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PACSAT Digipeater

1 Introduction

PACSAT can provide a digital repeater alongside the file system.

This document is organized into the following sections:

- **Historical Implementations** – Discussion of several previous space digipeaters
- **Design** - Discussion of the possible design approach for PACSAT.

References are given at the end.

2 Historical Implementations

A digipeater that repeats AX.25 or other digital packets have been setup in a number of ways:

2.1 Classic AX.25 repeater

The AX.25 Link Access Protocol[1] states that the address field contains a destination, a source and optionally two Layer 2 repeater sub-fields. In this way the destination address is the station you are sending the message to and the source address is the sending station.

Each address is 6 bytes followed by 4 bits of SSID and the C, command/response, bit

The Version 2.2 spec says that repeater chaining belongs in a higher protocol and is being phased out of the Layer 2 protocol.

If the address extension bit of the last byte of the source field is not set, then a repeater field follows the source address and would contain the PACSAT callsign.

The repeater address contains the H, Has been Repeated, bit. The H bit is set to 0 on frames going to a repeater. It is changed to 1 by the repeater.

There can be multiple repeaters listed though practically this should be limited to 2.

Various timers are usually adjusted to accommodate the path through a repeater. We will only support full duplex UI frames so this will not need adjustment at the spacecraft.



2.2 APRS digipeater

APRS uses generic digipeating. The sender does not need any prior knowledge of the network. Messages are not typically sent to a specific person, so the digipeater can be encoded in the destination address, shortening the packet. Most of the destinations have been depreciated with WIDEn-N remaining. 1 packet sent to WIDE2-2 will be repeated and the SSID decreased by 1, this is repeated again until the SSID is 0. The digipeater keeps a hash of each packet and will not repeat them again for 28 seconds.

2.3 ISS Style digipeater

The original approach was to send UNPROTO CQ VIAARISS. Then enter CONVERS mode and type away. Each line was sent as a UI packet via the ISS.

Now you can use various programs, such as UISS, which typically send an APRS encoded message with the via address.

2.4 FalconSat-3 style digipeater

FalconSat-3 used the callsign PFS3-1 for the digipeater. It was cross band, unlike the ISS. It was full duplex. It was 9600bps. You sent UI packets to CQ via PFS3-1

2.5 LEDSAT/ Greencube digipeater

GreenCube uses the CubeSat protocol[2] rather than AX.25. This has RS(223,255) FEC. It receives on 435.310 and transmits on 435.190 at 1200bps. It is half duplex using the AX100 radio.

Messages are formatted like this:

`$SourceCallsign > $DestCallsign, $SatelliteName, STORE=$Time $Message`

e.g., `IU0POY > IU0BFO, LEDSAT, STORE=5` This a message relayed by LEDSAT in 5 seconds

3 Design

Previous satellites all require one repeater address to be populated with the satellite name. They then typically support a message format such as CQ via PACSAT. The source address contains the sending station. A typical QSO is then something like:

```
G0KLA>CQ,PACSAT IO91
```

```
VE2TCP>CQ,PACSAT G0KLA QSL FN35
```

```
G0KLA>CQ,PACSAT VE2TCP QSL
```

This is based on it being fiddly to change the destination address for the UNPROTO path. If that is simplified through software, we can shorten this to:

```
G0KLA>CQ,PACSAT IO91
```

```
VE2TCP>G0KLA,PACSAT QSL FN35
```

```
G0KLA>VE2TCP,PACSAT QSL
```

Furthermore, if we think of the digipeater more like a transponder then it should just echo all UI packets back to the ground. Then the exchange is as short as:

```
G0KLA>CQ IO91
```

```
VE2TCP>G0KLA QSL FN35
```

```
G0KLA>VE2TCP QSL
```

As long as the spacecraft sends some telemetry with its ID every 10 mins then we do not need to include the via. We could allow the via to be included on the uplink but remove it before retransmission. It carries no useful information.

This would be limited to UI packets to prevent people connecting to other stations and hogging the uplink. Non UI packets would be ignored. Additional via's could be repeated or more likely we would ignore them.

Packets sent to the PB or the BBS would be processed as normal and not repeated.

We could dedicate one uplink to to the digipeater, configurable with a ground command.

Note that this would have the side effect of acting as a digipeater for APRS. If someone put the output of a WIDEn repeater on the uplink then those packets would be repeated. We



should consider if we support APRS and decrement the SSID before forwarding or if we simply repeat the packet unchanged.

4 References

1. AX.25 Link Access Protocol for Amateur Packet Radio, Version 2.2, July 1998, William A. Beech, NJ7P, Douglas E. Nielsen, N7LEM, Jack Taylor, N7OO, <https://www.tapr.org/pdf/AX25.2.2.pdf>
2. CubeSat protocol Space, <https://github.com/libcsp/libcsp>