Slovak University of Technology in Bratislava

Faculty of Informatics and Information Technologies

Computer and Communication Networks

Communication application using the UDP protocol

Sync ‘n’ Send Spectacle (SNSS)

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Exercise

A task was given to create a custom protocol and an application that works with this protocol. The protocol itself must be designed to work without interruption in an interfering environment.

So after a time, blood and sweat, a protocol emerged:

Sync 'n' Send Spectacle (SNSS)

- As a protocol for exchanging messages and files.
- Customisable, according to network needs and its maximum capabilities.
  - By setting `paload_size` and `window_size`.
- Based on UDP.
- Might be useful as a kind of torrent protocol.
  - Because of the way it works, it is possible to receive several files (parts of file) in parallel.
  - And set from which part to start receiving.

Sync 'n' Send Spectacle (SNSS)

ARQ Method

No off-the-shelf ARQ method was used for this. It was created on the basis of the best qualities of others.

Data (message) sending

- Sender sends an `N` packets and waits for an `ACK`.
  - If `ACK` is not received, it resends the same N packets.
  - Parallely If `NACK` is received, it resends the missing packet (only with `NACK`'s `seq_number`).
- The Receiver receives `N` packets and sends an `ACK`.
  - If the packet is corrupted, it sends a `NACK`.

Requesting / Keep-alive

Used a simple request-response principle.

Header Structure

The header structure itself will not be absolute and will be modified with respect to the type of segment being forwarded.

REQ (0x011)	Checksum	Window size	Payload size	Filename
3 bits	18 bits	8 bits	11 bits	...

- Sender sends when it wants to send a file.
- The filename is stored at the end (and by dots there's mean that there no fixed length for that field).

REQ_M (0x010)	Checksum	Window size	Payload size
3 bits	18 bits	8 bits	11 bits

- Sender sends when it wants to send a message.

Data (0x000)	Checksum	SEQ Number	Data
3 bits	21 bits	32 bits	...

- Chunk of message (file)

APR (0x100)	Checksum	SEQ Number
3 bits	21 bits	32 bits

- Acknowledge the received window.
- And as sender understands which window to send next.

NACK (0x101)	Checksum	SEQ Number
3 bits	21 bits	32 bits

- Negative acknowledge the received packet.

KEEP-A (0x110)
3 bits

- If one endpoint sends it to another - another must answer with the same packet to confirm that another endpoint is alive and ready for sending the packet.

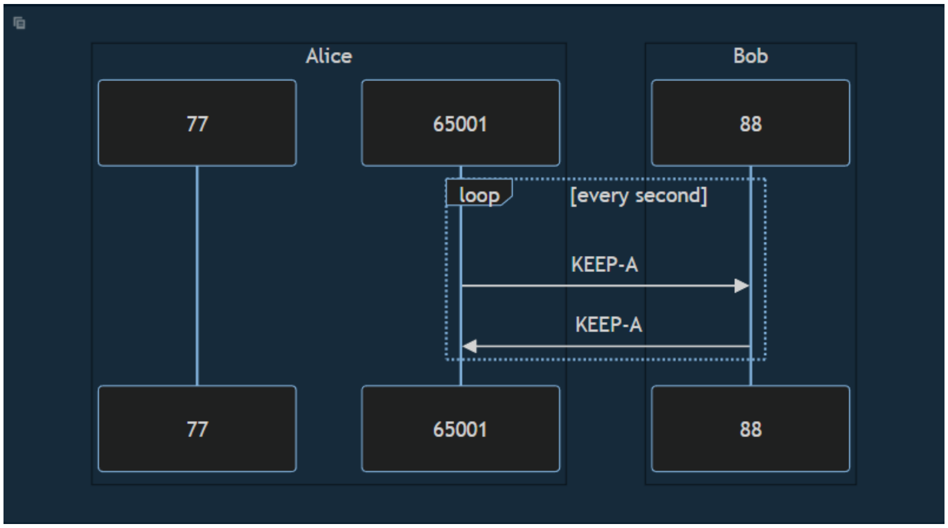
- **SEQ Number**
  - Used to mark segment with unique identification.
  - *32 bits -> 2^32 = 4,294,967,296 segments to send. 1472 - (21+32+3) = 1465. 4,294,967,296 * 1465 ~* ***6.25 GB is maximum****.*

- **Checksum**
  - Checksum field is used to avoid any bit errors.
  - *In ACK and NACK segments used bigger value to handle any error due to simultaneously sending chunks.*
  - *Will be used “Internet Checksum”: Calculating the Checksum, with a taste*.
  -
    ```
    def compute_checksum(bits_length, *data):
    checksum = sum(data)

    while checksum.bit_length() > bits_length:
      # Split the checksum into two halves
      mask = (1 << (checksum.bit_length() // 2)) - 1
      low_bits = checksum & mask
      high_bits = checksum >> (checksum.bit_length() // 2)

      checksum = low_bits + high_bits

    return checksum
    ```
- **Window size**
  - How many packets to send at once before send an acknowledgement.
- **Payload size**
  - How many bytes of data are sent in one packet.

Protocol journey

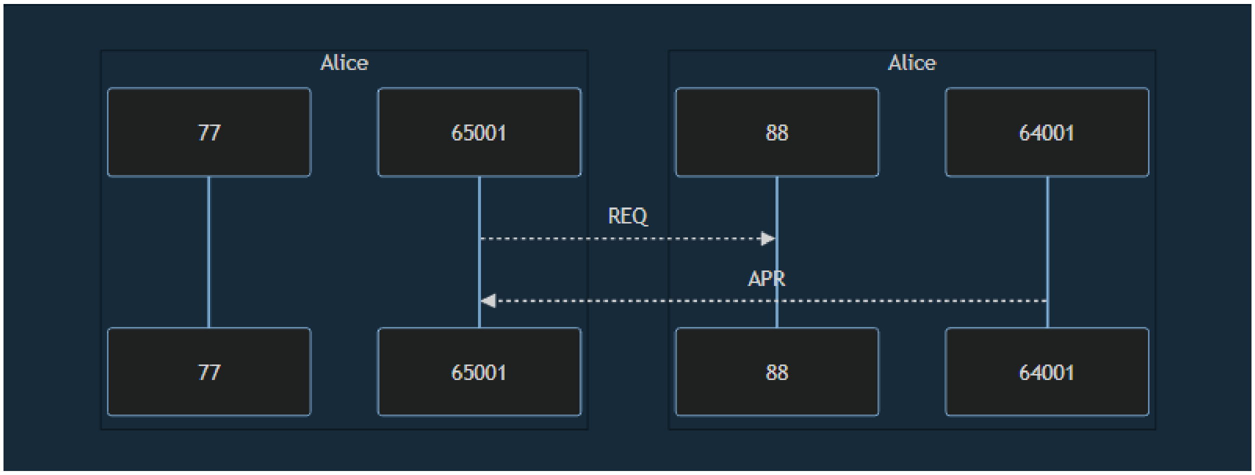
Keep-alive

Exchanging of KEEP-A packets is used to keep the connection alive in active (open) session.



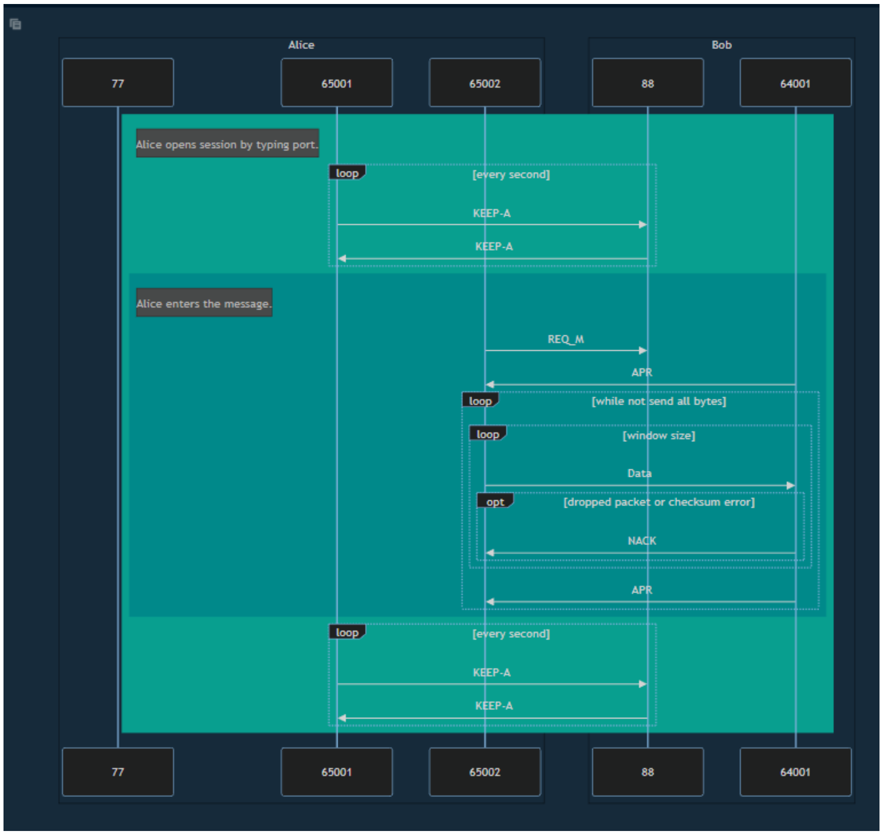
“(Two) Three-way handshake”

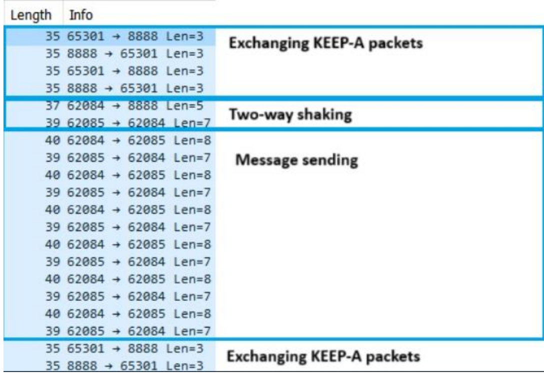
When connection is established, the sender sends a `REQ` to request sending the message or file.



Sending a message

1. Alice enters the `ip:port` of Bob.
   - *Session is opened*.
     - Exchanging of `KEEP-A` packets is started.
2. Alice enters the message.
   - *Sender request to send message (file)*.
     - Exchanging of `KEEP-A` packets is stopped.
   - *Receiver confirms that it is ready to receive the message (file)*.
3. *Message sent and received*.
   - Exchanging of `KEEP-A` packets is started again.





```
Length  Info
    35 65301 → 8888 Len=3       Exchanging KEEP-A packets
    35 8888 → 65301 Len=3
    35 65301 → 8888 Len=3
    35 8888 → 65301 Len=3
    37 62084 → 8888 Len=5       Two-way shaking
    39 62085 → 62084 Len=7
    40 62084 → 62085 Len=8
    39 62085 → 62084 Len=7      Message sending
    40 62084 → 62085 Len=8
    39 62085 → 62084 Len=7
    40 62084 → 62085 Len=8
    39 62085 → 62084 Len=7
    40 62084 → 62085 Len=8
    39 62085 → 62084 Len=7
    40 62084 → 62085 Len=8
    39 62085 → 62084 Len=7
    40 62084 → 62085 Len=8
    39 62085 → 62084 Len=7
    35 65301 → 8888 Len=3       Exchanging KEEP-A packets
    35 8888 → 65301 Len=3
```

Error handling

A rather large checksum field is used for this purpose. To control the smallest bit errors.

Depending on the given connection, the sender or receiver resends or requests the message, if a packet was dropped or received with invalid `checksum`.

Application

Application was written in `Python 3.10.11` and uses the following libraries:

- `argparse`
- `random`
  - Used to randomly drop or corrupt packets.
- `socket`
- `threading`
  - Used for multi-threading.
    - One thread for receiving packets.
    - One thread for sending packets (based on user-input).
    - etc...
- `time`

Usage

```
use:
   python main.py [options]
options:
    -p --port [int(default=3141)]      # Select the port to listen on
    -a --ip [str(default=localhost)]   # Select the ip to listen on
    -d --debug [bool(default=False)]   # True/False to enable/disable debug
mode
    -b --broken [bool(default=False)]  # True/False to enable/disable
randomly corrupting and dropping messages
```

The Application has two states:

- `opnened` - to be able to accept and receives messages.
  - *(when in session the application is still like in opened)*
- `in session` - when the session is opened.
  - When entering `ip` address and `port`.

In opened state the application can change:

- `window_size` by entering `>window_size [int]` command.
- `payload_size` by entering `>payload_size [int]` command.

To quit `in session` state enter `>exit` command.

Sending a file

- The file must be in the same directory as a python file.
- To send a file enter `\[filename]` command `in session` state.