

Programmable Telemetry Processor™

APPLICATIONS

- ▶ Satellite control networks
- ▶ Payload integration, testing, and simulation
- ▶ RF communication link testing and monitoring
- ▶ High-speed data acquisition and logging
- ▶ Ground network protocol conversion
- ▶ IP over Satellite (IP/SAT) communications gateway
- ▶ AFSCN (Air Force Satellite Control Network) interoperable edge devices

KEY FEATURES

- ▶ CCSDS/TDM telemetry and telecommand processing - complete solution from RF to network
- ▶ Interfaces with COTS satellite control software packages
- ▶ Space Link Extension (SLE) provider and user services
- ▶ Integrated KG control/status
- ▶ Integrated data quality monitor and bit error rate test tools



Versatile, modular, comprehensive, highly extensible: a complete CCSDS/TDM telemetry and telecommand front-end processing solution, linking spacecraft uplink/downlink with the ground segment.

PTP OVERVIEW The Programmable Telemetry and Command Processor (PTP) is a highly versatile, modular telemetry and command front-end processor for use in remote tracking stations and satellite operations centers. The PTP is also well suited for spacecraft integration and testing at the factory and on the launch pad. To support missions that employ bulk encrypted telemetry and command streams, the PTP provides a control and status interface for encryption/decryption equipment.

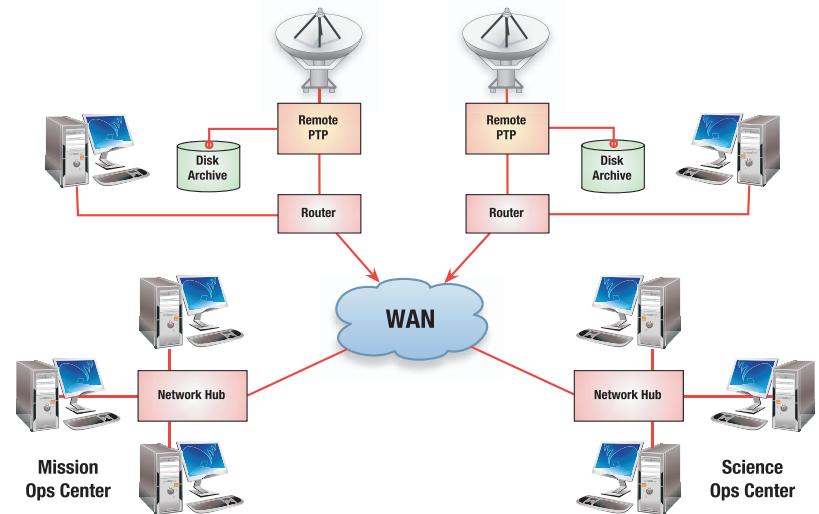
SATELLITE / GROUND GATEWAY The PTP acts as a gateway between spacecraft uplink/downlink and a distributed satellite control system. It accepts multiple serial telemetry downlinks and performs TDM or CCSDS telemetry processing functions, including frame synchronization, error control coding, and time tagging. Frame data with quality annotation and time tag is simultaneously logged to disk and routed to the control center via the network. The PTP receives commands from the control center for real-time uplink to the spacecraft, or for scheduled transmission (when the PTP is in

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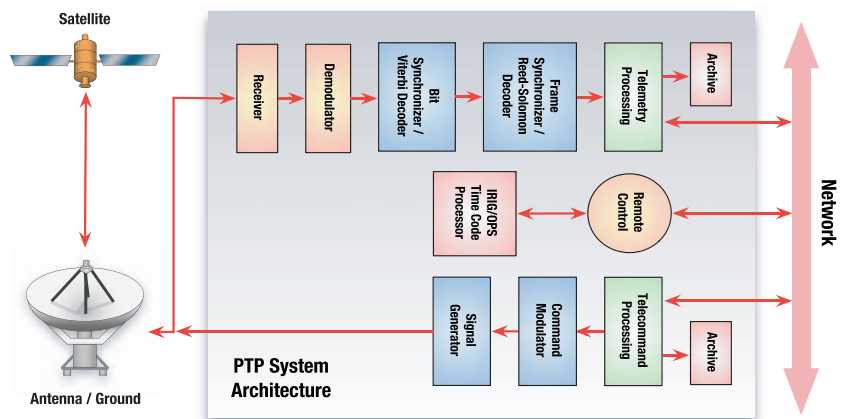
store-and-forward mode). It can perform all CCSDS telecommand processing, including COP-1 functions. PTP also provides local command probe verification and command echoes for command verification at the control center. For Space-Ground Link System (SGLS) applications, it supports ternary command formats.

BROAD, EXTENSIBLE PROTOCOL SUPPORT The PTP offers a wide variety of network encapsulation protocols to facilitate integration with different satellite control systems, and offers support for new protocol standards as they emerge. Leveraging its broad protocol support, the PTP can be configured to act as a **dedicated protocol translator** between incompatible network segments, transparently ingesting data in one format, converting it, and forwarding it on. Notable formats supported by the PTP include NASCOM RTP, IPDU, SFDU, LEO-T, and EDOS. PTP is also the first front-end system to support CCSDS Space Link Extension services with the AFSCN Adaptation Layer for interoperability between DoD, NASA, NOAA, and commercial tracking stations and control centers.

SIMULATION & TEST CAPABILITIES A highly-configurable TDM and CCSDS telemetry simulation capability for loopback testing is provided as part of PTP's built-in toolset. Also provided is a module offering comprehensive bit error rate test (BERT) functionality, which can be used to verify the integrity of uplink/downlink paths and network connections.



An example PTP deployment. In this configuration, the PTP acts as a gateway between spacecraft uplink/downlink and a distributed satellite control system.



System architecture of the PTP

EASY LOCAL OR REMOTE CONFIGURATION The PTP can be controlled locally or remotely via a highly functional, straightforward Graphical User Interface. A remote control library is also provided for integration with satellite control systems such as OS/COMET and EPOCH 2000, and a Simple Network Management Protocol (SNMP) agent is provided for integration with enterprise management platforms such as HP OpenView.

Programmable Telemetry Processor™ Specifications

PTP SPECIFICATIONS

Telemetry Processing

- Data rates up to 25 Mbps
- Integrated receiver, demodulator, bit synchronizer, and Viterbi decoder
- Frame synchronization, derandomization, Reed-Solomon decoding, and CRC decoding
- Turbo encoding and decoding
- Time tagging and data quality annotation
- CCSDS virtual channel sorting and packet processing
- IP over CCSDS or IP over HDLC protocol processing
- Disk logging and real-time network transfer

Telecommand Processing

- Accepts telecommand messages from control center
- Support for real-time and store-and-forward commanding
- CCSDS telecommand processing (COP-1)
- IP-over-CCSDS or IP-over-HDLC protocol processing
- Optional command echo

Simulation & Testing

- CCSDS and TDM telemetry simulation at data rates up to 25 Mbps
- CRC encoding, Reed-Solomon encoding, randomization, and convolutional coding
- Integrated data quality monitoring (CCSDS and TDM) and bit error rate test (BERT) tools
- Data logging and playback with high resolution time data correlation (TDC)

Communication Links

- High Performance Ethernet (10/100/1000) & ATM (OC-3) interfaces
- TCP/IP socket interface for network control and monitoring
- Real-time network data transfer (UDP, IP multicast, TCP client/server)
- Support for user encapsulation formats including NASCOM RTP, IPDU, SFDU, LEO-T, and EDOS
- SLE data services (FCLTU, RAF, RCF) with support for AFSCN Interoperability Standards
- IP over Satellite via Ethernet or serial interface

Receiver

- Frequency range: IF (50-90 MHz), L Band (1435-1545 MHz), and S Band (2200-2300 MHz)
- Demodulation: FM, Linear PM, AM, BPSK, QPSK
- Data rate: up to 20 Mbps

BPSK Subcarrier Demodulator

- Subcarrier range: 1 kHz to 5 MHz (1 Hz resolution)
- Data bandwidth: 100 Hz to 2.5 MHz
- Loop bandwidth: 1 Hz to 25 kHz
- Acquisition/tracking range: 2 x loop bandwidth

Bit Synchronizer / Viterbi Decoder

- Data rate: 10 bps to 20 Mbps
- PCM codes : NRZ-L/M/S, Biphase-L/M/S
- Loop bandwidth: 0.1% to 2%
- Convolutional code: Rate 1/2, Constraint Length (K) = 7, programmable G1/G2 order and polarity
- Symbol quantization: 1-bit hard-decision, 3-bit soft-decision
- Coding gain: >5 dB

Frame Synchronizer / R/S Decoder

- Data rate: 10 bps to 25 Mbps
- Sync pattern: up to 64 bits with programmable mask
- Acquisition strategy: programmable error threshold, check and flywheel frames, and bit slip window
- Derandomizer: $h(x) = x^8 + x^7 + x^5 + 1$
- Reed-Solomon decoder: CCSDS header RS (10,6) and frame RS (255,223) with interleave from 1 to 8
- CRC decoder: $g(x) = x^{16} + x^{12} + x^5 + 1$
- Time tag: IRIG-B, NASA-36, or GPS reference, 1 microsecond accuracy
- Support for TTL, RS-422, SGLS ternary
- QPSK ambiguity resolution

Telemetry Simulator / R/S Encoder

- Data source: CCSDS or TDM simulator, file playback, or network socket
- CCSDS channel coding: CRC, Reed-Solomon, pseudo-randomization, convolutional, and turbo
- PCM codes: NRZ-L/M/S, Biphase-L/M/S
- Data rate: 10 bps to 25 Mbps

BPSK Subcarrier Generator

- Subcarrier waveforms: sine or square wave
- Subcarrier range: up to 2 MHz
- Data rates: 1 bps to 1 Mbps
- Coherent or non-coherent

Signal Generator

- Frequency range: IF, L Band, S Band
- Modulation: FM, PM
- Modulation source: any combination of up to four signals

Physical Specifications

- 4U or 6U rackmount chassis (model-dependent)
- SBC w/ Pentium 4 2.8 Ghz, 1 GB RAM
- 1x80Gb or mirrored, hot-swap 2x80Gb SATA hard drives (model-dependent)
- 10/100 Ethernet for Monitor & Control
- Gigabit Ethernet
- DVD+-RW for program load & data storage
- PCI Slots: 3, 7, 11, or 12 (model-dependent)
- ISA Slots: 2, 3, 6 or 7 (model-dependent)

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