CCSDS TCONS/OBL

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The Core Team

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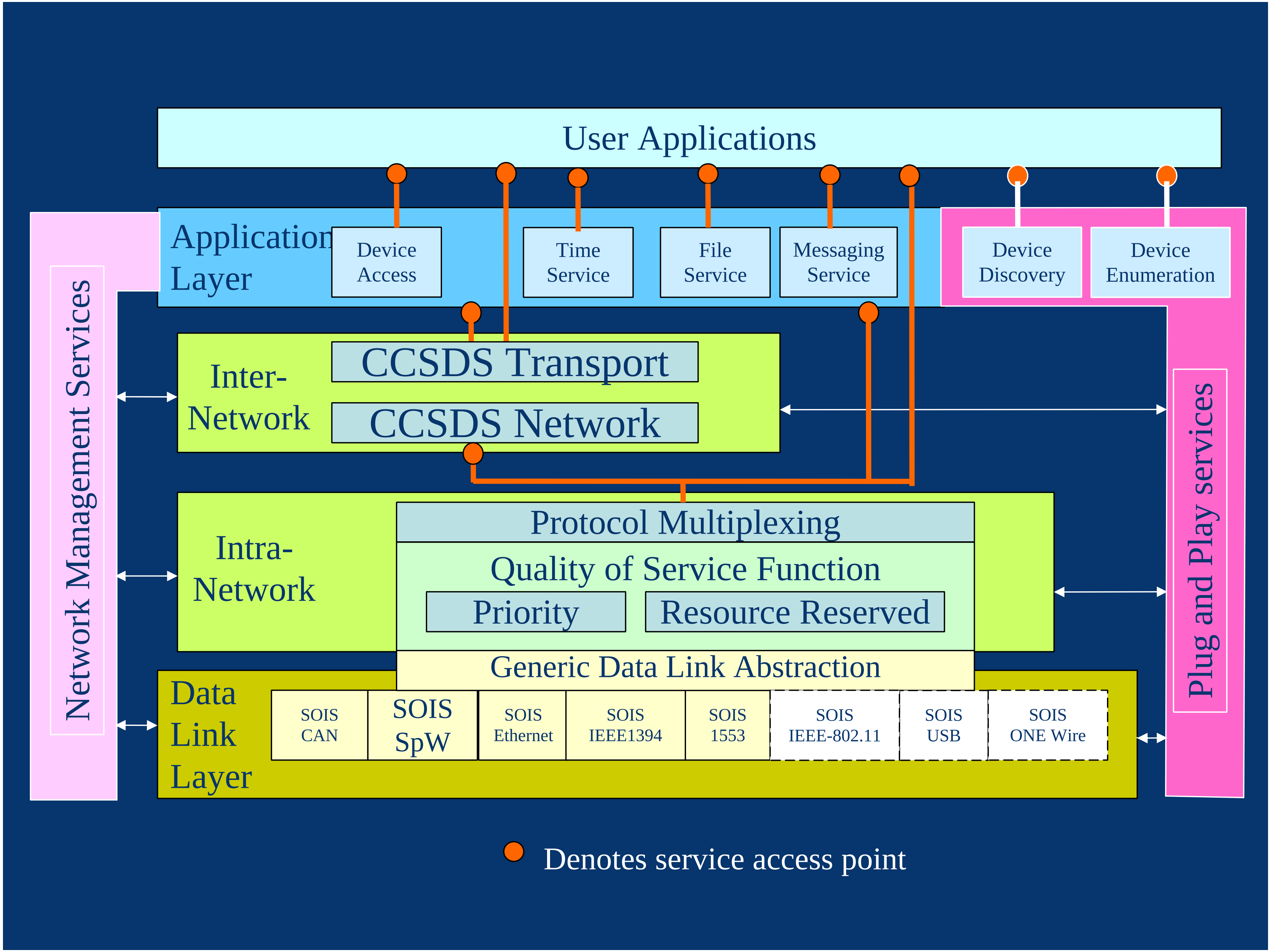
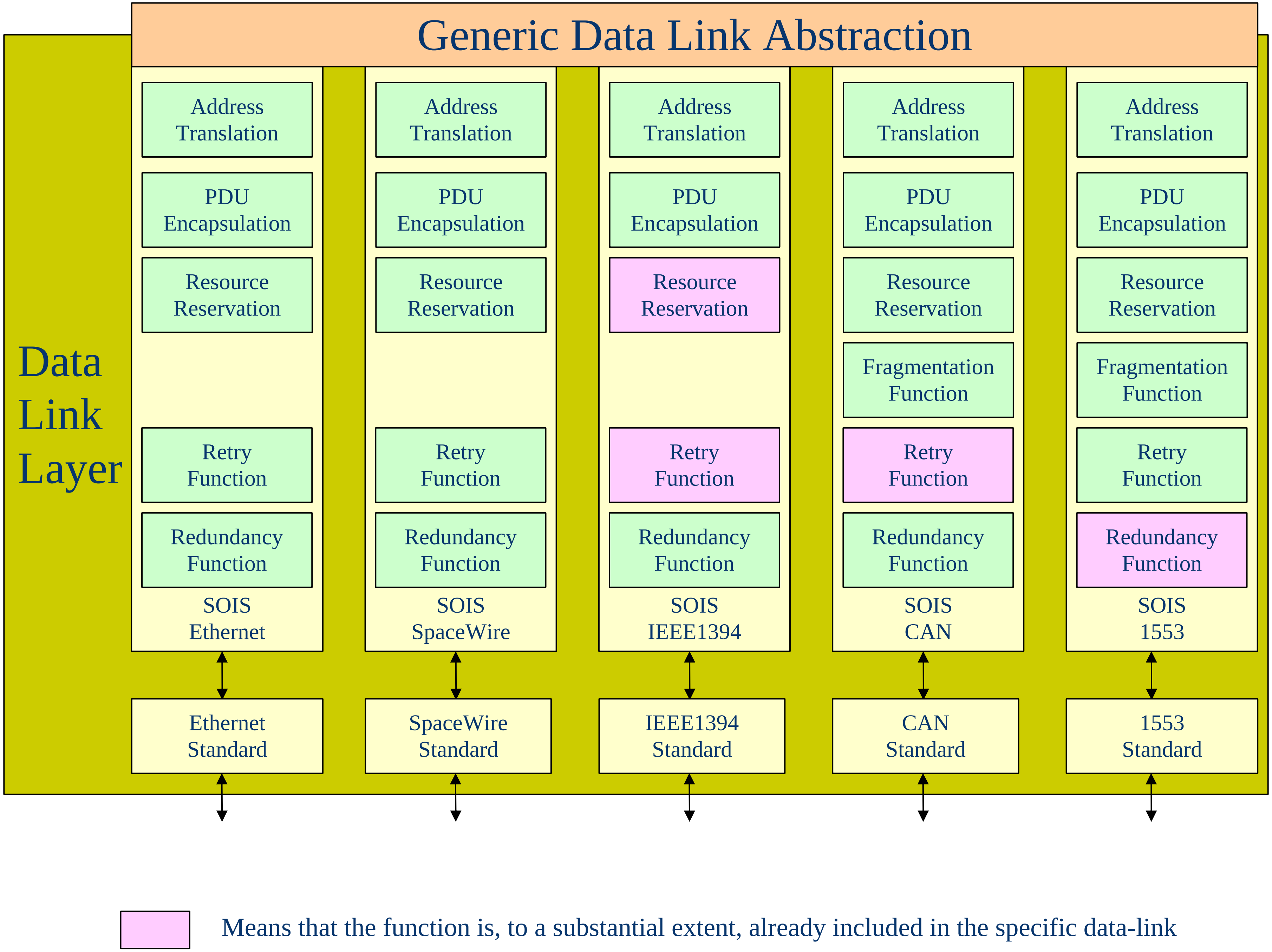

User Applications
Application Layer
Device Access
Time Service
File Service
Messaging Service
Device Discovery
Device Enumeration
Network Management Services
Inter-Network
CCSDS Transport
CCSDS Network
Intra-Network
Protocol Multiplexing
Quality of Service Function
Priority
Resource Reserved
Generic Data Link Abstraction
Data Link Layer
SOIS CAN
SOIS SpW
SOIS Ethernet
SOIS IEEE1394
SOIS 1553
SOIS IEEE-802.11
SOIS USB
SOIS ONE Wire
Plug and Play services
Denotes service access point


Generic Data Link Abstraction
Data Link Layer
Address Translation
PDU Encapsulation
Resource Reservation
Retry Function
Redundancy Function
SOIS Ethernet
Address Translation
PDU Encapsulation
Resource Reservation
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SOIS SpaceWire
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Address Translation
PDU Encapsulation
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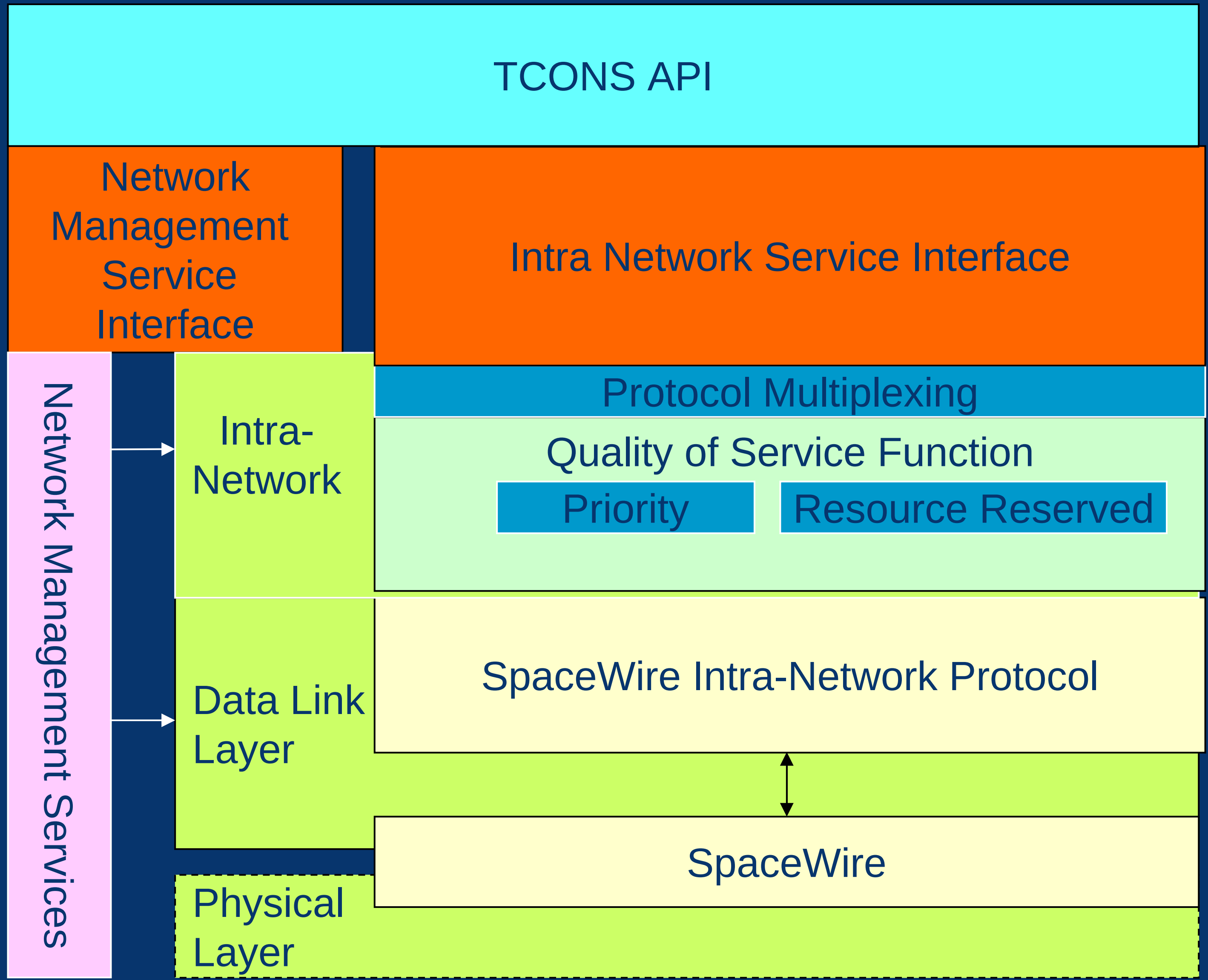
Retry Function
Redundancy Function
SOIS 1553
Ethernet Standard
SpaceWire Standard
IEEE1394 Standard
CAN Standard
1553 Standard
Means that the function is, to a substantial extent, already included in the specific data-link

SpaceWire Working Group



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Quality of Service

- QoS is ability to provide predictable, differentiated communication services
- Characterised in terms of features relevant to a communications service
  - Reliability
  - Transmission rate
  - Effective bandwidth
  - Latency
  - Error rate

TCONS QoS Model

- Three levels to TCONS QoS Model:
  a) Priority
  b) Resource reserved / non-reserved
  c) Try once / retry

TCONS QoS Model

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- Result in four service types
- Best Effort: Non-reserved, try once
- Assured: Non-reserved, retry
- Reserved: Resource reserved, try once
- Guaranteed: Resource reserved, retry

- Each of these service types also has several priority levels
  - Priority for non-reserved types is global
  - Priority for reserved types is within a channel

SpaceWire Mapping

- Work in progress
- Currently defining the mapping
- Aim to complete this in summer

- Mapping to Ethernet also underway

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Address Resolution

SOIS Logical Address	SpaceWire Logical Address	Prime SpaceWire Path Address	Redundant SpaceWire Path Address
0100h	34h	01 04 02h	02 04 02h
0120h	39h	01 06 05 02h	02 03 05 02h
0122h	54h (low priority)	01 04 03h	02 04 03h
0122h	55h (high priority)	01 04 03h	02 04 03h

– Could also have redundant SpaceWire logical addresses

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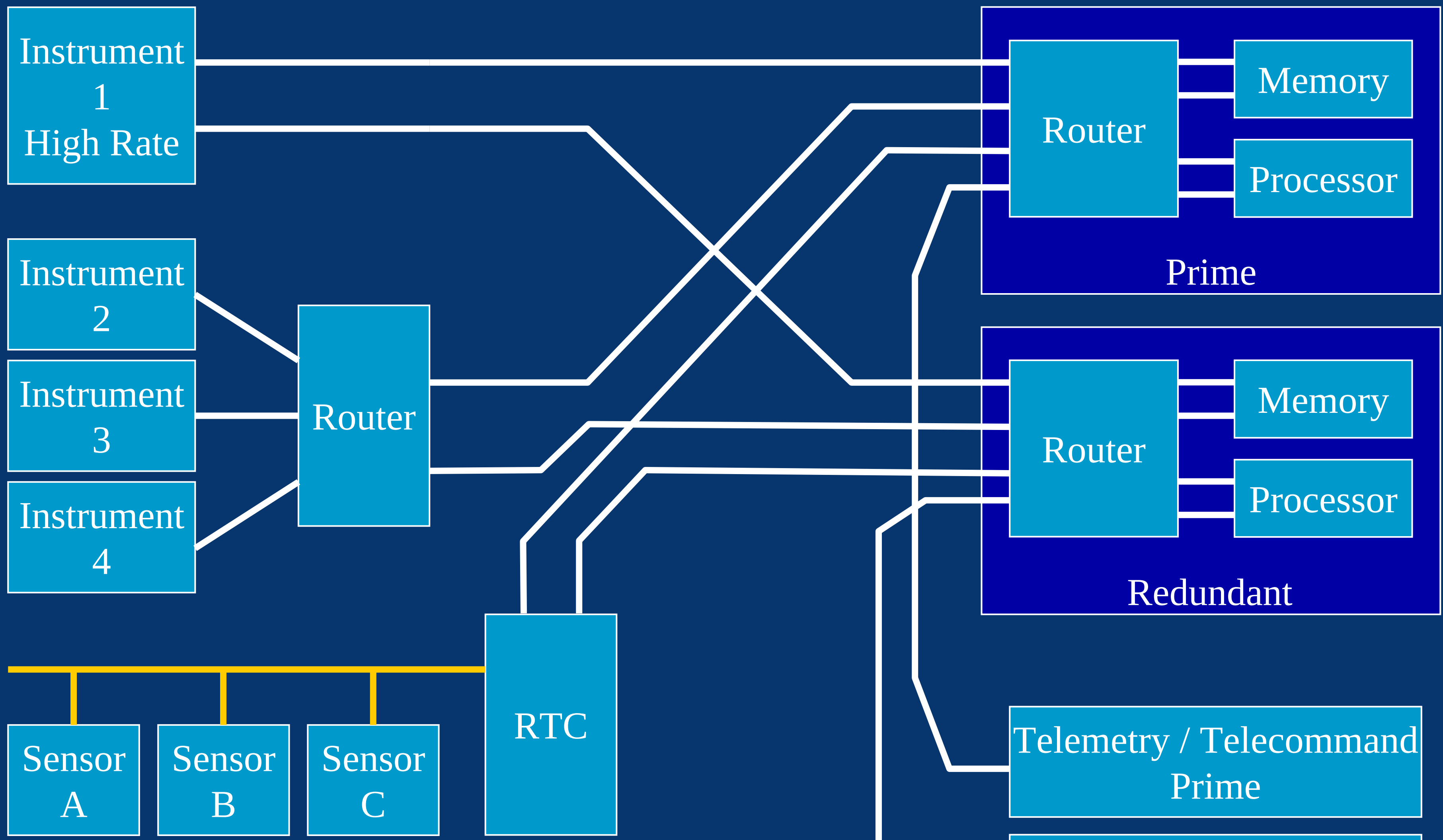
CCSDS SOIS SpaceWire PDU

First octet sent

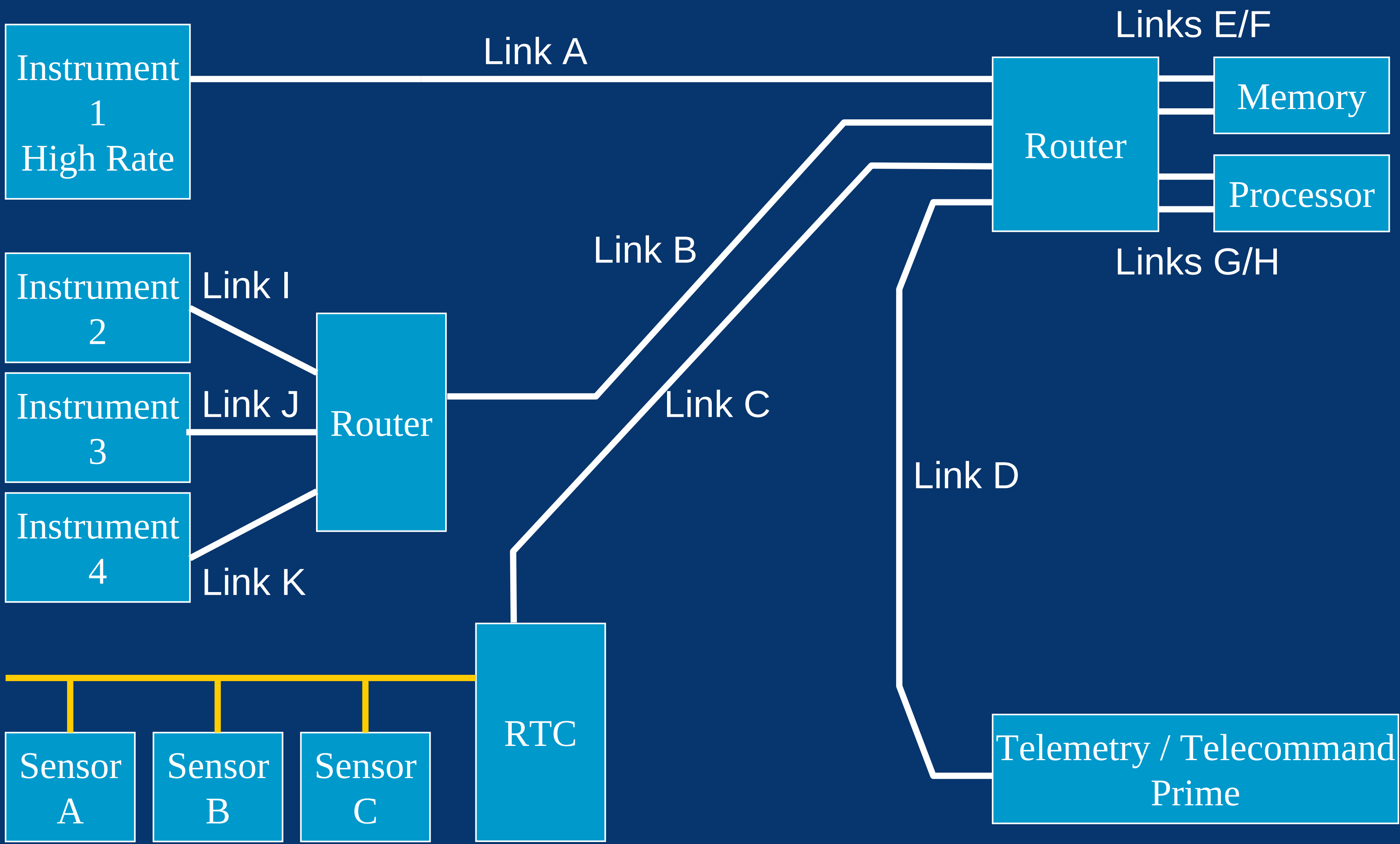
	Destination SpW Path Address	Destination SpW Path Address	Destination SpW Path Address
Destination SpW Logical Address	SpW Protocol ID	Type and QoS	Source SpW Logical Address
Sequence Number	Intra-Network Protocol ID	Header CRC	
Data	Data	Data	Data
Data	Data	Data	Data
Data	Data	Data	Data
Data	Data	Data	Data
CRC MS	CRC LS	EOP	

Last octet sent

Typical SpaceWire Architecture



Typical SpaceWire Architecture



Links E/F and G/H are configured in GAR pairs

Table 3-1 Utilisation of resources (links)		
Link	Left to right / up	Right to left/ down
A	Not shared	Processor commands and telecommands
B	Instruments 2, 3, 4	Processor commands and telecommands
C	RTC	Processor commands and telecommands
D	Telecommands	Data from memory for down link
E/F	Instruments 1, 2, 3, 4 and RTC Processor commands and telecommands	Date from memory for down link
G/H	Data from instruments or memory for processing	Processor commands Processed data
I	Not shared	Processor commands and telecommands
J	Not shared	Processor commands and telecommands
K	Not shared	Processor commands and telecommands

Table 3-2 Channel allocations			
Channel No.	Traffic	Links used L to R / Up	Links used R to L / Down
1	Instrument 1 to memory	A, E/F	
2	Instrument 2 to memory	I, B, E/F	
3	Instrument 3 to memory	J, B, E/F	
4	Instrument 4 to processor for processing	K, B, G/H	
5	RTC sensor data to memory	C, E/F	
6	Processor to memory – processed data	E/F	g/h
7	Memory to telemetry		e/f, d
8	Processor commands to any other unit	E/F	g/h, a, b, c, i, j, k
9	Telemetry commands to any other unit	D, E/F, G/H	a, b, c, i, j, k

Time-slots

- Means of dividing network bandwidth between channels
- Equal divisions of time
  - during which a discrete set of communications can take place
- Time-slots distributed by SpaceWire time-codes
- 64 time-code values
- 64 time-slots for minor cycle or epoch
- Used to separate time-slots in a scheduled system
- Used to measuring and allocating bandwidth usage in a bandwidth reserved system

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Time-slot allocation in a schedule system

	Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Slot 8	…
Channel 1	A, E/F	A, E/F	A, E/F	A, E/F	A, E/F	A, E/F	A, E/F	A, E/F		
Channel 2	I, B, E/F				I, B, E/F					
Channel 3		J, B, E/F								
Channel 4			K, B, G/H							
Channel 5				C, E/F						
Channel 6						g/h, E/F				
Channel 7	e/f, d	e/f, d	e/f, d	e/f, d	e/f, d	e/f, d	e/f, d	e/f, d		
Channel 8							E/F, g/h, a,b,c,I,j,k			
Channel 9								D,E/F,G/H a,b,c,i,j,k		

Scheduled System

- When a time-code arrives
- Any node that has a channel scheduled to communicate in that time-slot
- Can send a packet
- Or several short packets
- Or one packet and allow time for a retry

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Bandwidth Reserved System

- Sources measure average data rate sent over each channel
- Measured in each time-slot
- Averaged over 64 time-slots
- If there is one or more channels in a source waiting to send data
- Then one with lowest percentage
- Of it allocated bandwidth
- Is selected to for sending

Table 3-3 Channel bandwidth reservation			
Channel No.	Traffic	Resources	Reserved Bandwidth
1	Instrument 1 to memory	A, E/F	100%
2	Instrument 2 to memory	I, B, E/F	25%
3	Instrument 3 to memory	J, B, E/F	12.5%
4	Instrument 4 to processor for processing	K, B, G/H	12.5%
5	RTC sensor data to memory	C, E/F	12.5%
6	Processor to memory – processed data	E/F, g/h	12.5%
7	Memory to telemetry	e/f, d	100%
8	Processor commands to any other unit	E/F, g/h, a, b, c, i, j, k	12.5%
9	Telemetry commands to any other unit	D, E/F, G/H, g/h, a, b, c, i, j, k	12.5%

Scheduling and Bandwidth Reservation

- Almost two different ways of doing the same thing
- Over minor cycle they approximate achieve the same goal
- Providing controlled use of the network resource

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Operational Modes

- Spacecraft, instruments and other units
- Have different operational modes
- Each mode may have a different resource allocation table

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Retry and Redundancy

- Types of error
  - Header error (Header CRC)
  - Delivered to wrong destination (Destination Address)
  - Data error (Data CRC)
  - Missing packet (Sequence Number)
  - Duplicated packet (Sequence Number)
  - SpaceWire EEP

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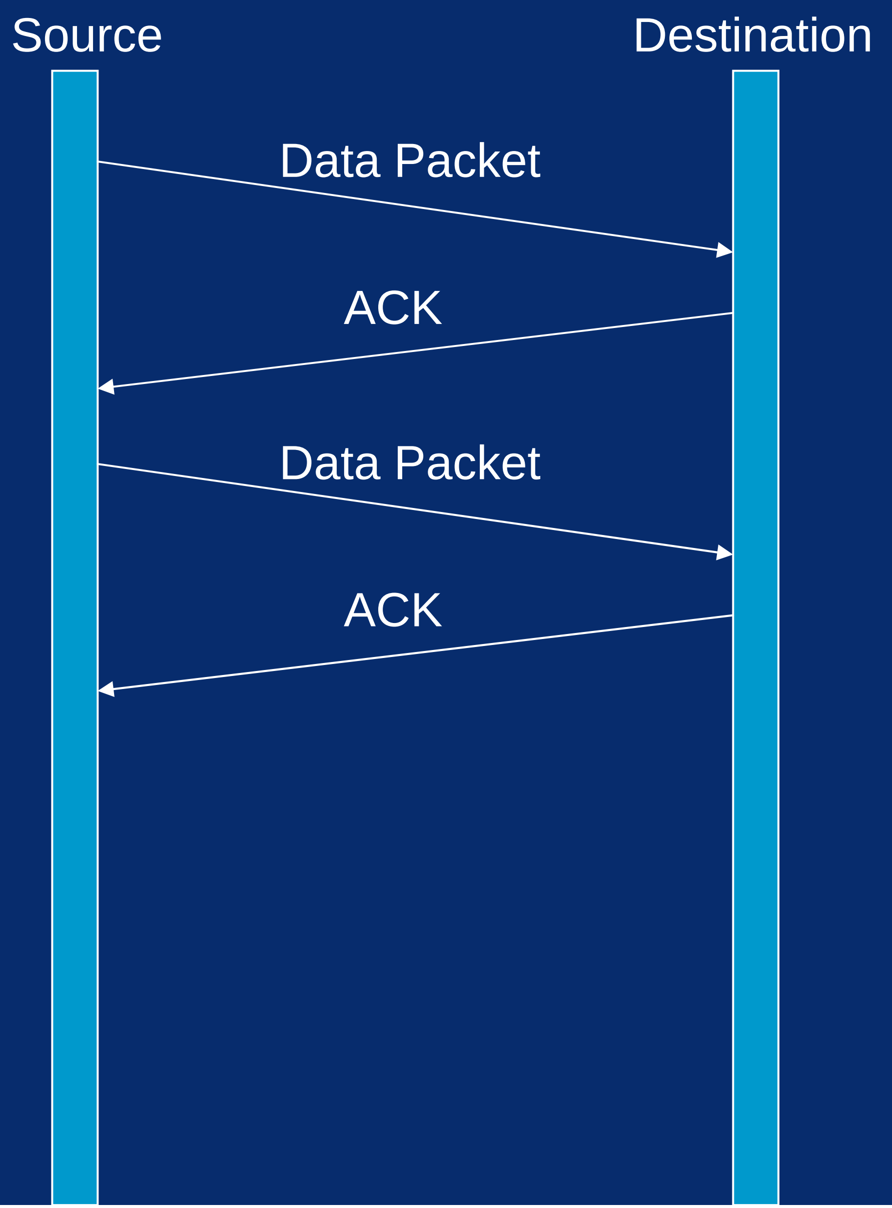
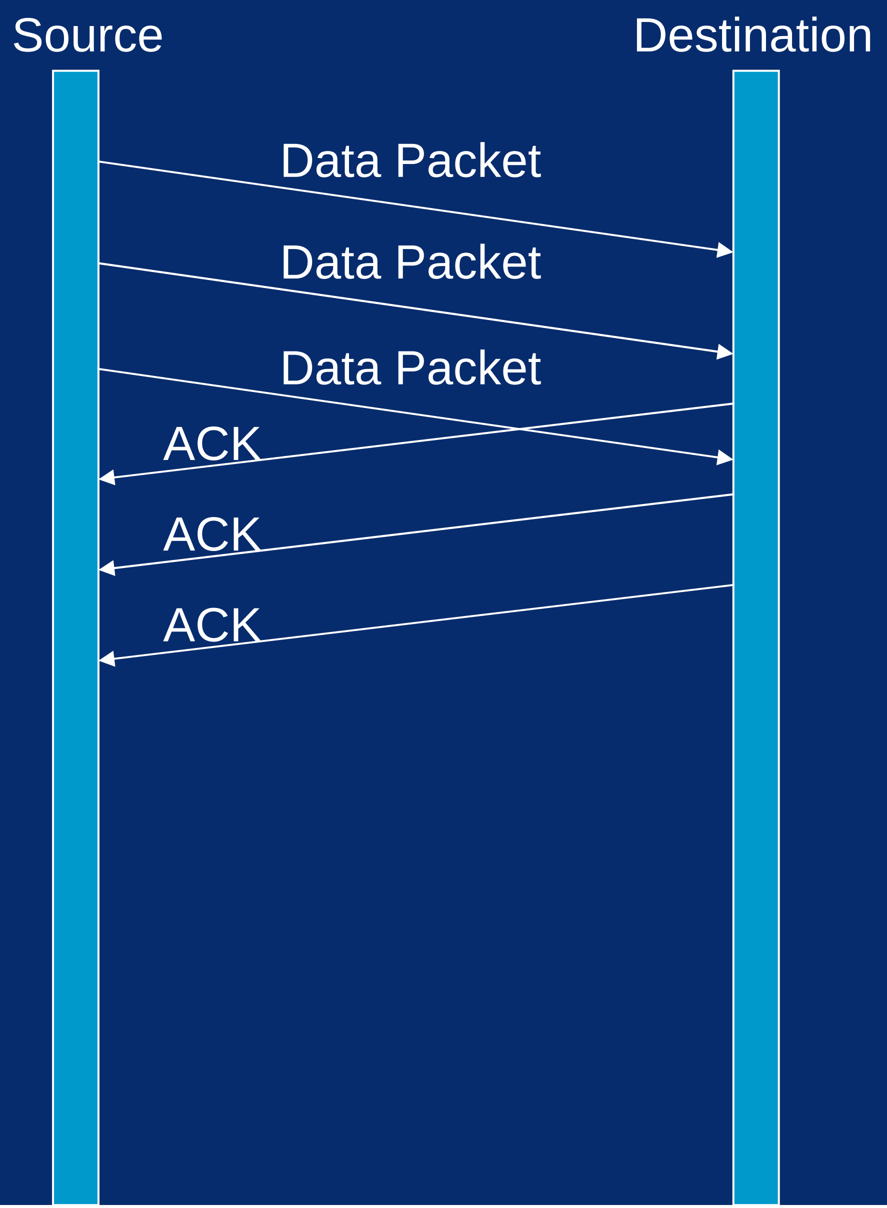
Retry and Redundancy

- Best Effort and Resource Reserved Services
  - No retry
  - Redundancy is managed
- Assured and Guaranteed Services
  - ACK each correctly received packet
  - NACK packets in error (where possible)
    - Allows immediate retry
  - Timeout in source when no ACK or NACK
    - Allows retry in the event of
    - Failure that cannot be NACKed
    - Lost ACK or NACK
  - Flow control provided by
    - Dropping packet
    - Sending NACK when ready

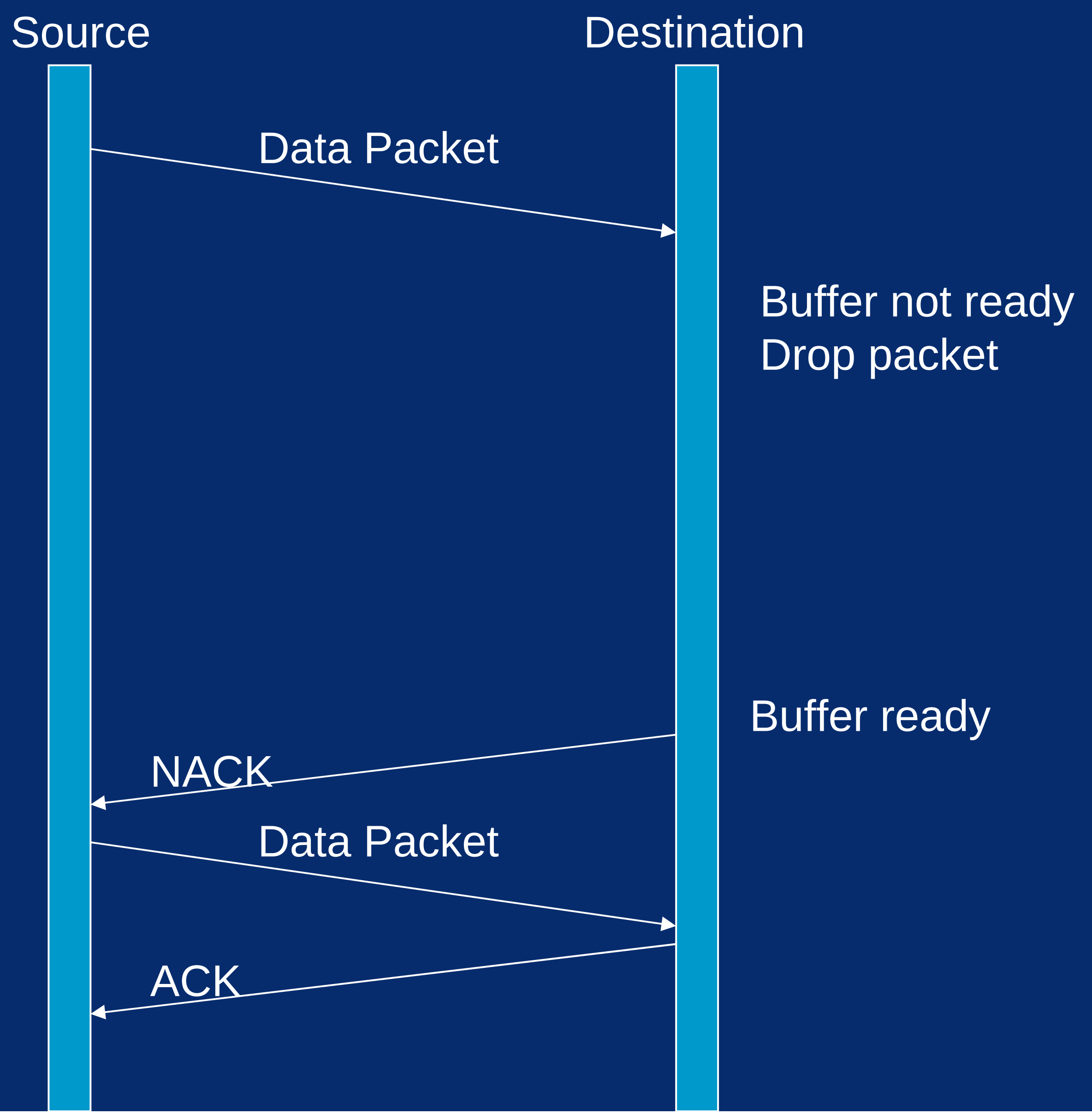
Normal Operation



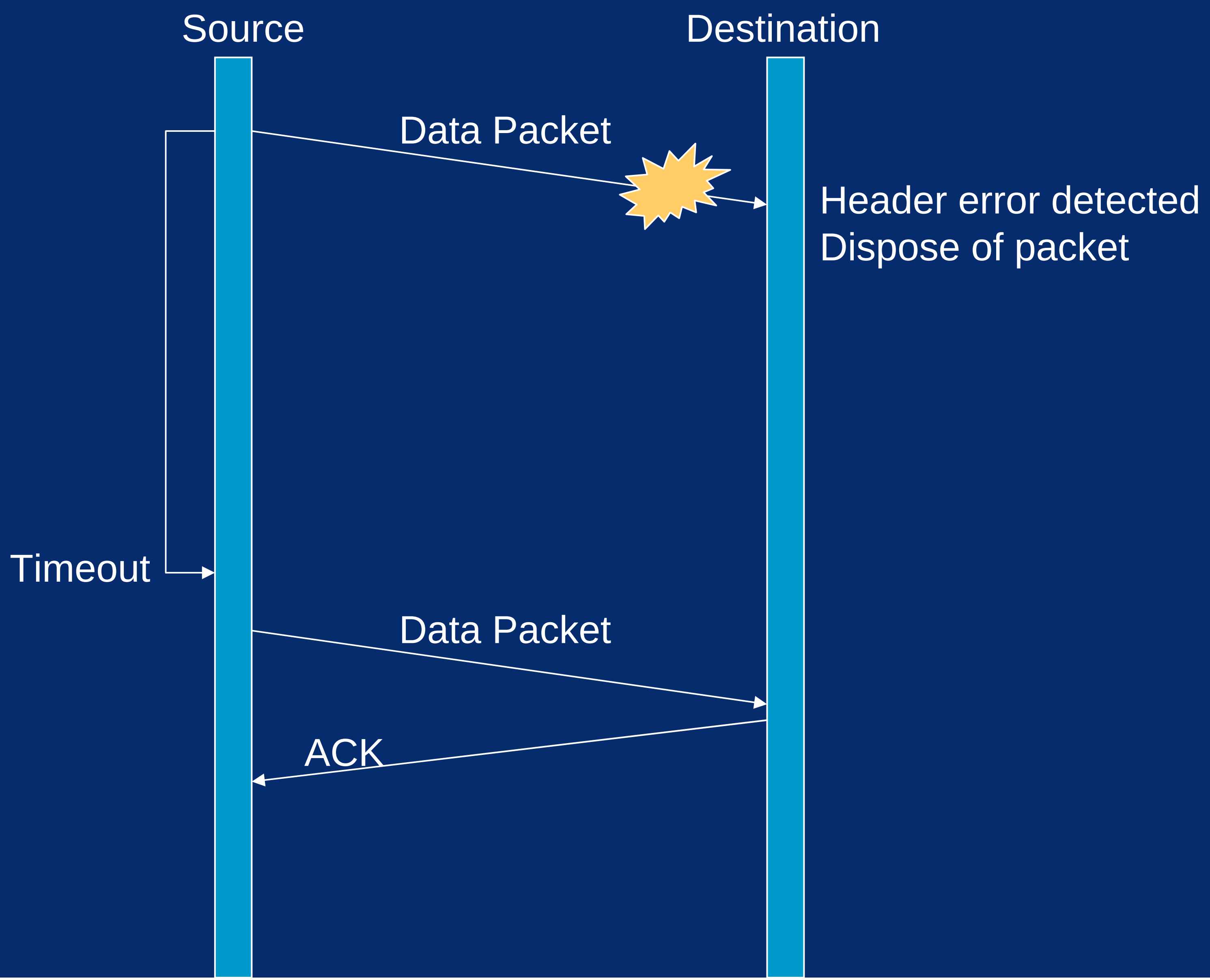
Multiple Outstanding Packets



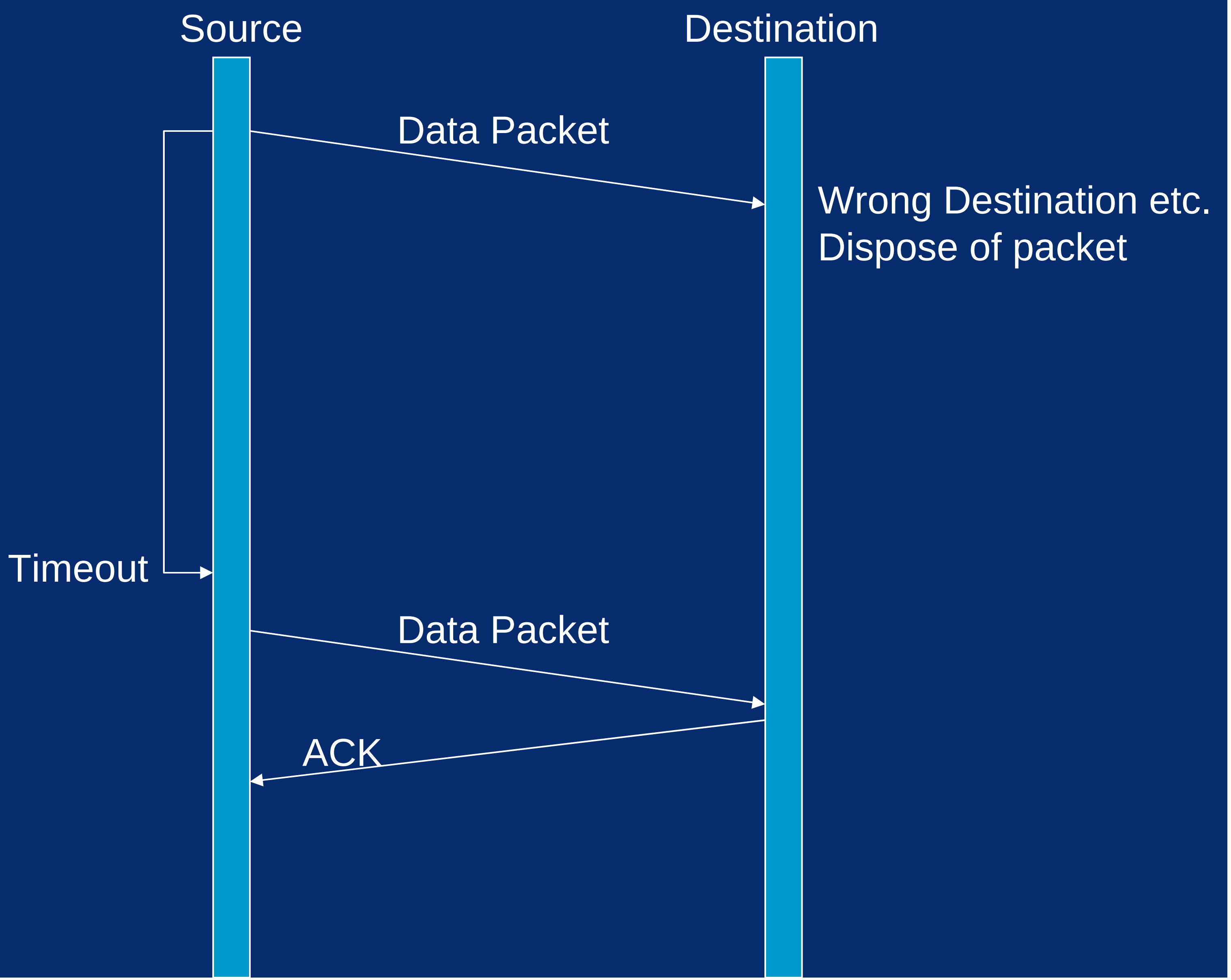
Flow Control by Dropping Packet



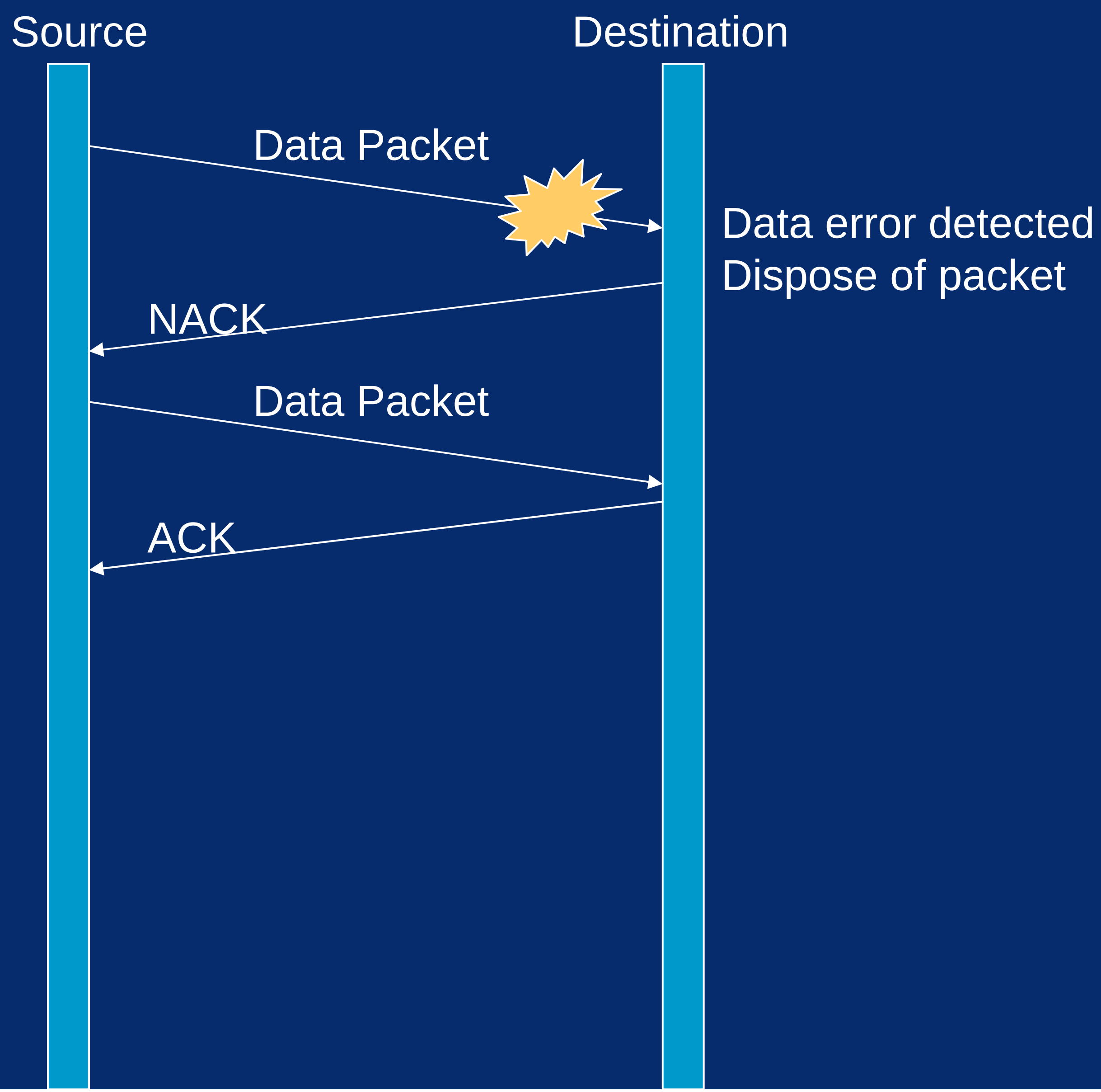
Header Error



Wrong Destination (etc)

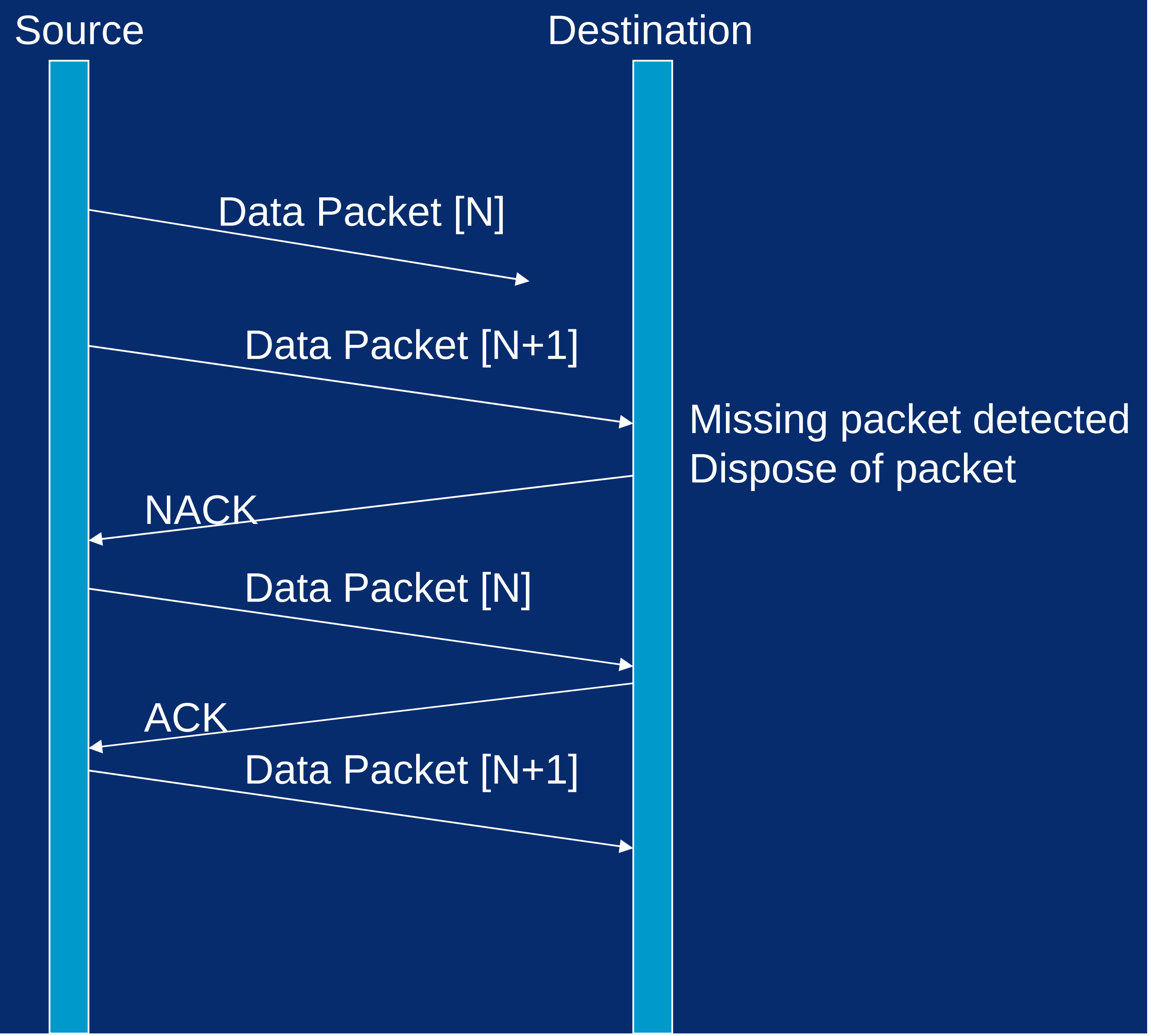


Data Error

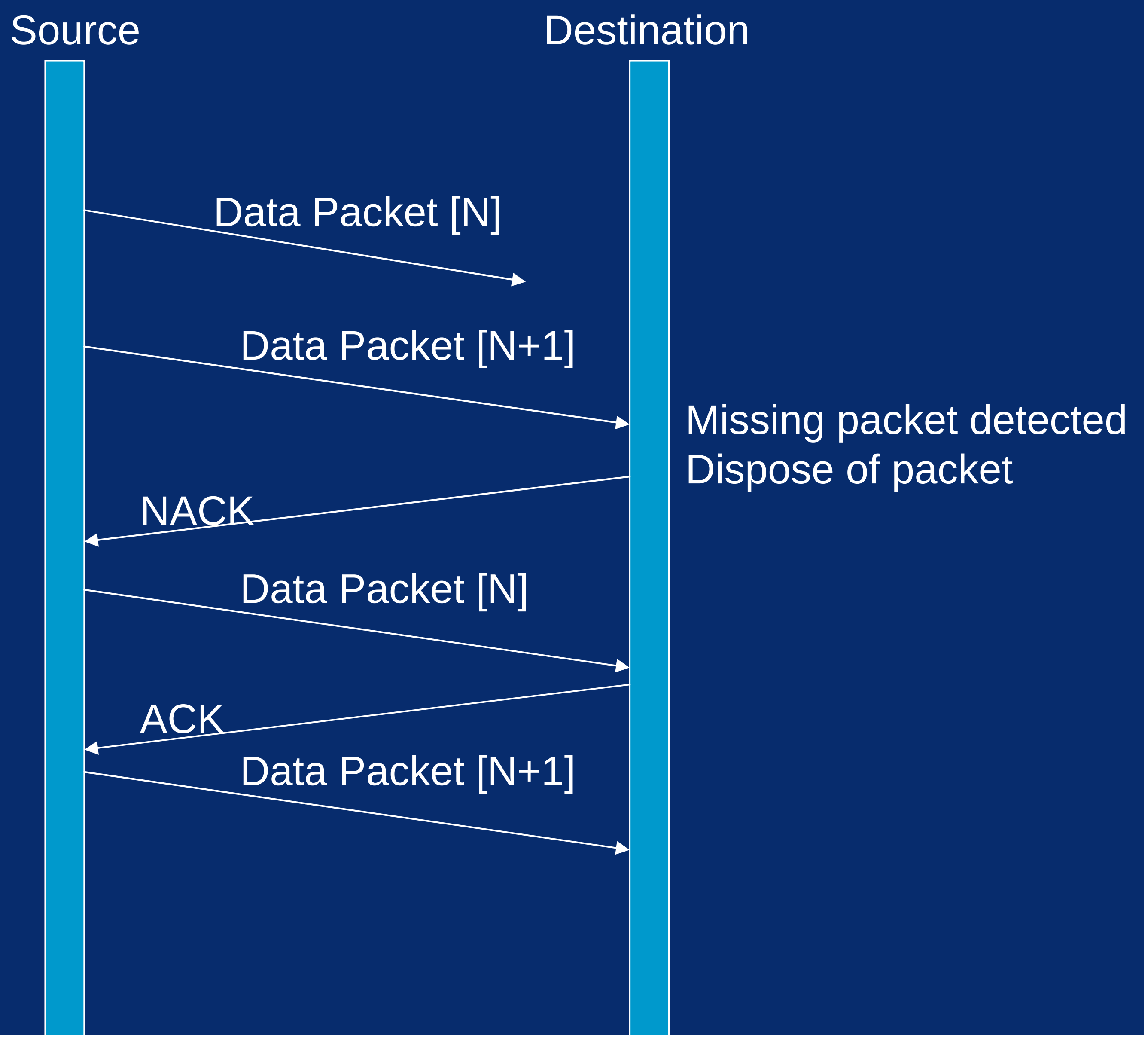


Source
Destination
Data Packet
Data error detected
Dispose of packet
NACK
Data Packet
ACK

Missing Packet Detected



Missing Packet



Retry

- For current outstanding packet with lowest sequence number
- Keep retry count
- If retry reaches prime limit raise error

Automated redundancy switching

- When automatic redundancy switching enabled
- If retry count reaches prime limit
  - Switch to redundant path
- If retry count reaches redundant limit
  - Stop sending
  - Inform network management

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Current status

- Draft red book
- To be reviewed by TCONS/OBL working group
- In June at next CCSDS meeting