



Real-Time Telemetry Display

by Using STK Connect

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Real-Time Telemetry Display



- The Kennedy Space Center Real-Time Telemetry Display
 - Real-Time flight data is obtained via Veridian-Omega hardware and software (IRIG Class II PCM decommutation)
 - Data is parsed in Veridian-Omega, and the positioning and attitude data is sent to STK
 - Vehicle position and attitude is displayed in near real time on a 3-D and/or 2-D graphics window

Real-Time Telemetry Display



•Real-Time Telemetry Display Data Path

- NASA Dryden Flight Facility in California performed flight testing using a F-15B with an onboard experimental space based telemetry system in the summer of 2003.

- An onboard GPS receiver logged the position data

- formatted with health and status data

- The data was up-linked to the Tracking and Data Relay Satellite System (TDRSS)

- The data was then down-linked to the TDRSS ground station at White Sands, NM

Real-Time Telemetry Display



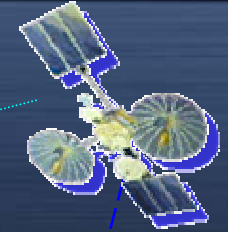
- Real-Time Telemetry Display Data Path (cont)
 - The data was formatted for land lines at White Sands, then sent over to Goddard, MD via land lines
 - The data was relayed down to KSC, FL via and lines
 - total delay about 1.5 seconds
 - Total land line distance about 3,000 miles
 - Total Space link 2-GEO links ($2 * 19,323$ nautical miles = 38,646 nautical Miles)

Real-Time Telemetry Display



Flown at Dryden, Ca

Uplink



TDRSS (GEO)
S-Band

Downlink



WSC

White Sands

GSFC

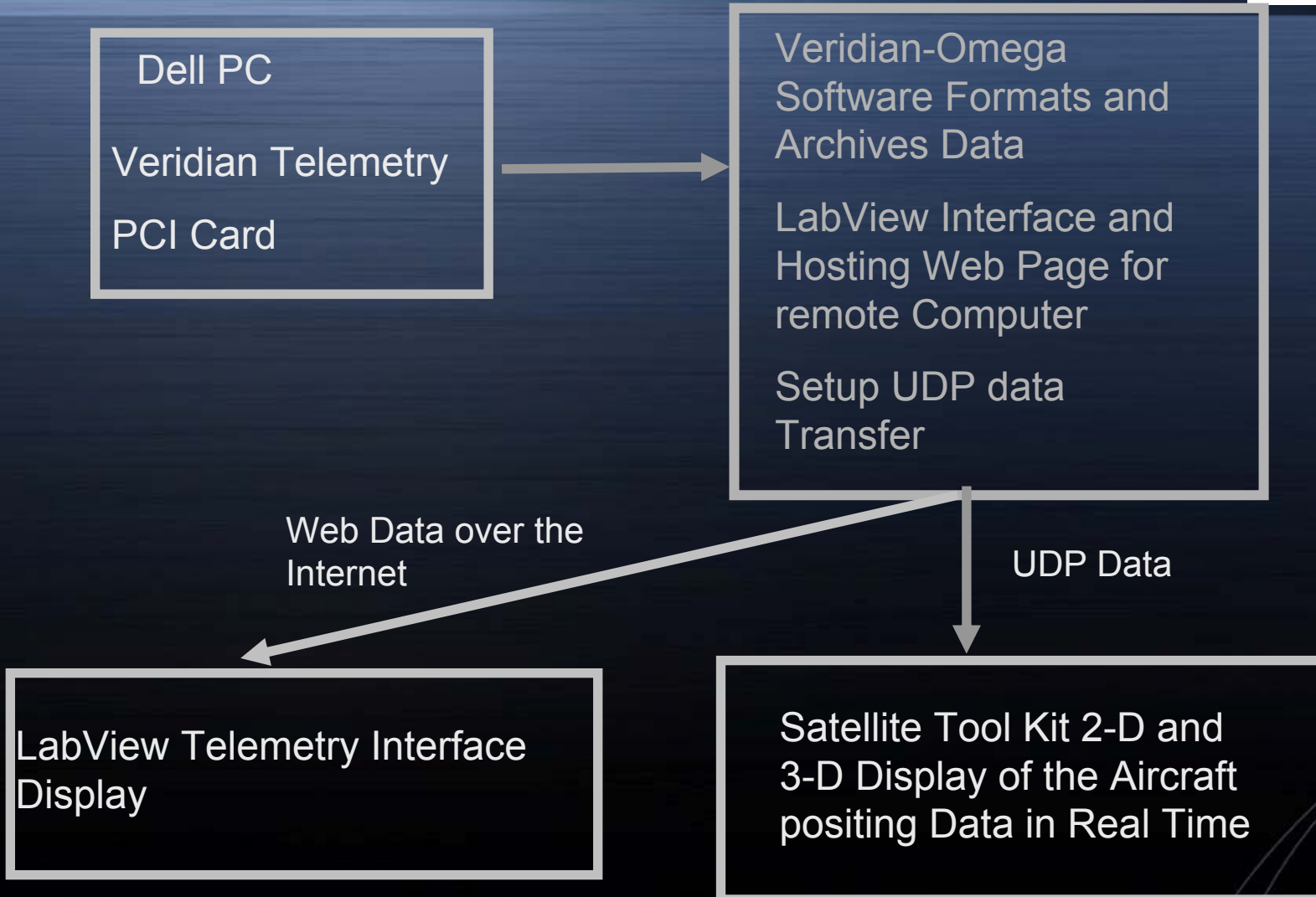
KSC

Real-Time Telemetry Display



- Real-Time Data Path (cont)
 - The Veridian Telemetry PCM Decom PCI board receives the PCM data stream from Goddard
 - Veridian Omega software parses the PCM data stream and outputs it over the network by using a User Datagram Protocol (UDP) socket
 - The UDP socket is read by a 'C' program, where it is reformatted and sent to STK via its Connect interface
 - A LabView program is used to display the health and status of the flight transponder on-board the aircraft
 - The health and status displays reside on the same workstation as the "decom" board and software

Real-Time Telemetry Display



Real-Time Telemetry Display



- STK CONNECT

- STK displays the aircraft movement in near real time with the use of CONNECT
- the GPS data is sent to the F15 scenario as external ephemeris data
- This allowed monitoring the aircraft moving over the maps while displaying position and movement data in the Data Display Object.
- External maps of the Dryden area were added to enhance the visualization.
- This system can be configured for any flight data that is streaming position and attitude data.

Real-Time Telemetry Display



•LabView Displays

STARS Data Display.vi

Main Display | GPS Display | LPT/C&DH Status | Receiver Status | Internal Locals | Quit

RX1 TDRSS PN 11	RX2 Launch Head PN 12	RX3 TDRSS PN 11	RX4 Launch Head PN 12
Carrier Lock: Lock	Carrier Lock: Lock	Carrier Lock: Lock	Carrier Lock: Lock
PN Lock: No Lock	PN Lock: No Lock	PN Lock: No Lock	PN Lock: No Lock
Data Valid: Valid	Data Valid: Valid	Data Valid: Valid	Data Valid: Valid
Processing State: Loss of Lock	Processing State: Loss of Lock	Processing State: Loss of Lock	Processing State: Loss of Lock
Eb/No: 17.0	Eb/No: 17.0	Eb/No: 17.0	Eb/No: 17.0
Avg Carrier doppler: 0	Avg Carrier doppler: 0	Avg Carrier doppler: 0	Avg Carrier doppler: 0

STARS Data Display.vi

Main Display | GPS Display | LPT/C&DH Status | Receiver Status | Internal Locals | Quit

GPS Time: 23978.000

Position	Velocity	DOP
X: -2473256.50	X: 30.91	HDOP: 2
Y: -4630610.00	Y: 48.02	VDOP: 5
Z: 3617192.75	Z: 82.08	TDOP: 3

Number of Satellites: 5

Position [Hex]	Velocity [Hex]
X: CA16F4A2	X: 41F747AE
Y: CA8D50A4	Y: 4240147B
Z: 4A5CC6A3	Z: 42A428F6

Real-Time Telemetry Display



- The following functions were written in C/C++ to support reading data off the UDP socket and sending it to STK
 - `initSTK()` – Connects to STK and Initializes Data
 - `sendData()` – Writes Data to STK
 - `initUDPSocket()` – Opens UDP Socket
 - `getData()` – Reads Data From the UDP Socket
 - `makeDate()` – Formats Time Stamp for STK

Real-Time Telemetry Display



- `initSTK()`
 - Initialize Connect
`AgConInit(FileName);`
 - Open a connection to STK
`AgConOpenSTK(&connection1, 0, connectName);`
 - Format and send Load Command */
`sprintf(cmdString, "Load / Scenario
\"/stk/Administrator/stkgps.sc\");`
`AgConProcessSTKCmd(connection1, cmdString, &returnInfo);`

Real-Time Telemetry Display



- `initSTK()` (cont)
 - Command used to init Time Period
`SetTimePeriod * \"1 Jan 2003 00:00:00.00\" \"1 Jan 2004 00:00:00.00`
 - Command used to Init Epoch Time
`SetEpoch * \"1 Jan 2003 00:00:00.00\"`
 - Command used to Initialize Animation
`Animate * SetValues \"1 Jan 2003 00:00:00.00\" 0.5 0.1\"`)
 - Command used to Add a Display Box
`ExternalData */Aircraft/f15 AddGroup \"ERROR_DOPS\" 4
\"HDOP\" \"Ratio\" \"VDOP\" \"Ratio\" \"TDOP\" \"Ratio\" \"GDOP\"
\"Ratio\"`

Real-Time Telemetry Display



- sendData()
 - Format and Send position data to STK

```
sprintf(cmdString, "SetPosition %s ECF \"%s\" %.4f %.4f %.4f %.4f %.4f %.4f", name, date, *posX_p, *posY_p, *posZ_p, *velX_p, *velY_p, *velZ_p);
```

AgConProcessSTKCmd(connection1, cmdString, &returnInfo);
 - Send Animate Time to STK

```
sprintf(cmdString, "Animate * SetTime \"%s\"", date);
```

AgConProcessSTKCmd(connection1, cmdString, &returnInfo);

Real-Time Telemetry Display

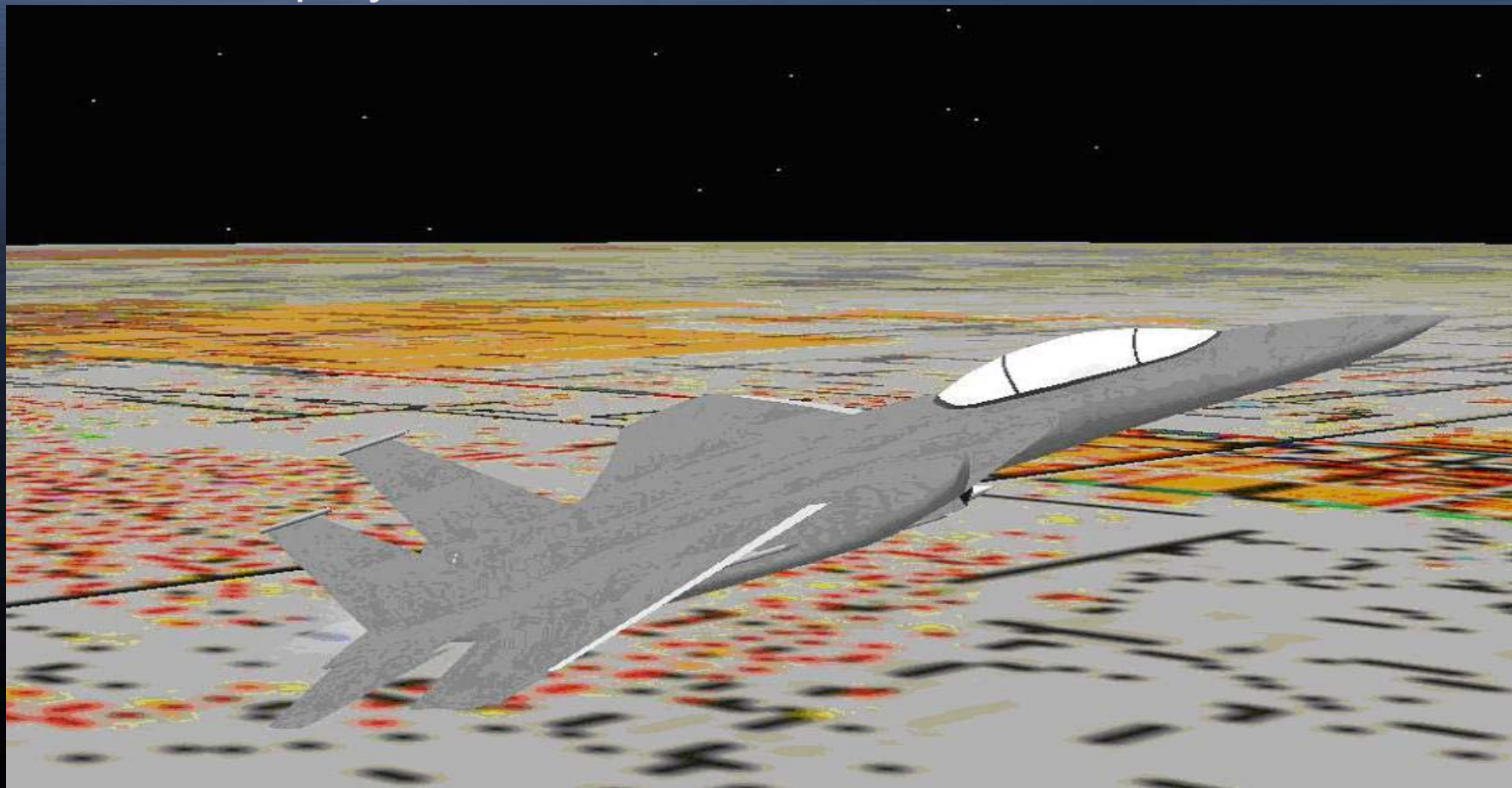


- Procedure to send the Real Time Data:
 1. Set Up Veridian Omega to decom the incoming PCM data stream
 2. Send GPS data stream over UDP Socket to the STK Computer
 3. Start STK 5.04 with STK_GPS scenario, airplane object (F15)
 4. Run the 'C' executable "StarsConnect .exe
 5. Enter Date of the beginning of the week; (GPS time)
 6. Propagator is StkExternal
 7. Automatically creates the ephemeris file f15.e
 8. Next time you run the f15 scenario the new GPS ephemeris data will be added to the f15.e file
 9. To play back the Veridian archive file you must delete the position data from the f15.e file

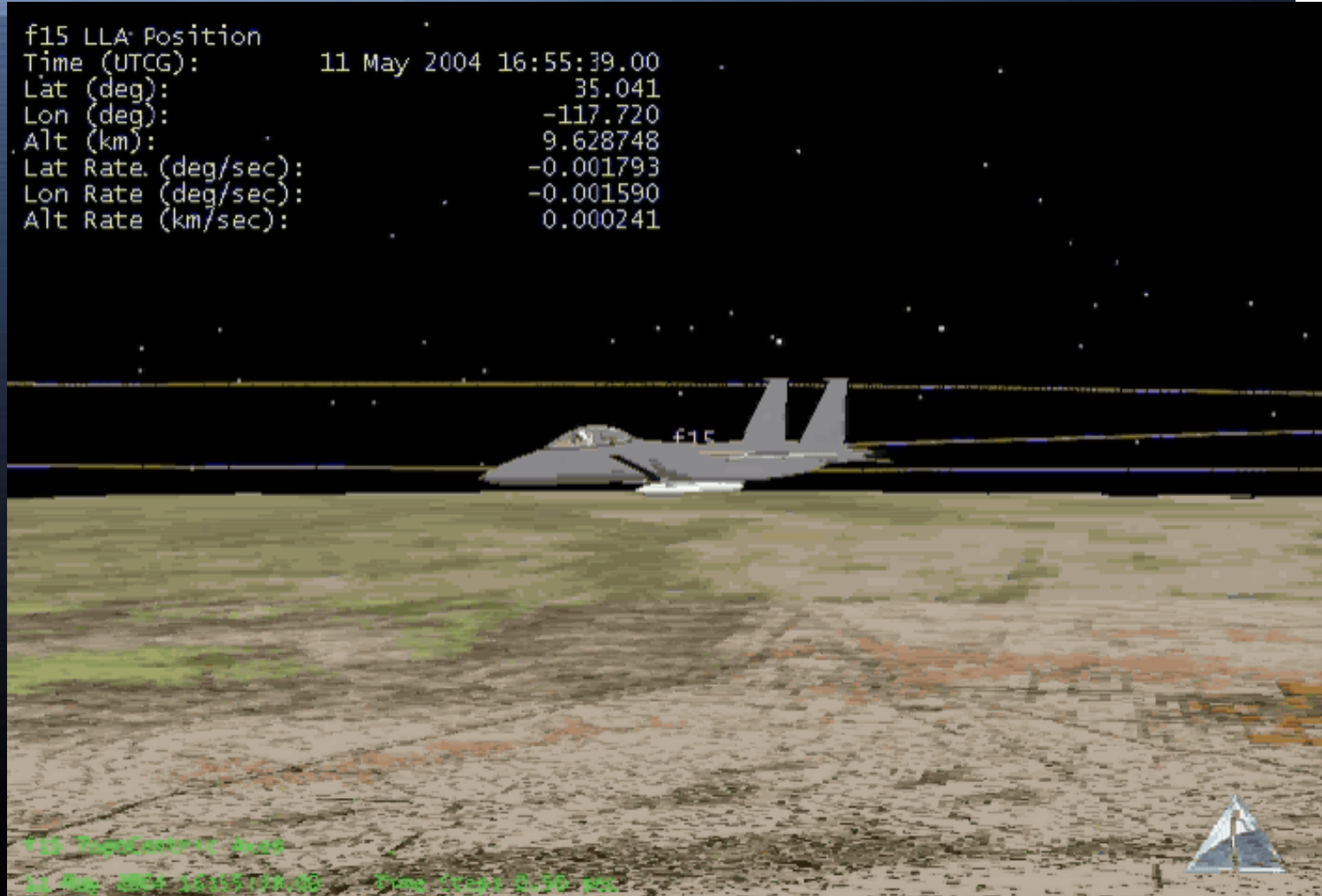
Real-Time Telemetry Display



F-15B Display in 3-D Window



Real-Time Telemetry Display



Real-Time Telemetry Display



Conclusion:

- KSC Real Time Telemetry Display can take real time data and display it onto the STK 2-D and 3-D displays with small delays.
- KSC developed the capabilities for a generic telemetry display not tied to a specific vehicle (can be ground or flight vehicle)
- These displays have been used for sounding rockets and various aircraft flights.
- Attitude data was not sent in real time. If attitude data was made available aircraft attitude can also be displayed in near real time.
- Can send other data and display it via External Data Display 3-D Graphics

Real-Time Telemetry Display



Q&A (F-15B video, LabView and STK)

