H.3 Mission Operations Software

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SPACE PHYSICS RESEARCH LABORATORY

TIDI

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  - Components
  - Data Flow
  - Data Products
  - Status
  - Changes since PDR

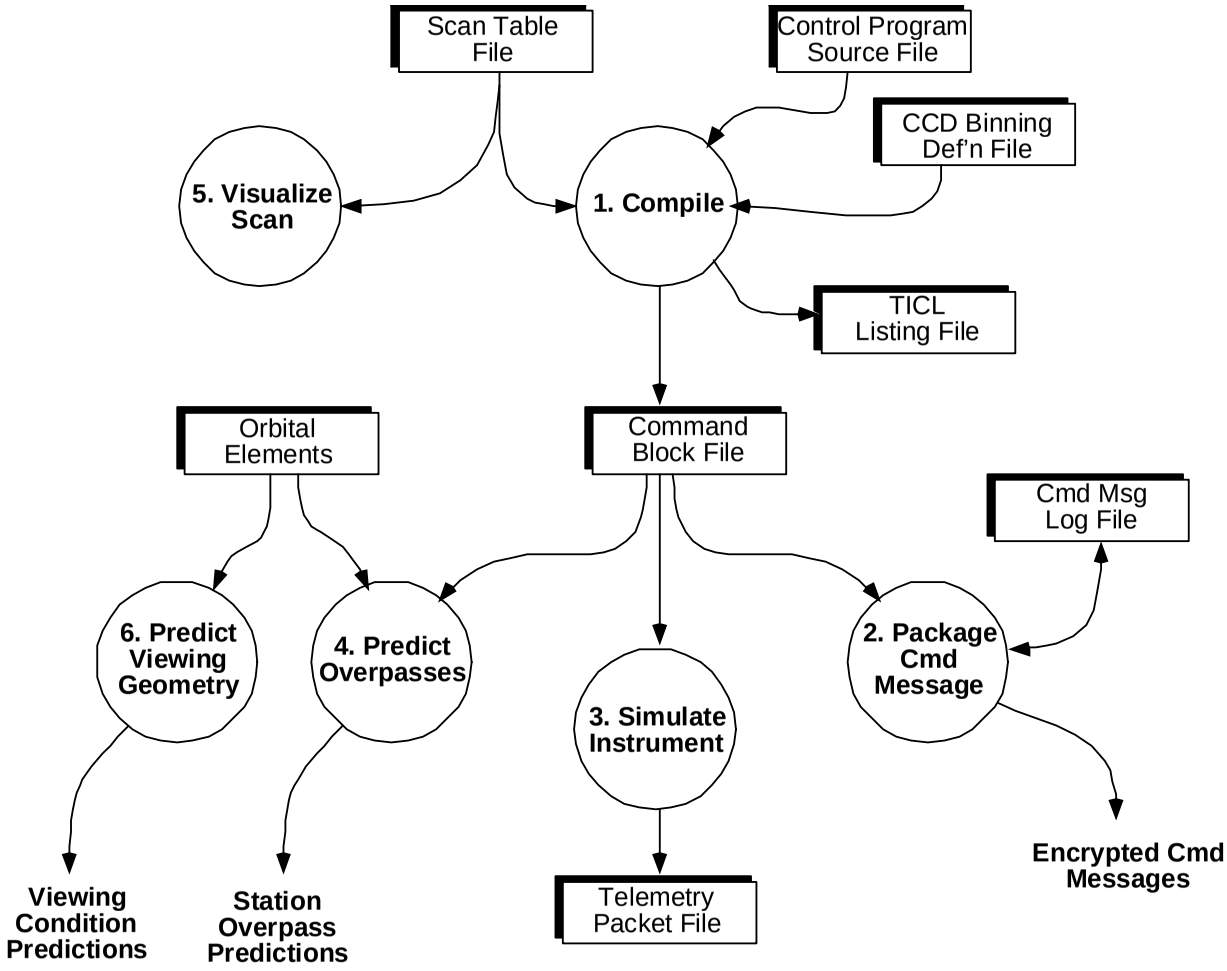
Uplink Software
Purpose and Requirements

- **Purpose**
  - Provide tools for planning instrument operations
  - Provide tools for command generation and transport
  - Provide tools for testing instrument programs
- **Requirements**
  - All tools must operate in the TIDI POC environment

    HP C-class workstations, HP-UX v10.20

    Component programs communicate via files
  - All interfaces must comply with the TIMED GIIS and TIDI SIIS
  - Each component will perform an orderly shutdown upon receipt of a SIGTERM signal
  - Programming will be performed in C, FORTRAN, or IDL as appropriate to the problem

Uplink Software Data Flow



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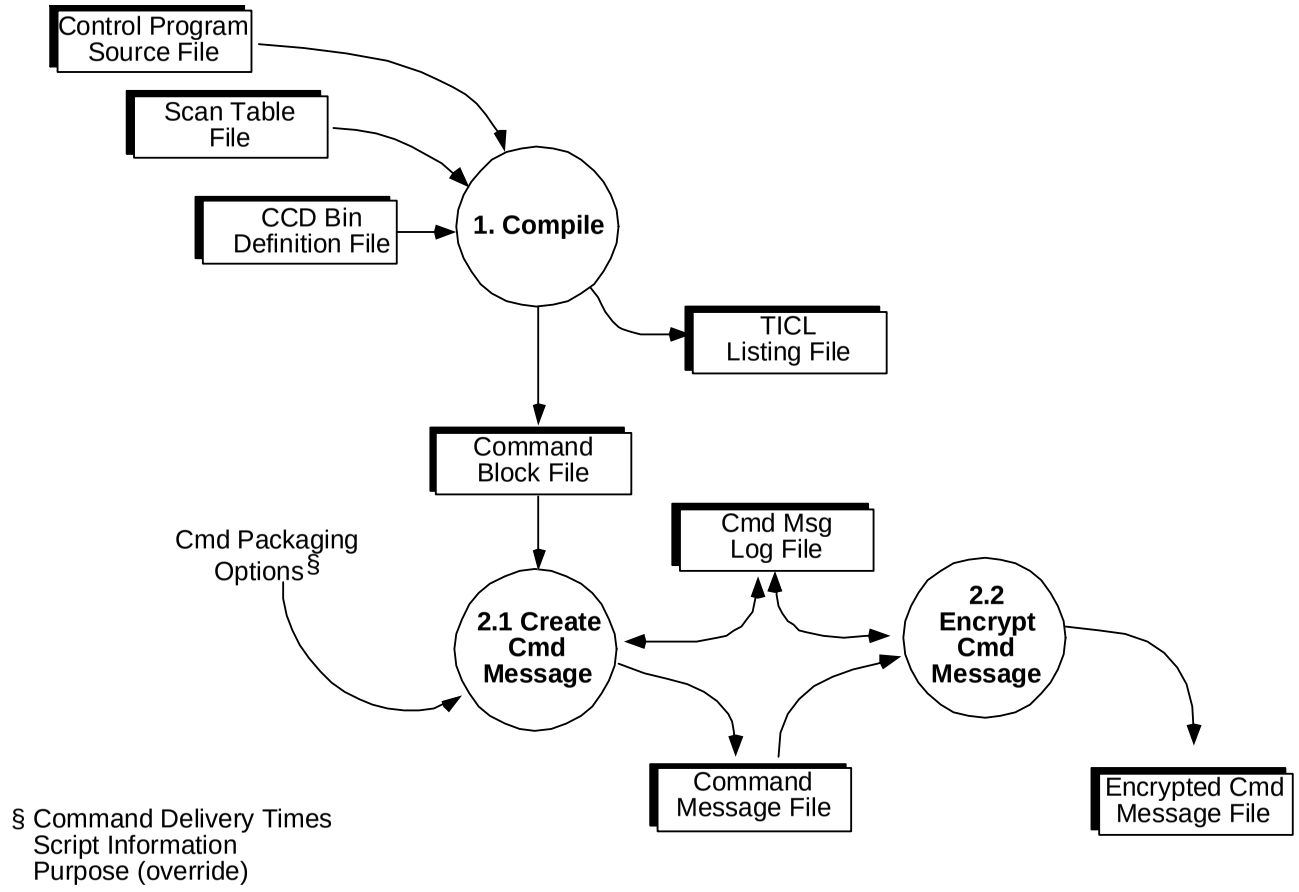
Uplink Software
Planning and Testing Components

- **VisualizeScan**
  - Displays scan performance and timing
  - Shows mechanism activity
  - Estimates resources required for scan
- **ViewPredict**
  - Determines viewing geometry
    sza, scattering, local solar time
- **OverPassPredict**
  - Determines coincidences with ground stations
- **Simulator**
  - Generates simulated TM based on an instrument control program

Uplink Software Command Processing



Uplink Software
Command Generation Components

- **Compile**
  - Combines scan definition, control program, and binning definition
  - Creates a file containing a stream of instrument commands
- **Package**
  - Forms one or more command message files from the output of COMPILE
  - Maintains log of CCSDS sequence numbers, processing times, and command enable times
  - Encrypts command message files and transmits to the TIMED MOC

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Uplink Software
Major Data Products

- **Command Block File**
  - Contains the instrument commands resulting from the compilation of a control program or an immediate command sequence
  - Contains descriptive information for the command message file header
  - Stored for re-use by scripts
- **Command Message File**
  - Contains the descriptive header and instrument command data
  - Each contains a unique CCSDS sequence number
- **Encrypted Command Message File**
  - PGP encrypted version of the command message file
  - Encrypted using the MOC public key and the TIDI private key

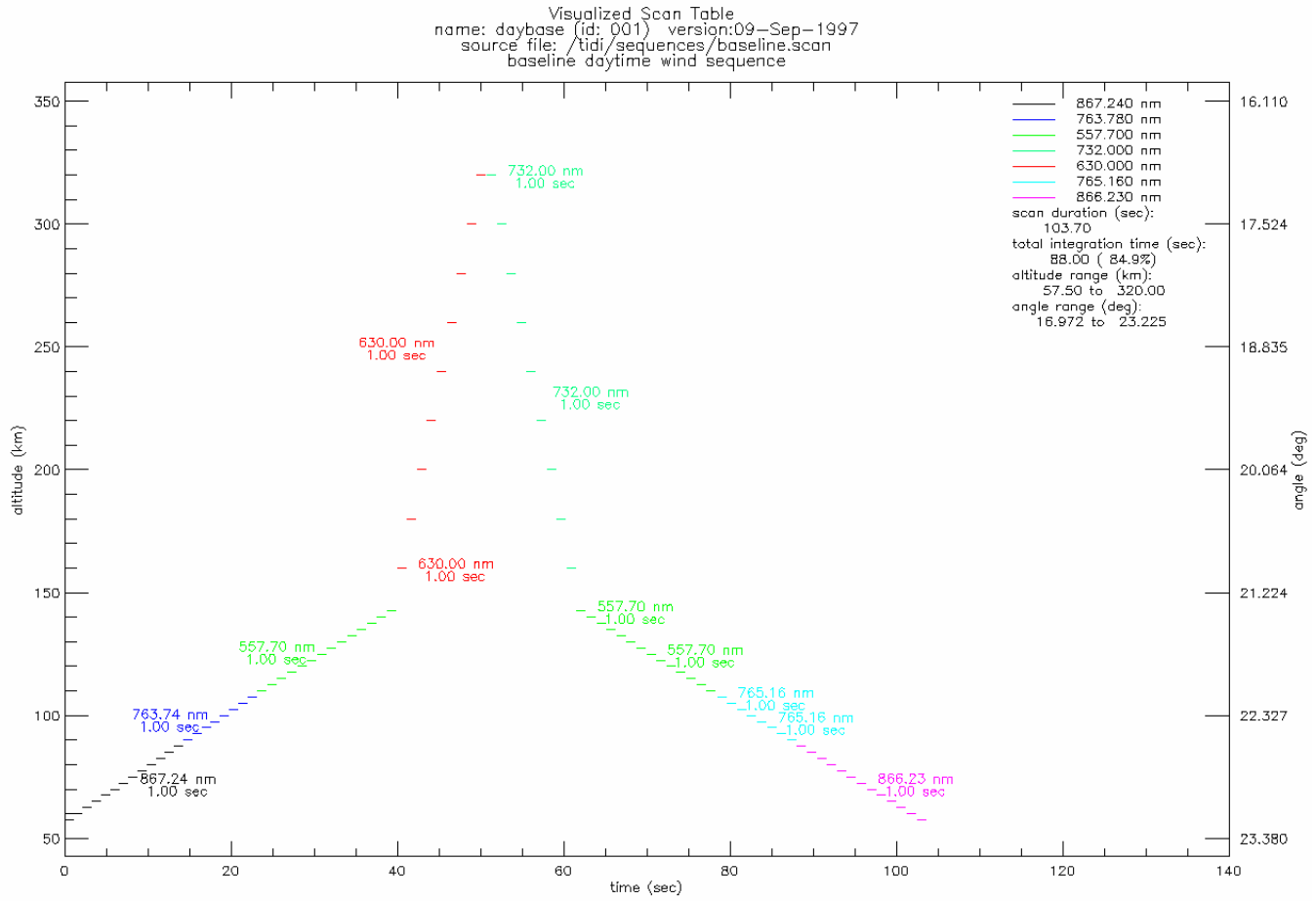
Uplink Software
Example Control Program

```
;
; file: example.ticl
; date: 1-Apr-1998
;
; method
;
; global useage
; global_01   telescope id to exercise for bearing lub
;
; change history:
; 1-Apr-1998  D. Gell   Initial coding
;
.purpose "example ticl program"
;
program 0          ; set program ID in telemetry
;
local    isDay
.define  dayside  1

store global_01   1    ; initialize telescope counter
;
top:
     store isDay spacecraft_day_night_status
     compare isDay dayside
     jump_eq  doday
     jump donight

doday:
     load_scan_table "/tidi/sequences/baseline.scan"
     start_scan
     jump wait_term

donight:
     load_scan_table "/tidi/sequences/mltNwind0.scan"
     start_scan
     jump wait_term

wait_term:
     wait 10  ; wait ten seconds
     compare isDay spacecraft_day_night_status
     jump_eq wait_term

     stop_scan_end
;    terminator crossing occured, exercise telescopes
;    one at each terminator crossing
;
     call bearingOverScan
     compare  global_01     5
     jump_eq top

     ;perform cal every 4th terminator crossing
     load_scan_table "/tidi/sequences/cal_mode"
     start_scan
     wait 1
     stop_scan_end
     jump top
end

bearingOverScan:  subroutine
; subroutine to exercise telescope
;
; global useage
; global_01 telescope to exercise
;
.define  maxEl    28
.define  minEl    18

     ; test telescope count and reset if greater than 4
     compare  global_01     5
     jump_lt doit
     load global_01     1

doit:    tele global_01 maxEl
     wait 2    ; wait 2 seconds
     tele global_01 minEl
     wait 2
     inc global_01
     return
end
```

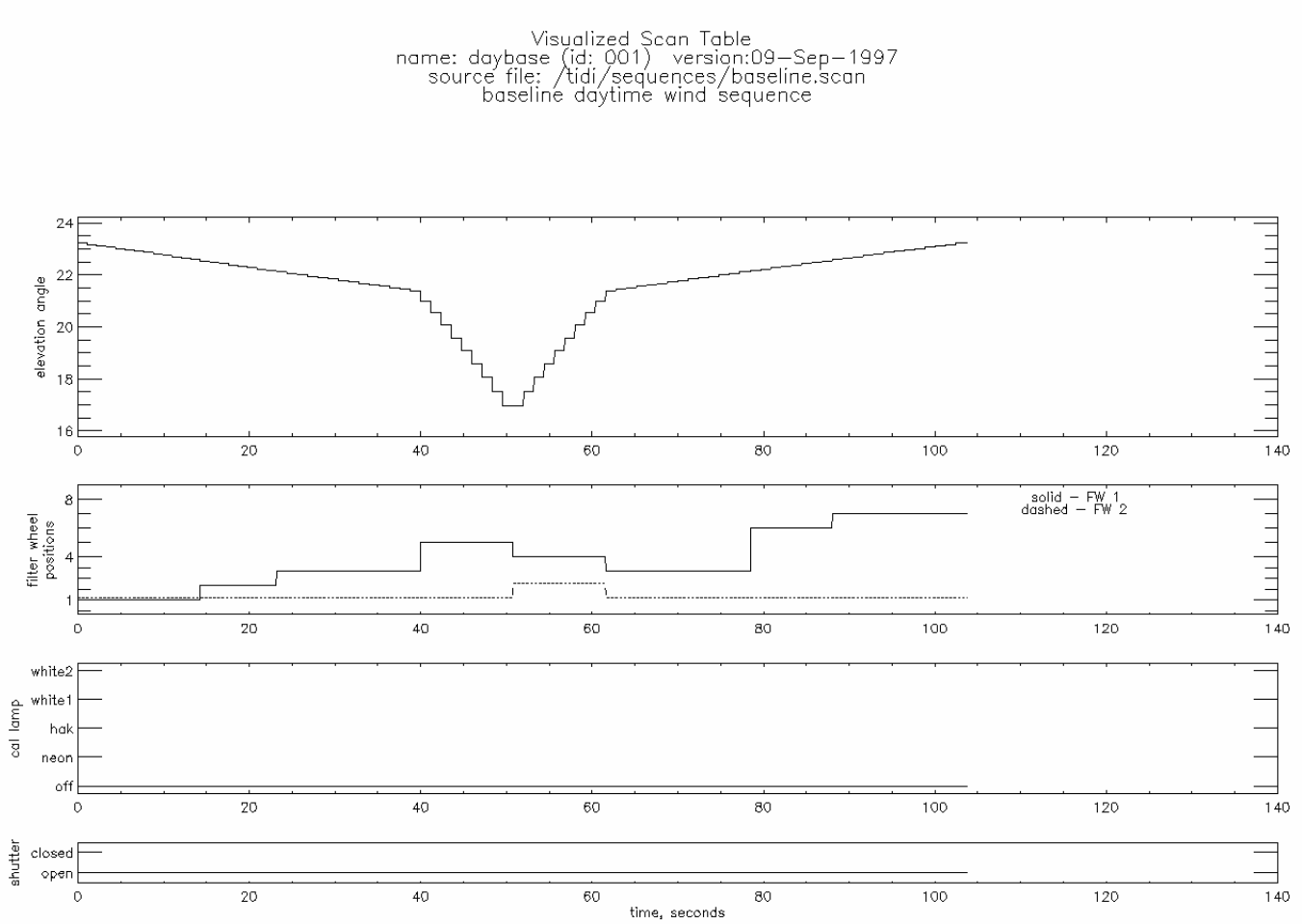
Uplink Software
Baseline Scan Table

```
.name:          daybase
.id:            1
.description:   baseline daytime wind sequence
.approved:      09-Sep-1997
.scan:          altitude
;-------------------------------------------------------------
; change history
; by   date           description
; DAG  01-Nov-1996    initial coding
; DAG  15-Nov-1996    Added header keywords and comments
; DAG  05-Sep-1997    updated to reflect two filter wheels
;                     which move sequentially
; DAG  09-Sep-1997    Updates per Q. Wu
;
;-------------------------------------------------------------
;
;start  end     step    waveln  fw1     fw2     tex     ter     cal     shutter
;
 57.5    87.5     2.5   867.24  1       1       1.0     0.1     off     open
 90.0   107.5     2.5   763.74  2       1       1.0     0.1     off     open
110.0   142.5     2.5   557.70  3       1       1.0     0.2     off     open
160.0   160.0    20.0   630.00  5       1       1.0     0.2     off     open
180.0   320.0    20.0   630.00  5       1       1.0     0.2     off     open
320.0   320.0   -20.0   732.00  4       2       1.0     0.2     off     open
300.0   160.0   -20.0   732.00  4       2       1.0     0.2     off     open
142.5   142.5    -2.5   557.70  3       1       1.0     0.2     off     open
140.0   110.0    -2.5   557.70  3       1       1.0     0.2     off     open
107.5   107.5    -2.5   765.16  6       1       1.0     0.3     off     open
105.0    90.0    -2.5   765.16  6       1       1.0     0.2     off     open
 87.5    57.5    -2.5   866.23  7       1       1.0     0.2     off     open
```

Uplink Software Baseline Scan



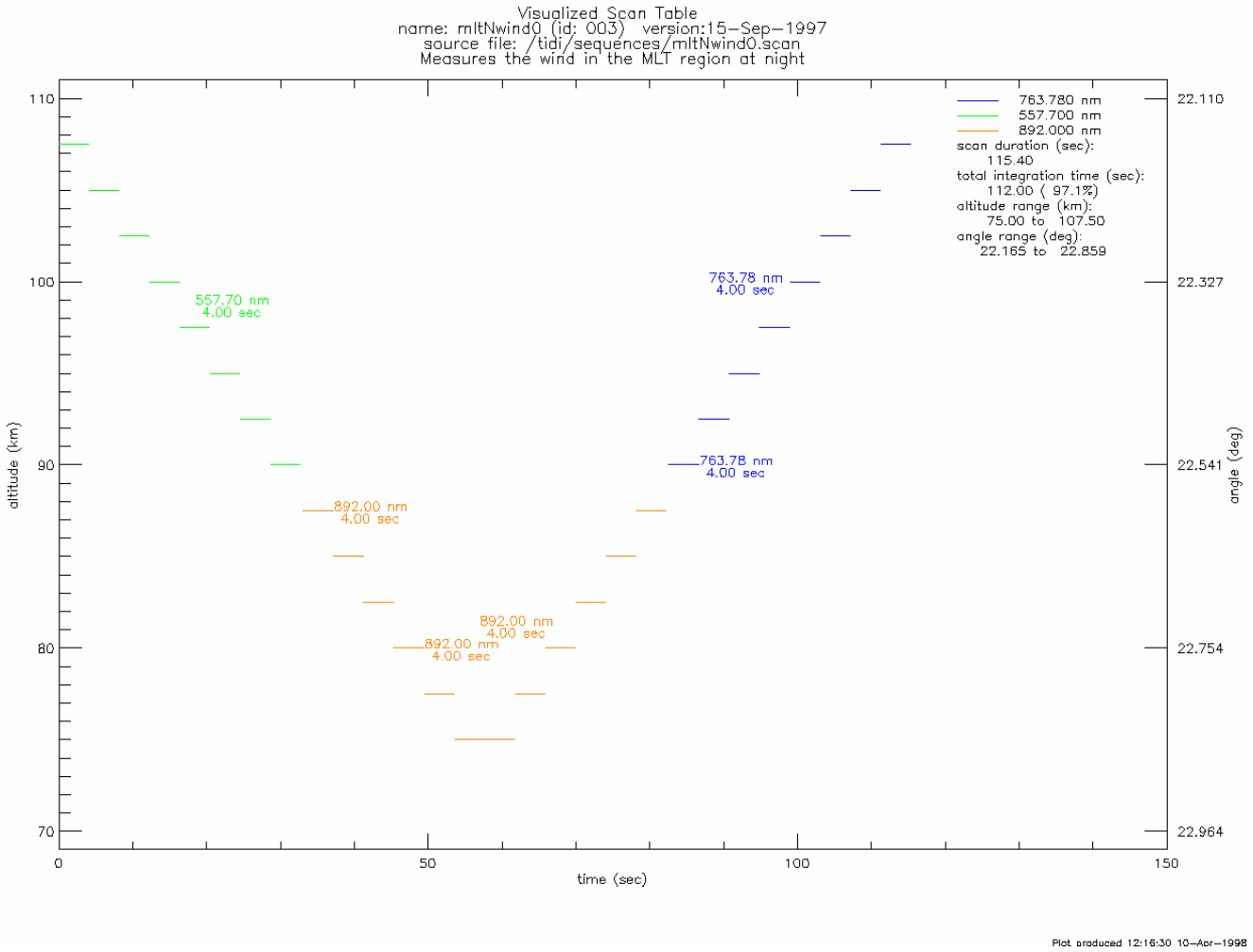
Uplink Software
Baseline Scan Mechanism Motion



Uplink Software
Nightime Scan Table

```
.name:          mltNwind0
.id:            3
.description:   Measures the wind in the MLT region at night
.approved:      15-Sep-1997
.scan:          altitude
;-------------------------------------------------------------
; change history
; by    date            description
; DAG   15-Oct-1997     entered from specification 055-3431A
;-------------------------------------------------------------
;
;start  end     step    waveln  fw1     fw2     texp    ter     cal     shutter
;
107.5    90.0   -2.5    557.70  3       1       4.0     0.1     off     open
 87.5    87.5   -2.5    892.00  8       1       4.0     0.4     off     open
 85.0    75.0   -2.5    892.00  8       1       4.0     0.1     off     open
 75.0    87.5    2.5    892.00  8       1       4.0     0.1     off     open
 90.0    90.0    2.5    763.78  2       1       4.0     0.4     off     open
 92.5   107.5    2.5    763.78  2       1       4.0     0.1     off     open
```

Uplink Software
Nighttime Scan



Uplink Software
Example Command Block File

```
.FFVID 101
.TIDL /tidi/ticl/example.ticl
.TCMD /tidi/tcmd/example.tcmd
.CTIME 19980912050
.CPROG /tidi/software/bin/compile
.CNODE tidi01
.CCMD ticl example.ticl
.PURPOSE example ticl program
.TYPE stored
12 26 B0 00 00 31 41 59 26 53 58 97 93 23 84 62 64 33 83 …
```

Uplink Software Status

Element	Requirements Specification	Design	Code	Test	notes
Compiler	1 Jun 98 DAG	1 Jul 98 CP	1 Aug 98 CP	15 Aug 98 CP	
Package	1 Jun 98 DAG	1 Jul 98 DAG	15 Jul 98 DAG	1 Aug 98 DAG	
ViewPredict	na	15 May 98 DZ	15 Jun 98 DZ	1 Jul 98 DZ	port from HRDI
OverPassPredict	na	1 Apr 98 DZ	1 May 98 DZ	15 May 98 DZ	port from HRDI
SGP4 Propogator	na	15 Mar 98 DZ	1 Apr 98 DZ	30 Apr 98 DZ	reproduces test cases provided in spacetrack report 3
Visualize Scan	3 Sep 97 DAG	22 Oct 97 DAG	1 Nov 97 DAG	11 Nov 97 DAG	complete
Simulate	1 Feb 99 DAG	1 Mar 99	1 May 99	15 Jun 99	to be completed 6 months prior to launch

DAG-David Gell MJB-Michael Burek ARM-Alan Marshal DZ -Dapeng Zu CP-Contract Prgmr

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Uplink Software Changes Since PDR

- **Merge function included in the compiler**
- **PGP specified for command encryption**

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Downlink Software Purpose

- Provide tools to monitor the performance of the instrument
- Transform instrument measurements into geophysically useful data
- Archive and serve results to the community
- Support correlative measurements

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Downlink Software Requirements

- **Environment**
  - **All components will execute on the TIDI data processing system**
    - **Hewlett-Packard C180 Workstation**
    - **HP-UX v10.20 (or later) operating system**
  - **Each component will perform an orderly shutdown upon receipt of a SIGTERM signal**
  - **Programming will be performed in C, FORTRAN, or IDL as appropriate to the problem**
- **Interfaces**
  - **All interfaces comply with the TIMED GIIS and TIDI SIIS**
  - **Scientific data products will be stored in netCDF files**
  - **netCDF files will include the project defined global attributes (GIIS section 8)**

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Downlink Software Components — I

- **TMLogger**
  - Acquires real time or playback TM
  - Produces a level 0 file, TIDI TM Packet File
- **Retrieve**
  - Converts measured spectra from instrument units into radiometric units, correcting for instrument artifacts and applying radiometric calibration
  - Determines actual viewing geometry
  - Produces a Level 1B file, TIDI Line of Sight file
- **Invert**
  - Inverts spectra producing profiles of wind, temperature and volume emission rate
  - Computes ancillary data for each profile

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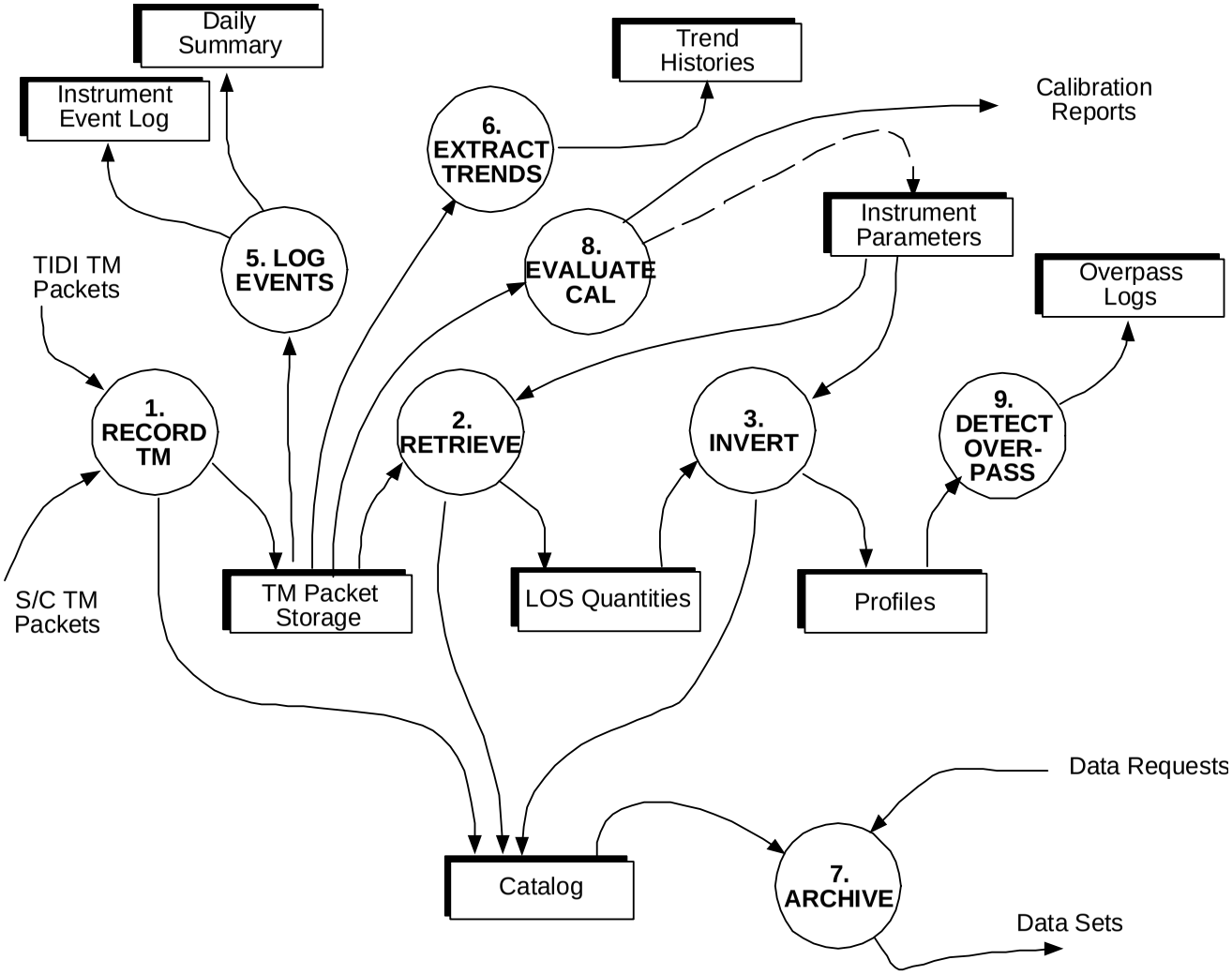
Downlink Software Components — II

- **Events**
  - Creates detailed log and daily summary
  - logs and counts limit transitions
  - logs changes of scan table
  - detects and logs contaminated spectra
  - detects and logs flight software error reports
- **Trend**
  - Produces a history of selected TM values
  - Creates a trend file for each selected item
- **OverPassDetect**
  - Compares profile locations with a ground station
  - Reports geographical coincidences

Downlink Software Data Flow



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Downlink Software
Major Data Products

- **TM Packet File**
  - Routine Level 0 Product
  - Contains TIDI and Spacecraft Data
  - Custom direct access file format
- **Line of Sight File**
  - Routine Level 1B Product
  - Contains spectra in photometry units (rayleigh)
  - Contains ancillary data for each spectra
  - netCDF file
- **Profile File**
  - Routine Level 2 Product
  - Contains profiles of wind, temperature and VER
  - Contains ancillary data for each profile
  - netCDF file

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Downlink Software Data Volume

File Level	File Type	Annual Production Mbytes
0	Packet Storage	9,463.
1B	LOS Quantities	3,016.
2	Profiles	244.
Ń	Trend	4.
Ń	Instrument Event Log	3.4
Ń	Overpass Log	7.5
Ń	Catalog	0.75
	Total	12,700.

Downlink Software Status

Element	Requirements Specification	Design	Code	Test	notes
TMLogger	11 Feb 98 DAG	15 Apr 98 MJB	1May 98 MJB	15 May 98 MJB	
Retrieve	11 Feb 98 DAG	1 Jul 98 ARM/DAO	1 Sep 98 ARM	15 Jun 99 ARM	Data processing software to be ready six months prior to launch
Invert	11 Feb 98 DAG	1 Jul 98 ARM/DAO	1 Sep 98 ARM	15 Jun 99 ARM	Data processing software to be ready six months prior to launch
Events	11 Feb 98 DAG	1 Jul 98 DAG	15 Aug 98 DAG	25 Sep 98 MJB	
Trend	11 Feb 98 DAG	15 Aug 98 MJB	1 Sep 98 MJB	25 Sep 98 MJB	
OverPassDetect	11 Feb 98 DAG	1 May 99 DAG	1 Jun 99 DAG	15 Jun 99 MJB	Data processing software to be ready six months prior to launch
Level0 Access API	11 Feb 98 DAG	30 Apr 98 MJB	15 May 98 MJB	15 Jun 98 MJB	
TM Query Extractor	11 Feb 98 DAG	23 Jun 98 MJB	15 Jul 98 MJB	1 Aug 98 MJB	

DAG-David Gell MJB-Michael Burek ARM-Alan Marshal DAO-David Ortland

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TIDI

Downlink Software Changes Since PDR

- **Profiles obtained directly from spectra without intermediate line of sight quantities**
  - **Level 1B file no longer contains line of sight winds, brightness …**
  - **RETRIEVE simplified**
- **Overpass detection separated from the event logging function**
- **Telemetry values are stored as TIDI packets**
  - **stored as raw values**
  - **Level 0 Access routines provide conversion to engineering units**
- **Identified requirement for TM Query Extractor**

Real-Time Software

- **Purpose**
  - Provides display of instrument status information
  - Provides real-time command interface for I&T and orbital operations
  - Logs data during tests and provides “ad-hoc” reports
- **Requirements**
  - Display and operator interface is to be implemented using the OASIS-CC package, unmodified
  - All elements must operate in the TIDI POC environment
  - All interfaces must comply with the TIMED GIIS and TIDI SIIS

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Real-Time Software Components

- **OASIS-CC**
  - Command and Display elements built on this product
- **Downlink Software Components**
  - TMLogger, Events and Trend

    Provide data logging, trend analysis and event detection
  - TM Query Extractor

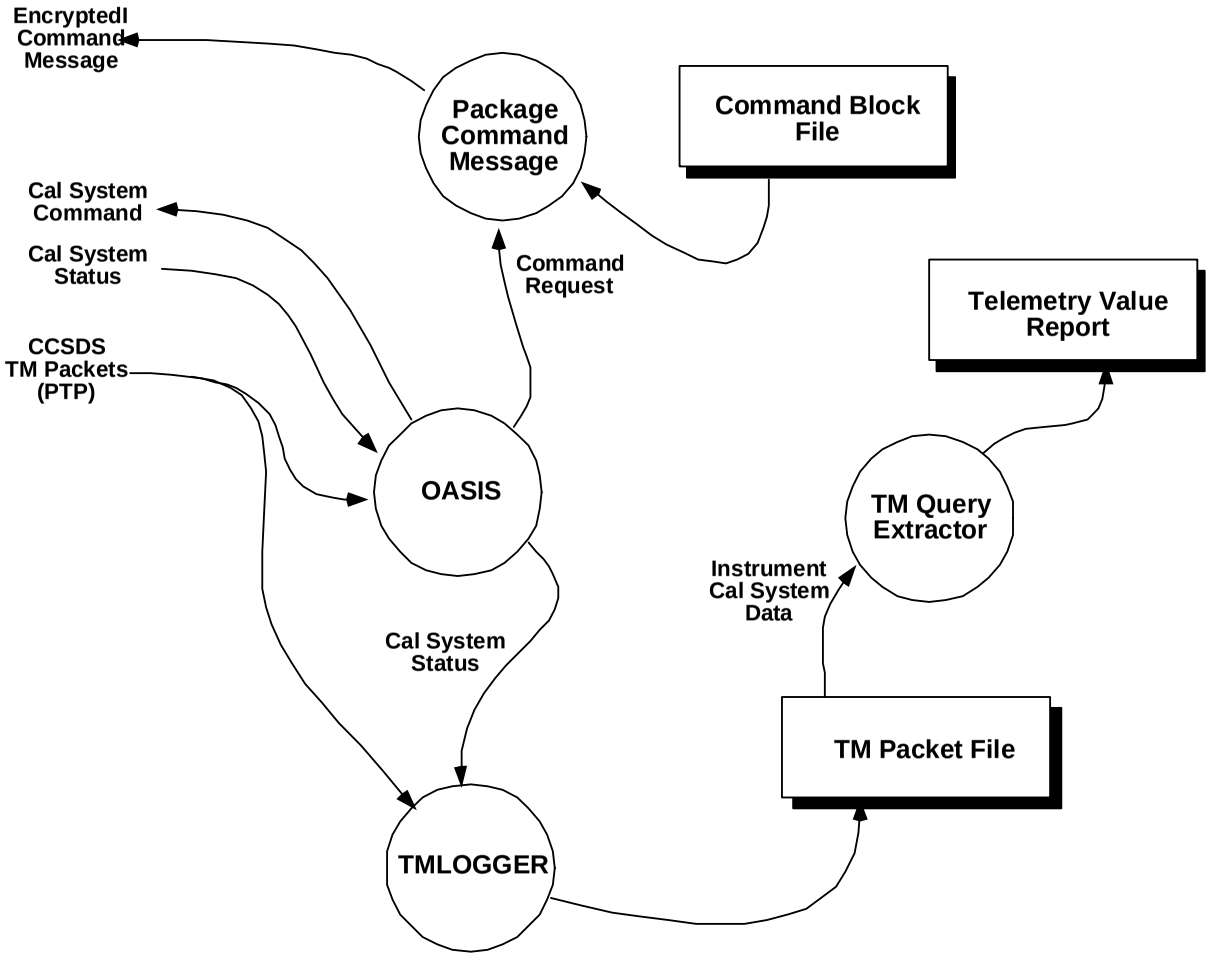
    Extracts engineering values from the TM Packet file

    Formats “ad-hoc” reports
- **Uplink Software Components**
  - Package

    Provides message file creation and encryption of previously compiled command programs

    Ensures unique CCSDS sequence numbering

Real-Time Software Data Flow



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Real-Time Software Data Products

- **The Real-Time software produces the same products as the Downlink software**
- **TM Value reports and limit reports will be generated as needed from the level 0 data and the event logger report**

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Real-Time Software Status

- **OASIS**
  - **OASIS and TAE Software installed**
  - **Table Definitions**
    - **Data Handling**
      - **Engineering data definitions complete using automation**
      - **Science packets need to be defined**
    - **External Communications**
      - **Link definition in progress**
    - **Command and User Interface remain**

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Real-Time Software Changes since PDR

- **Requirement for unique CCSDS sequence numbers in message files**