **TCP/IP provides capable “open communications standards” support for weather dissemination**
- **VDL-2/IP provides straightforward TCP/IP support over VDL-2 subnetwork**
- **TCP/IP and ATN applications can inter-operate over VDL-2**
- **VDL-2/IP documentation delivery September 2000**