MDU ICD

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1. System Overview

The interface described here shall be between the Motion Detection Unit (MDU) and the Base Computer. Each hardware component will send and receive data on an emulated serial port on USB. The connection is intended to be handled by an XBee radio pair, however due to the emulated serial, both ends are blind to modifications to the hardware between both endpoints. The messaging protocol to be used consists of 7 different message types with predefined contents.

1. Message Structure

The Messages used on this interface are structured as byte arrays with a three byte header and an ending byte containing a newline character. The first byte of the header contains the tID which is the byte ID of the destination system. It should be noted that this value cannot be 2 as that value is used by the MDU’s RFID tag reader as the leading value of its message packets which use the same bus on the MDU. For the base station this field is 0, and for each MDU this will match the LocoNet ID of the attached locomotive (ex. 26 in the test hardware). The second header byte is the sID which is the ID of the message sender. This Field uses the same ID numbering as the TARGET\_ID field. The third header field contains the mID which is an enum value for the given 7 message types.

|  |  |  |
| --- | --- | --- |
| mID | Value | Description |
| IMU | 3 | Message containing IMU readings |
| RFID | 4 | Message containing a RFID reading |
| RTT\_REQ | 5 | Message to initiate a RTT test |
| RTT\_RESP | 6 | Response message to RTT\_REQ |
| ID | 7 | Message sent by an MDU to identify itself to the base computer |
| TIME | 8 | A request message for time of day |
| TIME\_RESP | 9 | Response message containing the current time of day |
| ID\_RESP | 10 | Response message to ID |

1. Message Contents

The following sections will detail the contents and usages of each individual message used by the MDU and base computer during system initialization and operation.

* 1. Message - IMU

The IMU message is a 20 byte message with the standard 3 byte header and 1 trailing byte with 16 bytes of data. This message uses the mID enum IMU or 3. Bytes 3 through 6 contain the time the IMU was recorded at in milliseconds since the start of the day as an unsigned long. Bytes 7 and 8 contain the accelerometer X reading as a 16 bit int, bytes 9 and 10 contain the accelerometer Y reading as a 16 bit int, and bytes 11 and 12 contain the accelerometer Z reading as a 16 bit int. Bytes 13 and 14 contain the gyroscope X axis reading as a 16 bit int, bytes 15 and 16 contain the gyroscope Y axis reading as a 16 bit int, and bytes 17 and 18 contain the gyroscope Z axis reading as a 16 bit int.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Contents | tID | sID | mID | time | | | | AcX | | AcY | | AcZ | | GyX | | GyY | | GyZ | | ‘\n’ |

* 1. Message - RFID

The RFID Message is a 13 byte message with the standard 3 byte header and 1 trailing byte with 9 bytes of data. Bytes contain the time the RFID reading occurred in milliseconds since the start of the day as an unsigned long. Bytes 7-11 contain the 5 byte ID of the RFID tag.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Contents | tID | sID | mID | time | | | | RFID tag ID | | | | | ‘\n’ |

* 1. Message - RTT\_REQ

The RTT\_REQ message is used to imitate a round trip time calculation for the data link. The message only contains the 3 byte header and the one trailing byte. When this message is received by either piece of hardware, a response RTT\_RESP is immediately sent.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 |
| Contents | tID | sID | mID | ‘\n’ |

* 1. Message - RTT\_RESP

The RTT\_RESP message is sent as an immediate response to a received RTT\_REQ message. This message only includes the 3 byte message header and the 1 trailing byte.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 |
| Contents | tID | sID | mID | ‘\n’ |

* 1. Message - ID

The ID message is a 4 byte message sent by each MDU at initialization and received by the base station. It only contains the header and trailing newline character. The tID is always the base computer’s ID and sID will always be the sending ID of the sending MDU. The mID for this message is ID.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 |
| Contents | tID | sID | mID | ‘\n’ |

* 1. Message – TIME

The TIME message is sent by the MDU to request the current time of day from the base computer, which sends an immediate TIME\_RESP message. The round trip time of the data link should be determined prior to performing this message handshake. The current system time of the MDU should be recorded prior message being sent so that using the receiving time and the known RTT a more approximate time can be known.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 |
| Contents | tID | sID | mID | ‘\n’ |

* 1. Message – TIME\_RESP

The TIME\_RESP message is an 8 byte message sent to the MDU by the base computer in response to a received TIME message. The contents of this message are the standard 3 byte header and the 1 trailing by around 4 data bytes containing the current time in seconds as an unsigned long.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Contains | tID | sID | mID | Time | | | | ‘\n’ |

* 1. Message - RTT\_RESP

The ID\_RESP message is sent as an immediate response to a received ID message. This message only includes the 3 byte message header and the 1 trailing byte.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Byte | 0 | 1 | 2 | 3 |
| Contents | tID | sID | mID | ‘\n’ |