astrea

COMMUNICATIONS DEPARTMENT: PROTOCOL

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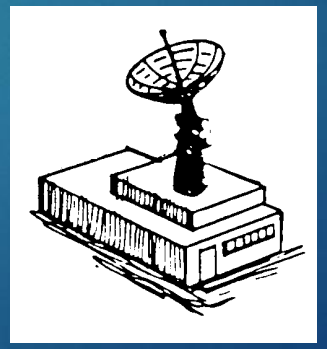
What are we going to talk about?

- Work done: Protocol
  - Space segment
  - Ground segment

- Work to do: Ground Station
  - Exploration avenues

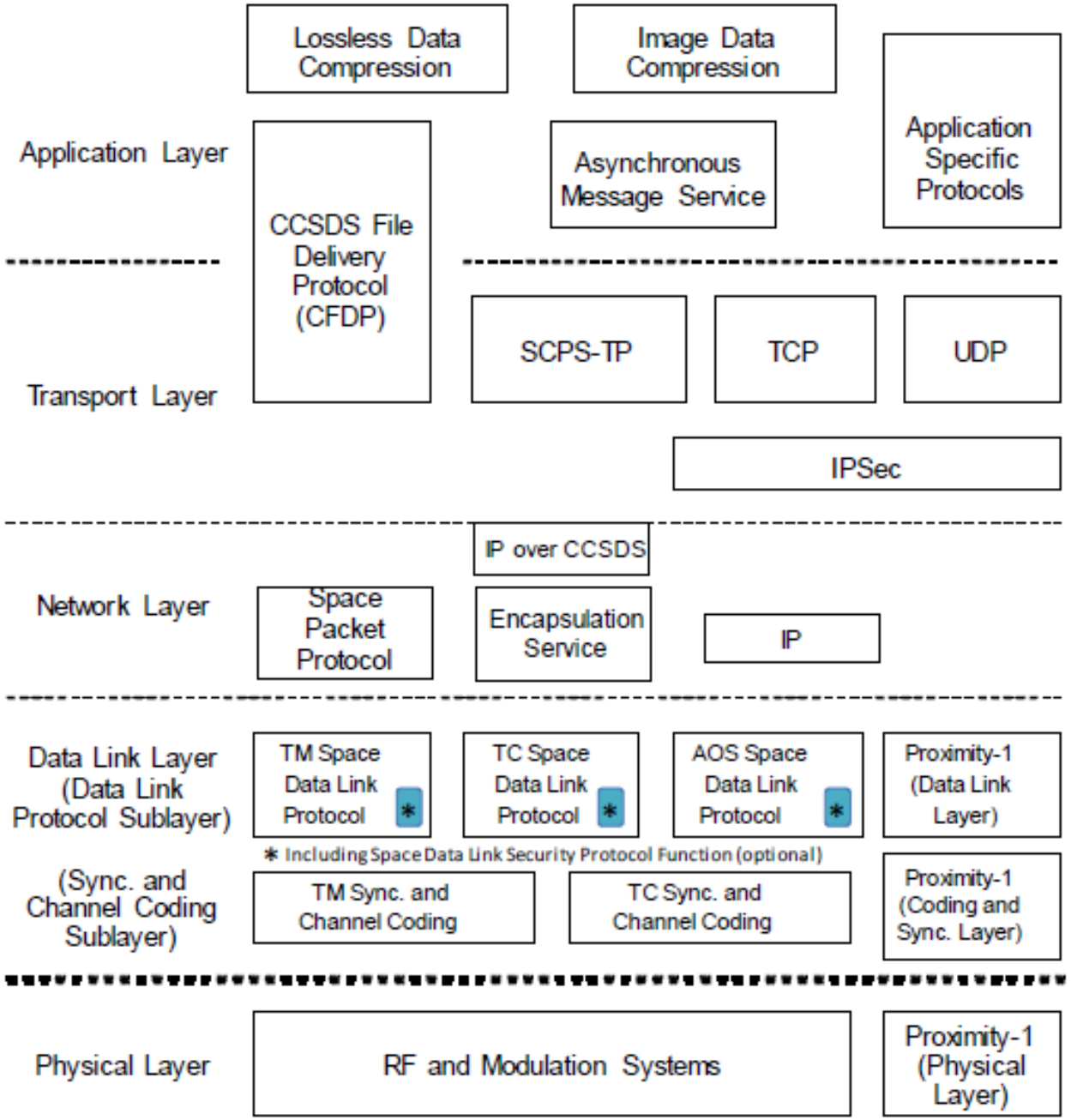


Space segment: Consultive Committee for Space Data Systems (CCSDS)

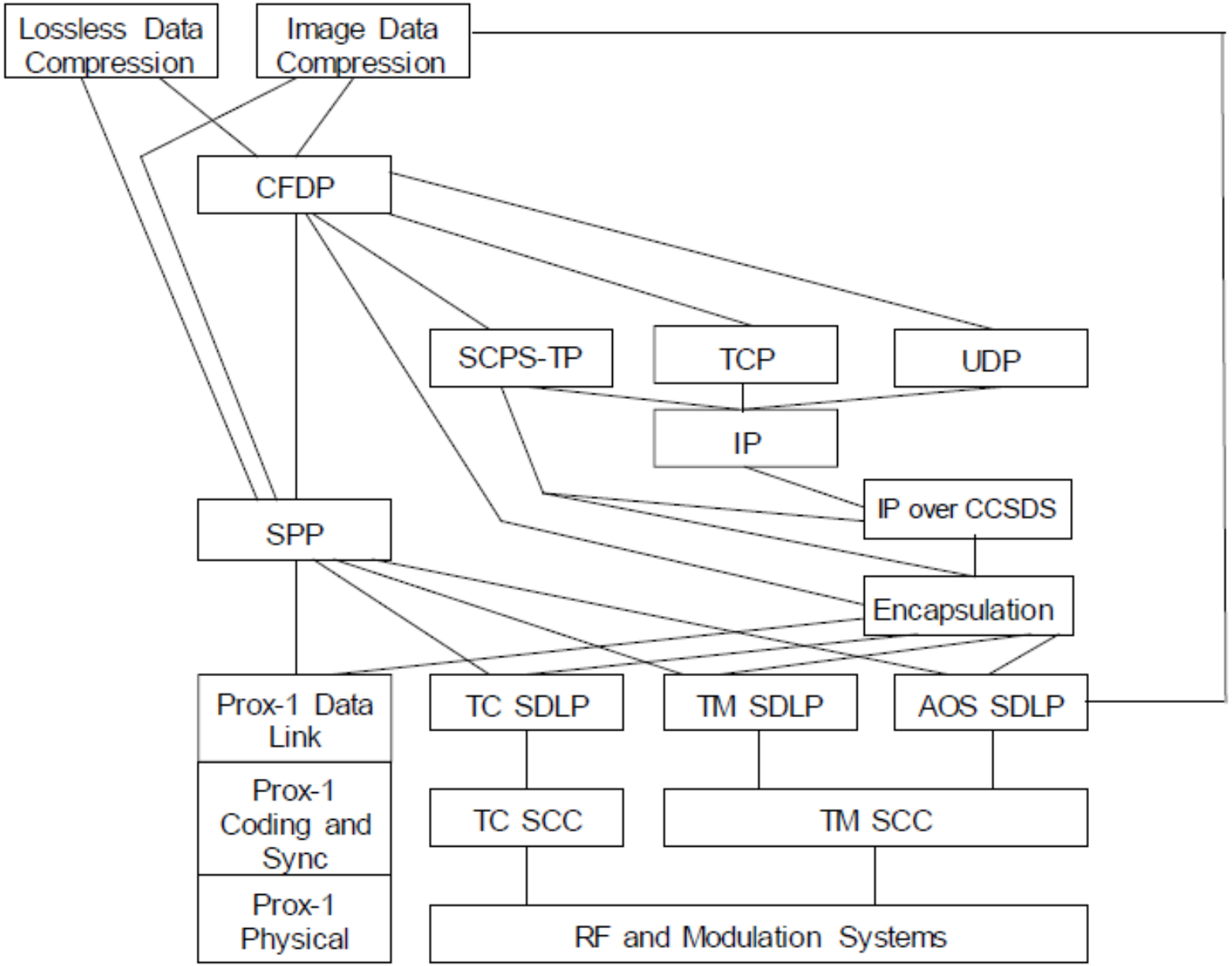
- Objective of CCSDS: Enhance governmental and commercial interoperability and cross-support while reducing risks during communications.
- CCSDS recommendations are routinely submitted to the International Organization for Standardization (ISO).
- Using CCSDS standards it is assured that communication between satellites of Astrea constellation and satellites of the clients is possible.

- The space communications protocols are defined for the five layers of the ISO model.

Layer	Name	Function
5	Application	Network process to application, data presentation
4	Transport	End-to-end connections and reliability
3	Network	Path determination
2	Data Link	Node-to-node data transfer
1	Physical	Electrical and physical specifications of the data connection



Space communications protocols



Some possible combinations for space communications protocols

Transport Layer

User Datagram Protocol (UDP)	Stream Control Transmission Protocol	Transmission Control Protocol (TCP)
- Conect - Unreli - Perf er d error cking	- Reliable - Messo d - Des or t applic ions	- Connection-oriented - Flow and error control mechanisms - Extension to adapt the protocol to space needs (SCPS-TP)

Protocol to be used in the Transport Layer: SCPS-TP

Network Layer: Main protocol

Space Packet Protocol (SPP)	Internet Protocol version 4 (IPv4)	Internet Protocol version 6 (IPv6)
- Work e[illegible]ne protoc[illegible] adjac[illegible] - Req[illegible]atr[illegible] Astrea [illegible]onstell[illegible]on there are 39800 possibe routes. - Path ID parameter: 11 bit. 2048 routes.	- Needs [illegible]CSDS and Er[illegible]tion Servi[illegible] - Ins[illegible] P[illegible]ses IP adres[illegible]f the s[illegible]rce and destination node. - Shorter header. - More additional protocols than IPv6.	- Needs IP over CCSDS and Encapsulation Service. - Instead of Path ID uses IP adress of the source and destination node. - Larger header. - Less processing than IPv4 - Progressively replacing IPv4

Main protocol of the Network Layer: IPv6

Network Layer: Routing protocol

Enhanced Interior Gateway Routi Protoc EIGRP)	Open Shortest Path First (OSPF)	Routing Information Pr ocol (R)
- Comp n IPv6 - Topolo ges, not the g table: les ed. - Auth ication processes 2000 entries to update frequently	- Compatible with IPv6 - Each router exchanges its adjacency links with adjacent routers - Each router creates its own routing table - Transmit only the adjacencies. 205 entries to update frequently	- More verge - Poor sc - Easier e

39800 different entries in the routing table (only satellite nodes)

Network Layer: Complementary protocols

- IP over CCSDS and Encapsulation Service
- ICMPv6: Expands features of IPv6

Data Link Layer: Working procedure

- Simplest Protocol: No error. No flow control.

```
1  while (true)                    // Repeat forever
2  {
3    WaitForEvent()i               // Sleep until an event occurs
4    if(Event(RequestToSend»       //There is a packet to send
5    {
6        GetData()i
7        MakeFrame()i
8        SendFrame()i              //Send the frame
9    }
10 }
```

Sender's algorithm

```
1  while(true)                     // Repeat forever
2  {
3    WaitForEvent()i               II Sleep until an event occurs
4    if(Event(ArrivalNotification» IIData frame arrived
5    {
6        ReceiveFrame()i
7        ExtractData()i
8        DeliverData ()i           //Deliver data to network layez
9    }
10 }
```

Receiver's algorithm

Data Link Layer: Working procedure

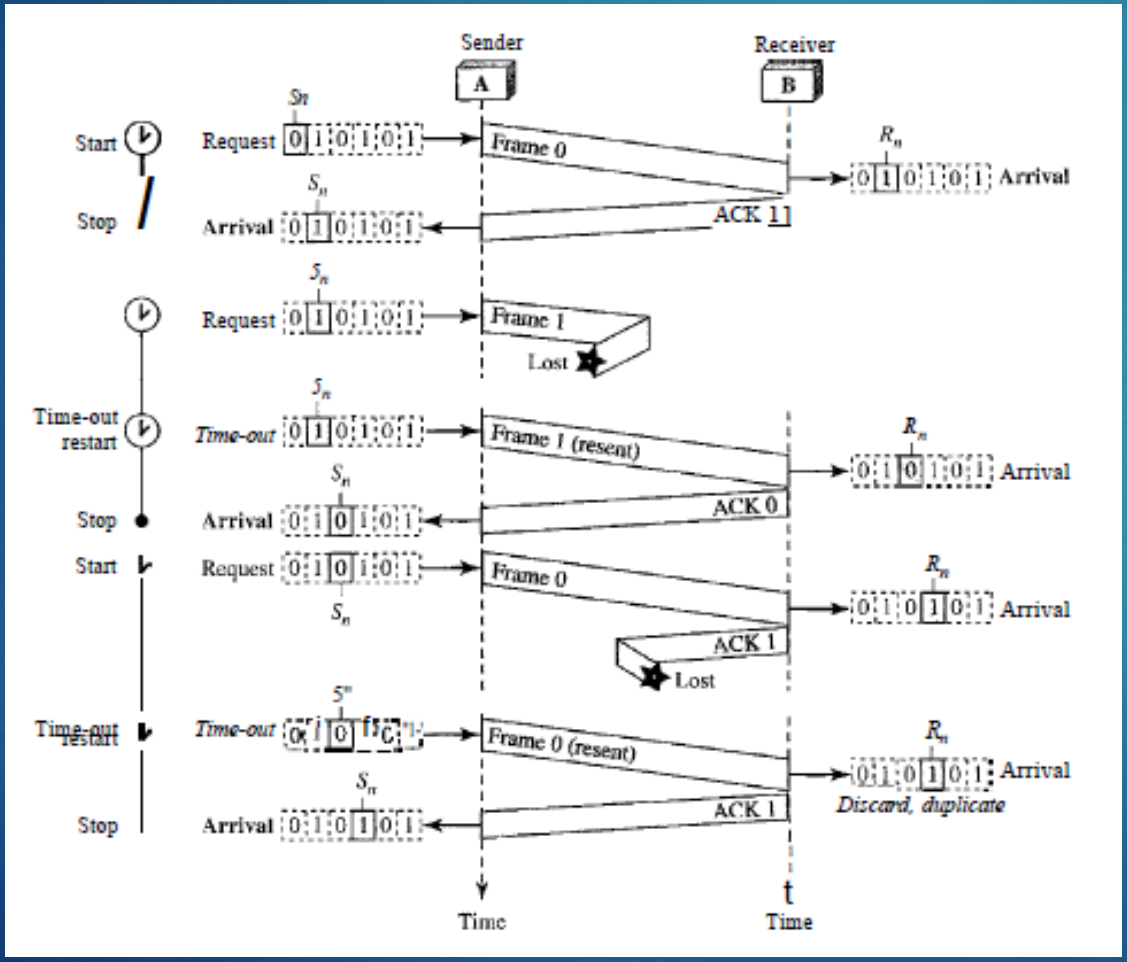
- Stop-and-Wait Protocol: Feedback included

```
1  while(true)                          //Repeat forever
2  canSend = true                       //Allow the first frame to go
3  {
4    WaitForEvent()i                    // Sleep until an event occurs
5    if(Event(RequestToSend) AND canSend}
6    {
7       GetData()i
8       MakeFrame()r
9       SendFrame()i                    //Send the data frame
10      canSend = false;                //cannot send until ACK arrives
11   }
12   WaitForEvent()i                    // Sleep until an event occurs
13   if(Event(ArrivalNotification)      //An ACK has arrived
14    {
15      ReceiveFrame();                 //Receive the ACK frame
16      canSend = true;
17    }
18 }
```

Sender's algorithm

Data Link Layer: Working procedure

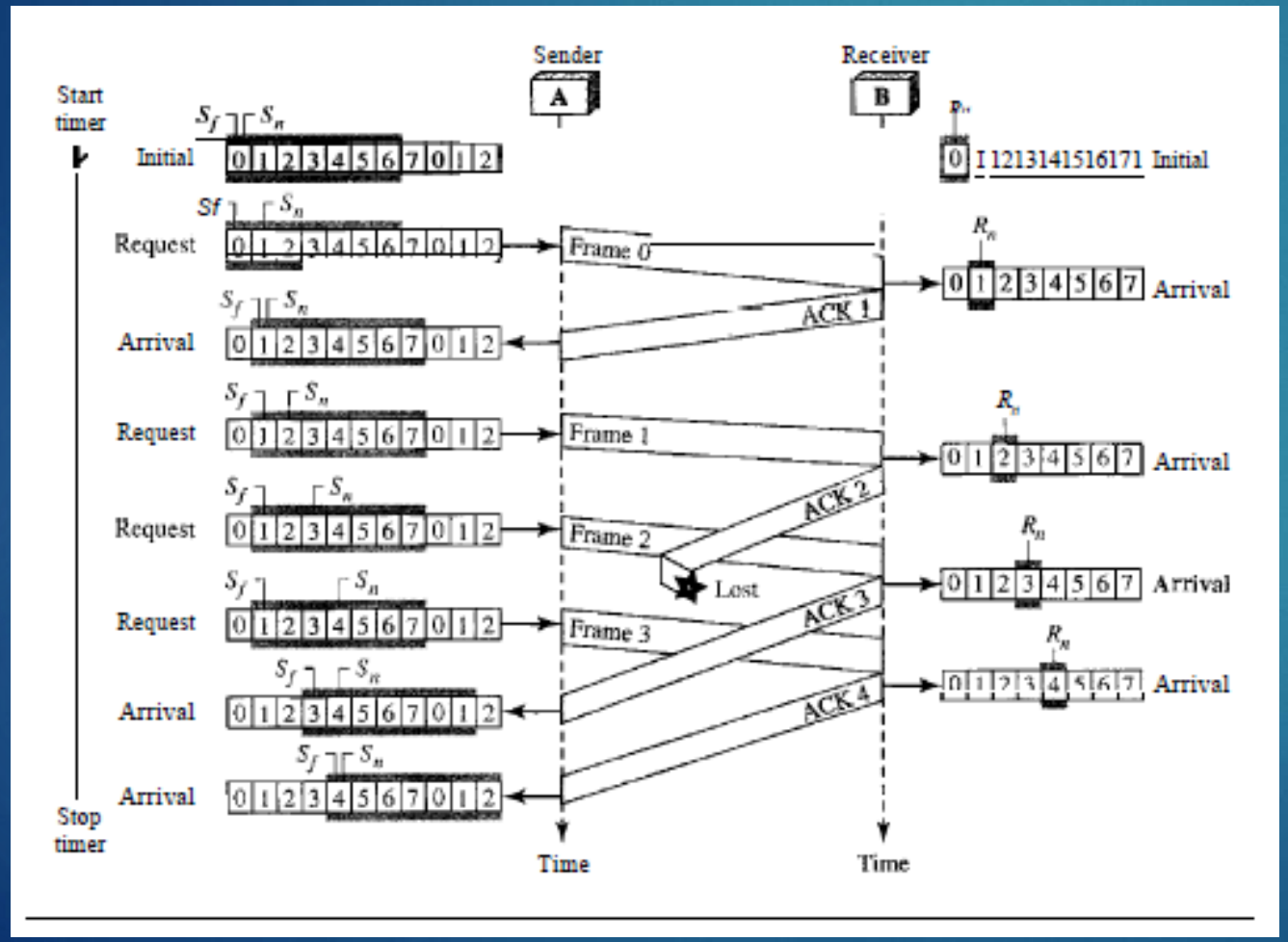
- Stop-and-Wait Automatic Repeat Request



Flow diagram

Data Link Layer: Working procedure

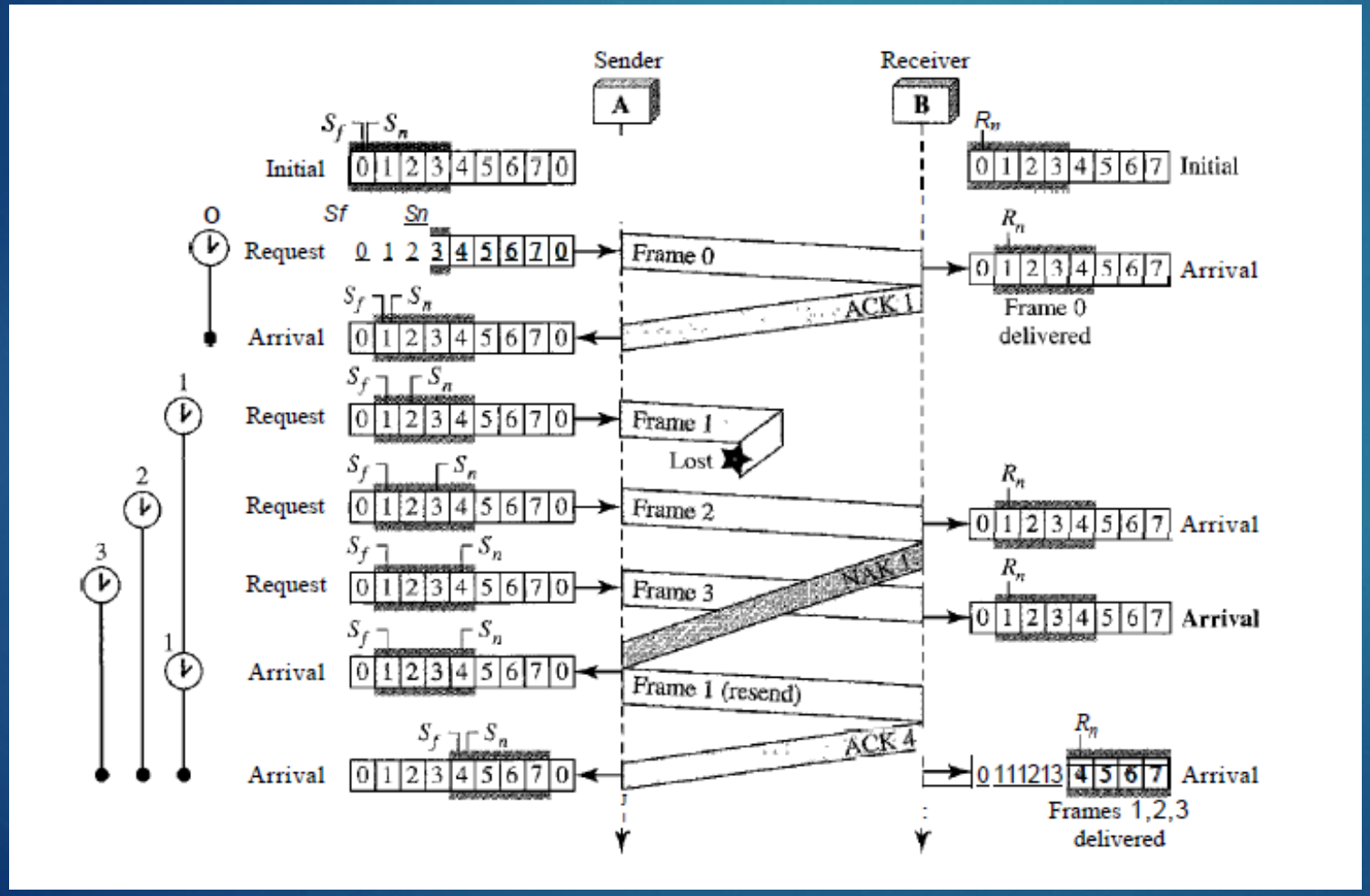
- Go-Back-N ARQ



Flow diagram

Data Link Layer: Working procedure

- Selective Repeat ARQ



Flow diagram

CCSDS DLL: Data Link Protocol Sublayer

TM Space Data Link Protocol	TC Space Data Link Protocol	AOS Space Data Link Protocol	Proximity-1 Space Link Protocol-Data Link Layer
- St it	- Type A: Go-Back-N ARQ - Ty Stop-and ait Pr l	- Stop	- Go-Back-N ARQ

TC Space Data Link Protocol is the chosen one because:

- Inserts security into a frame using the Space Data Link Security (SDLS)
- Allows more streams of bits in a single physical channel using VC

CCSDS DLL: Synchronization and Channel Coding Sublayer

- Makes a stream of bits that can be transfered by the antenna out of the data provided by the above layers.

TC Space Data Link Protocol → TC Sync and Channel Coding

Ground segment:

- How will the data be presented to the client? **Application**

- Protocols

File Transfer Protocol (FTP)	Secure Shell (SSH)
- To transfer computer files between a client and a server - Encryption - Secured using SSL/TLS Protocols - Slow	- Cryptographic network protocol - To operate securely over an unsecured network. - Creates a secure channel between the client and the server

SSH will be used

Ground station

- Two open exploration avenues:
  - Existing GS that can be used
  - Legislation

Svalbard Satellite Station

Summary

- Protocol
  - Space Segment
    - Transport Layer: SCPS-TP
    - Network Layer: IPv6, OSPF, IP over CCSDS, Encapsulation Service, ICMPv6
    - Data Link Layer: TC Space Data Link Protocol, TC Sync and Channel Coding and SDLS
  - Ground Segment
    - Application using SSH Protocol
- Ground Station