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GPS Constellation Simulators

Support Tools

&

Navigation Products

Revision Nov 2001

Closed Loop Operation of the LabPro-CL

A High Performance GPS Constellation Simulator designed for closed loop operation in multi-sensor dynamic simulation suites

The **LabPro** constellation simulator is an exciting product built around our high performance multi-channel L_1 L_2 P C/A WAAS satellite signal generation engine. This engine is wedded with our Tapestry Windows2000 operating software available in two configurations: **Scenario** or **Closed-loop**.

In the standard ***Scenario*** configuration, Tapestry performs all environmental and dynamic vehicle modeling in addition to the GPS system functions. This modeling includes:

- 6 degree-of-freedom jerk limited motion generation,
- Dynamic satellite attenuation and masking based on vehicle silhouette,
- Auxiliary sensor data generation such as IMU, Gyro, Accelerometer, Altimeter, and other sensor types,
- Error modeling associated with auxiliary sensors,
- RAIM and WAAS capability.
- Customization of Navigation Data Bit telemetry messages
- Discrete TTL level outputs associated with simulation events.

Tapestry-constructed scenarios are inherently file based and can be repeatedly and deterministically executed.

As an alternative to Scenario operational mode, the LabPro can be procured in a ***Closed-loop (CL)*** configuration. In CL configuration, vehicle modeling and the motion profile are controlled real-time by an external process via a remote data interface. The allowable interface types are

- GPIB/IEEE-488,
- Ethernet,
- SCRAMNet.

This system is designed for the following applications:

- Flight operational and Safety trainers: These include aircraft, helicopters and ground based systems.
- Multi-sensor qualification and certification laboratories
- Closed loop feedback systems.
- As a drop-in replacement to the STEL-7200 simulators.

The remainder of this article outlines the Closed-Loop operating configuration for the LabPro. The appendix provides a detailed ICD for the end user.

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LabPro-CL (closed loop)

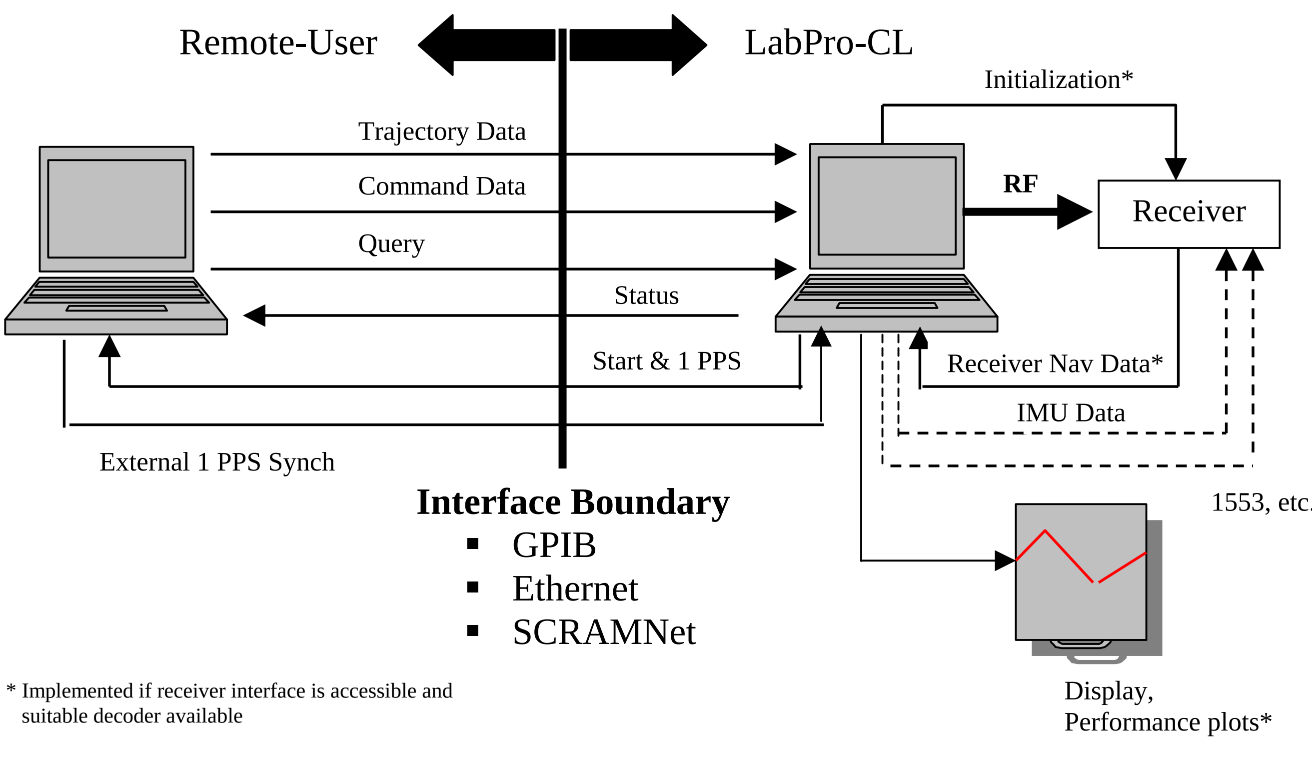
The LabPro-CL provides 10-14 simultaneous GPS satellite signals in one of two configurations:

- L_1 L_2 P C/A WAAS
- L_1 P C/A WAAS

In either arrangement, the LabPro-CL accepts modeling and input trajectory data from the Remote-User to construct the appropriate GPS RF outputs. Simply said, the Remote-User models the vehicle, the LabPro-CL models the GPS and performs the range computations. The dialog between the LabPro and Remote-User is implemented in one of the following real-time interfaces:

- GPIB/IEEE-488 (master or slave),
- Ethernet,
- SCRAMNet.

*(**Note:** the GPIB-master closed loop mode is a drop-in replacement for the Stanford Telecom 7200 series constellation simulators using the trajectory mode interface!)*. The following figure schematically illustrates the LabPro-CL and User.



Using the remote interface, there several message types from the Remote-User to the LabPro Tapestry system and from the LabPro to the Remote-User. Relative to the Remote User the outgoing messages are

- Initialization,
- Vehicle Trajectory Data (motion profile)
- Special affects messages (range ramp, file upload/download …)
- Ephemeris/almanac downloads
- System Query Messages.
- 1-PPS Start Command

The incoming message from the LabPro-CL is

- Status Response message.
- Acknowledgement
- Uploaded data

Additionally, the LabPro has several internal messages mechanized to interface to the GPS receiver under test. These messages allow the receiver to be initialized and provide possible acquisition aiding such as almanac and ephemeris. If an appropriate navigation data message filter is available, the LabPro-CL will compute and display the difference between the input trajectory navigation data (position and velocity) and the derived navigation data from the receiver under test. We also have available optional interfaces for ICD-GPS-059 1553 and Arinc429, and an IMU expansion card to provide outputs for the SLDC Honeywell HG-1700 and many of the RS422 AMRAAM formats. Other sensors can be provided if desired.

Our 1-PPS is synchronized with the 1 second GPS rollovers. The first rising edge signals the start of the simulation. Additionally, we can lock our 1-PPS to an external 1-PPS input.

A brief overview of the various message types is provided:

(a) Command Data Messages

The Remote-User may configure the modeling associated with the simulation in one of two ways: using the Tapestry GUI to setup and write the simulation database, or use the remote interface. If the remote interface is used, the following messages can be sent priori to the start of the trajectory data messages.

- Almanac upload – replaces the almanac stored in the dBase.
- Ephemeris upload – replace the ephemeris stored in the dBase.
- Msc. Sub frame 4 and 5 parameters – Ionosphere, UTC, etc.
- Vehicle Silhouette - replace the silhouette stored in the dBase.
- Set power: L_1 L_2
- Set Satellites – commands satellites to be generated

- Start 1PPS – this starts the 1 PPS if not already started
- Stop 1PPS – this stops the 1 PPS if not already stopped.

The following messages can be sent during a simulation asynchronously:

- Adjust Power by channel.
- Set Satellite by channel – this can add or drop a Satellite.
- Start, Stop, Pause, Reset

At a regular rate, the user must send the vehicle trajectory message. This message is used as the vehicle location and to compute the output GPS line-of-sight data to be broadcast. It is described in more detail in the following paragraph.

(b) Trajectory Data Messages:

The trajectory message is the mechanism that allows the Remote-User to control the time, position, and dynamics of the simulated vehicle. The first trajectory message received is a special message that sets the initial time and position for the simulation. Subsequent trajectory messages can be provided asynchronously, or at a maximum rate of 20Hz, or as infrequent as once. Trajectory messages can be preloaded (a large input buffer queue is available) or loaded asynchronously. They contain a time of applicability. If this time differs with current true system time, the message is either buffered until needed or propagated to the current time using linear extrapolation.

In closed loop operating mode, the user inputs fixed point formatted Earth-Centered-Earth-Fixed (ECEF) trajectory data with the following content:

- Time of Applicability of message
- Position X, Y, Z (meters)
- Velocity V_X V_Y, V_Z (m/s)
- Acceleration A_X A_Y, A_Z (m/s^2)
- Jerk J_X J_Y, J_Z (m/s^3)
- Attitude $\varphi_{R,}$ φ_P, φ_H (radians)
- Angular Rates, $\omega_{R,}$ ω_P, ω_H (radian/sec)

If any of the input parameters are missing we will compute them real-time using numerical differentiation.

(c) System Query Messages / Status Response Messages:

The Remote-User can query the LabPro at any time to obtain a formatted fixed-point status message. The available status messages are:

- Query Time – GPS week and seconds into week are returned.
- Query Satellites – generated satellite IDs returned by channel
- Query BIT – the user may run the low level BIT on the hardware.

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- Query Power – current power by channel is returned

(d) 1 PPS /Start Command

To compliment the overall system in which the LabPro is a component, we have implemented our 1PPS in a flexible format. The LabPro 1 PPS is software controlled and can be started in two modes. Nominally, the first rising edge of the 1PPS signals the start of the simulation (the first photon is generated at RF). This 1 PPS is synchronized to the 1 second rollovers in GPS to better than 25 nanoseconds one-sigma. When the simulation is completed, the 1 PPS output terminates. The remote user controls the second operational mode by the use of the start/stop 1 PPS Command message. In this case the 1 PPS will start on command even though the simulation has not yet started. When the simulation actually starts, the 1 PPS will snap to alignment with the 1 second GPS rollovers.

In addition, we can lock our 1-PPS to an external one-time pulse or 1-PPS input train. This allows the user to control precisely when our simulator starts. This feature allows us to synchronize to an external timing signal such as IRIG, or live GPS satellites if desired.

Summary

The LabPro-CL is an extremely powerful component within a distributed simulation system using GPS sensors. The LabPro has been used with great success in:

- Flight operational trainers – commercial aircraft and helicopters
- Flight safety trainer,
- Military multi-sensor qualification and certification laboratories
- As a replacement to the STEL-7200 simulators.
- As a pseudolite synchronized with live GPS satellites.

The LabPro-CL is controlled using a high speed data transfer interface such as GPIB and has been mechanized to reduce transport delay by implementing a robust data queuing and extrapolation algorithm. It will become an invaluable tool for WAAS trainers and continue to be an important military test component.

The LabPro can be flexibly configured to include 1553 or Arinc429 interfaces. In addition, a strapdown IMU output card is available implementing the Honeywell HG1700 SDLC and RS422 AMRAAM sensors.

The LabPro is packaged in a 5U rack-mount chassis, a 2U rack-mount keyboard, and popup monitor (optional). All operating software is preinstalled and the system is warranted for 1 year with optional extensions. They system can be calibrated on site without the need to be returned to the factory.

Appendix
Interface Control Document for the LabPro-CL

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1. Scope

This document describes the electrical and data interface for the **Tapestry GPS Constellation Simulator** System configured with the Real Time Closed Loop Control option. The interface consists of the data exchange between an external vehicle motion generator (EMG) and the Tapestry Computer System (TCS). The physical interface can be either

- GPIB
- Ethernet,
- SCRAMNet.

In addition, this document provides a description of the steps necessary to operate the Tapestry in the real time closed loop control mode. It is assumed that the user is familiar with the operation of the Tapestry system in the standard scenario based mode. The use of the Tapestry in scenario mode is described in the Tapestry Users Manual supplied with your simulator.

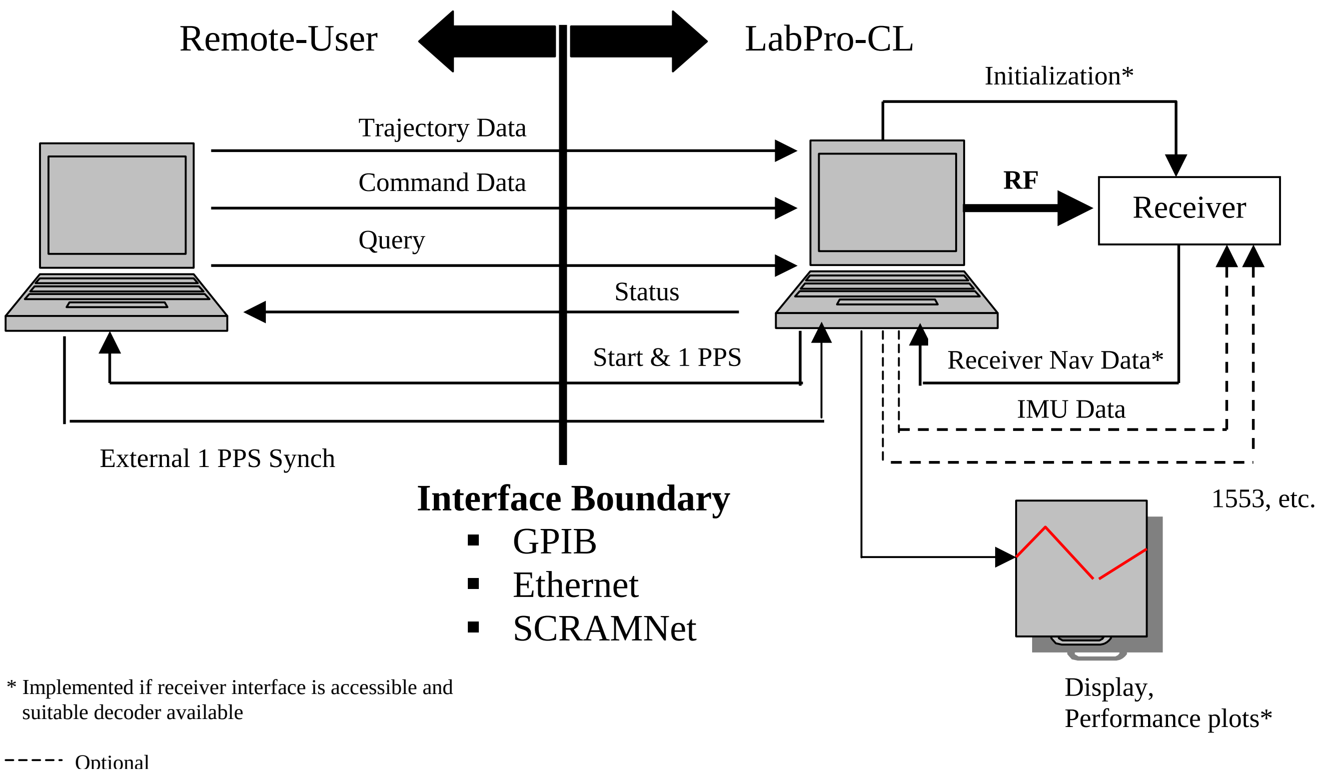

Figure 1

Figure 1 provides a block diagram of the Tapestry configuration in real time (remote) mode. This mode differs from the nominal Tapestry configuration described in the users manual. Nominally Tapestry consist of an digital and RF hardware engine (ENGINE) controlled by a high speed computer with commands and communication required by the ENGINE generated by the Tapestry software - *requiring no user or third party software*.

In closed-loop configuration, the ENGINE receives commands from a user supplied external motion generation (EMG) source. In this mode, the EMG must provide the necessary data, control, and timing required to operate the ENGINE properly. This document details the messages and interface particulars required to achieve this.

The EMG hardware and software is the sole responsibility of the purchaser of the Tapestry. To facilitate the development of this software, several PC based programs and C source code fragments are provided by Navigation Laboratories that can be used to ease the development of the EMG software. This development package is contained in the **\Tapestry\RUNS\REMOTE** sub-directory on the Tapestry system. This directory contains a pre-built remote simulation scenario that can be used as a beginning point for the EMG developer. A **readme.doc** text file is contained in the sub-directory that describes the scenario and code fragments. You may use these code fragments within your software without restriction.

The EMG controls the GPS simulation through trajectory messages sent to the TCS during a simulation. Several messages are supported from the EMG to the TCS (described in detail later in this document):

- Initialize Simulation Message - Indicates simulation mode, simulation start time, and initial position or channel assignments. Sent once per simulation.
- Trajectory Profile Message - Indicates vehicle position, velocity, acceleration, and jerk in earth-centered-earth-fixed (ECEF) coordinates. Sent at a maximum rate of 10 Hertz. This data type is used when the TCS is commanded into TRAJECTORY mode.
- Platform Attitude Message - Indicates vehicle attitude. Must be appended to Trajectory Profile Message.
- Stop Simulation Message - Indicates that the simulation is over. Sent once per simulation
- Range Maintenance Message - Range and range derivatives used during a simulation. This data type is used when the TCS is commanded into RANGE mode.
- Set Range Message - SVID/Channel assignment with initial pseudorange.
- Ramp Message - The given SVID will be ramped at the given time.
- Navigation Data Message - Updated GPS data message for a given SVID.

- Power Profile Message - Attenuation levels for a given SVID.
- Clock Request Message - Turns on the Tapestry's GPIB Clock Message.
- Data Extraction Request Message - Turns on the Tapestry's GPIB Data Message.
- Download Request - Transfers files from the Tapestry to the EMG over the GPIB.
- Poll Message - An asynchronous message letting the Tapestry communicate over the GPIB if no other traffic is sent.

It is important to note that the real-time remote Tapestry operation can be used in any one of three modes:

- TRAJECTORY
- RANGE
- FILE-BASED

In TRAJECTORY mode the TCS receives position (and derivatives of position) of the user vehicle. The TCS then computes the GPS data internally. In RANGE mode the TCS must provide the GPS range dynamics. In FILE-BASED mode the EMG merely tells the TCS which scenario to run. These modes are mutually exclusive - RANGE, TRAJECTORY, or FILE BASED mode can be used but not simultaneously.

The TCS sends the following messages to the EMG during a simulation:

- Message Reception Status - Contains status of last received message.
- Range Status - Contains an echo of the pseudorange and SV channel assignment values that were actually broadcast by the Tapestry RF. This message is sent only upon request at a maximum rate of 1 Hz.
- Clock status - Contains an echo of the currently simulation time as determined by the interrupts from the RF hardware. The units are milliseconds into simulation. This time is output at 10Hz.
- Download Data - Data from the requested download file.

In response to each message from the EMG, the TCS sends a Message Reception Status message. This response provides for verification of data link integrity by the EMG as well as simple data and command validity checks. Section 3 describes this and all other messages in the interface.

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2.0 APPLICABLE DOCUMENTS.

The following documents, of the exact issue shown, form a part of this ICD to the extent specified herein. In the event of a conflict between this specification and referenced documents, the contents of this document shall supersede.

ICD-GPS-200 Rev B Nov 30 1987 NAVSTAR GPS Space Segment/Navigation User

IEEE-488-1978 General Purpose Interface for Programmable Devices

Tapestry Users Manual Description of the use and operation of the Tapestry GPS Simulation System

3.0 EMG/TCS INTERFACES

3.1 EMG/TCS DATA INTERFACE.

This section describes both the physical and message interfaces between the External Motion Generator (EMG) and the Tapestry Control System (TCS) Interface Computer. The format and content of the messages are identical for the GPIB and Ethernet interfaces. The TCS comes configured for only one type of interface.

3.1.1 GPIB

The General Purpose Interface Bus is a byte serial communications bus specifically designed for connecting intelligent devices. A detailed bus description may be obtained in the IEEE document, IEEE-488-1978, General Purpose Interface for Programmable Devices.

3.1.1.1Command Subset Implemented.

The GPIB implementation for the TCS supports the following:

1. Source handshake
2. Acceptor handshake
3. Talker
4. Listener
5. Service request
6. Interface Clear

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The EMG shall be the bus controller.

3.1.1.2 Operational Interface.

The GPIB shall connect the components as depicted in Figure 1. The EMG will be the Controller-in-Charge and the System Controller. The TCS will initiate message transactions with the EMG by sending a Service Request (SRQ). The EMG will respond to the SRQ by addressing the TCS as Talker, The Tapestry Computer System (TCS) primary address is 10 (decimal). The Talker will then send the desired message block to the EMG.

3.1.2 Ethernet Interface

The Ethernet interface shall connect the components as depicted in Figure 1. The EMG shall accept a connection from the TCS. The TCS performs a socket connect while the EMG must perform a socket listen. The port number for the connection is 5307 and the IP address is stored in the Voyager.ini file under the value HostAddr.

3.1.3 ScramNet Interface

The ScramNet (Shared Common RAM NETwork) interface allows communication between the EMG and the TCS through virtual shared memory. The EMG writes data to the ScramNet and the data is automatically written to the memory on the TCS. This memory appears to be shared between the EMG and TCS. Since memory is used to communicate instead of some form of serial interface, the TCS and EMG must map data structures to the common memory area. This memory is accessed using the following structure:

```
typedef struct tagGIC_MEM {
        unsigned char EmgToGicNumBytes;
        unsigned char GicToEmgNumBytes;
        unsigned char EmgToGicBytes[1000];
        unsigned char GicToEmgBytes[1000];
} GIC_MEM;
```

The TCS initializes this memory area to zero. All messages from the EMG to the TCS shall be as described in the document. Before writing to the ScramNet, the EMG shall verify that the EmgToGicNumBytes location is zero. If it is, the EMG shall write the message bytes to the EmgToGicBytes location and then write the number of bytes to EmgToGicNumBytes. The TCS shall monitor this location and when non-zero copy the data out of the EmgToGicBytes buffer. Once the data has been copied out, the TCS shall zero the EmgToGicNumBytes value. This will allow the EMG to write another message. Communication from the TCS to the EMG shall be in the same way. The TCS shall build messages as described in the document. If the GicToEmgNumBytes value is zero, the message will be copied to the GicToEmgBytes buffer. The EMG will monitor the GicToEmgNumBytes location and when non-zero, shall copy the data out of the GicToEmgBytes buffer and zero GicToEmgNumBytes.

3.1.4 Physical Interface - External Start Pulse.

The external start pulse is connected to the Tapestry Computer System (TCS) through an SMA female connector. The start pulse is of TTL signal level. Use of the start pulse is optional.

3.1.5 Physical Interface - 1 PPS.

The 1 PPS is connected to the EMG through an SMA female connector. The 1 PPS is of TTL signal level.

3.1.6 EMG Software/TCS Data Interface.

The following paragraphs describe the data transferred between the EMG and the TCS. Included within this section is a definition of the structures used as tools in this description. Since the EMG Software/TCS interface employs blocks of data whose elements range from bits to bytes, these tools identify and define each block and each block item in detail.

Each block includes four parts:

- Message ID
- Data block length
- Data
- Data checksum.

The tables and figures used to describe these blocks consist of the following fields:

1. Byte index - the offset, in bytes of the current field from the first byte of the block.

2. Field description - a brief description of the current field.

3. ID - an identifier that links this field with the bit position map in the corresponding table description figure.

4. # bits - total number of bits in the block item.

5. MSB - most significant bit of the field within the block item.

6. Type - each item is described as a particular data type according to the following definition:

Data Type	Description
I	2’s complement binary integer (lsb = 2^0 = 1)
+I	Positive I and 0
F	Fixed point 2’s complement binary integer (lsb not = 1)
+F	Positive F (and 0)
D	Double precision floating point
S	Single precision floating point
B	Binary coded decimal
C	Discrete value (not numeric)
All numeric types (I, +I, F, +F, D, and S) are transmitted and received least significant byte first (e.g. 0x1234 is transmitted 0x34 then 0x12).	

7. Scale factor - value associated with the lsb of the "F" and "+F" data types.

8. Range - the minimum and maximum values, or discrete value, allowable for this item (if the range is unrestricted a "*").

9. Units - the units of measure for this item (e.g. Hz, meters…).

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Message Block ID: Data from GIC to EMG FF (reserved) F8 Message Reception Status Data from EMG to GIC 1 Initialize Simulation Message 4 Set Range Message 6 Range Maintenance Message 7 Navigation Data Message 10 Power Profile Message 11 Trajectory Profile Message 16 Clock Request Message 19 Data Extraction Request 22 Stop Simulation Message 28 Platform Attitude Message 48 Pseudorange Ramp Message 49 Set Navigation Data Message 50 Download Request Message 51 Poll Message 52 Initialize Simulation Time Milliseconds				
A	8	7	+I	1	0..255	N/a
1		Message Byte Count				
B	8	7	+I	1	0..255	bytes
2		First message data byte				
C	8	n/a	n/a	n/a	n/a	n/a
… … …		… … …				
N+1		Nth (last) message data byte				
N	8	n/a	n/a	n/a	n/a	n/a
N+2		-(2's complement sum) of previous N+3 bytes (when included in calculation, result = 0)				
m	8	7	+I	n/a	0..255	n/a

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3.6.1.1 Data From the GIC to the EMG.

This section describes the messages from the GIC to the EMG.

3.6.1.1.1 Message Reception Status Message.

Upon receipt of each message from the EMG, the TCS returns a status message that indicates the received message ID and a byte that indicates:

1. Received message condition.
2. Resource ownership.
3. Relationship of received message to simulation mode.
4. Message id validity.
5. Message size validity.

Received condition indicates received message checksum validity. Items 2 and 3 are reserved for future use. Items 4 and 5 indicate whether the received message had a legal ID and size. Content and format of this message is presented Table 1 and Table 2.

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Message reception status message ID				
A	8	7	I	n/a	F8	n/a
1		Message Byte Count				
B	8	7	+I	1	5	Bytes
2		Received message id				
C	8	7	I	1	Valid id	bytes

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3		Status: D - message checksum status (0=ok) E - resource ownership (0=ok) F - simulation mode (0=ok) G - message id (0=ok) H - message too small (0=ok)				
D	1	0	C	N/a	0..1	N/a
E	1	1	C	N/a	0..1	N/a
F	1	2	C	N/a	0..1	N/a
G	1	3	C	N/a	0..1	N/a
H	1	4	C	N/a	0..1	N/a
4		Message checksum				
m	8	7	+I	N/a	0..255	N/a

Table 1 - Message Reception Status Content

BYTE INDEX	BIT NUMBER msb						1sb
	7	6	5	4	3	2	1	0
0	1	1	1	1	1	0	0	0
1	0	0	0	0	0	1	0	1
2	C	C	C	C	C	C	C	C
3	0	0	0	0	G	F	E	D
4	m	m	m	m	m	m	m	m

Table 2 - Message Reception Status Message Format

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3.6.1.1.2 Download Data Message.

Upon receipt of a Download Request from the EMG, the TCS begins transferring file data to the EMG. This message contains file data and status. The status is 0 (download in progress) or -1 (end of file). Content and format of this message is presented in

Table 3 and Table 4.

BYTE INDEX		FIELD DESCRIPTION				
ID	# BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Download Data Message ID				
A	8	7	I	N/a	F0	N/a
1		Message Byte Count				
B	8	7	+I	1	0..255	bytes
2		Status 0 – Download in progress 1 – End of file				
C	8	7	I	1	0, -1	N/a
3		File Data				
D	*	*	B	N/a	N/a	N/a
4+n		Message checksum				
M	8	7	+I	N/a	0..255	N/a

Table 3 - Download File Data Message Content

• Navigation Laboratories Inc. • 11 Pine Valley, Coto De Caza Ca. 92679 • 949-766-0444, 949-713-2479 (fax) •

BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0
0	1	1	1	1	0	0	0	0
1	B	B	B	B	B	B	B	B
2	C	C	C	C	C	C	C	C
3	D	D	D	D	D	D	D	D
.								
.								
.								
4+n	M	m	m	m	m	m	m	m

Table 4 - Download File Data Message Format

3.6.1.2 Data From the EMG to the GIC.
This section describes the messages from the EMG to the GIC.

3.6.1.2.1 Initialize Simulation Message.

The Initialize Simulation Message provides various parameters required to prepare the Tapestry for a simulation run. It includes the following:

1. Mode of operation.
2. Simulation start mode
3. Simulation start time
4. Initial Position

Items 1 and 2 are reserved for future use. Content and format of this message is presented in Table 5 through Table 8.

If the simulation mode is <u>TRAJECTORY</u> the simulation initialization message is as follows.

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Initialize Simulation Message ID				
A	8	7	+I	N/a	1	N/a
1		Message Byte Count				
B	8	7	+I	1	21	bytes
2		Simulation Mode C – trajectory/range 0 – trajectory 1 – range D – start mode 0 – reset system time 1 – use current system time (reserved)				
C	1	0	+I	N/a	0..1	N/a
D	1	1	+I	N/a	0..1	N/a
3		Simulation time				
E	32	31	+I	1	0.6047799	sec
7		Simulation GPS week number				
F	16	15	+I	1	*	week
9		User position in ECEF G – X H – Y I – Z				
G	32	31	F	$1 * 10^{-2}$	*	m
H	32	31	F	$1 * 10^{-2}$	*	m
I	32	31	F	$1 * 10^{-2}$	*	m
21		Message checksum				
M	8	7	+I	N/a	0..255	N/a

Table 5 - Initialize Simulation Message (Trajectory) Content

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BYTE INDEX	BIT NUMBER msb							1sb
	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	0	0	0	1	0	1	0	1
2	0	0	0	0	0	0	D	C
3	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
7	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
9	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
13	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
17	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
21	m	m	m	m	m	m	m	m

Table 6 - Initialize Simulation Message (Trajectory) Format

If the simulation mode is FILE BASED the simulation initialization is as follows:

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BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Initialize Simulation Message ID				
A	8	7	+I	N/a	1	N/a
1		Message Byte Count				
B	8	7	+I	1	84	bytes
2		Simulation Mode C – trajectory/range 0 – trajectory 1 – range 2 – file based D – start mode 0 – reset system time 1 – use current system time (reserved)				
C	1	0	+I	n/a	0..2	n/a
D	1	1	+I	n/a	0..1	n/a
3		Simulation time				
E	32	31	+I	1	0.604799	sec
7		Simulation GPS week number				
F	16	15	+I	1	*	week
9		Number of time to run simulation				
G	8	7	+I	1	0..255	week
10		Simulation path and runid				
H	8*80	N/A	A	N/A	ASCII	N/A
90		Message checksum				
I	8	7	+I	n/a	0..255	n/a

Table 7 - Initialize Simulation Message (File Based) Content

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BYTE INDEX	BIT NUMBER msb							1sb
	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	0	0	0	1	0	1	0	1
2	0	0	0	0	0	0	D	C
3	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
7	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
9	G	G	G	G	G	G	G	G
10	H	H	H	H	H	H	H	H

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.
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89	M	M	M	M	M	M	M	M

Table 8- Initialize Simulation Message (File Based) Format

3.6.1.2.2 Power Profile Message.

This command enables the EMG to set the power levels for each channel on the Tapestry. Content and format of this message is presented in Table 9 and

Table

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BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Power Profile message id				
A	8	7	+I	n/a	10	n/a
1		Message Byte Count				
B	8	7	+I	1	13-58	bytes
2		GPS time reference for this data set				
C	32	31	+I	1	0..60479999	Msec
6		reserved				
D	8	7	C	n/a	0	n/a
7		SVID				
E	4	5	+I	n/a	1..32	n/a
8		L1 C/A power relative to –110 dBm				
F	16	15	-I	1	-110..-140	dBm
10		reserved				
G	16	15	-I	n/a	0	n/a

.

5n+7		Message checksum				
m	8	7	+I	n/a	0..255	n/a

(n = number of channels in message)

Table 9 – Power Profile Message Content

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BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	0	1
1	B	B	B	B	B	B	B	B
2	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	0	0	0	C	C	C	C	C
6	D	D	D	D	D	D	D	D
7	0	0	0	E	E	E	E	E
8	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
10	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G

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5n+7	m	m	M	m	m	m	m	m

Table 10 – Power Profile Message Format

3.6.1.2.3 Trajectory Profile Message.

The Trajectory Profile Message tells Tapestry about the vehicle motion. The message includes a reference time and the vehicle's position, velocity, acceleration, and jerk (in ECEF coordinates) at that time. The data provided in this message will be used within 100 ms after it is sent. The TCS integrates this information with the GPS satellite position to generate phase dynamics for each signal being generated in the simulation. Content and format of this message is presented in Table 11 and Table 12.

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Trajectory Profile message ID				
A	8	7	+I	n/a	11	n/a
1		Message Byte Count				
B	8	7	+I	1	43	bytes
2		GPS time at which the profile is applicable				
C	32	31	+I	1	0..60479999	n/a
6		User Position in ECEF D – X E – Y F - Z				
D	32	31	F	$1.0 * 10^{-2}$	*	m
E	32	31	F	$1.0 * 10^{-2}$	*	m
F	32	31	F	$1.0 * 10^{-2}$	*	m
18		User Velocity G – X H – Y I - Z				
G	32	31	F	$1.0 * 10^{-5}$	*	m/s
H	32	31	F	$1.0 * 10^{-5}$	*	m/s
I	32	31	F	$1.0 * 10^{-5}$	*	m/s
30		User Acceleration J – X K – Y L – Z				
J	16	15	F	$1.0 * 10^{-2}$	*	m/s^2
K	16	15	F	$1.0 * 10^{-2}$	*	m/s^2
L	16	15	F	$1.0 * 10^{-2}$	*	m/s^2

36		User Jerk M – X N – Y P – Z				
M	16	15	F	$1.0 * 10^{-2}$	*	m/s^3
N	16	15	F	$1.0 * 10^{-2}$	*	m/s^3
P	16	15	F	$1.0 * 10^{-2}$	*	m/s^3
42		Message checksum				
S	8	7	+I	n/a	0..255	n/a

Table 11 - Trajectory Profile Message Content

BYTE INDEX	BIT NUMBER msb						1sb
	7	6	5	4	3	2	1	0
0	0	0	0	0	1	0	1	1
1	B	B	B	B	B	B	B	B
2	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	0	0	0	C	C	C	C	C
6	D	D	D	D	D	D	D	D
	D	D	D	D	D	D	D	D
	D	D	D	D	D	D	D	D
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E

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	E	E	E	E	E	E	E	E
	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
18	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
30	J	J	J	J	J	J	J	J
	J	J	J	J	J	J	J	J
	K	K	K	K	K	K	K	K
	K	K	K	K	K	K	K	K
	L	L	L	L	L	L	L	L
	L	L	L	L	L	L	L	L
36	M	M	M	M	M	M	M	M
	M	M	M	M	M	M	M	M
	N	N	N	N	N	N	N	N
	N	N	N	N	N	N	N	N
	P	P	P	P	P	P	P	P
	P	P	P	P	P	P	P	P
42	S	S	S	S	S	S	S	S

Table 12 - Trajectory Profile Message Format

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3.6.1.2.4 Navigation Data Message.

The Navigation Data Message sent between the EMG and the TCS provides a copy of subframes 1, 2 and 3. This data will be used by the TCS to generate navigation data sent to the receiver. The data provided in this message will be used within 100 ms after it is sent. Content and format of this message is presented in Table 13and Table 14.

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Navigation Data Input Message ID				
A	8	7	+I	n/a	07	n/a
1		Message Byte Count				
B	8	7	+I	1	95	bytes
2		SVID				
C	8	7	+I	1	0..32	SVID
3		Upload Flag				
D	8	7	*	n/a	0..1	n/a
4..93		Navigation Data Subframes 1-3, words 3-10, including parity				
E	90*8	*	B	N/A	*	N/A
94		Message checksum				
F	8	7	+I	n/a	0..255	n/a

Table 13 - Navigation Data Message Content

BYTE INDEX	BIT NUMBER msb							1sb
	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	1	1
1	0	1	0	1	1	1	0	0
2	0	0	C	C	C	C	C	C
3	0	0	0	0	0	0	0	D
4	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
. . .								
	E	E	E	E	E	E	E	E
94	F	F	F	F	F	F	F	F

Table 14 - Navigation Data Message Format

3.6.1.2.5 Download Request Message.

The Download Request Message sent from the EMG to the TCS allows the EMG to extract a file from the TCS. Any file can be extracted and the full path is required. Content and format of this message is presented in Table

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Download Request Message ID				
A	8	7	+I	n/a	50	n/a
1		Message Byte Count				
B	8	7	+I	1	83	bytes
2		File Name				
C	80*8	8	A	n/a	ASCII	N/a
83		Message checksum				
D	8	7	+I	n/a	0..255	n/a

15 and 16

Table 15 - Download Request Message Content

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BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	1	0
1	0	1	0	1	0	0	1	1
2	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	.							
	.							
	.							
	C	C	C	C	C	C	C	C
83	D	D	D	D	D	D	D	D

Table 16 - Download Request Message Format

3.6.1.2.6 Poll Message.

The Poll Message is used to let the TCS send messages to the EMG. Since the TCS is not the GPIB system controller, it waits for messages to be sent from the EMG before responding. The poll message allows the TCS to send data back to the EMG. Content and format of this message is presented in Table 17 and Table 18.

BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	1	1
1	0	0	0	0	0	0	1	1
2	C	C	C	C	C	C	C	C

Table 17 - Poll Message Content

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BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Stop Simulation Message ID				
A	8	7	+I	n/a	22	n/a
1		Message Byte Count				
B	8	7	+I	1	3	bytes
2		Message Checksum				
m	8	7	+I	n/a	0..255	N/a

Table 18 - Poll Message Format

3.6.1.2.7 Stop Simulation Message.

This message stops the simulation currently in progress. Content and format of this message is presented in Table and Table .

BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0
0	0	0	0	1	0	1	1	0
1	0	0	0	0	0	0	1	1
2	1	1	1	0	0	1	1	1

Table 19 - Stop Simulation Message Content

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Poll Message ID				
A	8	7	+I	n/a	51	n/a
1		Message Byte Count				
B	8	7	+I	1	3	bytes
2		Message checksum				
C	8	7	+I	n/a	0..255	N/a

Table 20 - Stop Simulation Message Format

3.6.1.2.8 Platform Attitude Message.

The Platform Attitude Message provides sines and cosines of vehicle position in the WGS-84 geoid model and roll, pitch, and heading. This information is used in host vehicle masking and antenna pattern simulations. The data provided in this message will be used within 100 ms after it is sent. It must be appended to the corresponding Trajectory Profile message as part of the same message block. Content and format of this message is presented in Table and Table .

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Platform Attitude Message ID				
A	8	7	+I	n/a	28	n/a
1		Message Byte Count				
B	8	7	+I	1	23	bytes
2		Sine of Aircraft Latitude				
C	16	15	F	0.0001	+/- 1.0	N/a
4		Cosine of Aircraft Latitude				
D	16	15	F	0.0001	+/- 1.0	N/a
6		Sine of Aircraft Longitude				
E	16	15	F	0.0001	+/- 1.0	N/a
8		Cosine of Aircraft Longitude				
F	16	15	F	0.0001	+/- 1.0	N/a
10		Sine of Aircraft Roll				
G	16	15	F	0.0001	+/- 1.0	N/A
12		Cosine of Aircraft Roll				
H	16	15	F	0.0001	+/- 1.0	N/a
14		Sine of Aircraft Pitch				
I	16	15	F	0.0001	+/- 1.0	N/a
16		Cosine of Aircraft Pitch				
J	16	15	F	0.0001	+/- 1.0	N/a
18		Sine of Aircraft Heading				
K	16	15	F	0.0001	+/- 1.0	N/a

20		Cosine of Aircraft Heading				
L	16	15	+I	0.0001	+/- 1.0	N/a
22		Message Checksum				
M	8	7	+I	N/a	0..255	N/a

Table 21 - Platform Attitude Message Content

BYTE INDEX	BIT NUMBER msb							1sb
	7	6	5	4	3	2	1	0
0	0	0	0	1	1	1	0	0
1	B	B	B	B	B	B	B	B
2	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
4	D	D	D	D	D	D	D	D
	D	D	D	D	D	D	D	D
6	E	E	E	E	E	E	E	E
7	E	E	E	E	E	E	E	E
8	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
10	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G

12	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
14	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
16	J	J	J	J	J	J	J	J
	J	J	J	J	J	J	J	J
18	K	K	K	K	K	K	K	K
	K	K	K	K	K	K	K	K
20	L	L	L	L	L	L	L	L
	L	L	L	L	L	L	L	L
	I	I	I	I	I	I	I	I
16	J	J	J	J	J	J	J	J
	J	J	J	J	J	J	J	J
18	K	K	K	K	K	K	K	K
	K	K	K	K	K	K	K	K
20	L	L	L	L	L	L	L	L
	L	L	L	L	L	L	L	L
22	M	M	M	M	M	M	M	M

Table 22 - Platform Attitude Message Format

3.6.1.2.9 Pseudorange Ramp Message.

This command enables the EMG to introduce ramping errors into the pseudorange of satellites Content and format of this message is presented in Table 23 and Table 24.

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BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Pseudorange Ramp Message id				
A	8	7	+I	n/a	48	n/a
1		Message Byte Count				
B	8	7	+I	1	10-103	bytes
2		GPS time reference for this data set				
C	32	31	+I	1	0..60479999	Msec
6		Reserved				
D	8	7	C	N/a	0	N/a
7		SVID				
E	4	5	+I	N/a	1..32	N/a
8		Ramping On/Off (1 = On, 0 = Off)				
F	8	1	+I	1	0 – 1	n/a
9		Ramping error				
G	16	15	-I	1	-100..100	m/s

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3n+7		Message checksum				
m	8	7	+I	N/a	0..255	N/a

(n = number of SVIDs in message)

Table 23 – Pseudorange Ramp Message Content

BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	0
1	B	B	B	B	B	B	B	B
2	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	0	0	0	C	C	C	C	C
6	D	D	D	D	D	D	D	D
7	O	O	E	E	E	E	E	E
8	0	0	0	0	0	0	0	F
9	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G

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5n+7	m	m	m	m	m	m	m	m

Table 24- Pseudorange Ramp Message Format

3.6.1.2.10 Set Range Message.

The Set Range Message allows the EMG to assign a new satellite to a channel. Typically this would take place during a satellite transition as one satellite drops below the mask angle and another is assigned in its place. This message is valid in RANGE mode only. The data provided in this message will be used within 100 ms after it is sent. Content and format of this message is presented in Table 25 and
Table 26.

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Set Range Message ID				
A	8	7	+I	n/a	04	n/a
1		Message Byte Count				
B	8	7	+I	1	8-17	bytes
2		GPS time at which message is applicable				
C	32	31	+I	1	0..604799999	N/a
6		Channel ID				
D	4	3	+I	N/a	0..7	N/a
7		SV ID				
E	8	7	+I	1..39	*	N/a
8		Range at Toa				
F	32	31	F	$10 * 10^{-2}$	*	m
12		Tono delay at Toa				
G	16	15	F	$10 * 10^{-2}$	*	m

.
.
.

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14+8n		Channel ID				
h	4	3	+I	N/a	0..7	N/a
15+ 8n		SV ID				
i	8	7	+I	1..39	*	N/a
16+8n		Range at Toa				
j	32	31	F	$10 * 10^{-2}$	*	m
20+8n		Tono Delay at Toa				
k	16	15	F	$10 * 10^{-2}$	*	m
22+8n		Message checksum				
m	8	7	+I	N/a	0..255	N/a

Table 25 - Set Range Message Content

BYTE INDEX	BIT NUMBER msb						1sb
	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0	0
1	0	0	B	B	B	B	B	B
2	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	0	0	0	C	C	C	C	C
6	0	0	0	0	0	D	D	D
7	O	O	0	E	E	E	E	E
8	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
12	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G

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14+8n	0	0	0	0	0	h	h	h
15+8n	0	0	0	i	i	i	i	i
16+8n	j	j	j	j	j	j	j	j
	j	j	j	j	j	j	j	j
	j	j	j	j	j	j	j	j
	j	j	j	j	j	j	j	j
20+8n	k	k	k	k	k	k	k	k
	k	k	k	k	k	k	k	k
22+8n	m	m	m	m	m	m	m	m

Table 26 - Set Range Message Format

3.6.1.2.11 Set Navigation Data Message.

The Set Navigation Data Message allows the EMG to assign the bits to be transmitted by the simulated satellites in RANGE mode. The message consists of subframes 1, 2, and 3 followed by all the commutated subframes 4 and 5. The bits are packed in bytes with no empty bit space.

```
1    byte 1    byte 2    byte 3      byte 37   byte 38   byte 39
1000 1011 0000 0000 0000 0011...xxxx xxxx xxxx 1000 1011 ...
(subframe 1)                                   (subframe 2)

byte 76   byte 77   byte 78    byte 112  byte 113  byte 114
1000 1011 0000 0000 0000 0011...xxxx xxxx xxxx 1000 1011 ...
(subframe 3)                                   (subframe 4)

byte 151  byte 152  byte 153    byte 187  byte 188 byte 189
1000 1011 0000 0000 0000 0011...xxxx xxxx xxxx 1000 1011 ...
(subframe 5)                                   (subframe 4)
```

The data provided in this message will be used within 100 ms after it is sent. Content and format of this message is presented in Table 27 and Table 28.

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Set Navigation Data Message ID				
A	8	7	+I	n/a	49	n/a
1		Message Byte Count				
B	16	7	+I	1	1998	bytes
3		GPS time at which message is applicable				
C	32	31	+I	1	0-604799999	N/a
7		SV ID				
D	8	7	+I	1..39	*	N/a
8		Navigation Data (1988 bytes)				
E	15904	7	C	N/a	N/a	N/a
1997		Message checksum				
F	8	7	+I	N/a	0..255	N/a

Table 27 - Set Navigation Data Message Content

BYTE INDEX	BIT NUMBER msb							1sb
	7	6	5	4	3	2	1	0
0	0	1	0	0	1	0	0	1
1	1	1	0	0	1	1	1	0
	0	0	0	0	0	1	1	1
	C	C	C	C	C	C	C	C

	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C
	0	0	0	C	C	C	C	C
7	0	0	0	D	D	D	D	D
8	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	.							
	.							
	E	E	E	E	E	E	E	E
1997	F	F	F	F	F	F	F	F

Table 28 - Set Navigation Data Message Format

3.6.1.2.12 Initialize Simulation Message Time Milliseconds. \

The Initialize Simulation Message provides various parameters required to prepare the Tapestry for a simulation run. This message is identical to message "Initialize Simulation Message" (ID=1) except that time is in milliseconds instead of seconds and the message ID = 52. It includes the following:

1. Mode of operation.
2. Simulation start mode
3. Simulation start time
4. Initial Position

Items 1 and 2 are reserved for future use. Content and format of this message is presented in Table 5 through Table .

If the simulation mode is TRAJECTORY the simulation initialization message is as follows.

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BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Initialize Simulation Message Time Millisec				
A	8	7	+I	n/a	1	n/a
1		Message Byte Count				
B	8	7	+I	1	21	bytes
2		Simulation Mode C – trajectory/range 0 – trajectory 1 – range D – start mode 0 – reset system time 1 – use current system time (reserved)				
C	1	0	+I	N/a	0..1	N/a
D	1	1	+I	N/a	0..1	N/a
3		Simulation time				
E	32	31	+I	1	604799000	msec
7		Simulation GPS week number				
F	16	15	+I	1	*	week
9		User position in ECEF G – X H – Y I – Z				
G	32	31	F	$1 * 10^{-2}$	*	m
H	32	31	F	$1 * 10^{-2}$	*	m
I	32	31	F	$1 * 10^{-2}$	*	m
21		Message checksum				
m	8	7	+I	N/a	0..255	N/a

Table 29 - Initialize Simulation Message Time Milliseconds (Trajectory) Content

BYTE INDEX	BIT NUMBER msb							1sb
	7	6	5	4	3	2	1	0
0	0	0	1	1	0	1	0	0
1	0	0	0	1	0	1	0	1
2	0	0	0	0	0	0	D	C
3	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
7	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
9	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
	G	G	G	G	G	G	G	G
13	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
	H	H	H	H	H	H	H	H
17	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
	I	I	I	I	I	I	I	I
21	m	m	m	m	m	m	m	M

Table 30 - Initialize Simulation Message (Trajectory) Format

If the simulation mode is <u>FILE</u> <u>BASED</u> the simulation initialization is as follows:

BYTE INDEX		FIELD DESCRIPTION				
ID	#BITS	MSB	TYPE	SCALE FACTOR	RANGE	UNITS
0		Initialize Simulation Message Id				
A	8	7	+I	n/a	1	n/a
1		Message Byte Count				
B	8	7	+I	1	84	bytes
2		Simulation Mode C – trajectory/range 0 – trajectory 1 – range 2 – file based D – start mode 0 – reset system time 1 – use current system time (reserved)				
C	1	0	+I	N/a	0..2	N/a
D	1	1	+I	N/a	0..1	N/a
3		Simulation time				
E	32	31	+I	1	0..604799	sec
7		Simulation GPS week number				
F	16	15	+I	1	*	week
9		Number of times to run simulation				
G	8	7	+I	1	0..255	week
10		Simulation path and runid				
H	8*80	N/a	A	N/a	ASCII	N/a
I	8	7	+I	N/a	0..255	N/a

Table 31 - Initialize Simulation Message (File Based) Content

BYTE INDEX	BIT NUMBER msb							lsb
	7	6	5	4	3	2	1	0

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0	0	0	0	0	0	0	0	1
1	0	0	0	1	0	1	0	1
2	0	0	0	0	0	0	D	C
3	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
	E	E	E	E	E	E	E	E
7	F	F	F	F	F	F	F	F
	F	F	F	F	F	F	F	F
9	G	G	G	G	G	G	G	G
10	H	H	H	H	H	H	H	H

.
.

89	M	M	M	M	M	M	M	M

Table 32 - Initialize Simulation Message (File Based) Format

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4.0 GUIDE TO OPERATING THE REAL-TIME INTERFACE.

The commands sent over the GPIB interface allow the user to by-pass most of the Tapestry simulation software. In the closed loop mode, Tapestry accepts a time-tagged earth-centered-earth-fixed TRAJECTORY message. Tapestry can accept GPIB commands at a rate not to exceed 10Hz. The exact characteristics and content of the range message is defined in section 3 of this ICD.

A word of warning is in order. Great effort was made in the development of the VEHICLE PROFILE GENERATOR contained within the Tapestry software to assure the numerical integrity of the navigation solution and hence the computation of the range derivatives sent to the hardware. In closed loop mode, the consistency and viability of the navigation solution becomes the responsibility of the user through the EMG. In real time, The Tapestry software operates to assure the consistency of the integrated range rate and the computed pseudorange. Tapestry will adjust any inconsistencies at 10Hz, and if significant, (more than a meter or so) the receiver under test could be driven out of lock. Similarly, the ECEF TRAJECTORY message must also be consistent with some sort of jerk limiting or a similar effect will occur. You should not expect the real-time mode to operate properly if you have not validated the self-consistency of your simulator, or your design has not addressed these issues.

4.1 minimum communication

The real time interface supports a wide range of messages that are intended to support a variety of applications. Many of these messages are not required for normal operation and can be disregarded by the user. For a minimum and basic operation of Tapestry, the following messages are required:

Initialize Simulation Message.

Trajectory Profile Message (at least one message).

Stop Simulation Message.

The real time software has been designed to minimize the required interaction. For example, each time an Initialize Simulation Message is received, the ephemeris data is propagated to the current simulation time automatically.

4.2 message timing

The TCS maintains time through communication with the Tapestry RF hardware. Each Trajectory message contains a time of applicability. The message will either be stored until the simulation time is equal or exceeds the message time or propagated to the current time if sent late. This allows the TCS to buffer approximately 100 Trajectory messages. If a message is received that exceeds the buffer size, a Message Reception Status will be returned with the Resource Ownership bit set indicating that the message was refused.

It is important that the EMG read and use the Message Reception Status. This is especially true for the Initialize and Stop simulation messages. Although the TCS is a fast computer, the initialization and termination of simulation are time consuming processes, with many tasks restarting.

4.3 GPS modeling

The beauty of the Tapestry system in real-time configuration is that the EMG user is not required to have detailed knowledge of the GPS components of the simulation modeling. In particular, when the user sends the INITIALIZATION message the following processes occur:

- The GPS ephemeris and almanac data resident within the scenario folder c:\voyager\runs\TapGpib is propagated to the time within the initialization message. If there are multiple data sets within the folder they are propagated also.

- Any vehicle silhouette modeling developed by the user with the antenna gain pattern GUI is applied real-time to the scenario automatically.

- All GPS models, such as mask angle, review interval, data health, Ionosphere and Troposphere, are applied from the TapGpib scenario.

To change any of the default modeling you execute the ***Build Scenario*** application and select the TapGpib scenario. Make your changes and build the scenario. When you start the closed loop mode the changes will be applied to the GPS component of the simulation. Please review the ***Build Scenario*** Users Guide for the use and modeling associated with this application.

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