NASA DATA SYSTEM STANDARDS PROGRAM

CCSDS Link Layer Protocol Suite

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- Principle functions of the CCSDS link layer
- Overview of CCSDS link layer protocols
- Key characteristics of these protocols
- Example link layer configurations
- Link layer services

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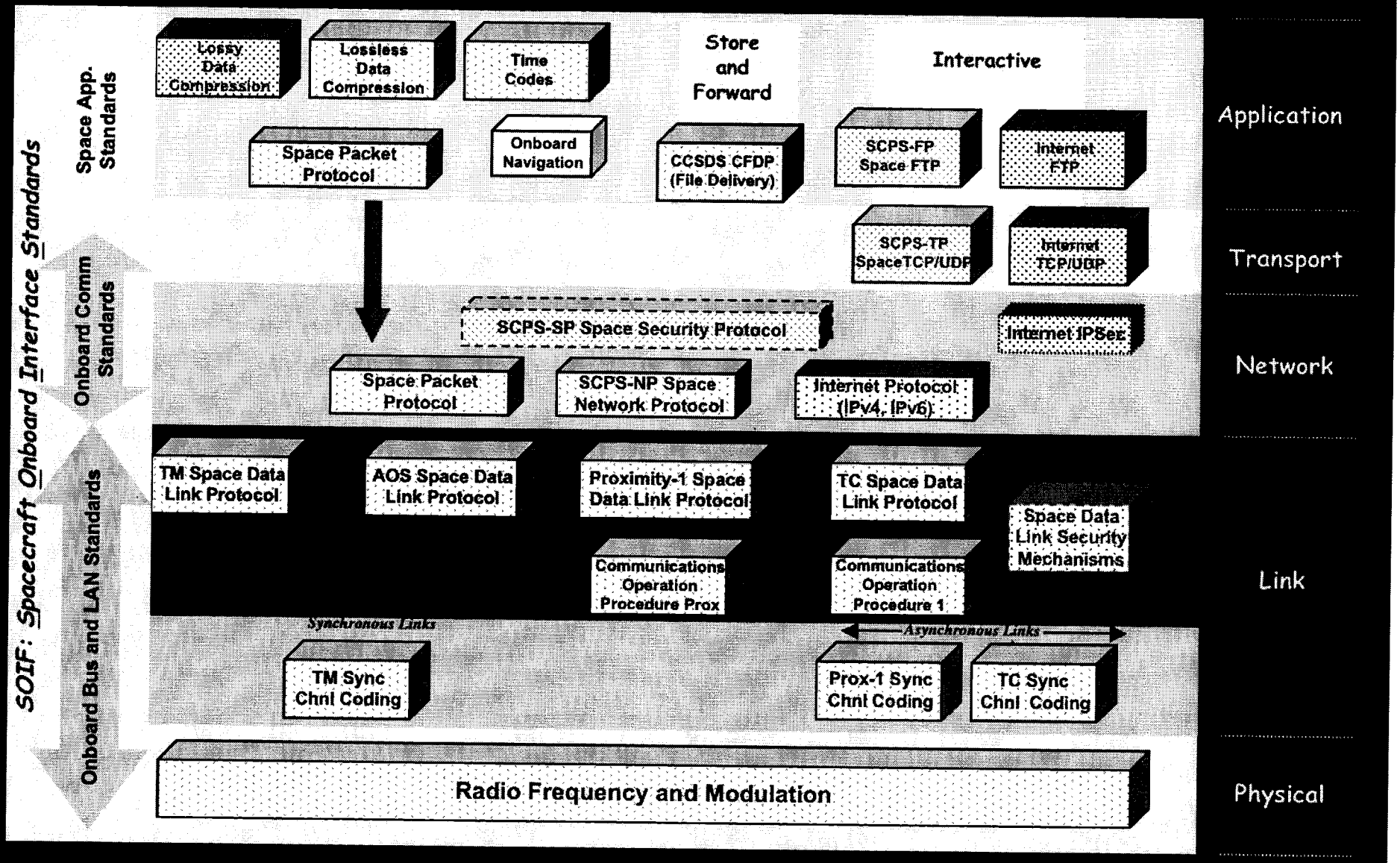
- To carry out the point to point transfer of error free* data
  - Capability to identify the sending source
  - Capability to address one out of many spacecraft
  - Capability to control the link configuration
  - Capability to compose (de-multiplex) a single physical stream from multiple logical streams
  - Capability to reorder the data based upon sequence control ARQ
- To transport Network Layer (CCSDS, IP, SCPs, Encapsulation) packets
- To transport point to point messages supporting remote control functionality

* See coding & sync viewgraph

Networked CCSDS Space/Ground Communications Protocol Stack



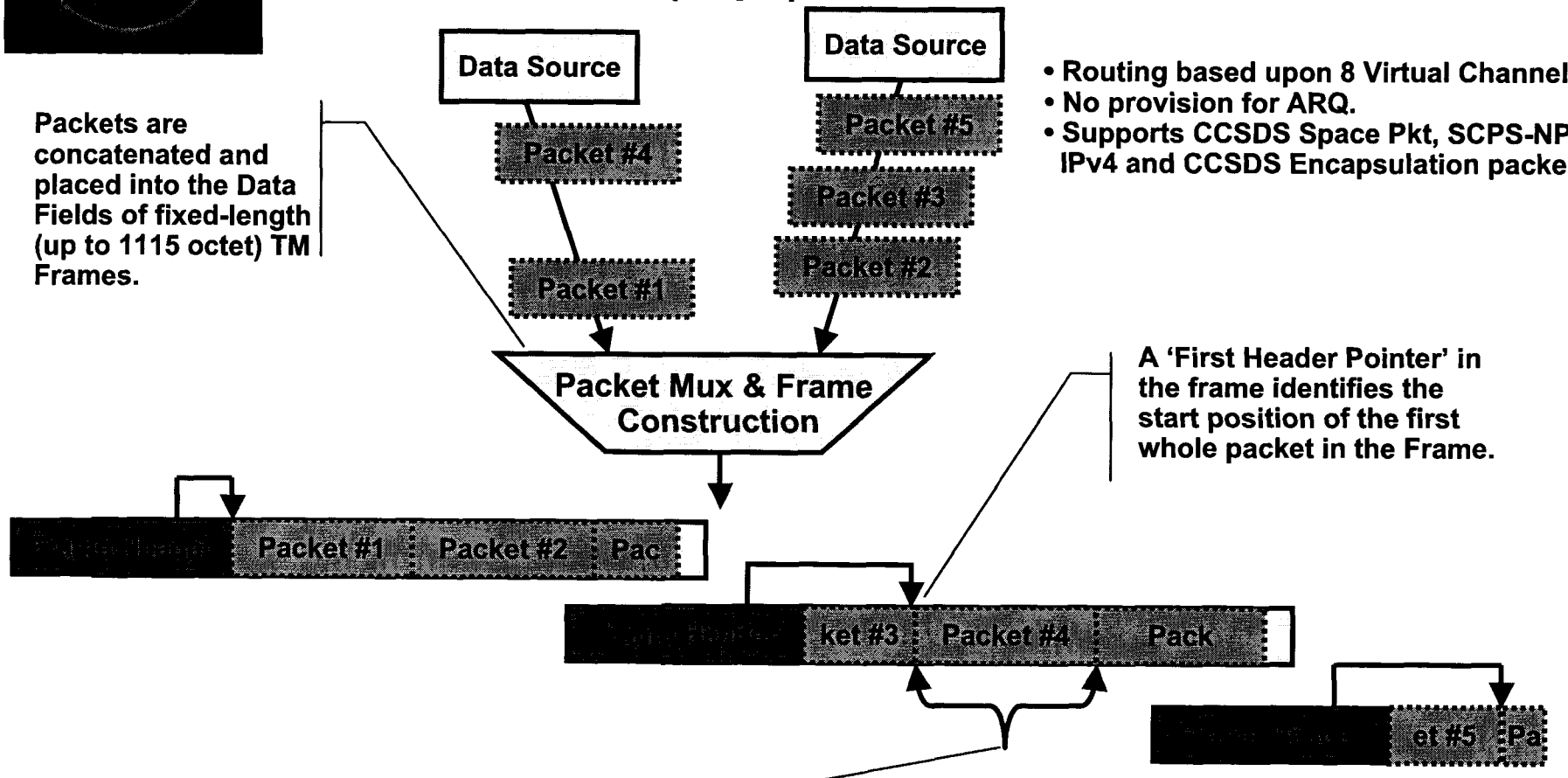
CCSDS Recommendation | Draft CCSDS Recommendation | CCSDS Report | Internet RFC

- Requirement on the link layer to deliver error free data (within a specified undetected error rate)
  - Deep Space Telemetry Links
    - Weak signal environment along with requirements to restrict mass and power dictate high coding gains
    - Block codes used to provide higher coding gains which provide a basis for efficient code/frame sync
  - Deep Space Command Links
    - Stong signal environment, low latency delivery dictate short frames, minimal error correction and detection codes

[redacted]

For Low Rate (kbps) Direct to Earth downlink

Packets are concatenated and placed into the Data Fields of fixed-length (up to 1115 octet) TM Frames.



- Routing based upon 8 Virtual Channels.
- No provision for ARQ.
- Supports CCSDS Space Pkt, SCPS-NP, IPv4 and CCSDS Encapsulation packets.

A 'First Header Pointer' in the frame identifies the start position of the first whole packet in the Frame.

...and the packet length information in each packet...

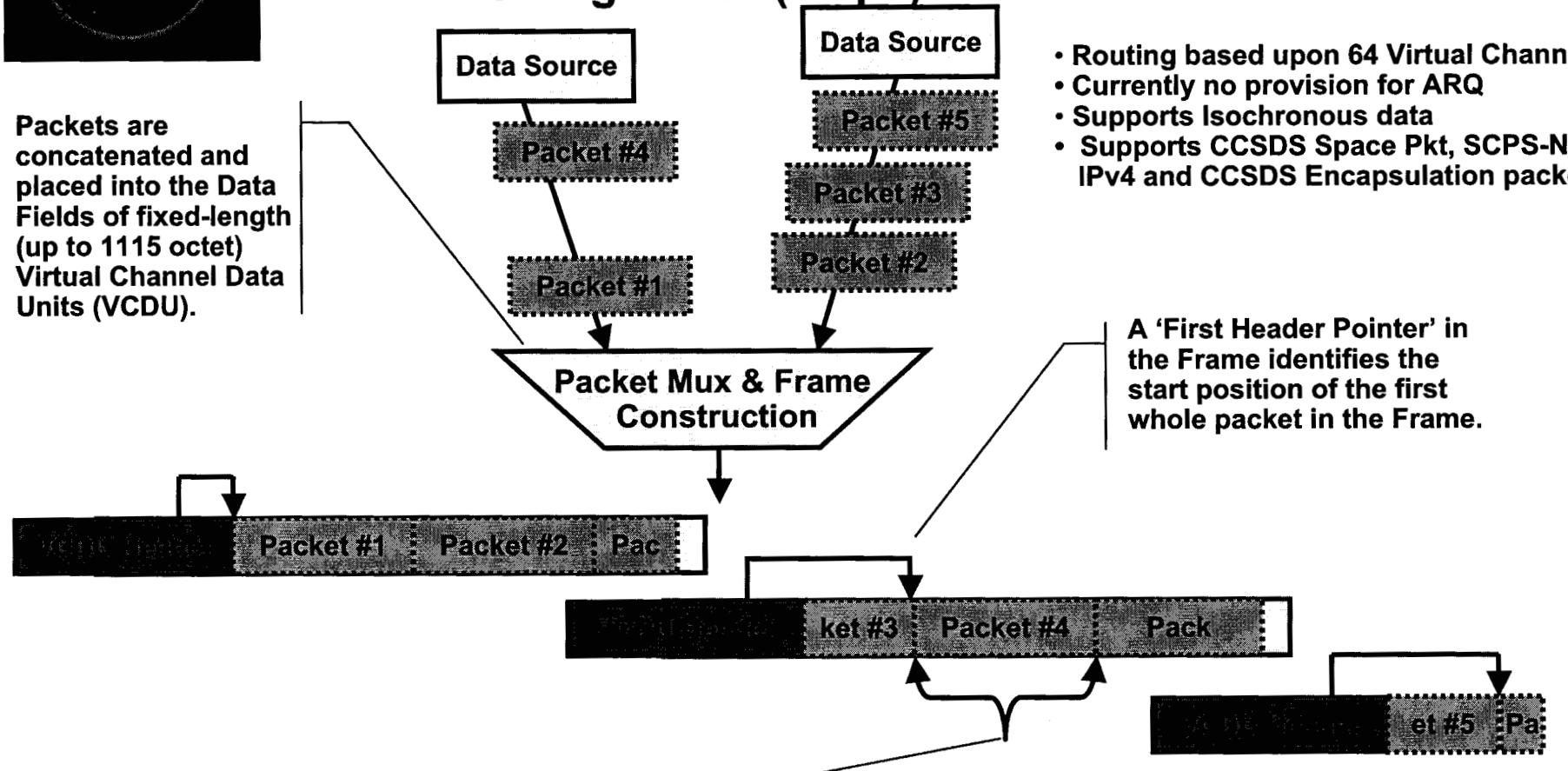
...are used to chain to the next packet in the frame enabling packet extraction.

[redacted]

For High Rate (Mbps) Direct to/from Earth

- Routing based upon 64 Virtual Channels.
- Currently no provision for ARQ
- Supports Isochronous data
- Supports CCSDS Space Pkt, SCPS-NP, IPv4 and CCSDS Encapsulation packets.

Packets are concatenated and placed into the Data Fields of fixed-length (up to 1115 octet) Virtual Channel Data Units (VCDU).



A 'First Header Pointer' in the Frame identifies the start position of the first whole packet in the Frame.

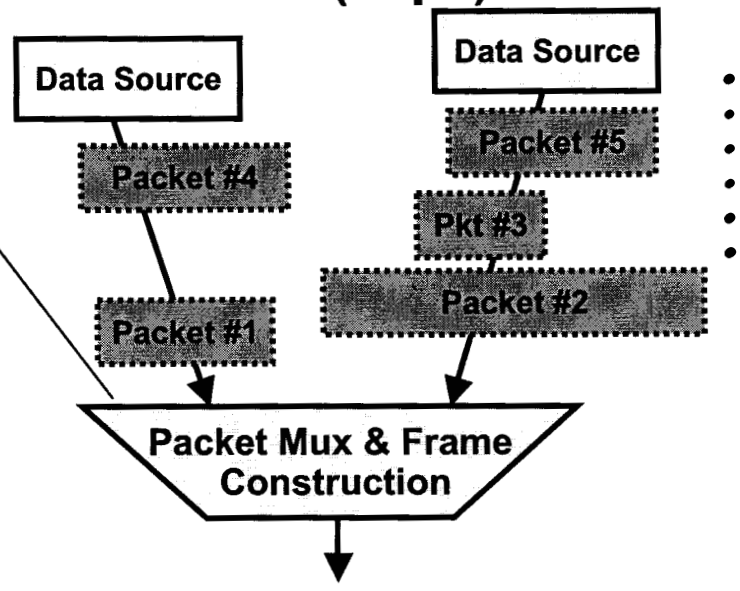
...and the packet length information in each packet...

...are used to extract Packets from VCDUs.

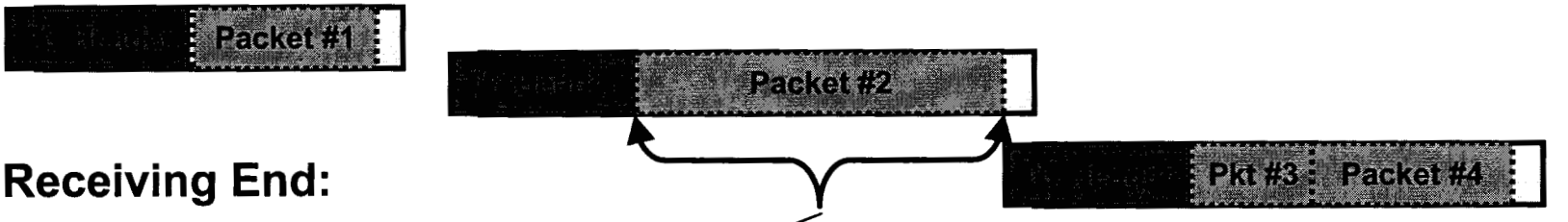
For Low Rate (kbps) Direct from Earth uplink

at Sending End:

Packets are placed into the Data Fields of variable-length (up to 1024 octets) Telecommand Frames



- For low rate(kbps) mission uplink
- HDLC Derivative
- 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.



at Receiving End:

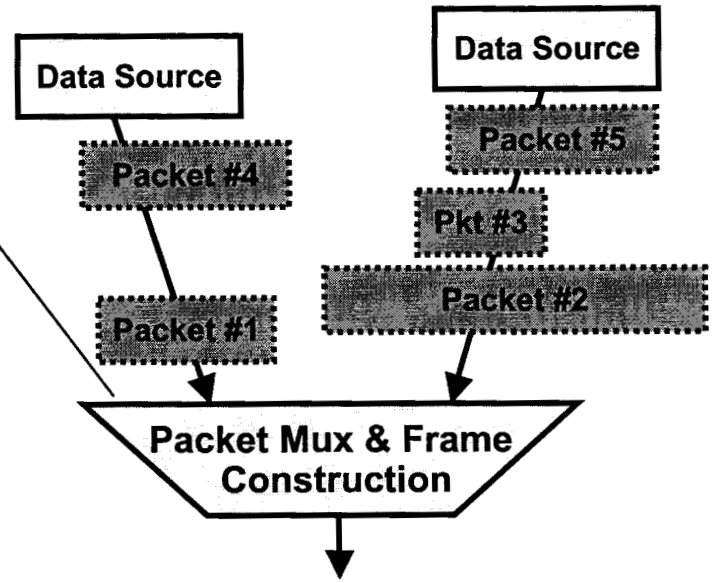
The packet length information in each packet is used to extract Packets from Frames.

[redacted]

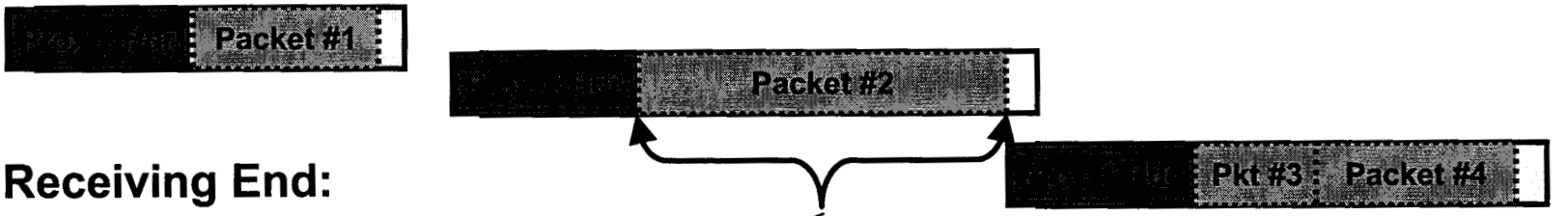
For In-Situ short haul bi-directional links

at Sending End:

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



- Routing based upon 8 Port Ids/Phy Chnl.
- 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
- Supports time tagging of incoming/outgoing frames for timing



at Receiving End:

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

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- Data Link Types
  - Synchronous (fixed length frame)
    - TM/AOS – to ensure robust synchronization using block codes over noisy links
  - Asynchronous (variable length frame)
    - TC/Proximity-1 – to receive short messages over high SNR links
- Multiplexing data over the physical link
  - Virtual Channels (TM/AOS/TC)
  - Port Ids (Proximity-1)
- ARQ (Retransmission)
  - Via sequence controlled in order, no gaps, no duplicate frame delivery: TC (COP-1), Prox-1 (COP-P)
  - No ARQ mechanisms: AOS, TM (retransmission can be done by a higher layer protocol)

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Service Type	TM	TC	AOS	Prox-1
Packet Services	Packet & Encapsulation Services	Packet & Encapsulation Services	Packet & Encapsulation Services	Packet & Encapsulation Services
User Defined Data	N/A	N/A	Isochronous (audio & data) Bit Stream Service	Bit Stream & Other user defined types
Timing	Time Correlation	N/A	Time Correlation	Time Correlation Time Xfer

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Addressing of TM/TC/AOS

Addressing of Proximity-1

MAP Channel: (TC only, Optional)
Identified by MAP ID

Virtual Channel:
Identified by VCID

Physical/Logical Port:
Identified by Port ID

Master Channel:
Transfer Frame Version # + Spacecraft ID

Physical Channel:
Named Entity

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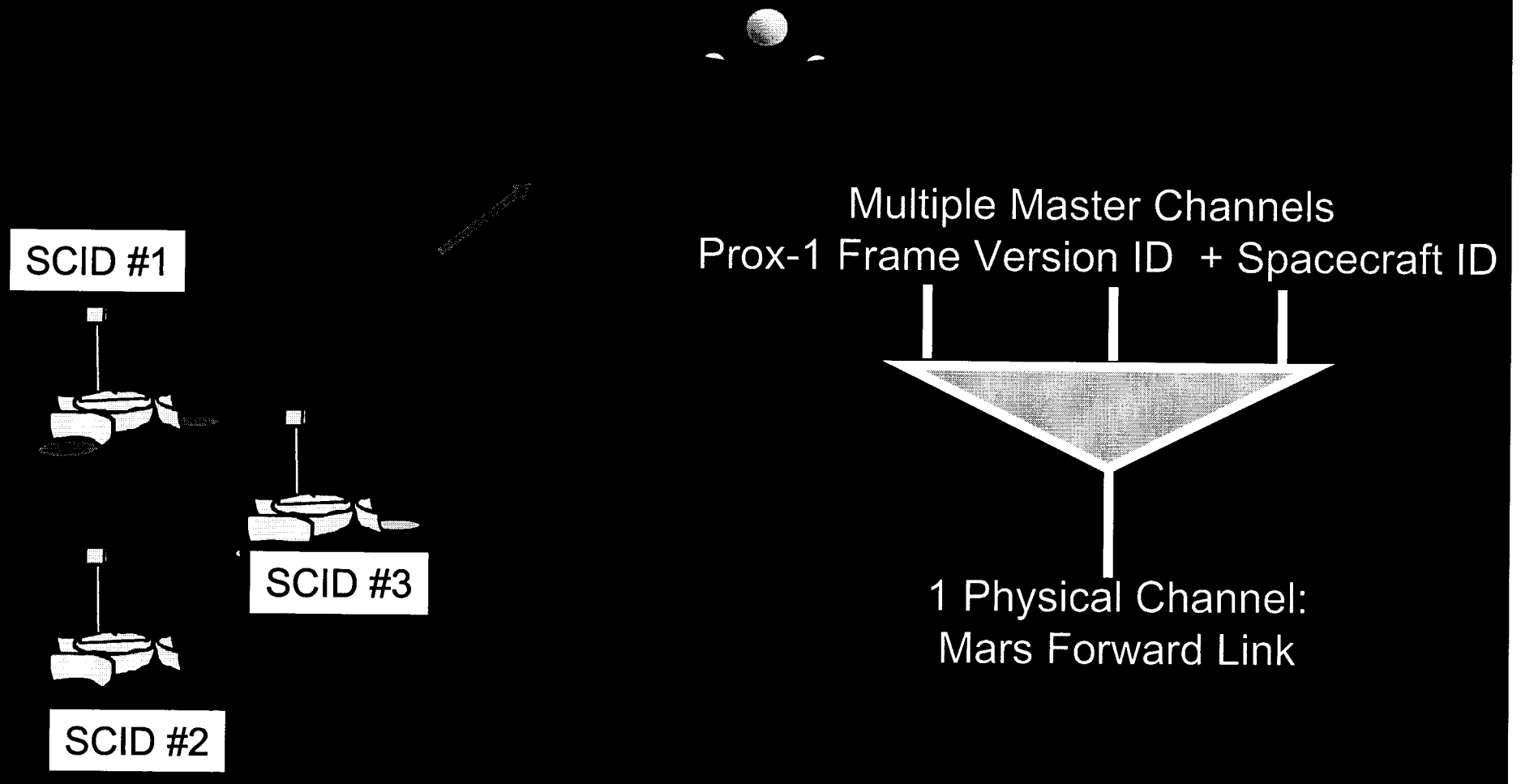
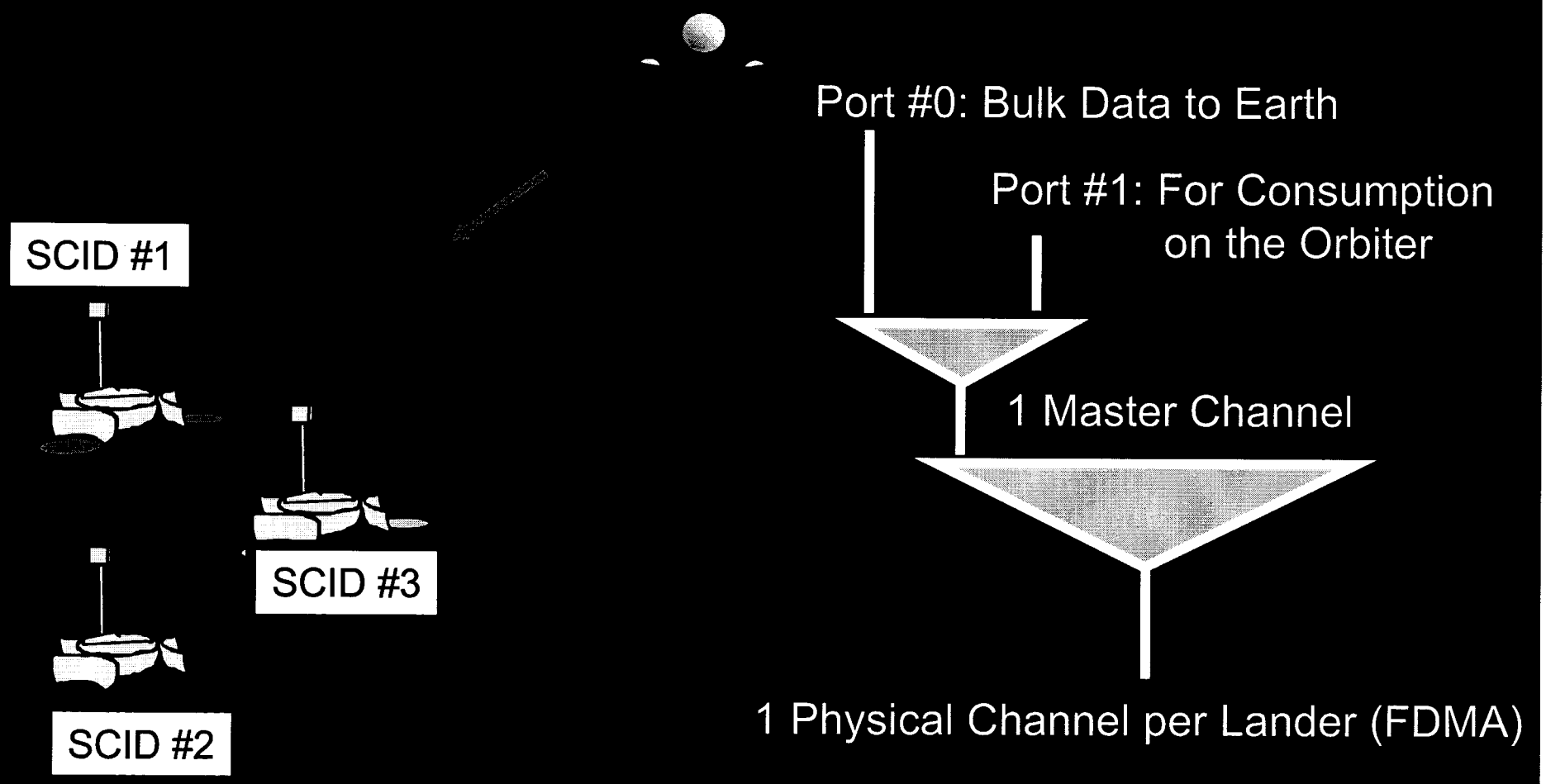
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