TREK

CHOOSING AN UPLINK FUNCTION

TUTORIAL

November 2012

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1 What You Need To Know Before You Read This Document

Before attempting to choose the correct TReK Command API for your needs, you should be familiar with some material contained in other TReK documents. It is suggested that you read the TReK Command Tutorial (TREK-USER-020) before reading this document. The TReK Command Tutorial contains information about how TReK performs commanding. It will also be beneficial if you are familiar with the Command Processing Applications Tutorial (TREK-USER-021).

2 Technical Support

If you are having trouble installing the TReK software or using any of the TReK software applications, please try the following suggestions:

Read the appropriate material in the manual and/or on-line help.

Ensure that you are correctly following all instructions.

Checkout the TReK Web site at http://trek.msfc.nasa.gov/ for Frequently Asked Questions.

If you are still unable to resolve your difficulty, please contact us for technical assistance:

TReK Help Desk E-Mail, Phone & Fax:

E-Mail:	trek.help@nasa.gov
Telephone:	256-544-3521 (8:00 a.m. - 4:30 p.m. Central Time)
Fax:	256-544-9353

TReK Help Desk hours are 8:00 a.m. – 4:30 p.m. Central Time Monday through Friday. If you call the TReK Help Desk and you get a recording please leave a message and someone will return your call. E-mail is the preferred contact method for help. The e-mail message is automatically forwarded to the TReK developers and helps cut the response time.

3 The TReK Command API Uplink Functions

TReK provides a total of six command API functions to uplink (or send) a command to your payload. This section will cover the details of how each command works.

3.1 UplinkPOICCommand

The UplinkPOICCommand function sends a request to the POIC to uplink a command from the POIC's Operational Command Database (OCDB). The POIC will create the

actual uplink pattern based on the current values defined in the OCDB. TReK users can update the OCDB using other functions that are available in the TReK Command API. The UplinkPOICCommand is only available for POIC destinations.

This function is used by TReK when you choose the "Uplink POIC Command" option on the Commands dialog in TReK. The data passed from different systems is shown in Figure 1.

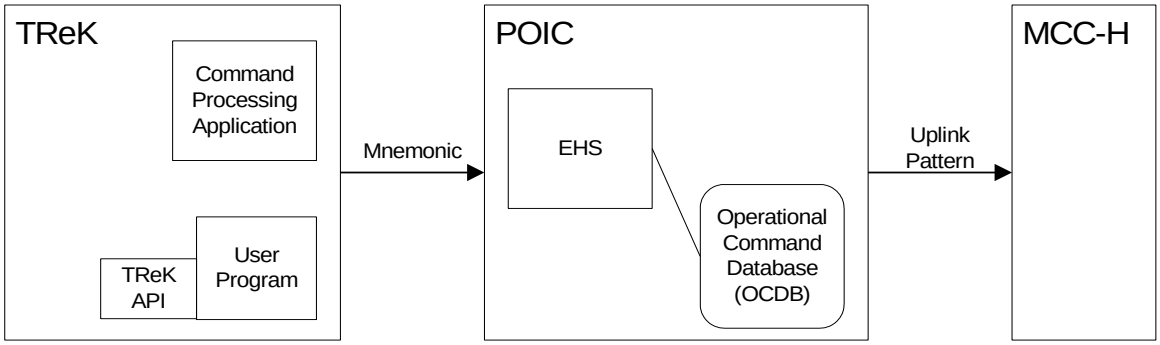

Figure 1 Uplink POIC Command

3.2 BuildAndUplinkCommand

BuildAndUplinkCommand takes the current TReK field values for a command and builds the entire uplink packet (including headers) locally and sends the uplink packet to the destination. The local field values can be updated using the Command User API.

This function is used by TReK when you choose the "Uplink Local Command" option on the Commands dialog in TReK. The data passed from different systems is shown in Figure 2.

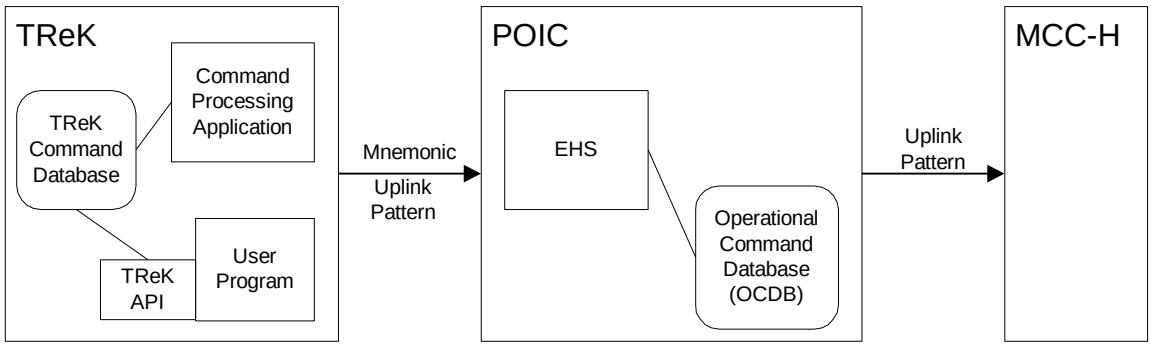

Figure 2 Build and Uplink Command

Note: TReK provides an option to pad variable length command fields that can be turned on via the Command Processing Set Command Processing Options dialog. ISS commands must be between 48 and 128 bytes in size and on a 16-bit word boundary.

This includes the CCSDS header, the user data zone, and the checksum. If TReK builds a command that is variable length, it is possible that the data specified by the user is not on a word boundary. TReK can pad the variable length field with an additional byte at the end of the field to enable the command to be sent successfully.

3.3 UplinkUserCommand

UplinkUserCommand takes the bit pattern supplied by the user and sends it to the destination. The time stamp in the CCSDS secondary header is modified to be within +/- 1 minute of the POIC time in order to meet the PGUIDD interface. This is a "pass-thru" command (or as close as TReK gets to one).

The command sent via the UplinkUserCommand function must be between 48 and 128 bytes in size and must be on a 16-bit word boundary. This size includes all of the headers, data zone, and the checksum for the command. The data passed from different systems is shown in Figure 3.

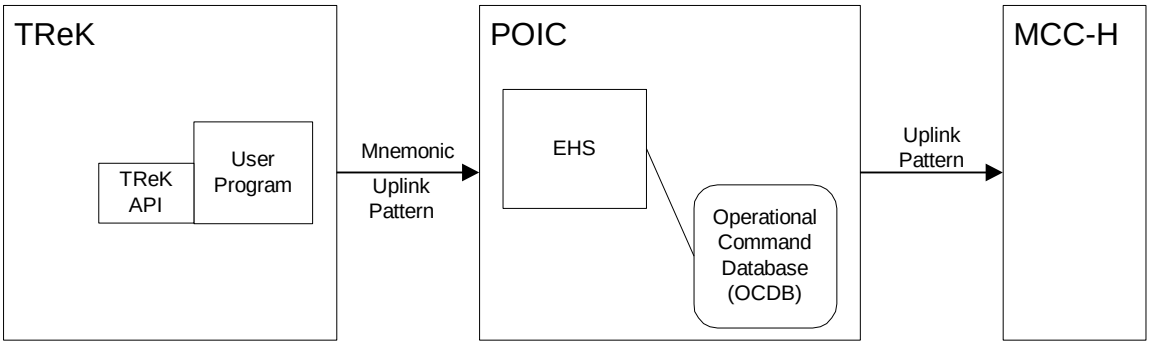

Figure 3 Uplink User Command

Note: TReK will not pad the data sent in via this function call even if the pad command checkbox is selected in Command Processing. Commands with a length of an odd number of bytes will be rejected.

3.4 UplinkUserCommandVB

UplinkUserCommandVB is identical to the UplinkUserCommand function except that it allows TReK to perform an additional check since Visual Basic does not support true unsigned data.

3.5 AddHeaderAndUplinkCommand

AddHeaderAndUplinkCommand takes the bit pattern supplied by the user and sends it to the destination. TReK will build the header and combine it with the user supplied command data to form the entire uplink packet.

This function requires that the header exists in the TReK command database that was specified when adding and activating a destination. Headers are added to the database either through the conversion of an EHS command database or through the Command Database application in TReK.

The command sent via the AddHeaderAndUplinkCommand function when added to the header built by TReK must be between 48 and 128 bytes in size and must be on a 16-bit word boundary. When using this function, two bytes should be reserved at the end of the data zone for the checksum. TReK will calculate the checksum once the header has been added. The data passed from different systems is shown in Figure 4.

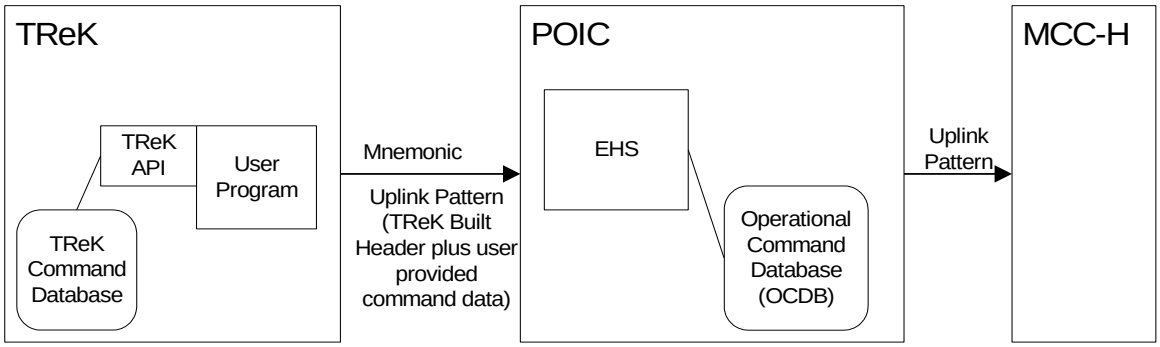

Figure 4 Add Header and Uplink Command

Note: TReK will not pad the data sent in via this function call even if the pad command checkbox is selected in Command Processing. Commands with a length of an odd number of bytes will be rejected.

3.6 AddHeaderAndUplinkCommandVB

AddHeaderAndUplinkCommandVB is identical to the AddHeaderAndUplinkCommand function except that it allows TReK to perform an additional check since Visual Basic does not support true unsigned data.

4 Choosing the Right TReK Command API Uplink Function

This section is written in a question and answer format to help you choose the right TReK Command API Uplink function for your applications. You may find it beneficial to use different functions for different tasks. The Visual Basic specific commands from the previous section are not referenced in this section. The same conditions for their use apply as with their counterpart functions.

Some of the discussion in each section may be similar to other sections. This was necessary due to the question and answer format used.

4.1 Do You Want the POIC and TReK to Know About Your Command Structure?

There is a minimum amount of information that the POIC requires from you about your commands. You will have to provide this information through the Payload Data Library (PDL). However, you can choose exactly how much detail you want the POIC to know.

If your command has the potential to be sent by a member of the POIC cadre, you probably should provide the details of the command structure in PDL. This will allow the cadre members to use the tools provided by the EHS system in the POIC to update and uplink your command. If you do not provide these details, they can still update and uplink your command. However, you will probably need to defined detailed procedures to identify the contents of the command, especially if there are fields that are modifiable in the command. If you choose to add the details of the command to the POIC database, you will probably want to use the UplinkPOICCommand or BuildAndUplinkCommand functions in TReK.

If the command is not one that could be sent by the POIC cadre, you can still provide the details in the POIC. Many payloads choose to create a command that has "one big modifiable" field. This option still allows the user of the UplinkPOICCommand or BuildAndUplinkCommand functions. However, most users do not provide the details because they wish to build the command structure in their own software. If you wish to build the command structure in your own software, you can use either the UplinkUserCommand or AddHeaderAndUplinkCommand function. If you choose the UplinkUserCommand function, you will also be building the header for the command. If you choose the AddHeaderAndUplinkCommand function, you will only have to provide the data portion of the command. TReK will build the header for you.

4.2 Do You Want to Use the Same API Functions for Testing and Flight?

Some EXPRESS payload teams write their ground system software in time for testing using the Suitcase Simulator system. If you want to use the exact same code for testing and flight, you will not be able to use the UplinkPOICCommand function. The UplinkPOICCommand function requires that you be connected to an EHS system such as the POIC or the Payload Test and Checkout Facility at KSC. You can still use any of the other TReK Command API functions for uplink.

It is important to remember that the POIC database that TReK would normally rely on in the BuildAndUplinkCommand function will probably not be available for your testing. However, you can use the TReK Command Database application to add your command details needed by the BuildAndUplinkCommand function via a simple ASCII text file. See the Command Database User Guide (TREK-USER-024) for details on using this feature. If you choose not to add these details to the TReK command database, you can still use the UplinkUserCommand and AddHeaderAndUplinkCommand functions in the TReK Command API.

4.3 Do You Want to Create a TReK Command Database from the POIC's Database?

TReK will always require that you specify a database when activating a destination (see the Command Applications Tutorial). However, it is acceptable to activate with a database that has no data other than the data added when TReK creates the database. If you choose not to create a database from the POIC or do not add the details yourself, you will be limited in which TReK Command API functions you may use.

The UplinkUserCommand and UplinkPOICCommand functions will work in this scenario since local database information is not needed. The BuildAndUplinkCommand function will not work since TReK has no knowledge of the actual contents of the command. The AddHeaderAndUplinkCommand function will work if you specify one of the headers that TReK automatically generates when you create a new command database in the TReK Command Database application. You may also add headers to the database without adding commands if you wish.

4.4 Are Any TReK or POIC Capabilities Not Available If You Choose to Use the UplinkUserCommand and AddHeaderAndUplinkCommand functions?

If you choose to use the UplinkUserCommand or AddHeaderAndUplinkCommand function with "one big modifiable" field, then you cannot get the benefit of some of the checking provided by TReK or the POIC. For example, there may be certain bytes in the command that should have the same value each time or be within a certain range. TReK and the POIC both provide the ability to perform these checks if there is information in their respective databases.

If you define this type of information in the POIC database, the POIC will check your command against it even if you use the UplinkUserCommand and AddHeaderAndUplinkCommand functions in TReK. However, TReK does not perform any of these checks when you choose one of these functions.

The command responses, command track, and other capabilities provided by TReK and the POIC will still be available with any of the TReK Command API functions.

Appendix A Glossary

Note: This Glossary is global to all TReK documentation. All entries listed may not be referenced within this document.

Application Programming Interface (API)	A set of functions used by an application program to provide access to a system's capabilities.
Application Process Identifier (APID)	An 11-bit field in the CCSDS primary packet header that identifies the source-destination pair for ISS packets. The type bit in the primary header tells you whether the APID is a payload or system source-destination.
Calibration	The transformation of a parameter to a desired physical unit or text state code.
Communications Outage Recorder	System that captures and stores payload science, health and status, and ancillary data during TDRSS zone of exclusion.
Consultative Committee for Space Data Systems (CCSDS) format	Data formatted in accordance with recommendations or standards of the CCSDS.
Consultative Committee for Space Data Systems (CCSDS) packet	A source packet comprised of a 6-octet CCSDS defined primary header followed by an optional secondary header and source data, which together may not exceed 65535 octets.
Conversion	Transformation of downlinked spacecraft data types to ground system platform data types.
Custom Data Packet	A packet containing a subset of parameters that can be selected by the user at the time of request.
Cyclic Display Update Mode	A continuous update of parameters for a particular display.
Decommutation (Decom)	Extraction of a parameter from telemetry.
Discrete Values	Telemetry values that have states (e.g., on or off).

Dump	During periods when communications with the spacecraft are unavailable, data is recorded onboard and played back during the next period when communications resume. This data, as it is being recorded onboard, is encoded with an onboard embedded time and is referred to as dump data.
Enhanced HOSC System (EHS)	Upgraded support capabilities of the HOSC systems to provide multi-functional support for multiple projects. It incorporates all systems required to perform data acquisition and distribution, telemetry processing, command services, database services, mission support services, and system monitor and control services.
Exception Monitoring	A background process capable of continuously monitoring selected parameters for Limit or Expected State violations. Violation notification is provided through a text message.
Expected State Sensing	Process of detecting a text state code generator in an off-nominal state.
EXPRESS	An EXPRESS Rack is a standardized payload rack system that transports, stores and supports experiments aboard the International Space Station. EXPRESS stands for EXpedite the PRocessing of Experiments to the Space Station.
File transfer protocol (ftp)	Protocol to deliver file-structured information from one host to another.
Flight ancillary data	A set of selected core system data and payload health and status data collected by the USOS Payload MDM, used by experimenters to interpret payload experiment results.

Grayed out	Refers to a menu item that has been made insensitive, which is visually shown by making the menu text gray rather than black. Items that are grayed out are not currently available.
Greenwich Mean Time (GMT)	The solar time for the meridian passing through Greenwich, England. It is used as a basis for calculating time throughout most of the world.
Ground ancillary data	A set of selected core system data and payload health and status data collected by the POIC, which is used by experimenters to interpret payload experiment results. Ground Ancillary Data can also contain computed parameters (pseudos).
Ground receipt time	Time of packet origination. The time from the IRIG-B time signal received.
Ground Support Equipment (GSE)	GSE refers to equipment that is brought in by the user (i.e. equipment that is not provided by the POIC).
Ground Support Equipment Packet	A CCSDS Packet that contains data extracted from any of the data processed by the Supporting Facility and the format of the packet is defined in the Supporting Facility's telemetry database.
Huntsville Operations Support Center (HOSC)	A facility located at the Marshall Space Flight Center (MSFC) that provides scientists and engineers the tools necessary for monitoring, commanding, and controlling various elements of space vehicle, payload, and science experiments. Support consists of real-time operations planning and analysis, inter- and intra-center ground operations coordination, facility and data system resource planning and scheduling, data systems monitor and control operations, and data flow coordination.

IMAQ ASCII	A packet type that was added to TReK to support a very specific application related to NASA's Return to Flight activities. It is not applicable to ISS. It is used to interface with an infrared camera that communicates via ASCII data.
Limit Sensing	Process of detecting caution and warning conditions for a parameter with a numerical value.
Line Outage Recorder Playback	A capability provided by White Sands Complex (WSC) to play back tapes generated at WSC during ground system communication outages.
Measurement Stimulus Identifier (MSID)	Equivalent to a parameter.
Monitoring	A parameter value is checked for sensing violations. A message is generated if the value is out of limits or out of an expected state.
Parameter	TReK uses the generic term parameter to mean any piece of data within a packet. Sometimes called a measurement or MSID in POIC terminology.
Payload Data Library (PDL)	An application that provides the interface for the user to specify which capabilities and requirements are needed to command and control his payload.
Payload Data Services Systems (PDSS)	The data distribution system for ISS. Able to route data based upon user to any of a number of destinations.
Payload Health and Status Data	Information originating at a payload that reveals the payload's operational condition, resource usage, and its safety/anomaly conditions that could result in damage to the payload, its environment or the crew.
Payload Operations Integration Center (POIC)	Manages the execution of on-orbit ISS payloads and payload support systems in coordination/unison with distributed International Partner Payload Control Centers, Telescience Support Centers (TSC's) and payload-unique remote facilities.

Payload Rack Checkout Unit (PRCU)	The Payload Rack Checkout Unit is used to verify payload to International Space Station interfaces for U.S. Payloads.
Playback	Data retrieved from some recording medium and transmitted to one or more users.
Pseudo Telemetry (pseudo data)	Values that are created from calculations instead of directly transported telemetry data. This pseudo data can be created from computations or scripts and can be displayed on the local PC.
Remotely Generated Command	A command sent by a remote user whose content is in a raw bit pattern format. The commands differ from predefined or modifiable commands in that the content is not stored in the POIC Project Command Database (PCDB).
Science data	Sensor or computational data generated by payloads for the purpose of conducting scientific experiments.
Subset	A collection of parameters from the total parameter set that is bounded as an integer number of octets but does not constitute the packet itself. A mini-packet.
Super sampled	A parameter is super sampled if it occurs more than once in a packet.
Swap Type	A flag in the Parameter Table of the TReK database that indicates if the specified datatype is byte swapped (B), word swapped (W), byte and word swapped (X), byte reversal (R), word reversal (V) or has no swapping (N).
Switching	A parameter's value can be used to switch between different calibration and sensing sets. There are two types of switching on TReK: range and state code.

Transmission Control Protocol (TCP)	TCP is a connection-oriented protocol that guarantees delivery of data.
Transmission Control Protocol (TCP) Client	A TCP Client initiates the TCP connection to connect to the other party.
Transmission Control Protocol (TCP) Server	A TCP Server waits for (and accepts connections from) the other party.
Telemetry	Transmission of data collected form a source in space to a ground support facility. Telemetry is downlink only.
Telescience Support Center (TSC)	A TSC is a NASA funded facility that provides the capability to plan and operate on-orbit facility class payloads and experiments, other payloads and experiments, and instruments.
User Application	Any end-user developed software program that uses the TReK Application Programming Interface software. Used synonymously with User Product.
User Data Summary Message (UDSM)	Packet type sent by PDSS that contains information on the number of packets sent during a given time frame for a PDSS Payload packet. For details on UDSM packets, see the POIC to Generic User IDD (SSP-50305).
Uplink format	The bit pattern of the command or file uplinked.
User Datagram Protocol (UDP)	UDP is a connection-less oriented protocol that does not guarantee delivery of data. In the TCP/IP protocol suite, the UDP provides the primary mechanism that application programs use to send datagrams to other application programs. In addition to the data sent, each UDP message contains both a destination port number and a fully qualified source and destination addresses making it possible for the UDP software on the destination to deliver the message to the correct recipient process and for the recipient process to send a reply.

User Product	Any end-user developed software program that uses the TReK Application Programming Interface software. Used synonymously with User Application.
Web	Term used to indicate access via HTTP protocol; also referred to as the World Wide Web (WWW).

Appendix B Acronyms

Note: This acronym list is global to all TReK documentation. Some acronyms listed may not be referenced within this document.

AOS	Acquisition of Signal
API	Application Programming Interface
APID	Application Process Identifier
ASCII	American Standard Code for Information Interchange
CAR	Command Acceptance Response
CAR1	First Command Acceptance Response
CAR2	Second Command Acceptance Response
CCSDS	Consultative Committee for Space Data Systems
CDB	Command Database
CDP	Custom Data Packet
COR	Communication Outage Recorder
COTS	Commercial-off-the-shelf
CRR	Command Reaction Response
DSM	Data Storage Manager
EHS	Enhanced Huntsville Operations Support Center (HOSC)
ERIS	EHS Remote Interface System
ERR	EHS Receipt Response
EXPRESS	Expediting the Process of Experiments to the Space Station
ES	Expected State
FAQ	Frequently Asked Question
FDP	Functionally Distributed Processor
FSV	Flight System Verifier
FSV1	First Flight System Verifier
FSV2	Second Flight System Verifier
FPD	Flight Projects Directorate
FTP	File Transfer Protocol
GMT	Greenwich Mean Time
GRT	Ground Receipt Time
GSE	Ground Support Equipment
HOSC	Huntsville Operations Support Center
ICD	Interface Control Document
IMAQ ASCII	Image Acquisition ASCII
IP	Internet Protocol
ISS	International Space Station
LDP	Logical Data Path
LES	Limit/Expected State
LOR	Line Outage Recorder
LOS	Loss of Signal
MCC-H	Mission Control Center – Houston
MOP	Mission, Operational Support Mode, and Project
MSFC	Marshall Space Flight Center
MSID	Measurement Stimulus Identifier

NASA	National Aeronautics and Space Administration
OCDB	Operational Command Database
OS	Operating System
PC	Personal Computer, also Polynomial Coefficient
PCDB	POIC Project Command Database
PDL	Payload Data Library
PDSS	Payload Data Services System
PGUIDD	POIC to Generic User Interface Definition Document
POIC	Payload Operations Integration Center
PP	Point Pair
PRCU	Payload Rack Checkout Unit
PSIV	Payload Software Integration and Verification
RPSM	Retrieval Processing Summary Message
SC	State Code
SCS	Suitcase Simulator
SSP	Space Station Program
SSCC	Space Station Control Center
SSPF	Space Station Processing Facility
TCP	Transmission Control Protocol
TReK	Telescience Resource Kit
TRR	TReK Receipt Response
TSC	Telescience Support Center
UDP	User Datagram Protocol
UDSM	User Data Summary Message
URL	Uniform Resource Locator
USOS	United States On-Orbit Segment
VCDU	Virtual Channel Data Unit
VCR	Video Cassette Recorder
VPN	Virtual Private Network