Lunar Mining Onboard Loopback Packet Structure

# Justification

The AI subsystem and the communications and control subsystems are being developed in parallel by two different groups of team members in two different languages. Further, the two languages are at two vastly different levels of abstraction. The AI subsystem is being developed in MATLAB, an interpreted, loosely typed, high-level scripting language. The communications and controls subsystems are being developed in C, a low-level, compiled, strongly-typed, imperative language.

These differences demand a simple common way to communicate between the MATLAB-based AI and the rest of the system. UDP Loopback ports are familiar to the developers of all subsystems, and provide a simple interface with sufficient performance.

# UDP Loopback Port Allocation

The Communications subsystem will only listen on a single UDP Loopback port. All other message routing must be handled internally.

The AI subsystem will listen on two different UDP Loopback ports. The first port will be for all traffic except camera data. The second port will be exclusively used for camera data.

|  |  |
| --- | --- |
| Port Number | Purpose |
| 10000 | Communications Subsystem Listening Port |
| 10001 | AI General Purpose Listening Port |
| 10002 | AI Camera Data Listening Port |

# UDP Heartbeat

For the communications subsystem to determine when the AI subsystem is up and running, and vice versa, the communications subsystem will periodically poll the AI subsystem to see if it is alive.

The AI subsystem will constantly listen for the QUERY\_HEARTBEAT packet. On receiving a QUERY\_HEARTBEAT packet, the AI subsystem will respond with a REPORT\_HEARTBEAT packet.

The communications subsystem will broadcast a QUERY\_HEARTBEAT packet to all known subsystem UDP ports once every second.

# UDP Packets

Each UDP Loopback packet consists of a start byte, an opcode byte, a payload-size byte, 0-255 payload bytes, and an end byte.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Byte 0 | Byte 1 | Byte 2 | Byte 3 to Byte *n*-1 | Byte *n* |
| Start Byte | Opcode | Payload Size | Payload | End Byte |
| 0xAB | See Opcodes table | Unsigned 8-bit integer | 0-255 bytes  See Opcodes table for specific formats | 0x7F |

## Specific Packets

The Opcode field in each packet identifies the purpose of each packet, as well as the acceptable values for the Payload Size and Payload fields of a packet.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Opcode | Name | Purpose | Payload Size | Payload Format | | |
| Byte Number | Format | Data |
| 0x14 | QUERY HEARTBEAT | Poll to see if a subsystem is active | 0 | N/A | N/A | N/A |
| 0x44 | REPORT HEARTBEAT | Response to report a subsystem is active | 0 | N/A | N/A | N/A |
| 0x02 | INIT | Start mining run | 0 | N/A | N/A | N/A |
| 0x45 | LOC | Report current location | 6 | 0 | Two’s Complement, centimeters from center of collection bin. When facing directly away from collection bin, left is positive and right is negative. | Current location x-coordinate, most significant byte |
| 1 | Current location x-coordinate, least significant byte |
| 2 | Unsigned, centimeters from collection bin | Current location y-coordinate, most significant byte |
| 3 | Current location y-coordinate, least significant byte |
| 4 | Two’s Complement, degrees from facing directly away from collection bin. Clockwise is positive, counterclockwise is negative. Capped between -180 and +180. | Current heading, most significant byte |
| 5 | Current heading, least significant byte |
| 0x46 | TARGET | Designate target location | 6 | 0 | Two’s Complement, centimeters from center of collection bin. When facing directly away from collection bin, left is positive and right is negative. | Current location x-coordinate, most significant byte |
| 1 |  | Current location x-coordinate, least significant byte |
| 2 | Unsigned, centimeters from collection bin | Current location y-coordinate, most significant byte |
| 3 |  | Current location y-coordinate, least significant byte |
| 4 | Two’s Complement, degrees from facing directly away from collection bin. Clockwise is positive, counterclockwise is negative. Capped between -180 and +180. | Current heading, most significant byte |
| 5 |  | Current heading, least significant byte |
| 0x47 | ENCODER | Report encoder data | 12 | 0 | Two’s complement, encoder ticks since last reading | Left-front wheel, most significant byte |
| 1 | Left-front wheel, least significant byte |
| 2 | Two’s complement, encoder ticks since last reading | Right-front wheel, most significant byte |
| 3 | Right-front wheel, least significant byte |
| 4 | Two’s complement, encoder ticks since last reading | Left-back wheel, most significant byte |
| 5 | Left-back wheel, least significant byte |
| 6 | Two’s complement, encoder ticks since last reading | Right-back wheel, most significant byte |
| 7 | Right-back wheel, least significant byte |
| 8 | Two’s complement, encoder ticks since last reading | Left linear actuator, most significant byte |
| 9 | Left linear actuator, least significant byte |
| 10 | Two’s complement, encoder ticks since last reading | Right linear actuator, most significant byte |
| 11 | Right linear actuator, least significant byte |