UHF Half- Duplex Telecommand and Telemetry for Successful and Accurate Satellite Communication

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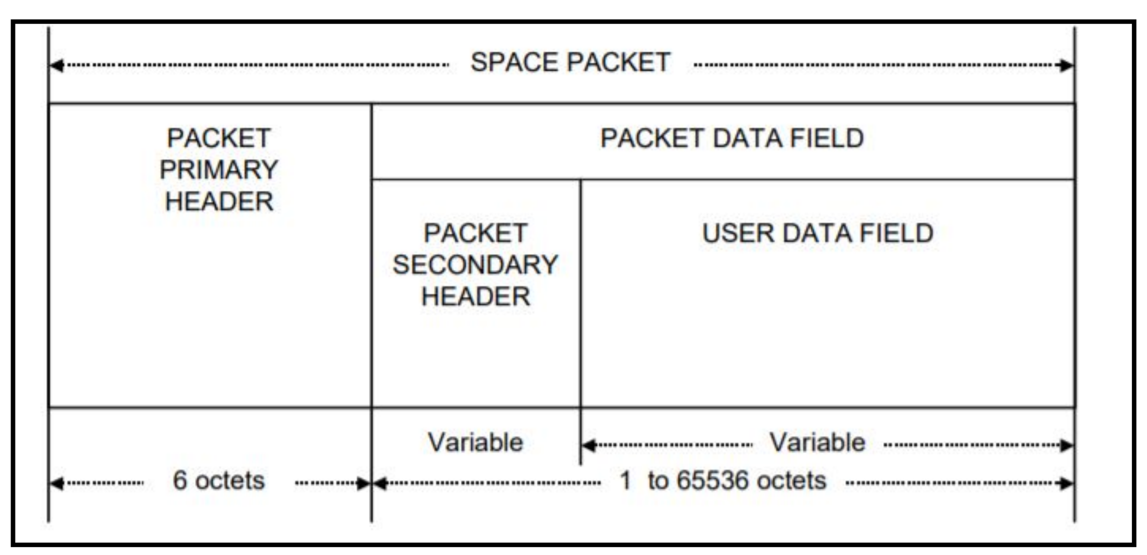
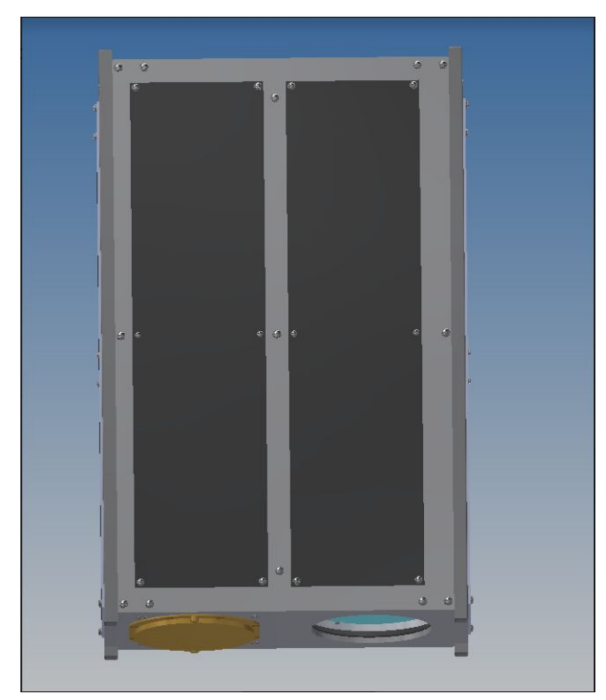
RESEARCH OVERVIEW and GOALS

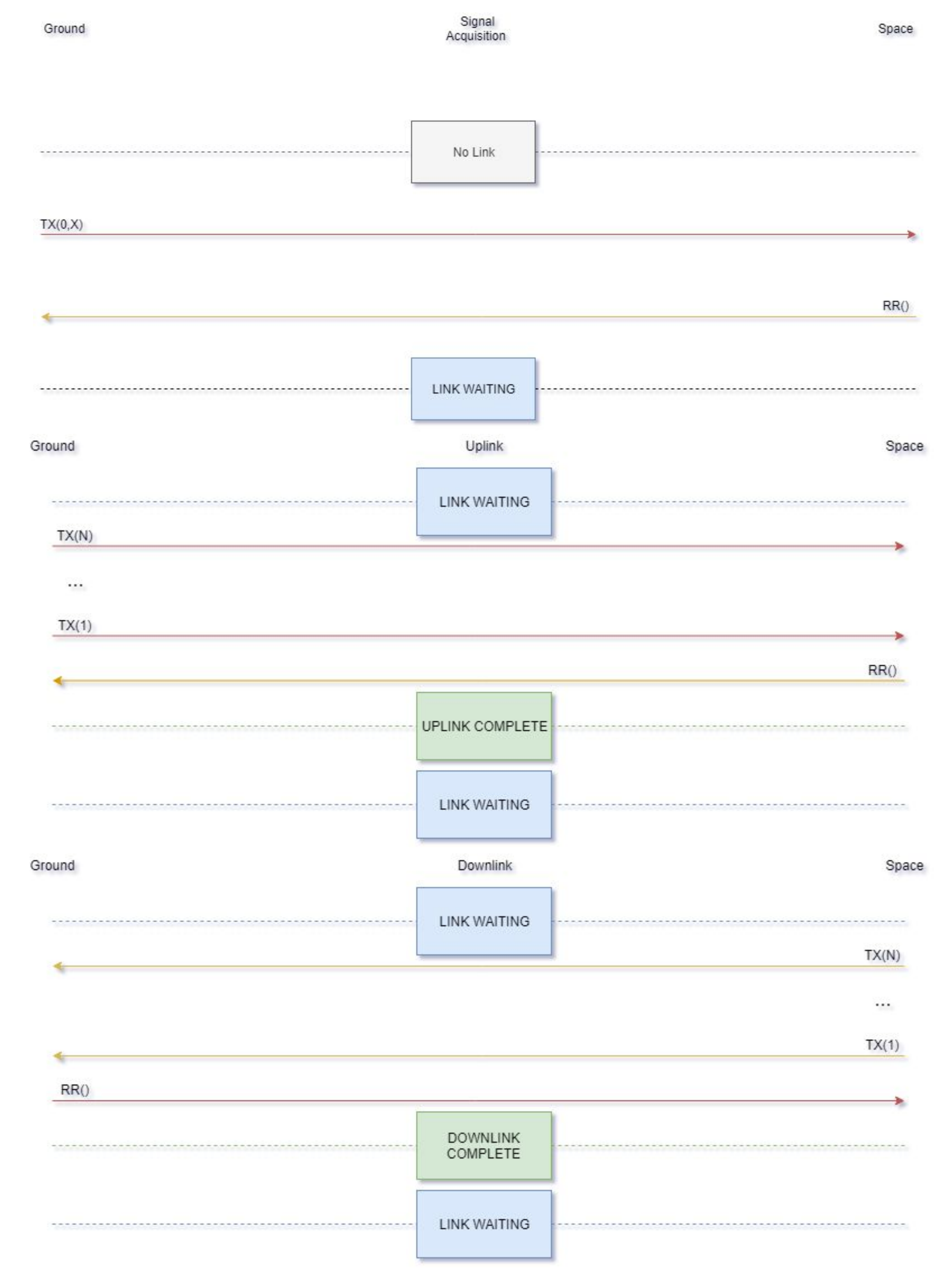
The purpose of this research is to create a protocol that would successfully transmit AX.25 packets from a ground station to a cubesat. While many packet protocols do exist for this purpose, many do not account for data integrity and efficiency thus a custom protocol allows for these problem to be addressed. Efficiency is vital to this protocol due to the limited amount of packets that can be sent before a satellite leaves the target zone of communication. Data integrity must also be taken into account because of the duration of a satellite pass. It is quite common for data to be transmitted and lost due to the satellite being out of range, therefore it is necessary to find a solution to ensure that no data is lost in transmission. Thus, it is necessary for the most amount of data to be transmitted and received each time a satellite passes over the specified region. These goals, data integrity and efficiency, are at the forefront of the design and the necessary steps have been take to ensure that the final product reflects these parameters. To verify that all the criteria has been met, the protocol must be modeled theoretically then programmed.

Structural Components of a Space Packet





SITUATIONS



PROBLEMS and SOLUTIONS

There are four main problems that can occur with common packet protocols. The first is the loss of signal between a spacecraft and the ground. This essentially occurs due to the limited range a satellite must be in for the ground to successfully receive and transmit communications from it. The second problem stems from the inevitable bit error that will occur, which exponentially increases as the satellite reaches the border of its range. This can cause multiple packets to be dropped, which must be mitigated to ensure sure that all data is either sent or received to the correct target. Another problem relates to the hardware used by the specific ground station and cubesat at the University of Georgia Small Satellite Research Laboratory. The Ultra High Frequency(UHF) transmitter uses half-duplex communications meaning that it can send and receive packets but not simultaneously. This makes it necessary to let the satellite know when it should transmit or receive packets. The final issue that relates to packet protocols is the size of the packets that can be sent. There is a limit of 256 bytes that can be sent in each packet.

The simplest way to correct the first problems presented, is to simply get back into contact with the satellite as soon as possible to ensure that all the necessary information has been shared between it and the ground. To correct the bit error issue, a checksum should be implemented into this protocol, which ensure that duplicated or dropped packets are prevented through the use of a read receipt packet that is sent at the end of every uplink or downlink. This packet would either let the ground of satellite know what packets were sent, and in the case of a packet being lost, would be retransmitted. To account of half-duplex communications, switching from transmitting and receiving should be done as little as possible to prevent any issues that can occur.

In the case in which the read receipt files do not match the data that was transmitted, different control flags will be implemented which will sent by the ground for certain situation which will yield different transmissions. There will be control flags at the initial connections between the ground and the spacecraft that will decide whether uplink, downlink, retransmission for uplink, and retransmission for downlink will occur. A final control flag will be used when the signal is lost between the ground and spacecraft during data transmission.

CONCLUSION AND FUTURE IMPROVEMENTS

From the results conducted from this research, once implemented, this packet protocol will allow for efficient communications from the ground to a satellite while maintaining data integrity. The use of read receipt packets ensure that even if packets omit information or are dropped, they will be retransmitted to the receiving party. This allows for the receiving party to receive all of the intended data necessary for a successful satellite mission. Multiple control flags allow for many different scenarios to be accounted for, which ensure that there will be little uncertainty when dealing with lost information. This also deals with the issue of half-duplex communication because either the satellite or the ground will switch telecommunications as little as possible, which will prevent scenarios from occurring such as both either transmitting or receiving at the same time.

While many problems have been solved with this protocol, a few do remain. This relates to the large amount of data that does need to be sent from the ground to the satellite, and since a single packet can only contain 256 bytes, the amount of packets that will need to be sent for 1 gigabyte of data will be quite large. This will be difficult to sent a read receipt that contains all the information that are sent in those packets. A solution that could be implemented into this protocol would be to create chunks of data which would then be sent to the receiving party, therefore allowing the read receipt to acknowledge that it either did or did not receive all the information in the chunk.

This protocol will continue to undergo improvements until it is ready for its inevitable implementation for the University of Georgia Small Satellite Research Lab.