STBee Serial Protocol

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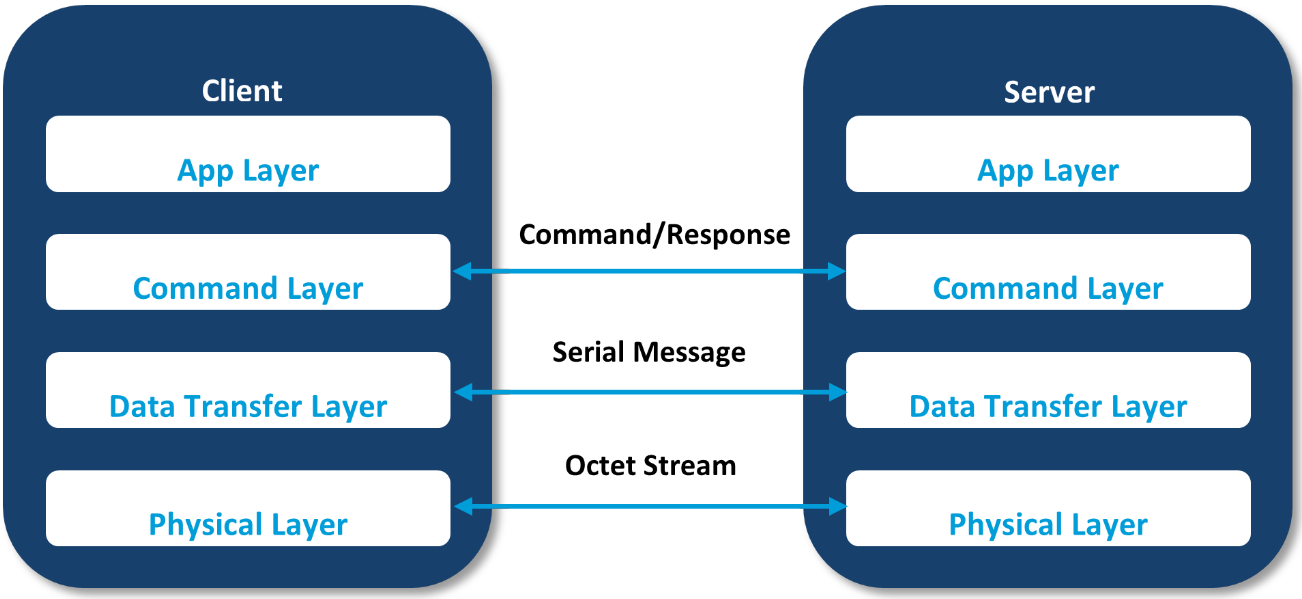
1. Introduction

1.1 Overview

This protocol depends on Command-Response-Acknowledgment (CRA) messages and is designed to handle multiple requests at same time.

CRA messages are binary encoded to reduce the overhead of using strings.

There are two types of messages: error-checked messages and non error checked messages introduced in DTL section.



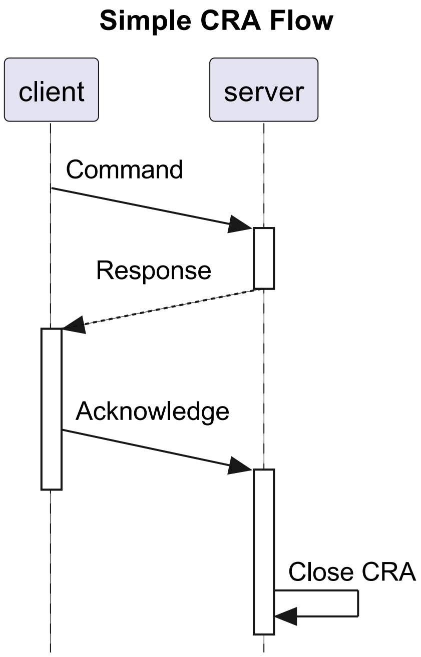
2. Command Layer Communication

2.1 CRA Frame

In this protocol standard there is three types of messages.

- Command Message: always sent from the client to request some action.
- Response Message: always sent from server after processing a request from client. Response is considered acknowledgment.

- Acknowledge Message: always sent from the client after processing to tell the server that response has arrived and processed correctly, so it can close the CRA call and discard response if needed.



2.2 Command Format

The following figure outlines the command format which is used for communication purposes.

Unique ID	Reserved	AF	DEV/NWK	Priority	Command	Payload
8 bits	4 bits	1 bit	1 bit	2 bits	8 bits	8 * n bits

2.2.1 Unique Identifier

This field contains a unique 8-bit integer used to identify each CRA session in order to allow handling multiple requests at same time and this allows handling up to 256 request at same time.

2.2.2 Reserved

This field contains 4-bits that are reserved for future uses and can be used as flags if needed.

2.2.3 Acknowledge Flag (AF)

This flag is used to distinguish between commands and acknowledge frames. It's set to zero if command and one otherwise.

2.2.4 Device or Network (DEV/NWK)

This flag is used to distinguish between device and network commands.
Zero for device commands and one otherwise.

2.2.5 Priority

Contains two bits to support four levels of priority. Server should handle higher priority commands before lower ones.

2.2.6 Command

This field contains 8 bits to support up to 256 commands for network and same for device.

2.2.7 Payload

This field contains any parameters sent by application layer and has maximum size of 300 bytes.

2.3 Response Format

The following figure outlines the response format which is used for communication purposes.

Unique ID	STATUS	RESPONSE
8 bits	8 bits	8 * n bits

2.3.1 Unique Identifier

This field contains a unique 8-bit integer used to identify each CRA session in order to allow handling multiple requests at same time and this allows handling up to 256 request at same time.

It's generated by client.

2.3.2 Status

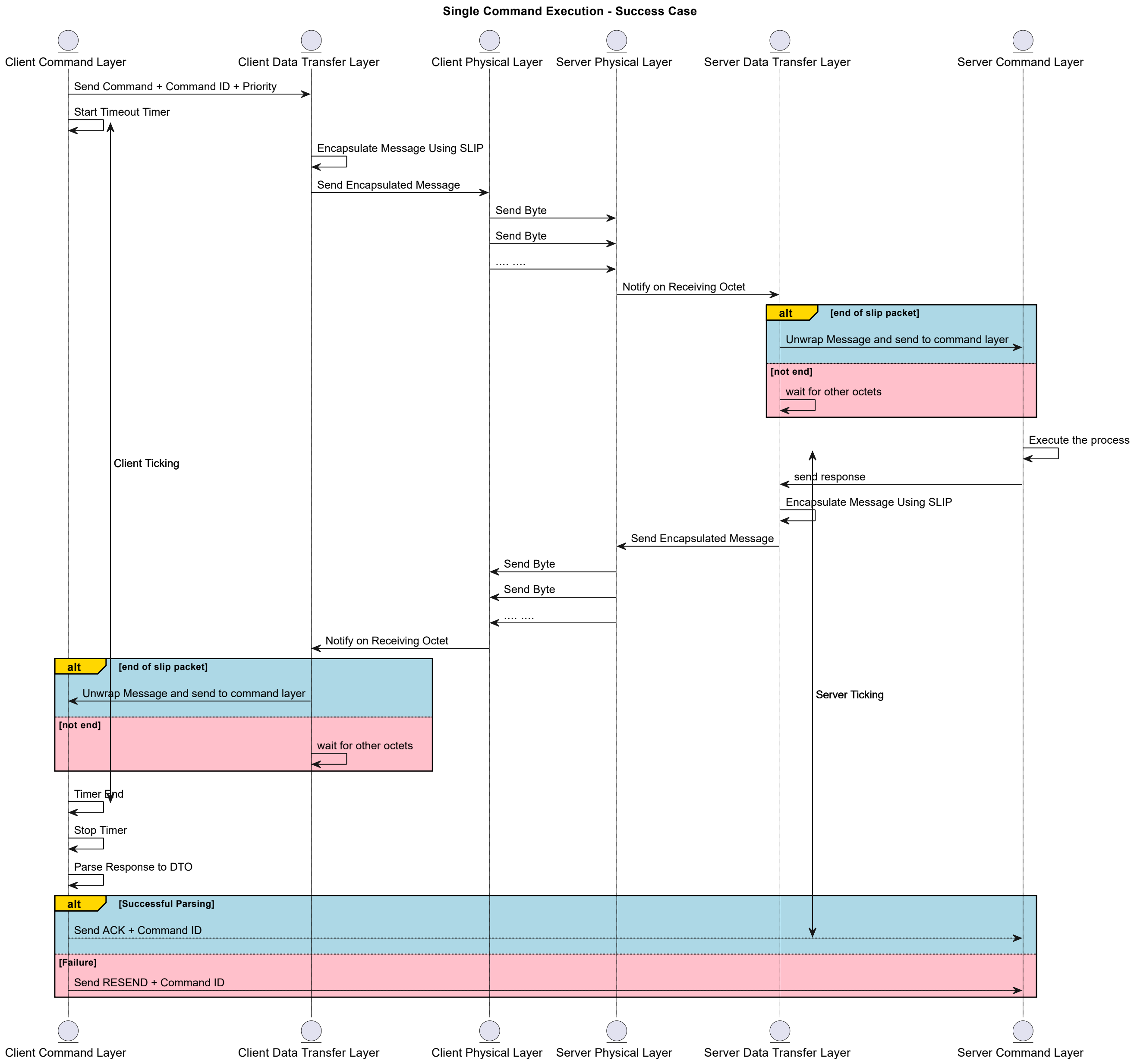
This field contains the status of response to support easy debugging and error handling.

2.3.3 Response

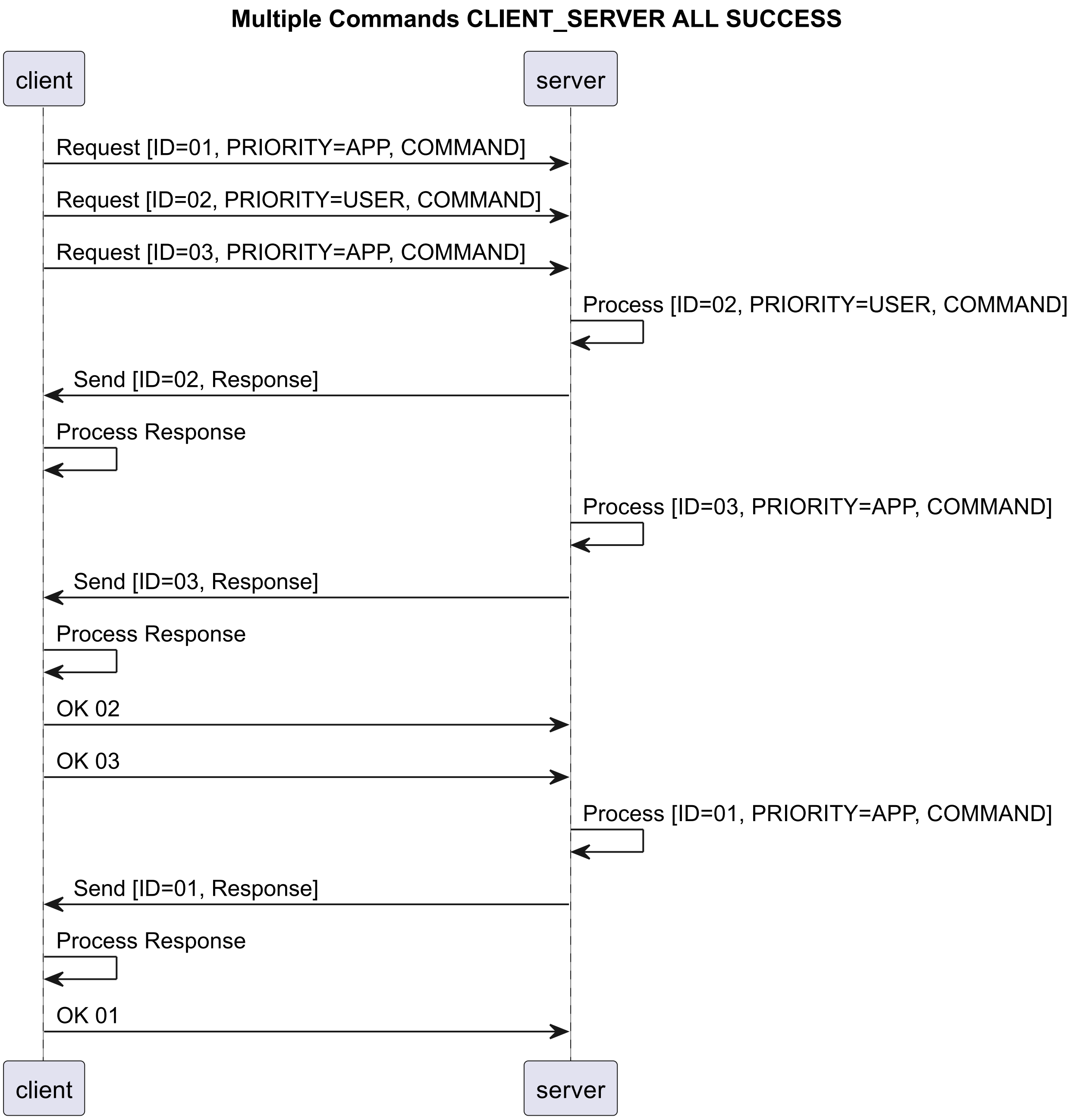
This field contains the response to the command sent.

2.4 Diagrams

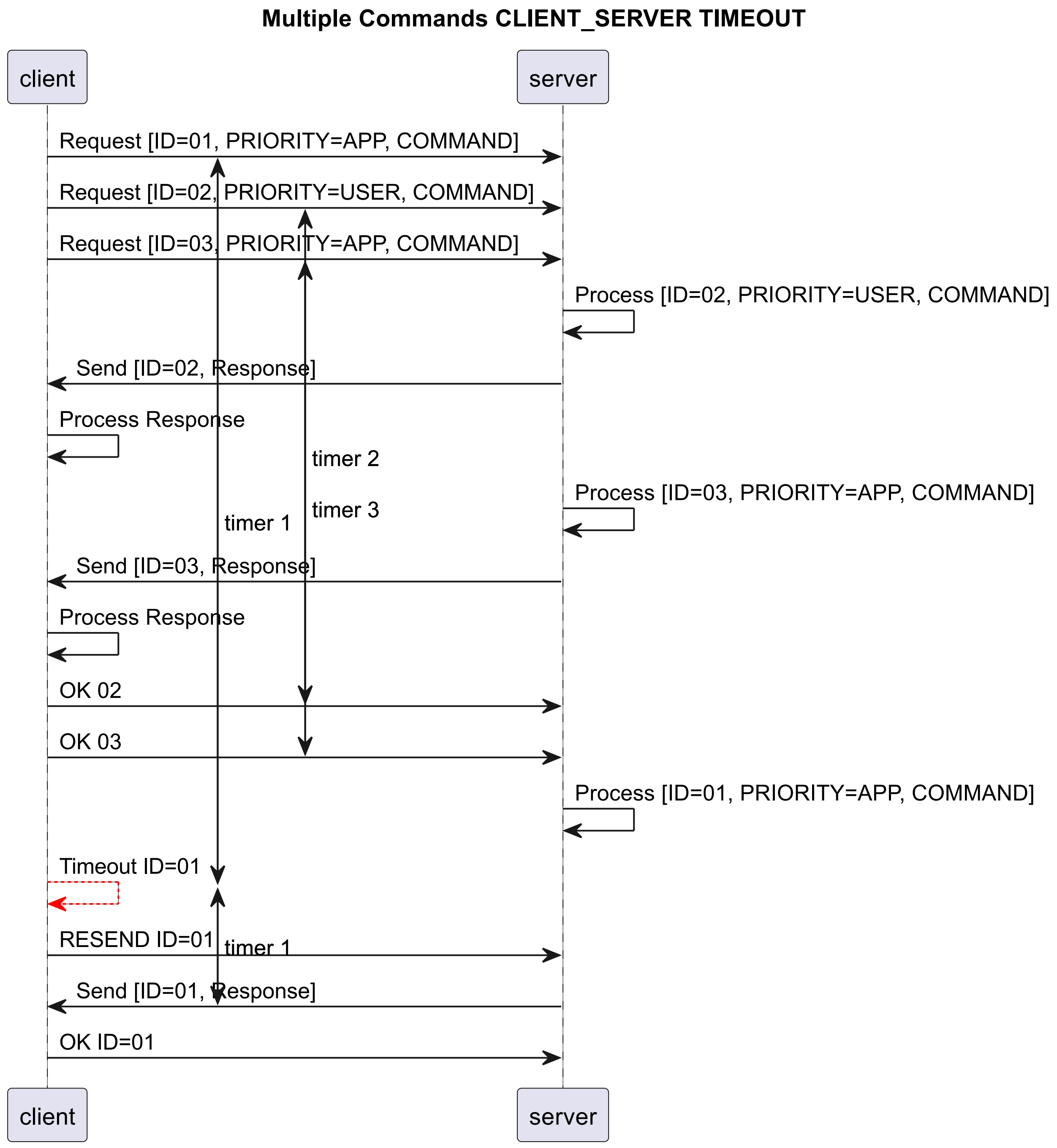
2.4.1 Layered diagram



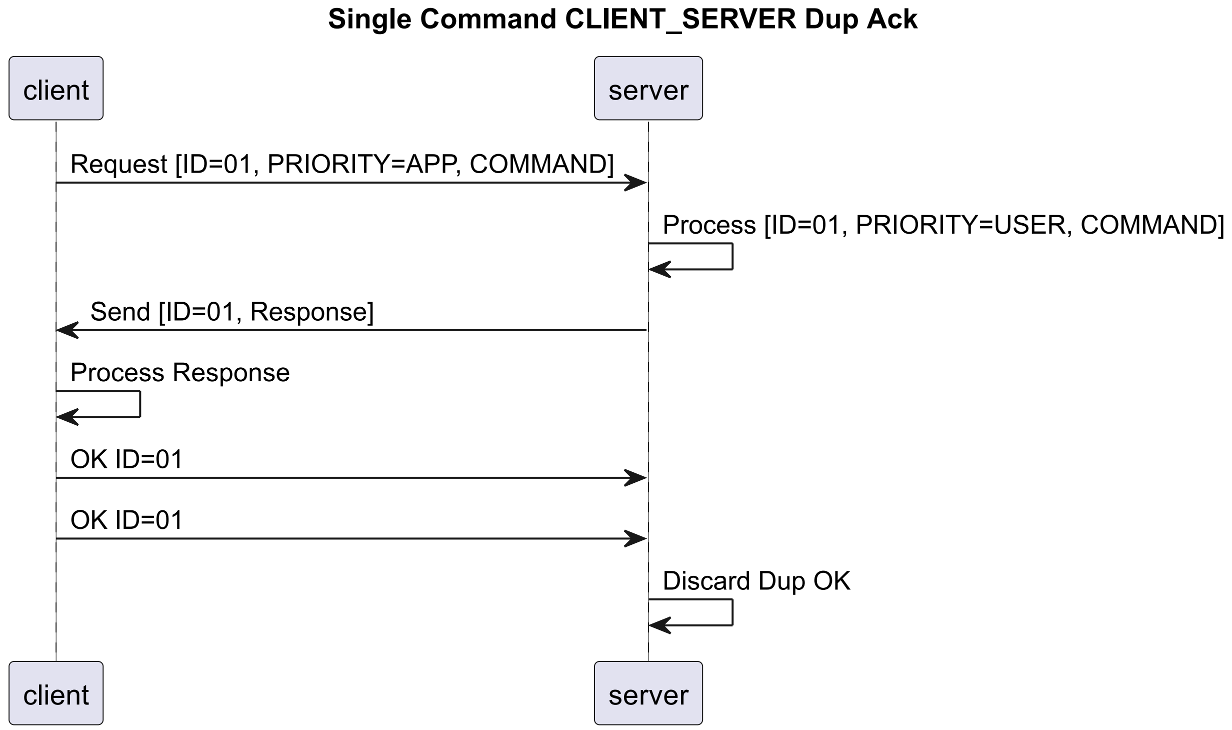
2.4.2 Multiple Requests All Success Case


Multiple Commands CLIENT_SERVER ALL SUCCESS
client
server
Request [ID=01, PRIORITY=APP, COMMAND]
Request [ID=02, PRIORITY=USER, COMMAND]
Request [ID=03, PRIORITY=APP, COMMAND]
Process [ID=02, PRIORITY=USER, COMMAND]
Send [ID=02, Response]
Process Response
Process [ID=03, PRIORITY=APP, COMMAND]
Send [ID=03, Response]
Process Response
OK 02
OK 03
Process [ID=01, PRIORITY=APP, COMMAND]
Send [ID=01, Response]
Process Response
OK 01
client
server

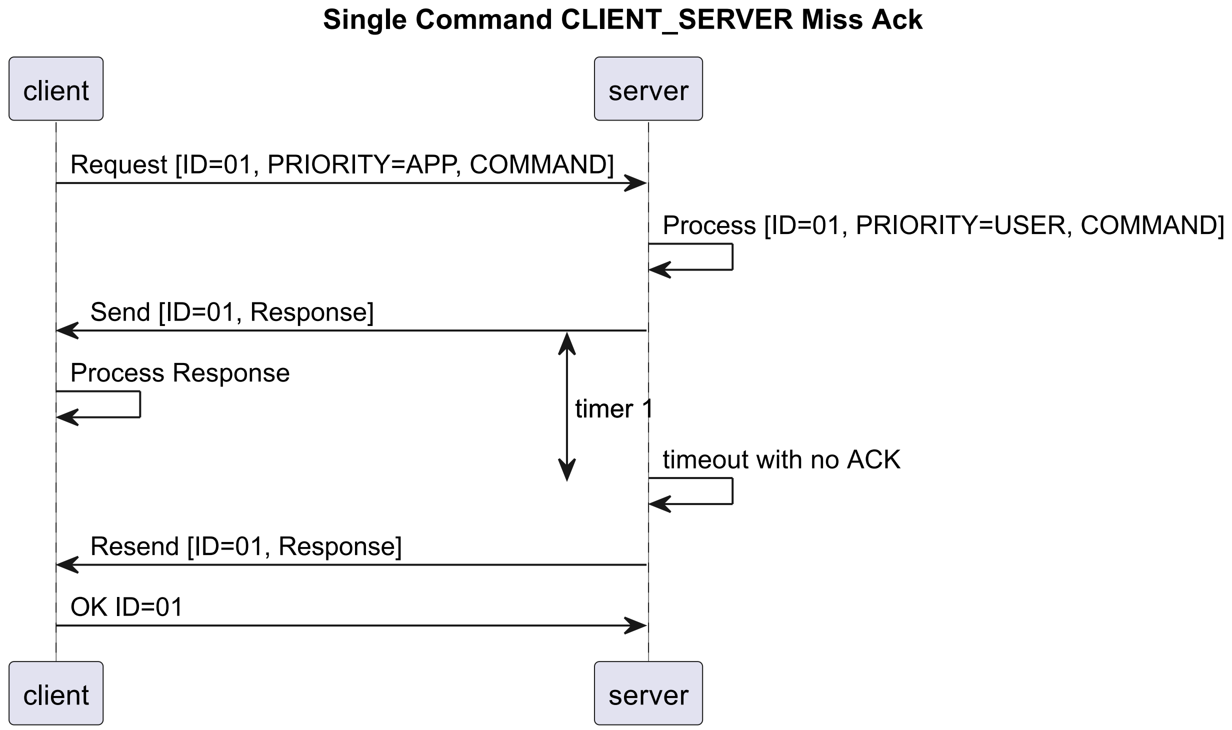
2.4.3 Multiple Requests Timeout Case


Multiple Commands CLIENT_SERVER TIMEOUT
client
server
Request [ID=01, PRIORITY=APP, COMMAND]
Request [ID=02, PRIORITY=USER, COMMAND]
Request [ID=03, PRIORITY=APP, COMMAND]
Process [ID=02, PRIORITY=USER, COMMAND]
Send [ID=02, Response]
Process Response
timer 2
timer 3
Process [ID=03, PRIORITY=APP, COMMAND]
timer 1
Send [ID=03, Response]
Process Response
OK 02
OK 03
Process [ID=01, PRIORITY=APP, COMMAND]
Timeout ID=01
RESEND ID=01
timer 1
Send [ID=01, Response]
OK ID=01
client
server

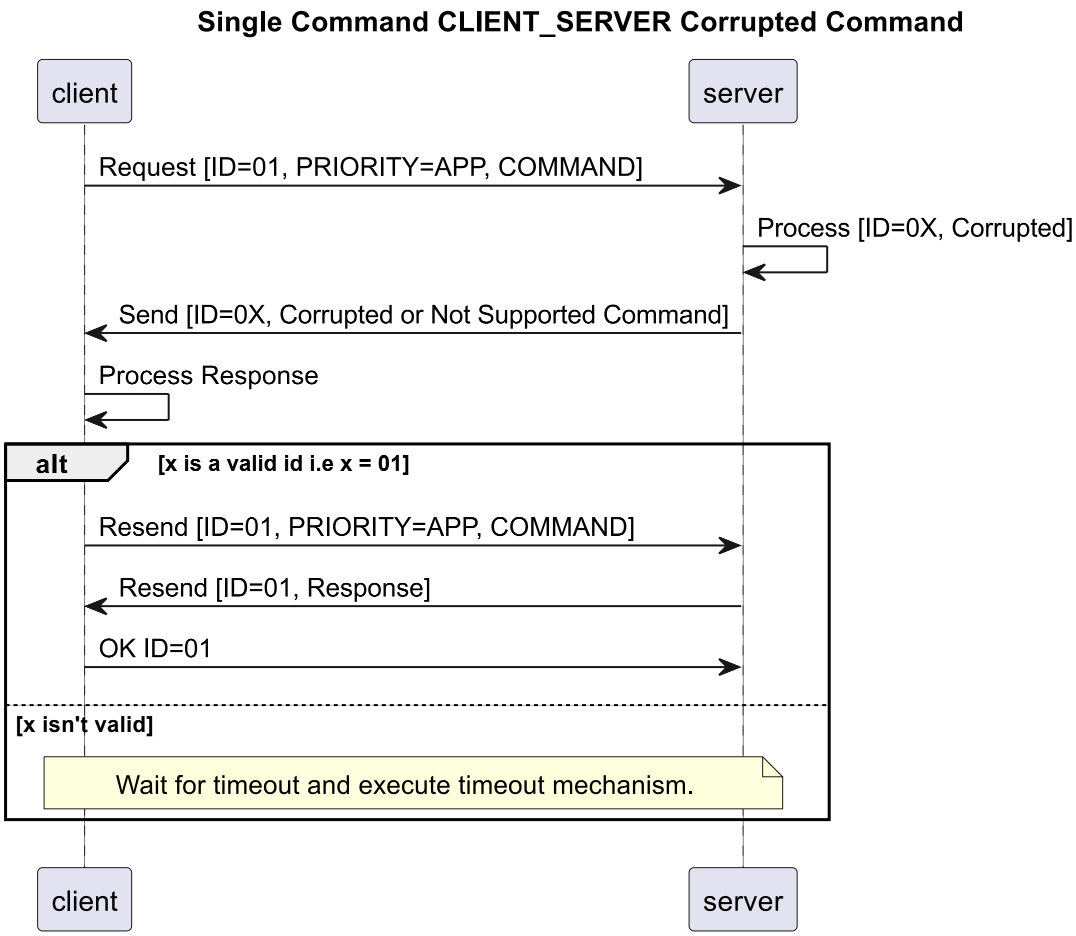
2.4.4 Single Command Duplicate ACK


Single Command CLIENT_SERVER Dup Ack
client
server
Request [ID=01, PRIORITY=APP, COMMAND]
Process [ID=01, PRIORITY=USER, COMMAND]
Send [ID=01, Response]
Process Response
OK ID=01
OK ID=01
Discard Dup OK
client
server

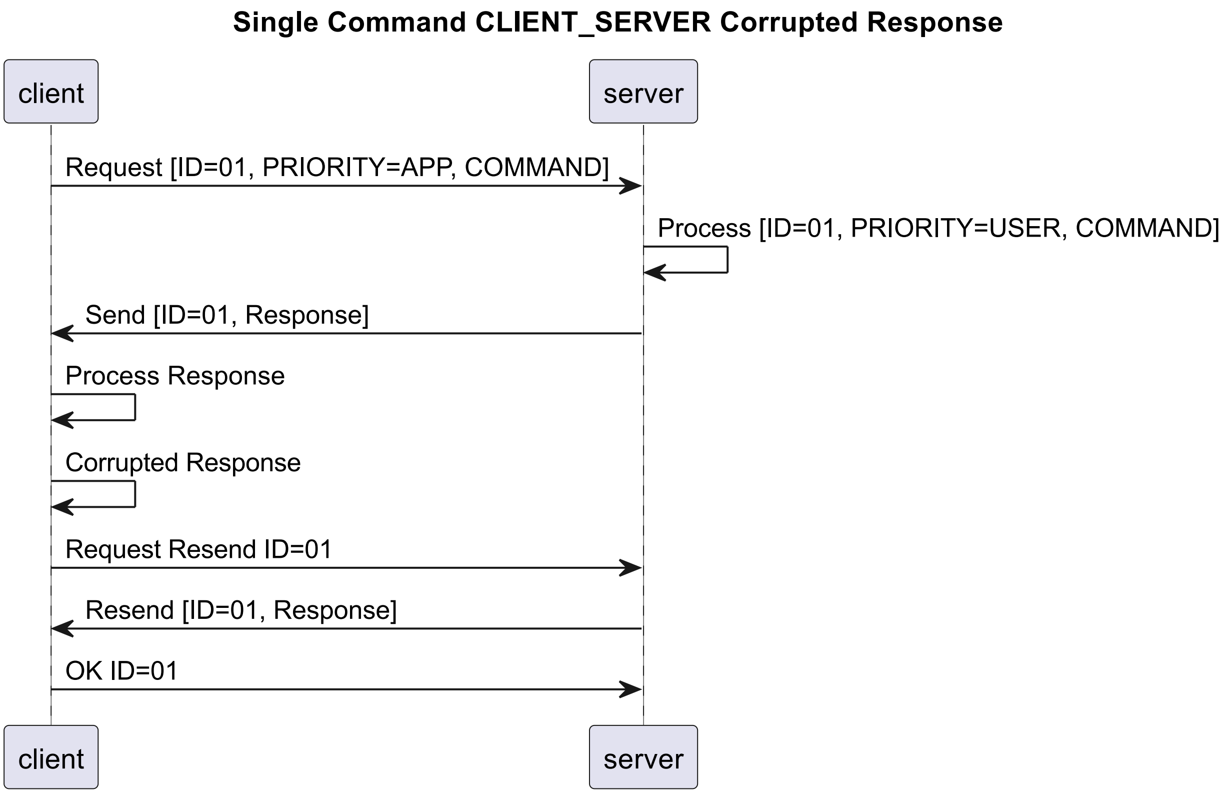
2.4.5 Single Command ACK MISS



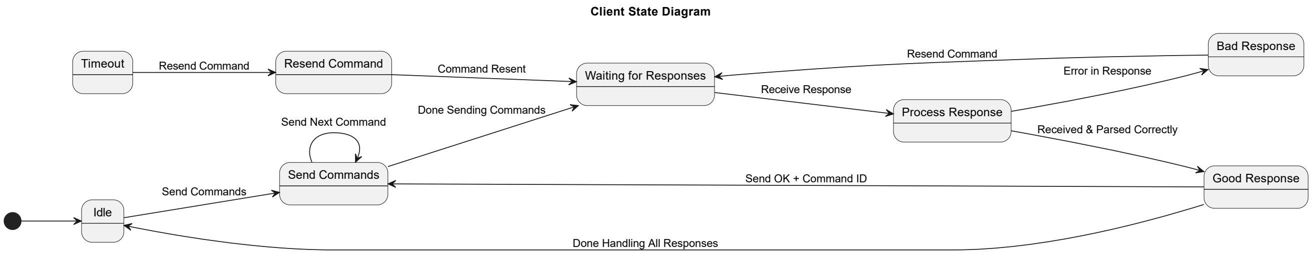
2.4.6 Single Corrupted Command


Single Command CLIENT_SERVER Corrupted Command
client
server
Request [ID=01, PRIORITY=APP, COMMAND]
Process [ID=0X, Corrupted]
Send [ID=0X, Corrupted or Not Supported Command]
Process Response
alt
[x is a valid id i.e x = 01]
Resend [ID=01, PRIORITY=APP, COMMAND]
Resend [ID=01, Response]
OK ID=01
[x isn't valid]
Wait for timeout and execute timeout mechanism.
client
server

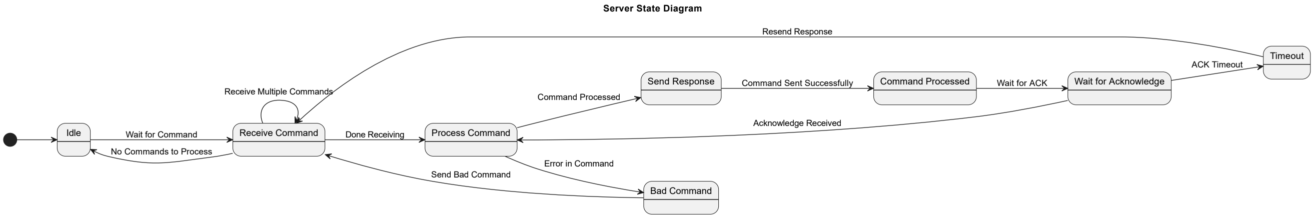
2.4.7 Single Command Corrupted Response



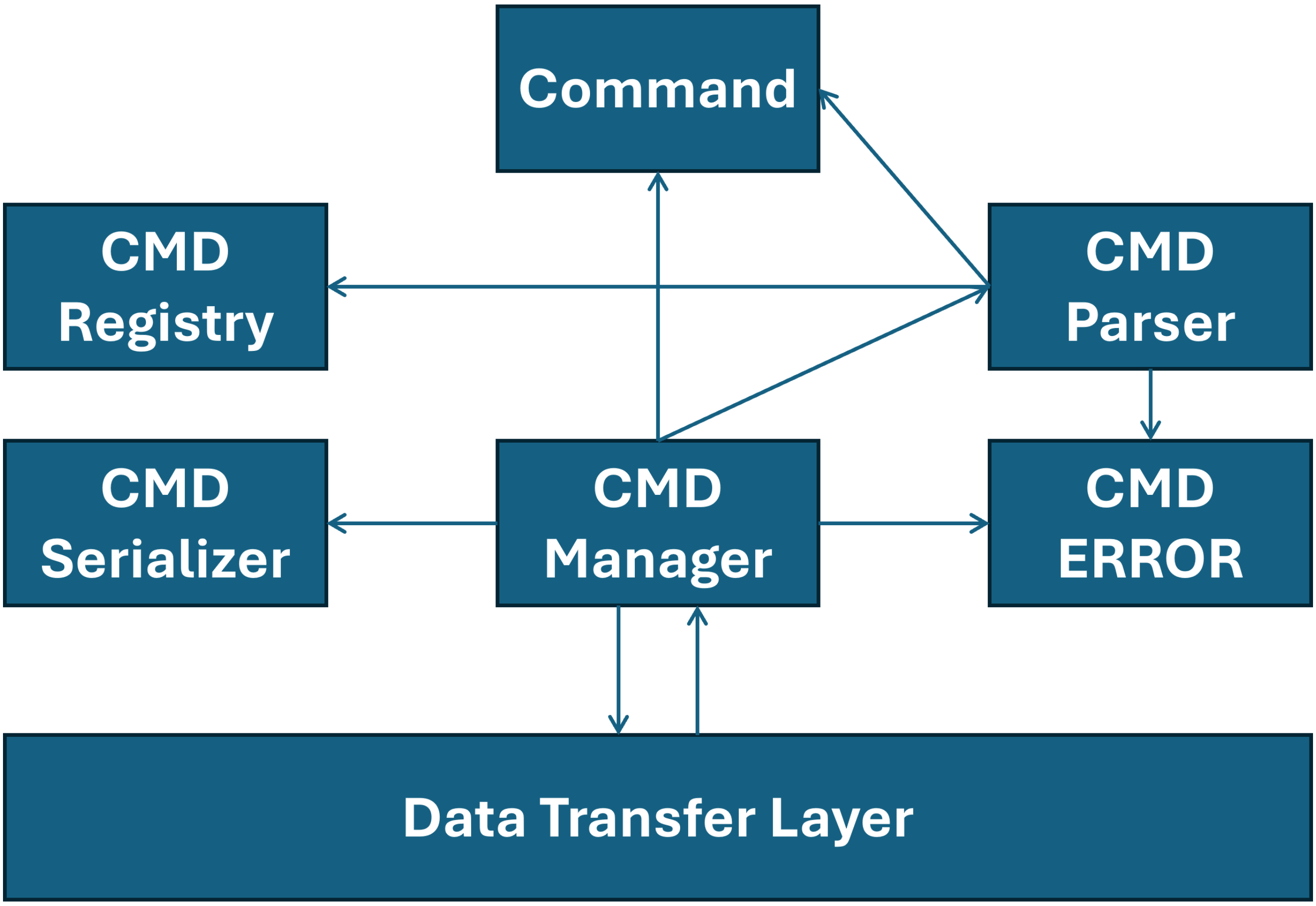
2.4.8 Client State Diagram



2.4.9 Server State Diagram



2.5 Entities



3. Data Transfer Layer (DTL)

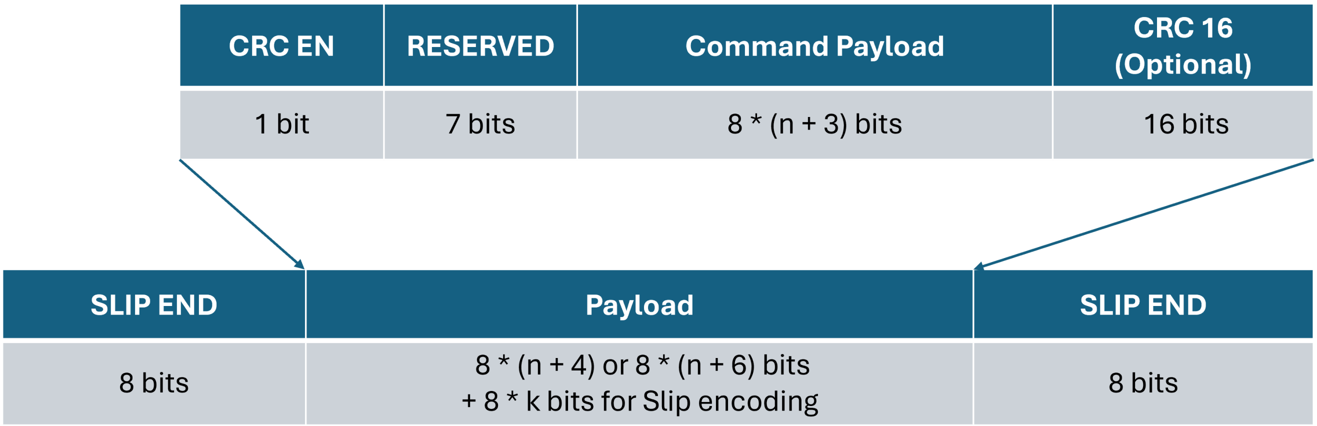
This layer provides two ways of sending messages: error-checked messages and non error checked messages.

In error-checked messages 16-bits FCS are added as footer.
On error found the error is reported to upper layer to be handled.

Slip encoding is performed as a last stage to wrap the packet and determine its length.

3.1 DTL Packet Format

The following figure outlines the dtl packet format.



CRC EN	RESERVED	Command Payload	CRC 16 (Optional)
1 bit	7 bits	8 * (n + 3) bits	16 bits

SLIP END	Payload	SLIP END
8 bits	8 * (n + 4) or 8 * (n + 6) bits + 8 * k bits for Slip encoding	8 bits

3.1.1 CRC Enable (CRC EN)

On set to one then a 16-bit CRC is generated and attached to the packet footer, otherwise no CRC is generated.

3.1.2 Reserved

7 bits reserved for future use.

3.1.3 Payload

Contains the payload of the upper layer.

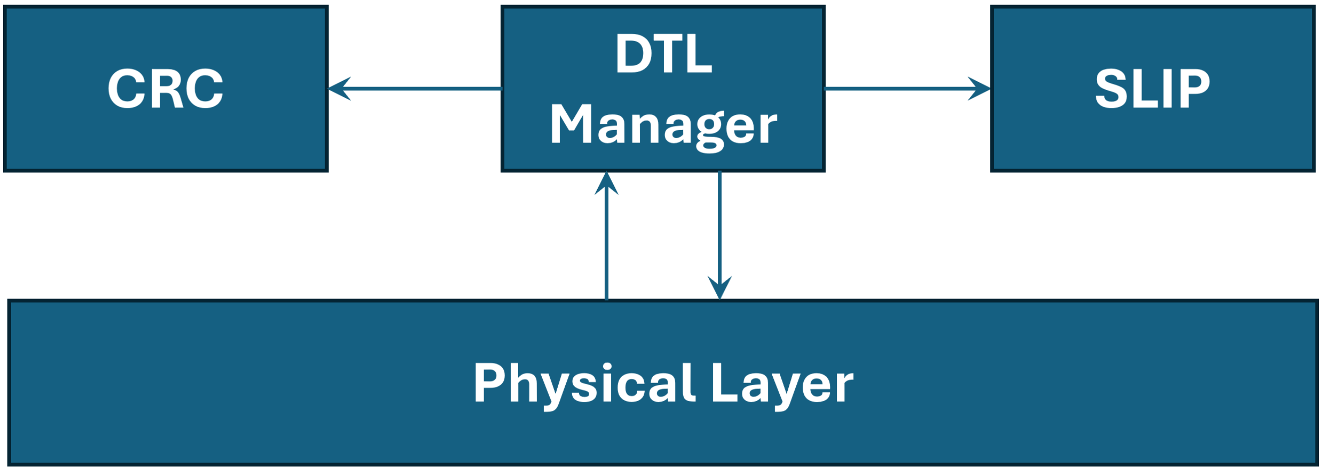
3.1.4 CRC 16

Optional 16-bits for CRC calculation.

3.1.5 SLIP Wrapper

This is used to wrap the packet before sending it to physical layer, this is important to determine the begin and end of the packet.

3.2 Entities



4. Physical Layer

This layer is responsible for sending packets over the physical wire using UART communication protocol.

Specifications:

- Baud Rate: 115200 bps
- One Stop Bit
- No Parity
- Data Bits: 8 bits
- Flow Control: RTS/CTS (if board doesn't support then use XON/XOFF)

5. Services

5.1 Network Services

5.1.1 Network Capture

This command should force the server to hold a capture of nodes and links.

Command Message

Field	**Content**	**Description**
AF	COMMAND_FRAME	Set frame as command frame
Command	NWK_CAPTURE	Network Capture Request

Response Message

Field	**Content**	**Description**
Status	Status byte	see appendix
Response[0]	Capture Status	0x00: START Capture Else this indicates a problem

5.1.2 Node Discovery

This command is used to discover a new node in the captured network, if all nodes are discovered then it returns `END_OF_CAPTURED_NODES`.

Command Message

Field	Content	Description
AF	COMMAND_FRAME	Set frame as command frame
Command	NWK_DISCOVER	Network Discovery Request

Response Message

Field	Content	Description
Status	Status byte	see appendix
Response[0..1]	Network Address of Node or `END_OF_CAPTURED_NODES`	16-bit integer
Response[2..11]	MAC Address of Node	64-bit integer
Response[12]	Logical Type of Node	0x00: Coordinator 0x01: Router 0x02: End Device
Response[13..14]	Parent Network Address of Node	16-bit integer

5.1.3 Link Query

Command Message

Field	Content	Description
AF	COMMAND_FRAME	Set frame as command frame
Command	LINK_DISCOVER	Link Discovery Request

Response Message

Field	Content	Description
Status	Status byte	see appendix
Response[0..1]	Network Address of First Node or `END_OF_CAPTURED_LINKS`	16-bit integer
Response[2..3]	Network Address of Second Node	16-bit integer
Response[4]	Income Cost of Link	Ranges from 0 to 7
Response[5]	Outcome Cost of Link	Ranges from 0 to 7

6. Appendix

ACK FRAME

Field	Content	Description
AF	ACK_FLAG_ON	Set to 1
Command	ACK_FRAME_ACTION	The action that should be done after receiving the ACK frame

STATUS Byte

Name	Value	Description
STATUS_OK	0x00	Successful Operation
STATUS_ERROR	0x01	Operation Error
STATUS_CMD_NOT_SUPPORTED	0x02	Operation Not Supported
STATUS_WRONG_PARAMETER	0x03	Invalid Parameter
STATUS_TIMEOUT	0x04	Operation Timeout