CCSDS Link Layer Protocol Suite

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AGENDA

- Principal functions of the CCSDS link layer
- Overview of CCSDS link layer protocols
- Link layer relationship to Coding & Synch.
- Key characteristics of these protocols
- How data is transported over the space link

What are the principal functions of the Link Layer?

- To carry out the point to point transfer of data within a given FER*
- To transport Network Layer (CCSDS, IP, SCP-NP, Encapsulation) packets
- To use a single physical channel to transfer multiple logical virtual channels
- To provide sequence controlled delivery of the data

For Command

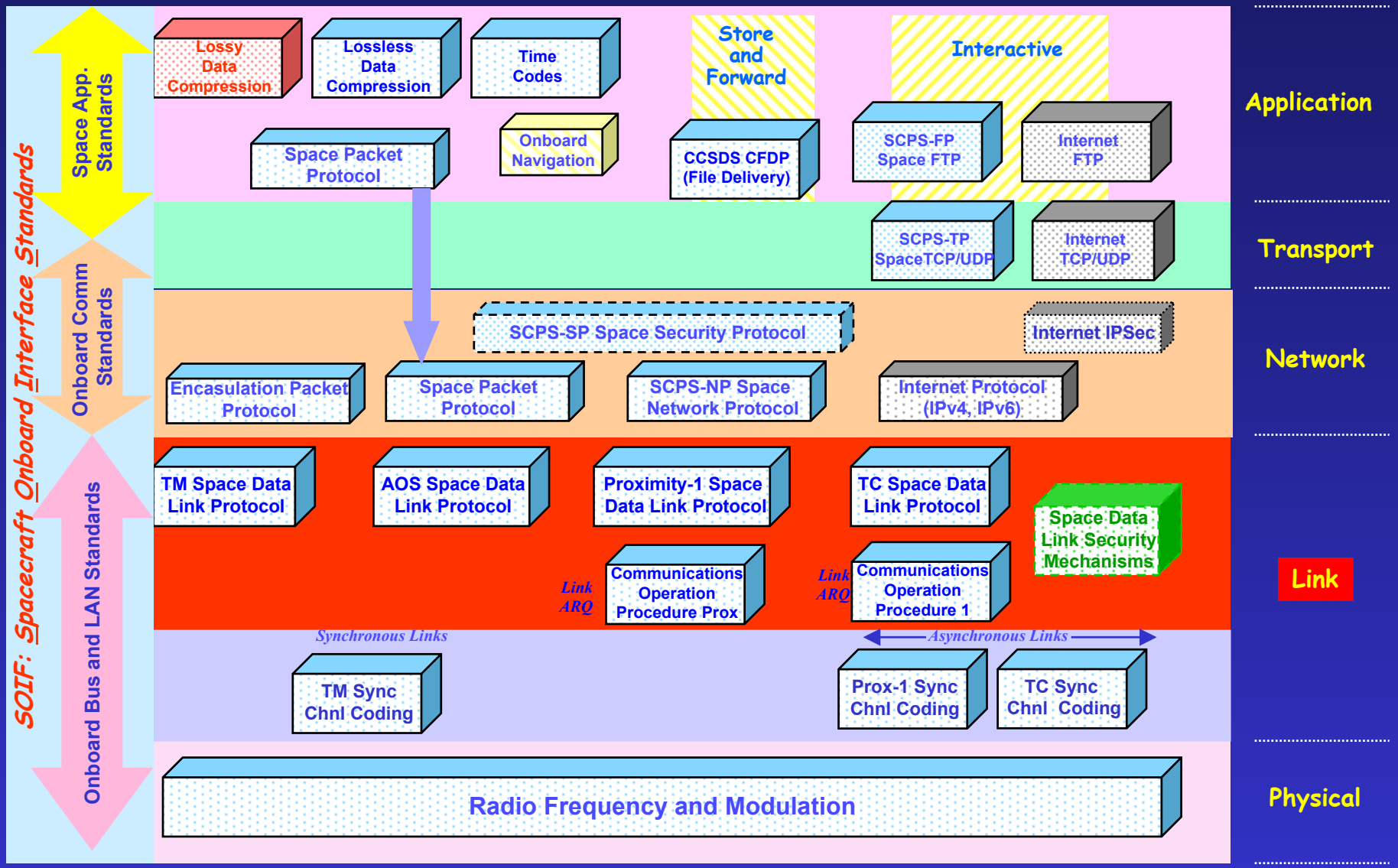
- To individually address one out of many spacecraft
- To control the forward link configuration and pass spacecraft directives to hardware controller for emergency support

For Telemetry

- To identify the sending physical and logical stream sources enabling ground stations to selectively handle the data streams

* Both detected and undetected frame error rate

Networked CCSDS Space/Ground Communications Protocol Stack



CCSDS Recommendation | Draft CCSDS Recommendation | CCSDS Report | Internet RFC

Data Link Coding & Synchronization

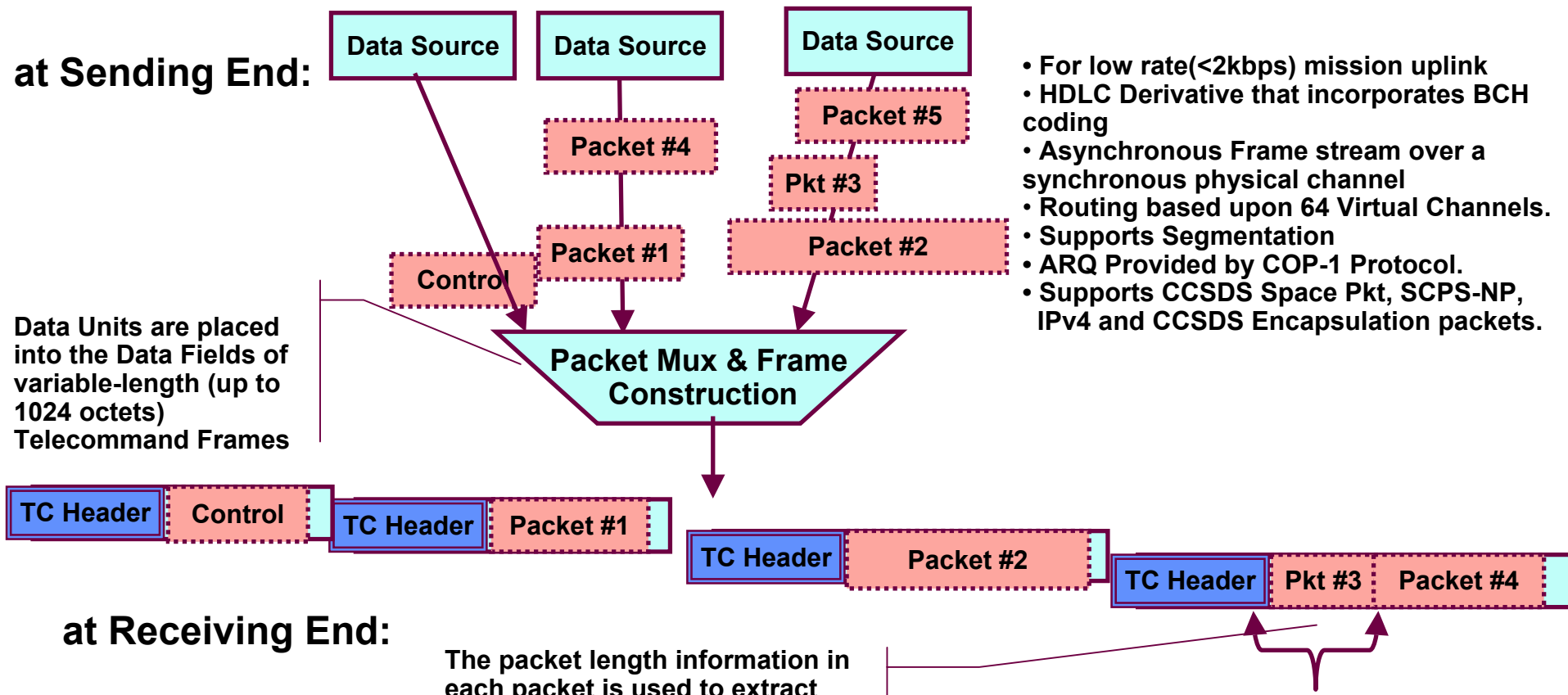
- Requirement on the link layer to deliver data
  - Error free frames with possible omissions when ARQ not provided
  - Space Telemetry Links
    - Weak signal environment along with mass and power limitations drive high performance coding to maximize gains

      (NOTE: the longer the distance the more significant the requirement)
      - Block codes provide the highest coding gains
      - Fixed length frames provide the most robust frame synchronization
      - Together they provide the lowest data loss due to code block errors
  - Space Command Links (applies also for bi-directional communications links)
    - Strong signal environment with minimal delivery latency dictate short variable length frames, short code, minimal code lockup times, and sufficiently low undetected frame error rate performance.

Link Layer Protocol Key Characteristics

- Data Link Types
  - Synchronous (fixed length frame)
    - TM/AOS – to ensure robust synchronization using block codes over very low SSNR links
  - Asynchronous (variable length frame)
    - TC/Proximity-1 – to receive short messages over high SNR links
- Virtual Channels (TM/AOS/TC)
  - Multiplexing data over the physical link
  - Stream splitting at the link terminus
  - Can be used for data prioritization
- ARQ (Retransmission)
  - Via sequence controlled in order, no gaps, no duplicate frame delivery: TC (COP-1), Prox-1 (COP-P)
  - No ARQ mechanisms in TM (low rate missions); Adding ARQ protocol within AOS for high rate (e.g., 6 to 40 Mbps) missions

TC (DFE) Space Data Link Protocol



- For low rate(<2kbps) mission uplink
- HDLC Derivative that incorporates BCH coding
- Asynchronous Frame stream over a synchronous physical channel
- Routing based upon 64 Virtual Channels.
- Supports Segmentation
- ARQ Provided by COP-1 Protocol.
- Supports CCSDS Space Pkt, SCPS-NP, IPv4 and CCSDS Encapsulation packets.

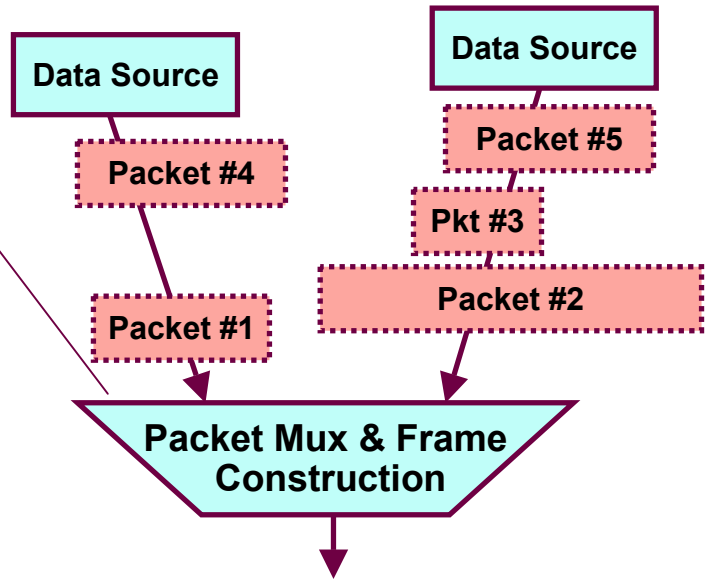
CCSDS Link Layer Protocol Suite

Proximity-1 Space Data Link Protocol

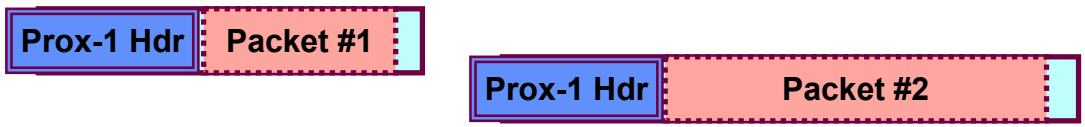
For In-Situ short haul bi-directional links

at Sending End:

Packets are placed into the Data Fields of variable-length (up to 2048 octets) Proximity-1 Frames



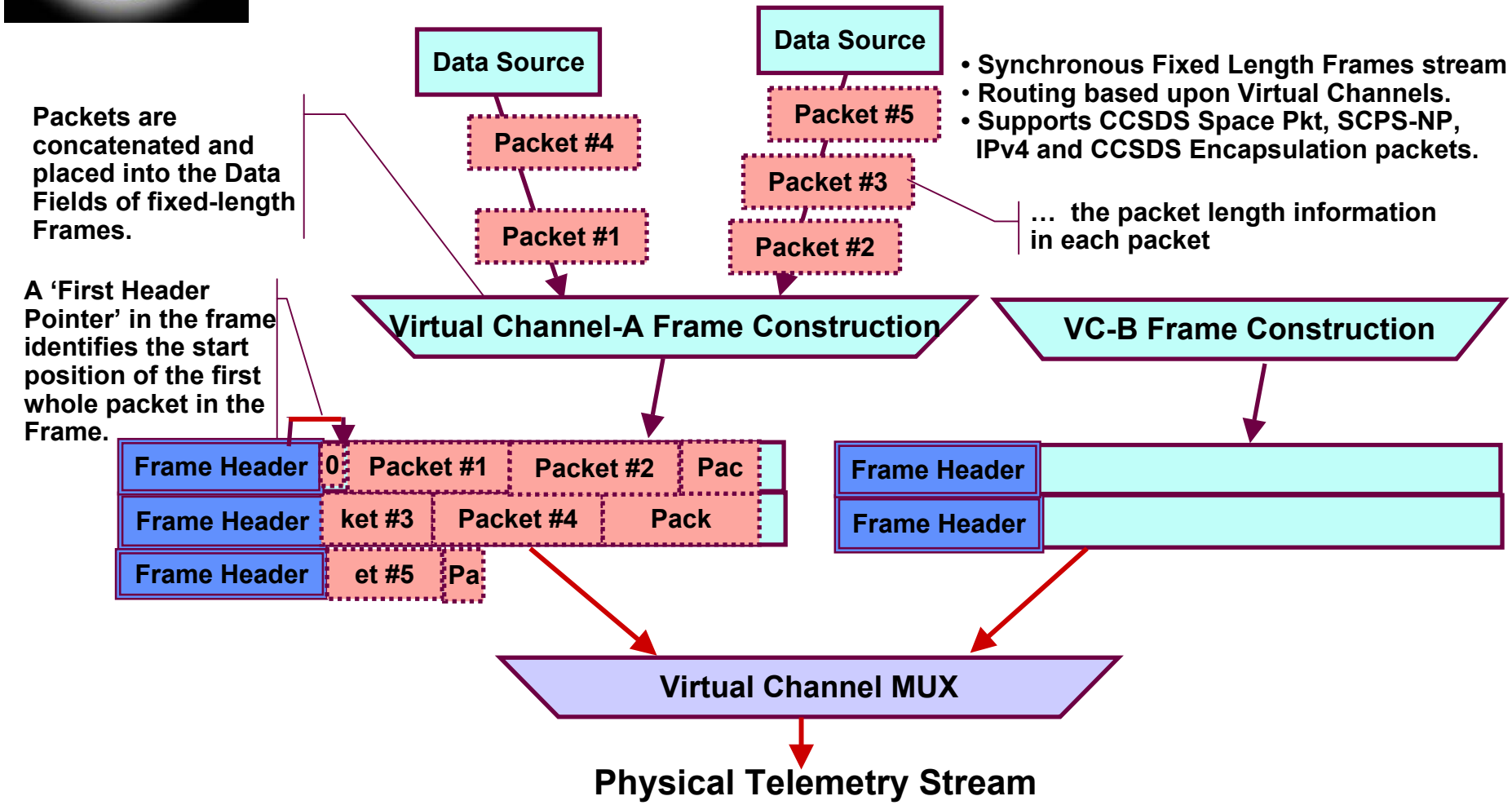
- HDLC Derivative
- Supports Segmentation
- ARQ Provided by COP-P Protocol.
- Full, Half Duplex, Simplex in-situ links
- Supports CCSDS Space Pkt, SCPS-NP, IPv4 and CCSDS Encapsulation packets.
- Supports session establishment/tear down
- Output control for data routing to local S/C links based upon 8 Port Ids/Phy Chnl.
- Supports time tagging of incoming/outgoing frames for time correlation activities and time setting



at Receiving End:

The packet length information in each packet is used to extract Packets from Frames.

Telemetry (DTE) Space Data Link Protocols



Telemetry (DTE) Space Data Link Protocols

Packet Telemetry Protocol (established in the 80s)

- Provides for 8 Virtual Channels
- Contains a 1 byte (256 count) VC frame sequence counter
- Contains a 1 byte (256 count) Master frame sequence counter
- Provides for reverse playback tape recorder data insertion
- Provides for secondary header (managed by VC)
- Provides an Operations Control Field for Command Reporting

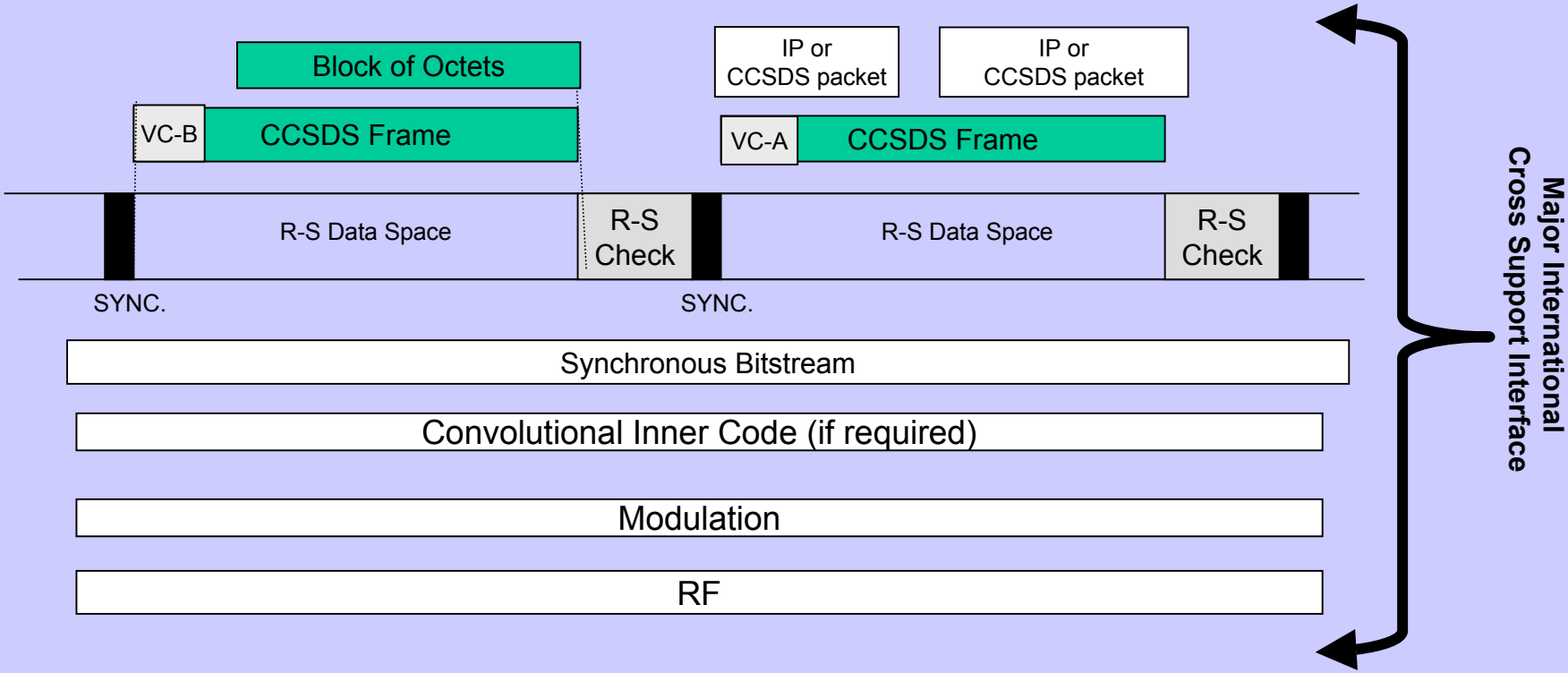
AOS Telemetry Protocol (established in the 90s)

- Provides for 64 Virtual Channels
- Contains a 3 byte (16,777,216 count) VC frame sequence counter
- Provides for isochronous insert data (for audio and video)
- Provides for secondary headers (managed by VC)
- Incorporating ARQ for retransmission (presently being reviewed for upgrading/replacement)

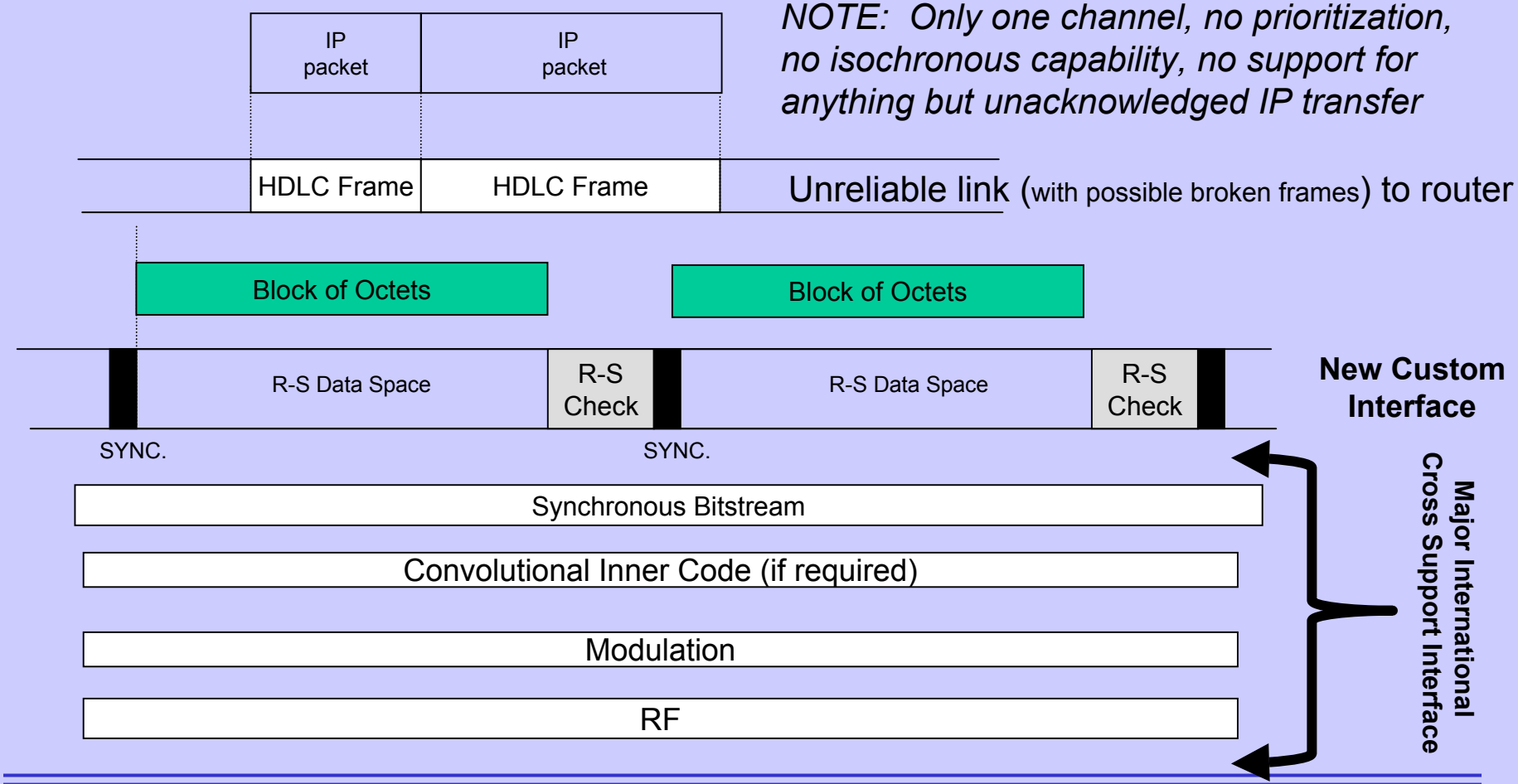
CCSDS Space Telemetry Links

Virtual Channel B carries:
User Defined Bit Stream Data

Virtual Channel A carries:
Packet Stream Data

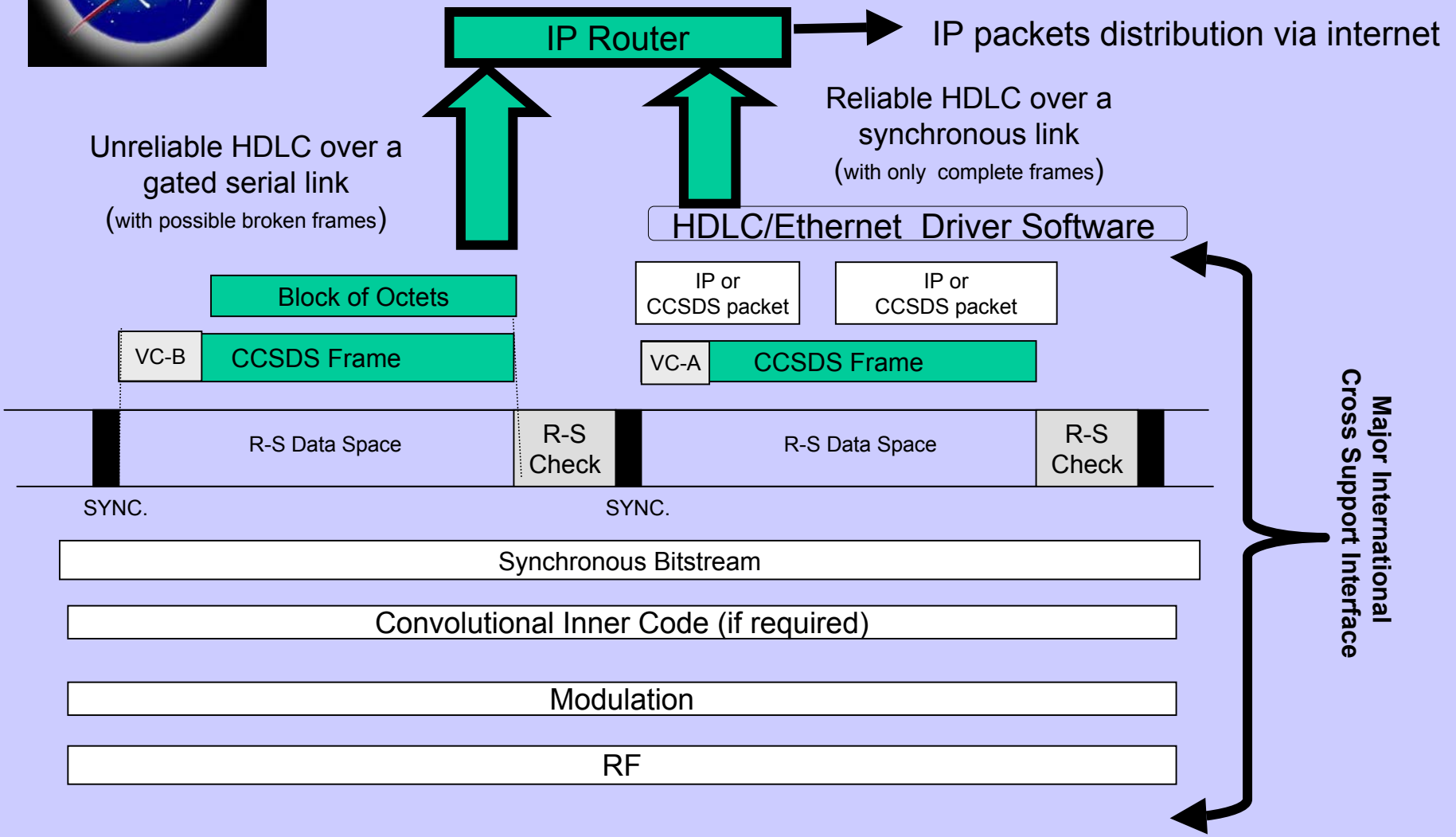


Proposed HDLC, GSFC "STD0001"?



NOTE: Only one channel, no prioritization, no isochronous capability, no support for anything but unacknowledged IP transfer

CCSDS Space Telemetry Links

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CCSDS Space Link Protocols
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Command & Telemetry Data Processing
Information Interchange Processes
Shuttle CS Gateway
ULDB