MODIS SCIENCE DATA SUPPORT TEAM PRESENTATION*

May 31, 1991

AGENDA

1. Action Items
2. MODIS Airborne Simulator and MCIDAS
3. MODIS Data Packets
4. MODIS Level-1 Processing
5. Assumptions/Tracking List

*The MODIS Science Data Support Team (SDST) was formerly called the MODIS Data Study Team

ACTION ITEMS for 5/31/91:

05/03/91 [Team]: Document plans for Level-1A and Level-1B processing, and indicate what information will be included in each product. Include a list of assumptions, brief rationale, scenarios, and trade-offs. This document is being prepared. An outline is included in today's presentation. STATUS: Open. Due date 06/07/91

05/03/91 [Tom Goff and Lloyd Carpenter]: Prepare a Level-1 processing assumptions, questions and issues list, to be distributed to the Science Team Members and the MCST for comment. An updated version is included in today's presentation. STATUS: Open. Due date 06/07/91

05/24/91 [Liam Gumley]: Find out the cost of the PC version of MCIDAS, and the availability of graphics. Information is included in today's presentation. STATUS: Closed.

05/24/91 [Liam Gumley and Lloyd Carpenter]: Check with Fritz Hasler on the availability of PC based MCIDAS at GSFC. Information is included in today's presentation. STATUS: Closed.

ACTION ITEMS FROM MSDST MEETING 05/24/91 [Liam Gumley]

(1) Talk to Paul Menzel, Yoram Kaufman, Mike King about MAS.

I met with Yoram Kaufman at GSFC, and discussed several aspects of his requirements for the MAS. He sees MAS as a system which will continue to fly and acquire data up to and beyond the launch of EOS-A, assuming the data are of good quality. Thus he thought that some effort should be directed to designing a flexible MAS processing system at GSFC. Some issues which he raised were as follows.

- Quick looks. A facility to quickly look at the entire set of images from a flight to select regions of interest would be desirable.
- Processing capabilities. Image processing facilities should be available on the processing system, as well as calibration, navigation, atmospheric correction etc.
- Connection to other systems. The MAS processing system should allow links and transfers with other systems such as mainframes and personal computers (IBM PC or Macintosh). Data volume is of concern here, so Ethernet links are desirable.
- Data format. The system should be set up so that end users of the data and/or products do not have to worry about what the format the data is in - it should be a standard format.
- Navigation. For his applications, it is important to be able to co-register images from different flights over the same area.

He suggested that for a perspective on the requirements of the land disciplines I should talk to Chris Justice. This will be done next week.

(2) Continue enquiries about availability of MCIDAS at GSFC.

I spoke to Fritz Hassler about MCIDAS at GSFC, and he said that the Severe Storms Branch has a WETNET terminal, which is essentially a PC-MCIDAS system (see item 3). He suggested I contact Bob Adler for further details. Bob confirmed that Severe Storms does have a WETNET terminal, and currently it is not used. He did not see any problem with us utilizing this machine. He will get one of his people to call me so I can go out and take a look at the machine.

(3) Enquire about the cost of PC-MCIDAS.

I contacted Bob Fox at the Space Science and Engineering Center (SSEC), University of Wisconsin-Madison, and ended up talking to J.T. Young, one of the MCIDAS designers. SSEC currently markets MCIDAS versions for
(a) IBM mainframe (MVS) systems
(b) IBM PC (OS/2) systems.
By the end of 1991 they expect to ship a Unix workstation version of MCIDAS which supports IBM System 6000, Sun, and Silicon

Graphics systems. The cost of the Unix version is expected to be around twice that of PC-MCIDAS.

The cost of PC-MCIDAS (site license) is $3000, including software and manuals. Prices are cheaper for multiple copies. This assumes that the user has a SSEC recommended PC system with OS/2. SSEC will only provide full support if the user has a recommended PC system. SSEC will supply IBM PS/2 PC systems if desired. PC-MCIDAS provides 640x480 pixel graphics resolution with 16 colors.

SSEC recommends that users of MCIDAS join the MCIDAS Users Group (MUG). This provides access to MCIDAS User Services at Wisconsin, and quarterly complete software upgrades. The annual membership fee for MUG is $2000 for single PC-MCIDAS installations. Access to the mainframe MCIDAS at Wisconsin is available via modem or Internet at a cost of $500 per CPU hour.

A WETNET terminal consists of an IBM PS/2 computer, 650 Mb re-writable optical disk, modem, and PC-MCIDAS software, and costs $15000.

I asked J.T. Young to send some hardcopy information on pricing, features etc. of PC-MCIDAS. Future investigations in this area should look at what other processing systems are available commercially.

MODIS-N Instrument Specification (October 5, 1990)

"3.5.2.2 Data Packet Format."

"The MODIS-N data shall be packetized within the instrument. The format of the data packets transmitted to the EOS spacecraft is defined in the EOS General Instrument Interface Specification. All bands for a given pixel shall be in the same packet. The contractor shall propose method(s) for multiplexing the varying pixel sizes. Data shall be time tagged with real-time time code often enough to assure compliance with pointing and registration requirements."

MODIS-T Instrument Specification (June 1990)

"3.5.2.2 Data Packet Format."

"Data shall be packetized within the instrument. The format of the data packets is defined in the EOS General Instrument Interface Specification. Packetized data shall be Band Interleaved by Line (BIL) and time tagged."

EOS General Instrument Interface Specification (GIIS)

(January 15, 1990. Note that this specification is outdated; an updated and revised version is under review.)

"5.8.2.1 High Rate Science Data Formats."

"High rate science data shall be packetized into CCSDS Version 1 source packets..."

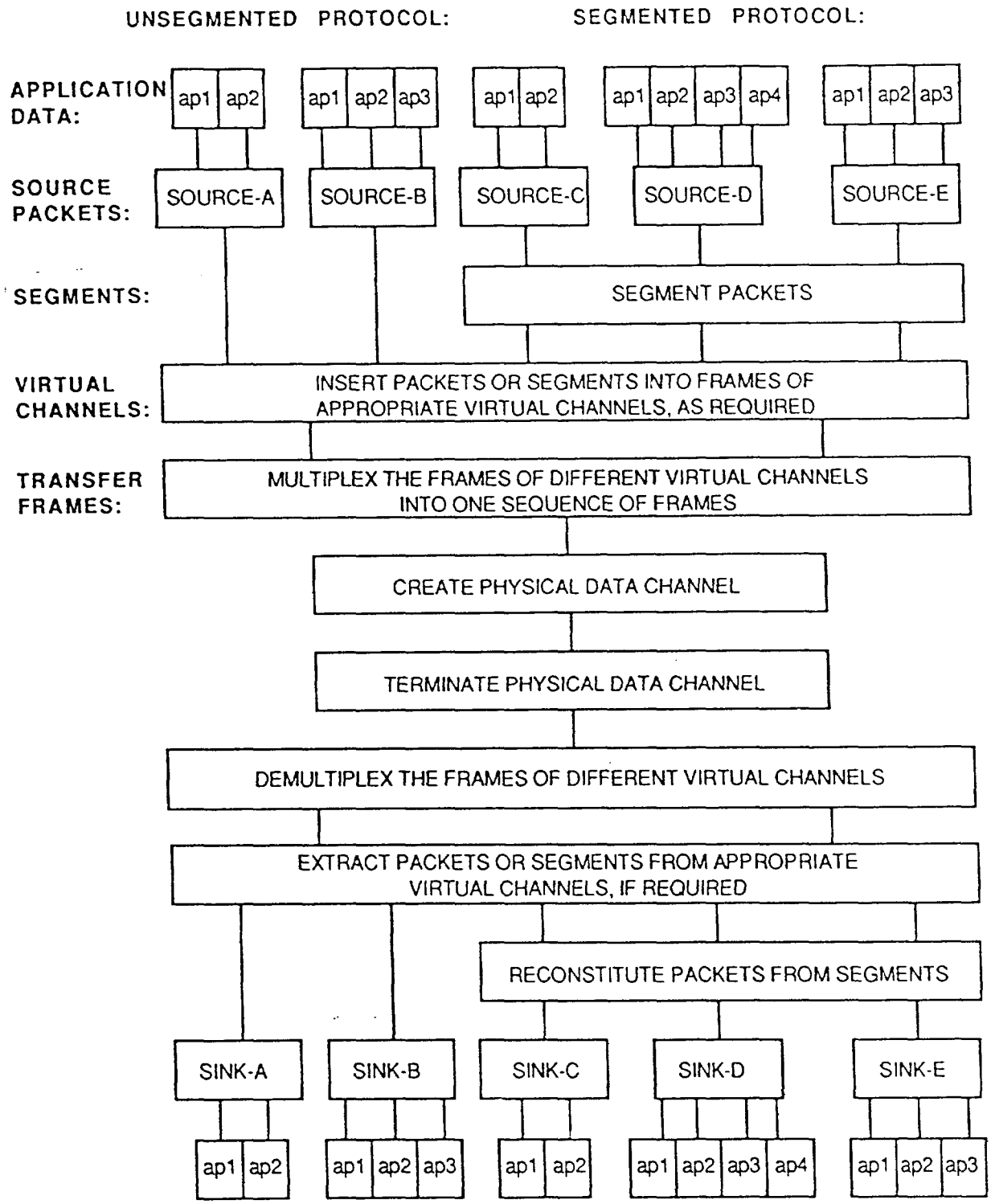


Figure 1: Telemetry Data Flow

Reproduced from "Packet Telemetry", Recommendation CCSDS 102.0-B-2, Issue 2, Blue Book, Consultative Committee for Space Data Systems, January 1987

Major Field	Length (Bits)
Primary Header	48
Secondary Header	Variable (optional)
Source Data	Variable
Packet Error Control	Variable (optional)

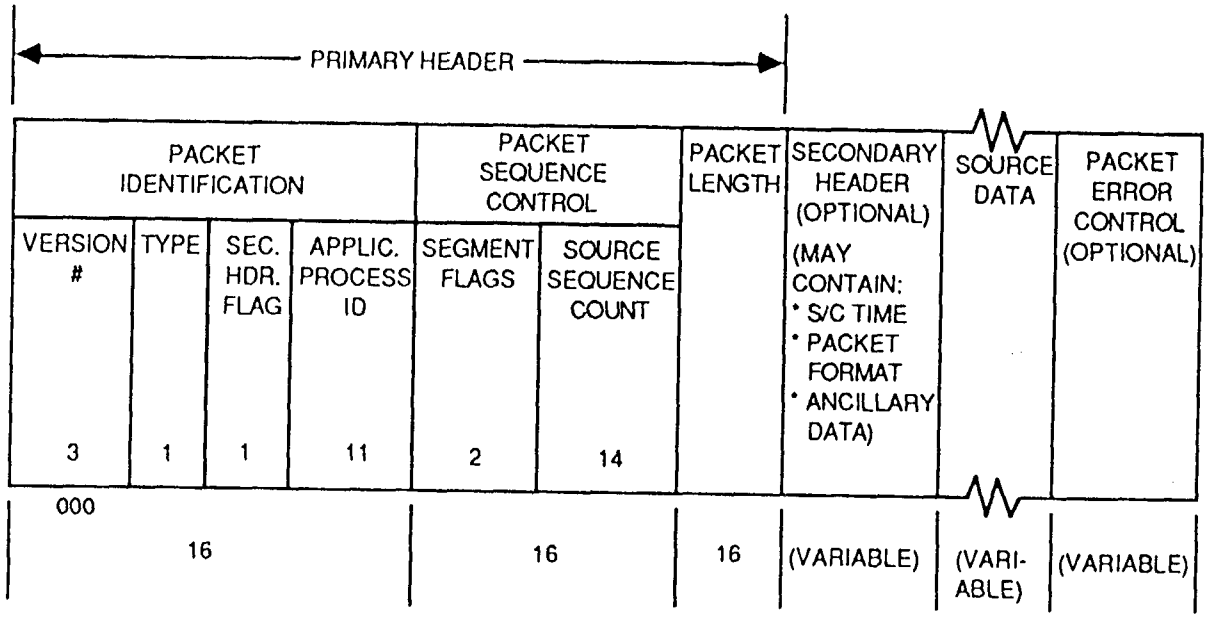
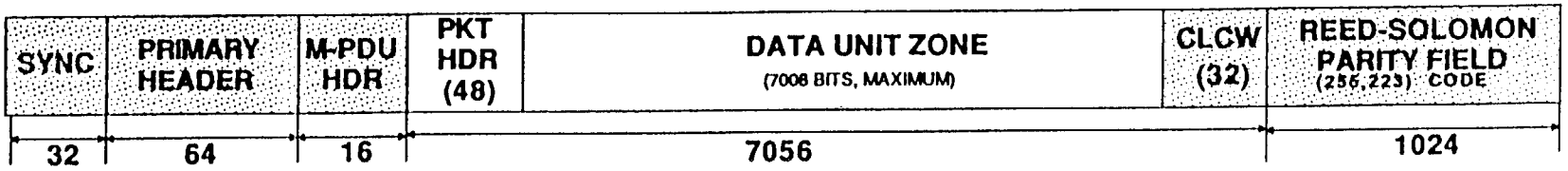


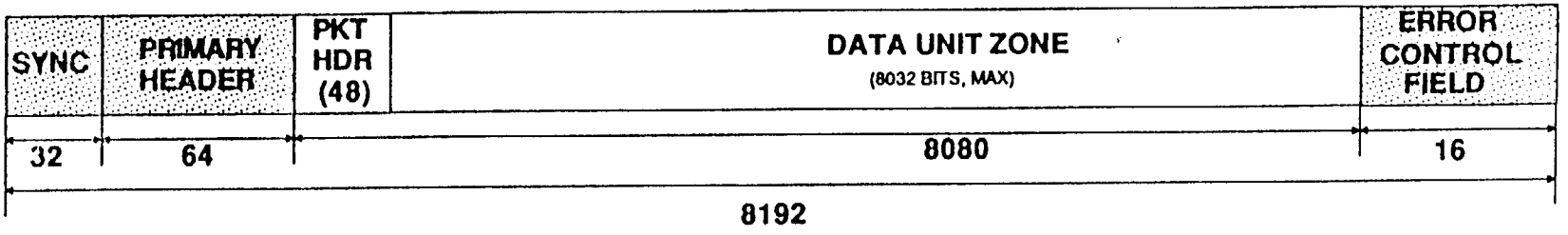
Figure 2: Version 1 "Source Packet" Format

Reproduced from "Packet Telemetry", Recommendation CCSDS 102.0-B-2, Issue 2, Blue Book, Consultative Committee for Space Data Systems, January 1987

STANDARD SERVICE: (14.5 % MIN. OVERHEAD) = CODED VIRTUAL CHANNEL DATA UNIT (CVCDU)



HIGH THROUGHPUT SERVICE: (2.0 % MIN. OVERHEAD) = VIRTUAL CHANNEL DATA UNIT (VCDU)



NOTE: The 48-bit packet header (PKT HDR) on this chart corresponds to the primary header of the CCSDS Version 1 "Source Packet.

FORMATS BASED ON 6/89 CCSDS RED BOOK ON ADVANCED ORBITING SYSTEMS

Transfer Frame Overhead

Notes: 1) Minimum overhead calculations assume 1 packet per frame, no CLCW
2) M-PDU = Multiplexed Protocol Data Unit
CLCW = Command Link Control Word
3) CLCW only in frames on Low Rate Data Virtual Channel

Reproduced from "General Instrument Interface Specification for the EOS Observatory", January 15, 1990.

Figure 5-24 Downlink Transfer Frame Formats

Conversation with Allen Tarleton
EOS Observatory Data Systems Manager (Code 421)

Current outlook:

- New version of GIIS within a few months
- Secondary header mandatory - first 64 bits for time code (ancillary data format)
- Packet segmentation not allowed
- Maximum packet length, including header, 7056 bits
- Ping-pong transfer buffer architecture - transfer rate 63.5 Mb/s

MODIS Level-1 Processing Assumptions and Scenarios

1. LEVEL-1A

1.1 Inputs

1.1.1 Standard Processing

1.1.1.1 Level-0 MODIS Data
1.1.1.2 Platform ancillary data

1.1.2 Quick-look processing

1.1.2.1 Quick-look Level-0 MODIS data
1.1.2.2 Quick-look platform ancillary data

1.2 Functions

1.2.1 Packet to scan processing
1.2.2 Scan to granule processing
1.2.3 Create granule header
1.2.4 Append ancillary data
1.2.5 Metadata generation

1.3 Outputs

1.3.1 MODIS Level-1A granules
1.3.2 Level-1A metadata

1.4 Scenarios for Use

1.4.1 As input for Level-1B product generation
1.4.2 MODIS Ocean Team Validation
1.4.3 Level-0 product recovery
1.4.4 Possible updating of platform ancillary data

MODIS Level-1 Processing Assumptions and Scenarios (Continued)

2. LEVEL-1B

2.1 Inputs

2.1.1 MODIS Level-1A granules

2.2 Functions

2.2.1 Unpacking
2.2.2 Navigation
2.2.3 Calibration
2.2.4 Data quality checks
2.2.5 Create granule header
2.2.6 Metadata generation
2.2.7 Browse generation

2.3 Outputs

2.3.1 MODIS Level-1B granules
2.3.2 Level-1B metadata
2.3.3 Level-1B browse

2.4 Scenarios for Use

2.4.1 MODIS Level-2/3 product generation
2.4.2 CERES Standard/Special product generation
2.4.3 MODIS Ocean Team Validation
2.4.4 MODIS land product generation at EDC
2.4.5 MODIS snow/ice product generation at NSIDC

Assumptions/Tracking List
for the
MODIS Science Data Support Team
31 May 1991

This list of assumptions, tracking items and questions is intended to clarify issues and prevent misunderstanding. The list can be changed as necessary.

LEVEL-1A PROCESSING ASSUMPTIONS

1. MODIS Data. All Level-0 data packets with an Application Process ID that designates MODIS data will be retained in the MODIS Level-1A product.

2. Data Granules. MODIS Level-1A data will be stored as granules with a granule header. Each granule will consist of a number of complete scan cubes. Each granule shall contain no more data than that taken during an orbital period.

~~**3. Data Packets**. Each MODIS scan cube will consist of a number of complete data packets which are numbered sequentially in time order within the scan. Each data packet will be provided with a secondary header that includes the packet sequence counter and the scan sequence counter~~

~~**4. Scan Cube Boundaries**. Each MODIS data packet will be contained within a single scan cube. Thus, the scan cube boundaries coincide with packet boundaries.~~

3. Unpacking Data. MODIS data will not be unpacked at Level-1A.

4. Navigating Data. MODIS data will not be navigated at Level-1A.

5. Instrument Status Comparison. The MODIS Level-1A processing will not check instrument states contained in the Level-0 header against the Instrument Status Information issued by the ICC.

~~**6. Level-1A Data Quality Checks**. There will be no detailed, or pixel-by-pixel, data quality checks at Level-1A, other than the detection of problems which make the data unsuitable for archival, or prevent the completion of Level-1A processing.~~

6. Quick-Look. Level-1A Quick-Look data will be generated using the same version of software as is used for the standard Level-1A product. ~~Quick-Look processing may require prior time-ordering, redundancy elimination, and quality control measures not required of standard Level-1A processing.~~

7. Reversibility. Level-1A processing will be reversible to time ordered instrument packets of Level-0 data with redundancies eliminated.

8. Reversing Software. A separate software package will be provided to reverse Level-1A data to Level-0.

~~**10. Ancillary Data**. Spacecraft ancillary data, including satellite position and attitude knowledge, will be supplied by the EOS project before Level-1A processing. The ancillary data will be obtained in a process external to the MODIS Level-1A processing. It will be appended (but not applied) to the Level-1A data.~~

9. Orbit and Attitude Correction. The process of correcting orbit and attitude information already appended to Level-1A data will be done in a separate utility process.

~~**11. Data Storage**. The Level-0 data packets and the MODIS program backing stores will be local to the computer performing the MODIS processing.~~

10. Engineering Data. MODIS Level-1A processing will check ~~compare~~ and evaluate selected instrument engineering data ~~values~~ at ~~both the packet processing stage and at~~ the completion of processing each scan cube ~~processing stage~~.

11. Processing Log. The MODIS Processing Log will consist of a time ordered list of all MODIS processing events. The Processing Log will receive messages in time order from all MODIS processing programs (Level-1A, Level-1B, Level-2, etc.).

12. Land/Ocean Flags. Land/Ocean, Cloud, or other derived flags will not be included in the Level-1A data product. The Level-1A product will be supplied without separation into land/ocean or other categories.

13. Level-1A Browse. There will be no Level-1A browse product.

14. Data Compression. No data compression will be performed within the MODIS Level-1A processing.

LEVEL-1B PROCESSING ASSUMPTIONS

1. Data Granules. During Level-1B processing, the data contained in each MODIS Level-1A data granule will be subdivided into a time-ordered sequence of Level-1B data granules. Each Level-1B data granule may be considered as consisting of a time-ordered sequence of "scenes", each of which is made up of a time-ordered sequence of "scan cubes". Each scene covers a more-or-less square area on the earth's surface.

2. Coordinate System. Coordinates will be represented in the geodetic latitude-longitude coordinate system on the standard 1984 oblate spheroid.

3. Anchor Points. For each scan, a set of anchor points will be selected for interpolating the ground locations of pixels within the scan. (See the report "An Analysis of MODIS Anchor Point Accuracies for Earth Location". MODIS Data Study Team, Revised: April 5, 1991.)

4. Anchor Point Parameters. The following parameters will be provided in the Level-1B data set for each anchor point: earth location (geodetic latitude-longitude) of the pixel, satellite slant range, satellite azimuth and zenith angles, and solar azimuth and zenith angles (all with respect to the pixel).

5. Anchor Point Error Statistics. No measure of earth location accuracies based upon anchor points will be included in the Level-1B data product.

6. Feature Identification No Feature Identification/Ground Control Points will be used at Level-1B for earth location.

7. Level-1B Elevation Correction. There will be no terrain elevation correction (beyond the basic spheroid) to earth location at Level-1B.

8. Platform Position and Attitude Knowledge. MODIS Level-1B processing will use the satellite position and attitude knowledge supplied by the EOS project and appended to the Level-1A data.

9. Atmospheric Correction. No atmospheric correction will be applied to the MODIS level-1B data.

10. Land/Ocean Flags. Land/Ocean, Cloud, or other derived flags will not be included in the Level-1B data product.

11. Land/Ocean Level-1B Products. The Level-1B product will be supplied without separation into land/ocean or other categories.

12. Level-1B Browse. The Level-1B processor will not generate browse products. A separate browse processor will be used to provide for easy adaptation to technology advances.

13. Required Ancillary Data. All information required for MODIS Level-1B processing will be included in the MODIS Level-1A product.

14. Calibration. Calibration algorithms and parameter values will be provided by the MCST ~~prior to Level-1B processing~~. They will be incorporated into the Level-1B software by the SDST.

15. Engineering Data. MODIS Level-1B processing will extract instrument engineering values from the Level-1A data as needed for calibration. All of the instrument engineering values needed for calibration will be included in Level-1A.

16. History Files. No history files will be required for calibration.

17. Instrument Status Comparison. The MODIS Level-1B processing will not check instrument states against the Instrument Status Information issued by the ICC.

~~**17. Level-1B Data Quality Checks**. There will be no detailed, or pixel-by-pixel, data quality checks at Level-1B, other than the detection of problems which make the data unsuitable for archival, or prevent the completion of Level-1B processing.~~

18. Level-1B Quick-Look. Level-1B Quick-Look data will be generated using the same version of software as is used for the standard Level-1B product.

19. Data Compression. No data compression will be performed within the MODIS Level-1B processing.

~~**20. Data Storage**. The Level-1A data granules and the MODIS program backing stores will be local to the computer performing the MODIS Level-1B processing.~~

20. Processing Log. The MODIS Processing Log will consist of a time ordered list of all MODIS processing events. The Processing Log will receive messages in time order from all MODIS processing programs (Level-1A, Level-1B, Level-2, etc.).

QUESTIONS AND ISSUES:

Where will the cloud/no-cloud flag come into the system?

Will the scheduler check to see that the required data is available before calling the MODIS processor?
The answer is yes. However the SDSTwe may be required to generate the table of data availability.

Is there any circumstance under which the MODIS-T instrument will be changing tilt during a scan? If so, is it possible to determine pixel locations during a change in tilt?

What will be the source of orbit and attitude data for Quick-Look?

Will the MCST and/or the Science Team provide a list of data quality checks to be applied in the Level-1A and Level-1B processing?

Will the spacecraft ancillary data, including satellite position and attitude knowledge, be supplied by the EOS project before Level-1A processing?