Use of the EVTM system greatly increases the ability for science to download their data. The system uses UDP packets to complete this transfer. There are configurations for both LOS and OTH portions of missions. The LOS portion will typically have a much higher bitrate than that of OTH. This needs to be considered when providing data for each link type. Current bitrate availability for LOS is 12Mbps. The TDRSS EVTM is currently under development with an expected bitrate range of 100kbps to 1Mbps. The bitrate for TDRSS at time of flight will be identified in the payload support meetings held with science.

1.1 GONDOLA SIDE CONFIGURATIONS

Depending on the requirements of each flight, various combinations of EVTM based systems can be used which will require different equipment and configuration settings.

A constant for all flights are IP address allocation and port allocation. CSBF will reserve 192.168.0.*. and ports <20000 for flight equipment. Science will utilize 192.168.(1-3).* and ports 20000 to 30000. A table with science allocations will be generated during payload planning meetings and will be reviewed during integration. Additional networking details will be made available during payload planning meetings.

LOS Only

If no OTH systems are required, only an EVTM enabled transmitter and an unmanaged ethernet switch with the necessary number of ports is required. All UDP packets transmitted downstream will be fed into the Mission Network.

LOS & TDRSS EVTM

An OTH link requires a managed switch with two primary capabilities – VLAN and Multicast MAC filtering – which will be provided by LDB. The VLAN setting allows specific ports to be segregated from the outgoing links – if a system does not need to downlink via LOS or TDRSS it can be removed from those virtual LANs as needed. The LOS and TDRSS ports are then assigned to a multicast MAC Address – 01:00:5e:7f:00:01 for LOS and 01:00:5e:7f:00:02 for TDRSS. So long as they are also on the VLAN with the originating traffic, any multicast packets destined to (224-239).255.0.1 will be routed to the LOS port, while any multicast packets destined to (224-239).255.0.2 will be routed to the TDRSS port. If any source needs to be routed down both networks, make sure it is subscribed to both VLANs and any UDP broadcast packets will be routed to both TM systems. All devices connected to the switch which intend to pass information through it must be assigned a static IP within the switch's subnet.

LOS & TDRSS EVTM + Iridium Pilot

The addition of an Iridium Pilot mirrors the above settings with a couple of additions. First, the managed switch and all TCP/IP connected devices need to set their default gateway to the same address as the Iridium Pilot's internal address. All equipment which intends to use the Pilot must be set to a static IP within the Pilot's subnet and must have the Pilot's address set as its default gateway. As above any multicast traffic will be routed to its specific links, while broadcast traffic will be routed through both LOS and TDRSS EVTM links. However, any traffic routed to an external IP address or domain name (TCP or UDP any port) will be forwarded only to the Pilot. Any incoming traffic must be set up to a corresponding rule and allowed using the Iridium Pilot interface, i.e. incoming TCP traffic directed to port 25022 will be forwarded to 192.168.1.150 port 22 (SSH). Because of the simplicity, it is ideal for science groups to generate data and 'push' it down to a

known IP address / server, while the Pilot rules are used for incoming commands, SSH connections, and configuration pages. Pilot port forwarding rules are limited to 15 total rules. These 15 rules must be shared between all flight hardware (CSBF and science).

1.2 Ground Station Equipment Configurations

Data will be available at the launch location on the Mission Network. The TDRSS portion of the flight data will be available at the OCC in Palestine on the Mission Network. The Mission Networks between locations are not interconnected. They are local to each location and provide science their interface to the data. The Mission Network will be behind the CSBF Science firewall and have internet access with translation to the outside available if required.

LOS EVTM

As data is received by the EVTM decoder ground station, it is put directly onto the Mission Network. There is no routing.

LOS & TDRSS EVTM

The launch location Mission Network will remain the same as described in LOS EVTM. There will be an additional Mission Network at the OCC in Palestine, with similar setup and configuration requirements. The only difference between the two locations is that the GSEs shall be setup to listen to two different multicast addresses ((224-239).255.0.1 for the LOS Mission Networks and 0.2 for the OCC Mission Network) in addition to any broadcast traffic common to both networks. Note, the receiving server code will require language specific settings in order to subscribe to and listen to multicast packets, otherwise the GSE may reject multicast packets.

LOS & TDRSS EVTM + Iridium Pilot

In addition to the above configuration, Pilot gives the gondola TCP/IP access to the internet. If traffic is directed from the gondola to a server behind CSBF's Science network, necessary ports and addresses will need to be configured and set up at the beginning of the campaign for the GSEs by CSBF IT. Conversely, outgoing traffic from the GSEs or other locations to the Pilot will need to be set up on the gondola network by an LDB engineer, and an IP address to direct traffic to will be provided. In return, an IP address, traffic type, and internal port will be required for each path. The LDB engineer will then assign a rule and provide the external port to direct traffic into. All incoming traffic to the gondola needs to be whitelisted so if access is needed outside a CSBF network, an originating IP address or network will need to be provided. This information is provided to Iridium and can take time to process.

1.3 Testing and Verification

These links can be mocked up and tested prior to arrival at CSBF for integration.

LOS EVTM

There is no routing, so UDP unidirectional traffic can be simulated and tested with an unmanaged ethernet switch between the payload and the GSE. There is no uplink to the gondola, so any acknowledgements or TCP traffic will not work on the flight EVTM network.

LOS & TDRSS EVTM

In order to replicate and test this setup, a managed switch with multicast filtering and VLAN needs to be configured. The outgoing TM ports need to be tied to both the TDRSS and LOS ports via VLAN, and the LOS port and TDRSS ports should be subscribed to the static multicast MAC Addresses – 01:00:5e:7f:00:01 for LOS and 01:00:5e:7f:00:02 for TDRSS. The LOS and TDRSS ports can then be connected directly to their respective GSEs to test the link. Alternatively, simply verifying the server / client connection on an unmanaged switch for each of the multicast addresses will work but will not test traffic filtering.

LOS & TDRSS EVTM + Iridium Pilot

An Internet connected router with an assigned external IP address can be used to simulate the Pilot system for testing with the gondola network. Many routers have the ability to set up a dynamic IP address which can be linked through a domain name and used to connect to an external router – if configured properly as determined by the specific router. Any IP rules used for the Pilot can be set up and configured on the test router. Connect the 'inside' of the router network to an unmanaged switch or a managed switch with a VLAN configured and the outside port to the internet. Any traffic directed from behind the router externally will be routed on the Internet, and any incoming traffic directed to the static external IP & port will be directed as set up by the rules on the router.

1.4 Bandwidth and Packet Size Considerations

EVTM units do not have the ability to buffer large amounts of data, so any device that generates data for downlink needs to have its own buffer & rate limited output so as not to exceed the bitrate of the link. There will be no feedback on the gondola network if the buffer is overrun – only data loss on the GSE side. Note: Any data going over a TM link should be checksummed or paritied.

The EVTM system has a limit to the packet size. It's MTU for ethernet traffic is 1500 bytes. The UDP packets shall conform to the limit or they will not be processed by the EVTM encoders.

LOS EVTM

A data rate budget will be determined by flight requirements. CSBF will provide a data rate allocation for each available link. The data rate shall not be exceeded unless direction is given by CSBF. This could change in flight due to completion of other science. Consider having the ability to vary the data rate to take advantage of this event.

LOS & TDRSS EVTM

LOS and TDRSS both have very different bit rate constraints and in addition TDRSS network bitrate is subject to change depending on satellite coverage and event type. A bitrate budget will be provided for the LOS system which can be static, and different modes for TDRSS will be provided for different bitrates. Each data source should have separate on/off and bitrate control for both LOS and TDRSS. Configure initial startup for all modes to be the lowest bitrate setting.

TDRSS availability will be reported to science each day with a schedule of data events and rates for the events. CSBF will always try to schedule the maximum data rates available. The schedule is determined by predicting the path the balloon will take during the following 24-hour period. This schedule is subject to change as balloon trajectory can vary from predictions used to make the schedule. CSBF will update the POC for science operation to any changes. Updated schedules will also be sent out in the case there is a deviation from the predictions.

LOS & TDRSS EVTM + Iridium Pilot

In addition to the above requirements, Iridium Pilot will also require separate on/off and data rate control for outgoing sources. Max theoretical link speed is 128kbps, but usually average UDP data throughput is in the 60kbps range. Configured initial startup to lowest data rate setting.

(EOD)