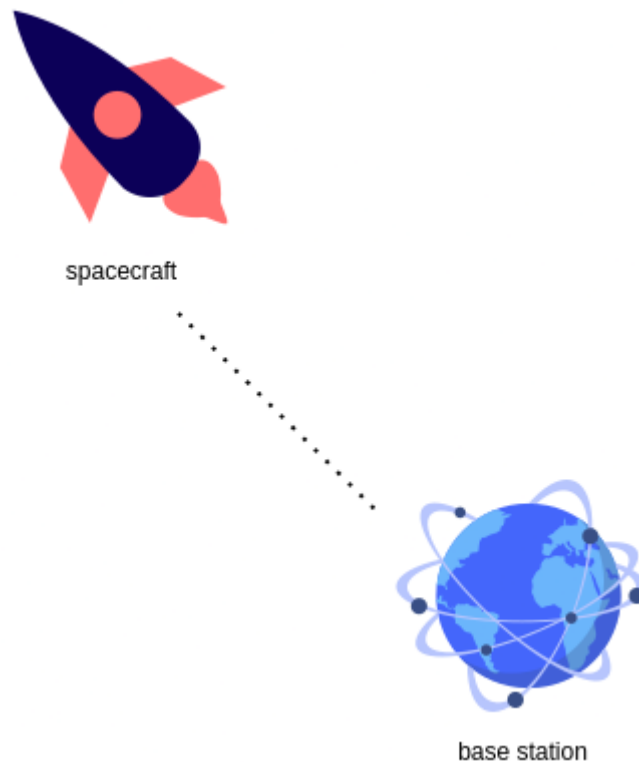


Spaceship communication system

Part 1

The communication system between a base station and a spaceship allows the base station to issue commands to spaceships, while the spaceships report back their position to a monitor so the base station operator can check it.



Each message sent is a bytes array. There are two types of messages

- command messages
- reporting messages

The first byte of the array is the type of message. Its value is 0 for reporting messages and 1 for command messages.

Command messages $b_0b_1b_2b_3$:

b_0 - message type: for command messages, this is 1

b_1 - spacecraft id: it is the id of the spacecraft that the command is issued to

b_2 - move direction: It takes one of the values 1,2,3,4 where 1 corresponds to upwards, 2 to right, 3 to downwards and 4 to left

b_3 - move distance: it takes one of the values 1,2,3,4 and it corresponds to the number of places that a spaceship shall move

For example command message 1123 is a command message for spacecraft with id 1 to move to the right for 3 places.

Reporting messages $b_0b_1b_2b_3$:

b_0 - message type: for reporting messages this is 0

b_1 - spacecraft id: it is the id of the spacecraft that sends the message

b_2 - position x: is the position of the spacecraft on the x-axis

b_3 - position y: is the position of the spacecraft on the y-axis

For example, reporting message 0245 is a reporting message from spacecraft with id 2 which is at position (4,5).

Task 1.1

You shall get yourself familiar with the system by operating it according to the following instructions:

- Execute `environment.sh` and leave it running on a terminal (you have to check this only for debugging purposes)

`./environment.sh 1.1`

- Execute `monitor.py` and let it run in a terminal (this will create a space map and show the spacecrafts)

`python3 monitor.py`

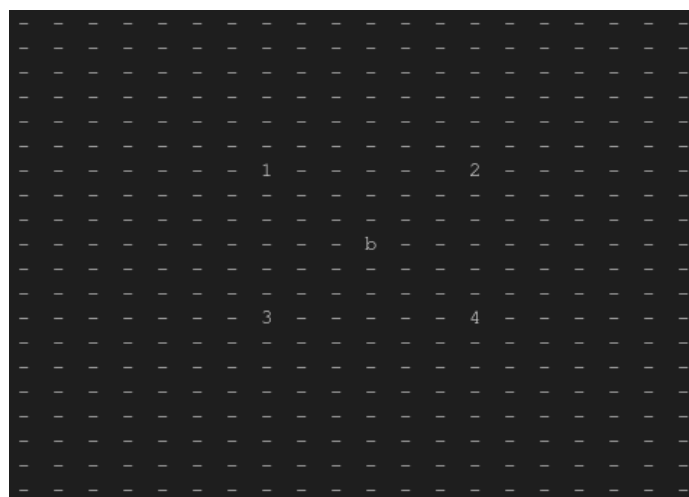
- Launch 4 spaceships by executing

`python3 launch_spaceships.py 4`

- Send commands to the spaceships by executing

`python3 base_station.py`

You should be able to arrange the 4 spaceships in the following way:



Submit: A screenshot with the required arrangement of the spaceship

Task 1.2

You have to modify the code in the file `spaceship_inst.py`, which corresponds to the code that each one of the spaceships runs. You shall add logging functionality to the spaceships as follows.

- When the spaceship launches it shall create a file under the name `id.log` (where `id` is the id of the spaceship).
- Every time the spaceship accepts a command message that is destined for its id, it shall append to the log file a line of the following format:

timestamp,direction, distance

In order to achieve that you can modify the function **`handle_msg`** in the file `spacecraft_inst.py` (you can also add imports of any required libraries in the same file).

Submit: The modified `spacecraft_inst.py` file

Task 1.3

Given the fact that the space environment is a difficult environment to communicate through it is common to have errors in the communication. Setup the system in a more realistic way that multiple errors occur in the communication between the base station and the spacecrafts by running:

```
./environment.sh 1.3  
python3 monitor.py  
python3 launch_spacescrafts.py 4  
python3 base_station.py
```

In this case, if you try to play around with the base station and issue commands to the spaceships you will see that many times these commands are accidentally changed during communication and thus spaceships either ignore commands or misinterpret those.

You need to modify the file `spacecraft_inst.py` and the `base_station.py` files, in order to add an integrity checking mechanism to the communication. Specifically:

- The base station shall add a signature (of 4 bytes) to the message through the use of the sha256 algorithm.
- The spacecraft shall check that signature and if it is valid it shall forward the message, either wise it shall reject it.

In order to achieve that you can modify the function **handle_msg** in the file `spacecraft_inst.py` and the **prepare_msg** function in the `base_station.py` file (you can also add imports of any required libraries in the same files).

Submit: The modified `spacecraft_inst.py` and `base_station.py` files

Task 1.4

When a message is rejected by the spaceship, the base station never gets to know that. You are required to build an acknowledgement mechanism through which the spaceship is going to respond to the base station about what has happened with the messages received. Define a new type of message that is intended for acknowledgement. It shall include only the id of the spaceship and a 0 or 1 value according to whether the command message has been accepted or rejected.

Each time a spacecraft receives a command message it sends out an acknowledgement message to inform the base station of what has happened with the command message. You have to modify the function **handle_msg** in the file `spacecraft_inst.py`, so it sends out such messages. You can find the transmission functionality in the `base_station.py` file.

You have also to create a new script **listen_ack.py** that listens for such messages in the base station and prints the corresponding details. You can find the functionality of receiving messages in the `spacecraft_inst.py` file.

Submit: The modified `spacecraft_inst.py` file and the new `listen_ack.py` file.