SLM-5650A Satellite Modem

Satellite Modems

Overview

Comtech EF Data's SLM-5650A Satellite Modem is compliant with the strict requirements defined in MIL-STD-188-165A, modem types I, II, IV, V and VI for applications on DSCS, WGS and commercial satellites. Data rates from 8 kbps to 155 Mbps and symbol rates from 32 ksps to 64 Msps are supported. The modem provides standard MIL-STD-188-114 (EIA-530 / RS-422), and EIA-613 (HSSI) serial interfaces, and can be optionally configured to support G.703 and Low Voltage Differential Signaling (LVDS) serial interfaces. It can also optionally be equipped with a 4-port 10/100/1000Base-T Ethernet Network Processor module that supports switching, routing and advanced Quality of Service protocols.

Typical Users

- Government
- Military
- Secure Commercial Networks

Common Applications

- Communications at-the-Pause
- Communications on-the-Move
- Rugged Environments
- Secure Networks

The SLM-5650A can be integrated with the Vipersat Management System (VMS) to provide fully automated network and capacity management. An AES-256 TRANSEC module, compliant with the FIPS-140-2 NIST standard is also available as an option. All traffic (including overhead and all VMS control traffic) is encrypted when using the TRANSEC module.

Advanced forward error correction (FEC) capabilities are a Comtech EF Data standard feature. Viterbi, Trellis, Concatenated Reed-Solomon, Sequential, Turbo Product Codes, and Low Density Parity Check codes (LDPC) are all supported.

Advanced FEC and modulation capabilities are integrated with the revolutionary DoubleTalk® Carrier-in-Carrier® bandwidth compression allowing for maximum state-of-the-art performance under all conditions. This combination of advanced technologies enables multi-dimensional optimization, allowing satellite communications users to:

- Minimize required satellite bandwidth
- Maximize throughput without using additional transponder resources
- Maximize availability (margin) without using additional transponder resources
- Enable use of a smaller BUC/HPA and/or antenna
- Or, a combination of the above to meet specific mission needs

Direct sequence Spread Spectrum is available as an option in conjunction with LDPC-based FEC and BPSK modulation. Spreading factors up to 128 are supported. Spread spectrum results in operation with ultra-low power spectral densities. This enables use of small antenna apertures when adjacent satellite interference (ASI) is an important consideration. It can also be utilized to provide low probability of detection / intercept (LPD/LPI) operation and/or strong resistance to jamming.
The IF interface supports 52 to 88, 104 to 176, and 950 to 2000 MHz frequency ranges.

Features

- MIL-STD-188-165A compliant (Types I, II, IV, V, VI)
- Selectable 70/140 MHz and 950 – 2000 MHz IFs
- AES-256 TRANSEC, FIPS-140-2 L2 certified
- Dynamic bandwidth allocation with Vipersat Management System
- Support for bridged point-to-multipoint network architecture
- DoubleTalk Carrier-in-Carrier bandwidth compression
- BPSK, QPSK, OQPSK, 8PSK, 8-QAM, 16-QAM
- Viterbi, Reed Solomon, Trellis, Sequential, Turbo Product Code (TPC), & Low Density Parity Check FEC
- FEC rates 1/1, 5/16, 1/2, 2/3, 3/4, 5/6, 7/8, and others
- Direct sequence spread spectrum, integer factors 2-128, plus 256 and 512
- 8 kbps to 155.52 Mbps
- IESS-308, -309, -310, -315
- ASYNC RS-485 overhead channel & AUPC
- Asymmetrical loop timing & data source bit synchronization
- Ethernet interface for remote control using HTTP, Telnet and Simple Network Management Protocol (SNMP)
- EIA-485 and EIA-232 interface for remote control

Compatibility

The SLM-5650A is interoperable with the OM-73, SLM-3650, MD-1352(P)/U (BEM-7650), SLM-7650, SLM-8650, CDM-570, CDM-600/600L, CDM-625, CDD-562, CDD-564, DMD20, DMD2050, and DMD2050E satellite modems. Special ordering option enables compatibility with the SDM-9000 modem using legacy Triple Viterbi modes.

Data Interfaces

The modem supports EIA-530 (RS-422), EIA-612/613 (HSSI) as standard features. Optional interface modules are available to support G.703, LVDS serial, or 4-port Gigabit Ethernet interfaces.

TRANSEC Module

An optional transmission security (TRANSEC) module provides bulk AES-256 encryption/decryption certified to FIPS-140-2 Level 2. The TRANSEC module encrypts all traffic sent over the air, including data traffic, overhead channel and Vipersat Management System messages (if present).

Advanced Iterative Forward Error Correction

Turbo coding provides superior error correction performance over Viterbi, Trellis and Reed-Solomon FEC. The SLM-5650A TPC is compatible with Intelsat IESS-315 and Comtech EF Data's CDM-570, CDM-600, CDM-625, SLM-3650, SLM-7650, DMD20, DMD2050, and DMD2050E Satellite Modems and the CDD-562/564 IP Demodulators. The high-performance LDPC is compatible with the CDM-600, CDM-625, DMD2050, and DMD2050E. The ultra low latency LDPC is compatible with the CDM-625.

ASYNC Overhead Channel / AUPC

An asynchronous overhead channel supporting 2- and 4-wire RS-485, as well as RS-232 can be optionally configured. This overhead channel is typically used to support control and monitoring of equipment external to the modem in a remote network. The ASYNC overhead channel can be provisioned in conjunction with any of the supported traffic interfaces (RS-422, HSSI, G.703, LVDS or Ethernet). Automatic Uplink Power Control (AUPC) is available to maintain a desired Eb/No at the demodulator despite link fades due to excessive rain or other power level variations.

Network Processor

The Network Processor (NP) module provides a wide variety of advanced Internet Protocol (IP) features including routing, switching, Quality of Service, and Vipersat dynamic bandwidth control.

Networking

With the NP module installed, the modem can be configured as an Ethernet switch or as a high-speed router. Networking options include configuration of a bridged point–to-multipoint network, which enables bridged network connectivity (desired in many satellite networks carrying encrypted traffic) in a hub-spoke network architecture.

Multicast

Multicast traffic forwarding is supported via static multicast addressing, dynamic multicast address learning through IGMP router and IGMP Proxy, and via the bridged point-to-multipoint mode of operation.

Flow Control

Flow Control is supported via Ethernet pause frames (IEEE 801.3)

Proxy ARP

Proxy ARP is supported to enable transparent subnets.

Quality of Service (QoS)

The NP module supports multi-level QoS to reduce jitter and latency for real time traffic, provide priority treatment to mission critical applications and allow non-critical traffic to use the remaining bandwidth. Supported functionality includes differentiated services code point (DSCP) in accordance with RFCs 2474 and 2475, Expedited Forwarding in accordance with RFC 3246, and Per Hop Behavior in accordance with RFC 3247.

VMS Bandwidth Management

The Vipersat Management System (VMS) is the engine that provides dynamic Single Carrier per Channel (dSCPC) bandwidth management of the space segment.

When a remote in the network has an application to transport over the satellite link, dSCPC technology provides the mechanism to automatically establish the SCPC carrier for that transmission. dSCPC resizes the carrier based on the increase or decrease in applications being sent over the link, and it returns the remote to its home state once the application is completed. dSCPC yields true bandwidth-on-demand, giving the user the low-latency, low-jitter dedicated SCPC connection when it is needed for real-time applications, such as Voice over IP (VoIP), video conference, broadcasts and large applications (file or image transfers).

VMS automates bandwidth utilization while optimizing space segment efficiency. It allows intelligent management of satellite networks through port and system configuration and alarm management of the protocol, modem, RF equipment and IP broadband networking. The graphical user interface of VMS enables centralized network configuration and management. It provides auto-detection of satellite modems, configuration and monitoring of the modems, and real-time views of network health and transmission quality. These allow operators to easily configure and monitor dynamically controlled networks. The VMS can be configured to dynamically allocate satellite network capacity in a variety of ways. Supported modes for capacity allocation include:

1. Entry channel mode, which allows a modem to automatically enter/exit a network, sets a fixed capacity for the terminal when in the network.
2. Load: Capacity allocation based on load demand of terminals on the network.
3. Type of Service (ToS): Type and priority based allocation using DiffServ Code Point (DSCP) fields.

Both shared forward link and multiple point-to-point hub-spoke architectures can be configured and dynamically controlled by the VMS.

Antenna Handover

Supports lossless, low-latency antenna handover in conjunction with the CRS-311-AH antenna handover switch controller.

Expanded Dynamic Range

The modem exceeds the MIL-STD-188-165A input signal dynamic range requirements by extending the low signal input level requirement of –55 dBm to down to –70 dBm for lower baud rate carriers.

Redundancy

Ultra high reliability, redundant configurations are supported in conjunction with Comtech EF Data's CRS-311 and CRS-300 switches. The CRS-311 can be configured to support 1:1 redundancy for any SLM-5650A configuration. The CRS-300 provides the same functionality for 1:N redundant system architectures.

Network Management / Remote Control

The modem supports access to network management information via HTTP using a standard web browser. SNMP and Telnet remote control is also supported. The modem includes separate Ethernet and EIA-485/EIA-232 remote control interfaces. Remote control can also be accomplished via the Ethernet ports of the optional Network Processor. Secure network management via Secure Sockets Layer (SSL), Secure Shell (SSH) and SNMPv3 are available as options.

Doubletalk Carrier-In-Carrier

DoubleTalk Carrier-in-Carrier is based on patented bandwidth compression technology originally developed by Applied Signal Technology, Inc. Using "Adaptive Cancellation" it allows transmit and receive carriers of a two-way link to share the same transponder space. Figure 1 shows the typical full-duplex satellite link, where the two carriers are adjacent to each other. Figure 2 shows the typical DoubleTalk Carrier-in-Carrier operation, where the two carriers are overlapping, thus sharing the same spectrum.

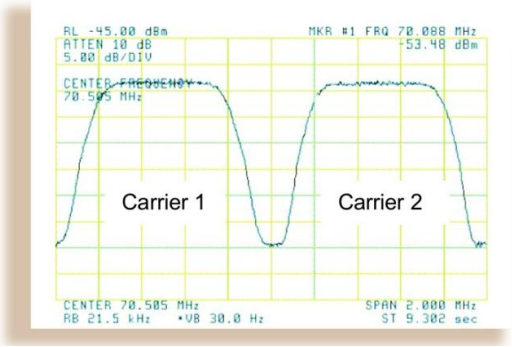


Figure 1

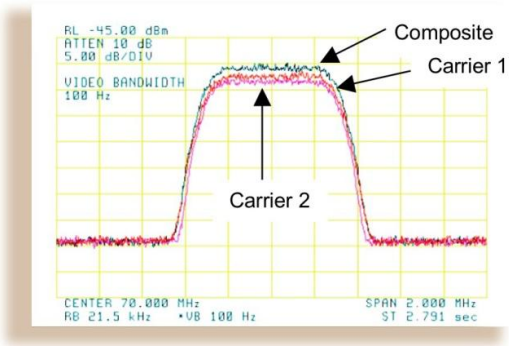


Figure 2

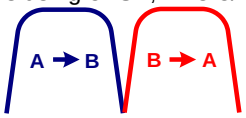
When observed on a spectrum analyzer, only the Composite is visible. Carrier 1 and Carrier 2 are shown in Figure 2 for reference only.

DoubleTalk Carrier-in-Carrier is complementary to all advances in modem technology, including advanced FEC and modulation techniques. As these technologies approach theoretical limits of power and bandwidth efficiencies, DoubleTalk Carrier-in-Carrier utilizing advanced signal processing techniques provides a new dimension in bandwidth efficiency.

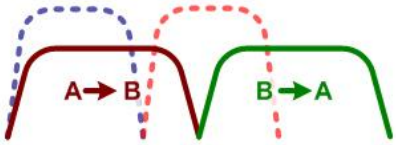
DoubleTalk Carrier-in-Carrier allows satellite users to achieve spectral efficiencies (i.e. bps/Hz) that cannot be achieved with traditional links. For example, DoubleTalk Carrier-in-Carrier when used with 16-QAM approaches the bandwidth efficiency of 256-QAM (8bps/Hz). As DoubleTalk Carrier-in-Carrier allows equivalent spectral efficiency using a lower order Modulation and/or FEC Code, it can simultaneously reduce CAPEX by allowing a smaller BUC/HPA and/or antenna.

DoubleTalk Carrier-in-Carrier can be used to save transponder bandwidth and/or transponder power thereby allowing successful deployment in bandwidth-limited as well as power-limited scenarios. The following example illustrates the typical process for implementing DoubleTalk Carrier-in-Carrier in a power-limited scenario:

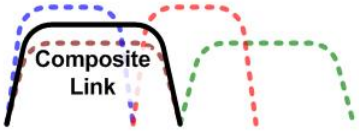
The conventional link is using 8PSK, TPC 3/4:



Spread the signal by switching to a lower order modulation and/or FEC code – say QPSK, TPC 7/8. This increases the total transponder bandwidth, while reducing the total transponder power:



Now using DoubleTalk Carrier-in-Carrier, the second QPSK, TPC 7/8 carrier can be moved over the first carrier – thereby reducing the total transponder bandwidth and total transponder power when compared to the original side-by-side 8PSK, TPC 3/4 carriers:



Demodulation Only & Asymmetric Data Rates

In order to cost-effectively enable hub-spoke networks, two cost saving configurations are supported. First, the SLM-5650A is available in a demodulation-only version (SLM-5650AD). This configuration is often used as a hub demodulator. Hub-spoke networks using the CDD-564 multi-channel demodulators are also supported.

There is also a reduced cost configuration option that allows the remote modems to receive a large shared outbound and transmit a smaller return channel.

Specifications

Operating Frequency Range	52 to 88 MHz, 104 to 176 MHz, 950 to 2000 MHz in 100 Hz steps
Modulation Types	BPSK, QPSK, OQPSK, 8PSK, 8-QAM, 16-QAM
Spreading Factors	Integer factors 2-128, plus 256 and 512; BPSK LDPC only
Digital Data Rate	EIA-530: 64 kbps to 20 Mbps, 1 bps steps EIA-613: 64 kbps to 51.84 Mbps, 1 bps steps Gigabit Ethernet: 8 kbps to 155.52 Mbps
Symbol Rate	32 ksps to 64 Msps
External Reference Input	TNC connector, 1, 5, or 10 MHz, selectable
INT REF Stability	1 x 10^{-7}
Scrambling	V.35, OM-73 and synchronous
IDR/IBS Framing Compatibility	Support for IDR and IBS framing. Allows basic IDR/IBS open network compatible operation
Built-in Test (BIT)	Fault and status reporting, BER performance monitoring, IF loopback, programmable test modes, built in Fireberd emulation
Summary Faults	Reported via front panel LEDs, 15-pin D sub, FORM C relay contacts for TX, RX, common equipment faults, and TX and RX alarms
Unit Management	EIA-485, EIA-232, 10/100Base-T Ethernet with HTTP, Telnet and SNMP

Modulation

Output Power	+10 to –40 dBm, adjustable in 0.1 dB steps
Output Return Loss	14 dB (70/140 MHz) 9 dB (L-Band)
Output Impedance	50 Ω
Spurious	From Carrier + symbol rate to 500 MHz -51 dBc
Harmonics	From carrier (CW) to 4000 MHz -60 dBc
TX Clock Source	INT, TX terrestrial, and data source sync, RX satellite
Output Connectors	TNC for 52 to 88 MHz, 104 to 176 MHz Type “N” for 950 to 2000 MHz

Demodulation

Input Carrier Power	70/140MHz bands: +10 to -55dBm L-Band: +10 to –55 dBm carrier (SR > 3.2 Msps) +10 to [-55 - $10\log_{10}(3.2/SR)$], (SR ≤ 3.2 Msps)
Maximum Composite Power	+20 dBm or +40 dBc
Input Impedance	50 Ω
Input Connectors	TNC for 52 to 88 MHz, 104 to 176 MHz Type “N” for 950 to 2000 MHz
Carrier Acquisition Range	± 30 kHz, selectable
Input Return Loss	14 dB (70/140 MHz) 9 dB (L-Band)
Buffer Clock	INT, TX terrestrial, RX satellite
Doppler Buffer	32 to 16,777,216 bits, selectable

Coding Options

Uncoded	Standard	1/1
Viterbi	Standard	K=7,1/2, 3/4, and 7/8 rates
Viterbi & Reed-Solomon	Standard	Closed network, per IESS-308, IESS-308 v2 & IESS-309
Trellis	Standard	Per IESS-310
Trellis and Reed-Solomon	Standard	Per IESS-310
Triple Viterbi	Optional	Legacy SDM-9000 compatibility
Sequential	Optional	1/2, 3/4, and 7/8 rates
Turbo Product Code (TPC)	Optional	5/16, 21/44, 3/4, and 7/8 TPC per IESS-315
Low Density Parity Check (LDPC)	Optional	1/2, 2/3, 3/4, and 7/8 HP, LL, and ULL modes

Available Options

How Enabled	Option
FAST	Data rates to 5, 10, 20, 52 or 155 Mbps
FAST	8PSK/8-QAM and 16-QAM
FAST	TPC to 5, 10, 20, 52 or 155 Mbps
FAST/Hardware	LDPC to 5, 10, 20, 46 Mbps
FAST	Vipersat Management System
FAST	Diff-Serv QoS
FAST	Secure Network Management (SSL/SSH/SNMPv3)
FAST	ASYNC RS-485/232 overhead channel /AUPC
FAST	Sequential FEC
FAST	DoubleTalk Carrier-in-Carrier
FAST	Asymmetric TX/RX data rate levels
FAST	Bridged point- to-multipoint
FAST	SDM-9000 compatibility (including Triple Viterbi)
FAST	Spread Spectrum (DSSS and/or DSSS-MA)
Hardware	G.703 data interface
Hardware	LVDS data interface
Hardware	TRANSEC module
Hardware	Gigabit Ethernet Bridge or Network Processor
Hardware	Extended Operational Temperature
Hardware	24 VDC power supply

Environmental And Physical

Prime Power	90 to 264 VAC, 47 to 63 Hz 130 W (max), 90 W typical 24 VDC optional
Mounting	1RU
Dimensions (height x width x depth)	1.71” x 19” x 19” (4.3 x 48 x 48 cm)
Weight	≤ 12 lbs (5.5 kg)
Temperature, Operating Extended Temp Option:	0 to 50°C (32 to 122°F) -32° to 50°C (-25 to 122°F)
Temperature, Storage (Non-operational)	-40 to +70°C (-40 to 158°F)
Humidity	0 to 95%, non-condensing

BER Performance

Example Modes and Performance

Mod / FEC	Code Rate	Eb/No Guaranteed (Typical)				Data Rate Range (kbps)
		10^{-6}	10^{-7}	10^{-8}	10^{-10}	
Legacy Modes						
QPSK/OQPSK VIT	1/2	6.1 (5.7)	6.7 (6.2)	7.2 (6.6)	-	64 - 51,840
QPSK/OQPSK VIT	3/4	7.5 (6.9)	8.2 (7.6)	8.8 (8.3)	-	64 - 51,840
QPSK/OQPSK VIT	7/8	8.6 (7.9)	9.2 (8.5)	10.2 (9.4)	-	64 - 51,840
QPSK/OQPSK VIT R-S	1/2	4.1 (3.6)	4.2 (3.8)	4.4 (4.0)	5.0 (4.6)	64 - 51,840
QPSK/OQPSK VIT R-S	3/4	5.6 (4.9)	5.8 (5.1)	6.0 (5.3)	6.3 (5.6)	64 - 51,840
QPSK SEQ	1/2	5.0 (4.5)	5.4 (4.9)	5.8 (5.3)	-	64 - 2,500
QPSK SEQ	3/4	5.9 (5.4)	6.4 (5.9)	6.8 (6.3)	-	64 - 3,750
QPSK SEQ	7/8	7.3 (6.8)	7.8 (7.3)	8.4 (7.9)	-	64 - 4,375
8PSK TRE	2/3	7.3 (6.8)	8.1 (7.6)	8.8 (8.3)	-	256 - 51,840
8PSK TRE R-S	2/3	6.2 (5.7)	6.5 (6.0)	6.7 (6.2)	7.3 (6.8)	256 - 51,840
TPC Modes						
BPSK TPC	5/16	2.5 (2.0)	2.8 (2.3)	3.1 (2.6)	3.4 (2.9)	64 - 20,000
BPSK TPC	21/44	3.3 (2.8)	3.4 (2.9)	3.5 (3.0)	3.7 (3.2)	64 - 30,545
QPSK TPC	21/44	3.3 (2.8)	3.4 (2.9)	3.5 (3.0)	3.7 (3.2)	64 - 61,091
QPSK TPC	3/4	4.1 (3.6)	4.3 (3.8)	4.6 (4.1)	5.5 (5.0)	64 - 96,000
QPSK TPC	7/8	4.5 (4.0)	4.6 (4.1)	4.7 (4.2)	4.8 (4.3)	64 -112,000
8PSK TPC	3/4	6.5 (5.8)	6.9 (6.0)	7.2 (6.3)	7.8 (7.3)	64 -144,000
8PSK TPC	7/8	7.1 (6.6)	7.2 (6.7)	7.3 (6.8)	7.5 (7.0)	64 -155,000
16-QAM TPC	3/4	7.6 (7.0)	7.95(7.3)	8.3(7.7)	9.0 (8.5)	64 -155,000
16-QAM TPC	7/8	8.2 (7.7)	8.35(7.8)	8.5(7.9)	8.8 (8.3)	64 -155,000
LPDC Modes						
High Performance						
BPSK LDPC	1/2	2.0 (1.7)	2.1 (1.8)	2.2 (1.9)	2.3 (2.0)	8 - 15,000
QPSK LDPC	1/2	2.0 (1.7)	2.1 (1.8)	2.2 (1.9)	2.3 (2.0)	32 - 30,000
QPSK LDPC	2/3	2.3 (2.0)	2.4 (2.1)	2.5 (2.2)	2.6 (2.3)	42.7 -40,000
QPSK LDPC	3/4	3.0 (2.6)	3.1 (2.7)	3.2 (2.8)	3.3 (3.0)	48 - 45,000
8-QAM LDPC	2/3	4.6 (4.2)	4.7 (4.3)	4.8 (4.4)	4.9 (4.5)	256 - 41,000
8-QAM LDPC	3/4	5.6 (5.2)	5.7 (5.3)	5.8 (5.4)	5.9 (5.5)	256 - 46,000
16-QAM LDPC	3/4	6.8 (6.2)	6.9 (6.4)	7.0 (6.6)	7.1 (6.8)	256 - 46,000
Low Latency						
BPSK LL	0.378	1.9 (1.6)	2.0 (1.7)	2.1 (1.8)	2.2 (1.9)	8 - 5,000
BPSK LL	0.451	2.1 (1.8)	2.2 (1.8)	2.3 (2.0)	2.4 (2.1)	8 - 5,000
BPSK LL	0.541	2.2 (1.9)	2.3 (2.0)	2.4 (2.1)	2.5 (2.2)	8 - 5,000
QPSK LL	1/2	2.3 (2.0)	2.4 (2.1)	2.5 (2.2)	2.6 (2.3)	32 - 5,000
QPSK LL	2/3	3.1 (2.8)	3.2 (2.9)	3.3 (3.0)	3.4 (3.1)	42.5 – 5,000
QPSK LL	3/4	3.8 (3.5)	3.9 (3.6)	4.0 (3.7)	4.1 (3.8)	47.7 – 5,000
QPSK LL	7/8	4.6 (4.3)	4.7 (4.4)	4.8 (4.5)	4.9 (4.6)	55.8 – 5,000
8-QAM LL	2/3	5.5 (5.2)	5.6 (5.3)	5.7 (5.4)	5.8 (5.5)	256 – 5,000
8-QAM LL	3/4	6.3 (6.0)	6.4 (6.1)	6.5 (6.2)	6.6 (6.3)	256 – 5,000
16-QAM LL	2/3	6.6 (6.3)	6.7 (6.4)	6.8 (6.5)	6.9 (6.6)	256 – 5,000
16-QAM LL	3/4	7.4 (7.1)	7.5 (7.2)	7.6 (7.3)	7.7 (7.4)	256 – 5,000
Ultra Low Latency						
BPSK ULL	1/2	3.1 (2.8)	3.4 (3.1)	3.7 (3.4)	3.8 (3.5)	8 - 2,000
QPSK ULL	1/2	3.1 (2.8)	3.4 (3.1)	3.7 (3.4)	3.8 (3.5)	32 - 2,000
QPSK ULL	2/3	3.6 (3.3)	3.9 (3.6)	4.2 (3.9)	4.3 (4.0)	41.8 - 2,000
QPSK ULL	3/4	4.1 (3.8)	4.2 (3.9)	4.7 (4.4)	4.8 (4.5)	47.0 - 2,000

SLM-5650A Rear Panel

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