MODIS DATA STUDY
TEAM PRESENTATION

December 21, 1990

AGENDA

1. Action Items
2. Earth Shape Models for MODIS Level-1B Geolocation, II

ACTION ITEMS:

10/19/90 [Al McKay and Lloyd Carpenter]: Expand introductory material in Earth Model write-up to include broad discussion of MODIS geolocation and need for Earth model. Coordinate with Al Fleig to distribute report. STATUS: Open.

11/16/90 [Doug Hoyt]: Review MODIS Level-1 data flow diagrams and identify data items potentially provided by the MCST. Provide a list of instrument parameters required to Earth locate MODIS pixels (e.g. detector locations, electronic delays, mirror rotations, etc). STATUS: Presently available information insufficient to address item. Report due approximately one year from the assignment date. Open.

12/7/90 [Daesoo Han]: Arrange a meeting with appropriate EOSDIS civil service personnel to discuss data processing services to be provided on each side of the EOSDIS/MODIS interface and to set up communications structures to periodically review the needs and expectations of system developers working both sides of the interface. STATUS: Open.

12/14/90 [Lloyd Carpenter and Al McKay]: Add detail to the previous discussion of numerical offsets between ellipsoid and geoid referenced pixels, analyze the differences in computational requirements using the two Earth models, and integrate new and previous write-ups on Earth models into a single discussion. STATUS: Report in this week's handout. Open.

EARTH MODELS/GEOID

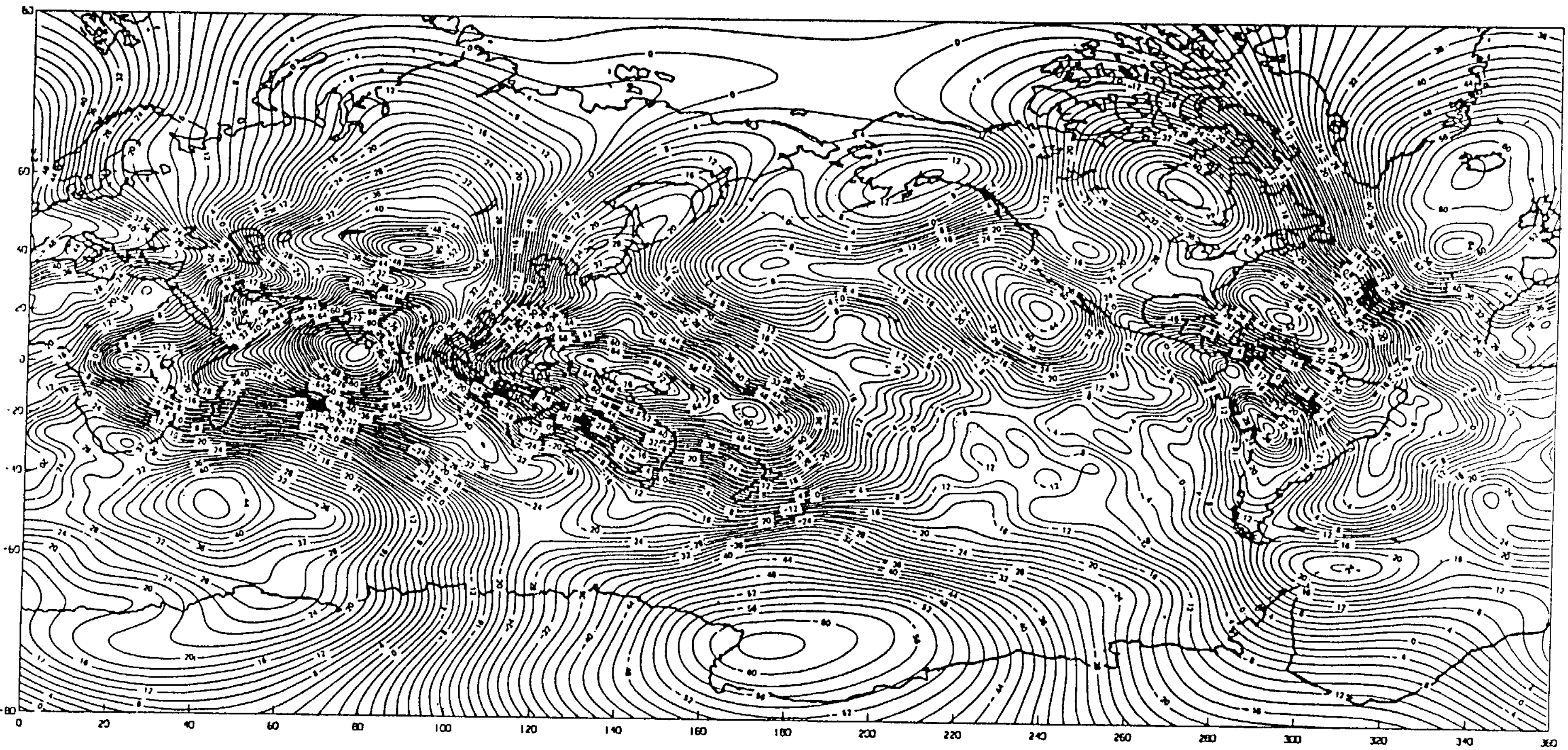
The use of the geoid as the reference surface for the reduction of MODIS (and other) observations raises the question of how this should be done, and what computer resources are required.

The best current geoid/gravity field model is designated OSU89B. It was developed at Ohio State University by N.K. Pavlis and R.H. Rapp. OSU89B is complete to degree and order 360. The resolution is 1/2 degree, and the series contains approximately 120,000 coefficients. (N.K. Pavlis and R.H. Rapp. The Development of an isostatic Gravitational Model, Geophys. J. Int. (1990) Vol 100, p 369-378)

The best "satellite only" model is GEM-T2, developed at Goddard for the Topex experiment. (Marsh, J.G. et al., 1989 The GEM-T2 Gravitational Model: NASA TM 100746, GSFC). The next version of this model will be completed in approximately one month (GEM-T3, degree and order 50, 1 degree resolution, approximately 2,300 coefficients.) See also: Marsh, J.G, et al, 1988, A new Gravitational Model for the Earth from Satellite Tracking Data: GEM-T1, J.G.R. Vol 93, No B6, p 6169-6215. June 10, 1988. An example of the geoid heights obtained from the predecessor model, GEM-T1, is shown in Figure 1.

Any of these models would be more that sufficient for the present purpose. For operational use, the most efficient approach is to use a table of geoid height values (e.g. tabulated at one degree intervals in latitude and longitude) and use bilinear interpolation. These grids have been generated, and should be available through GSFC Code 920. A numerical study should be done to determine the optimum grid spacing to yield the required accuracy and minimize the storage requirement. With this method the required number of operations will be minimal.

From Figure 1 we note that the maximum difference between the GEM-T1 geoid and a reference ellipsoid corresponding to the GRS-80 (Geodetic Reference System) spheroid (which also happens to correspond to the flattening of the WGS-84) is about 100 m. Using this value, we computed the differences in Earth location as determined by MODIS-N and T on the EOS platform, as a function of scan angle (Figure 2). At nadir for a non-tilting sensor there is, of course, no difference. The difference increase both as a function of scan angle and tilt angle, such that a maximum difference of > 700 m is obatined at the scan edge for a 50° tilt. In this instance, the pixel size is about 16,000 m, so the difference is only ≈ 4%, but the absolute difference is still large. There is presently little difference among the geoid models in current use, so these results may be considered representative.



GEOID HEIGHTS

REFERRED TO GRS-80 ELLIPSOID
a_e = 6378137 m 1/f = 298.257

Figure 9.0. The GEM-T1 Geoid.

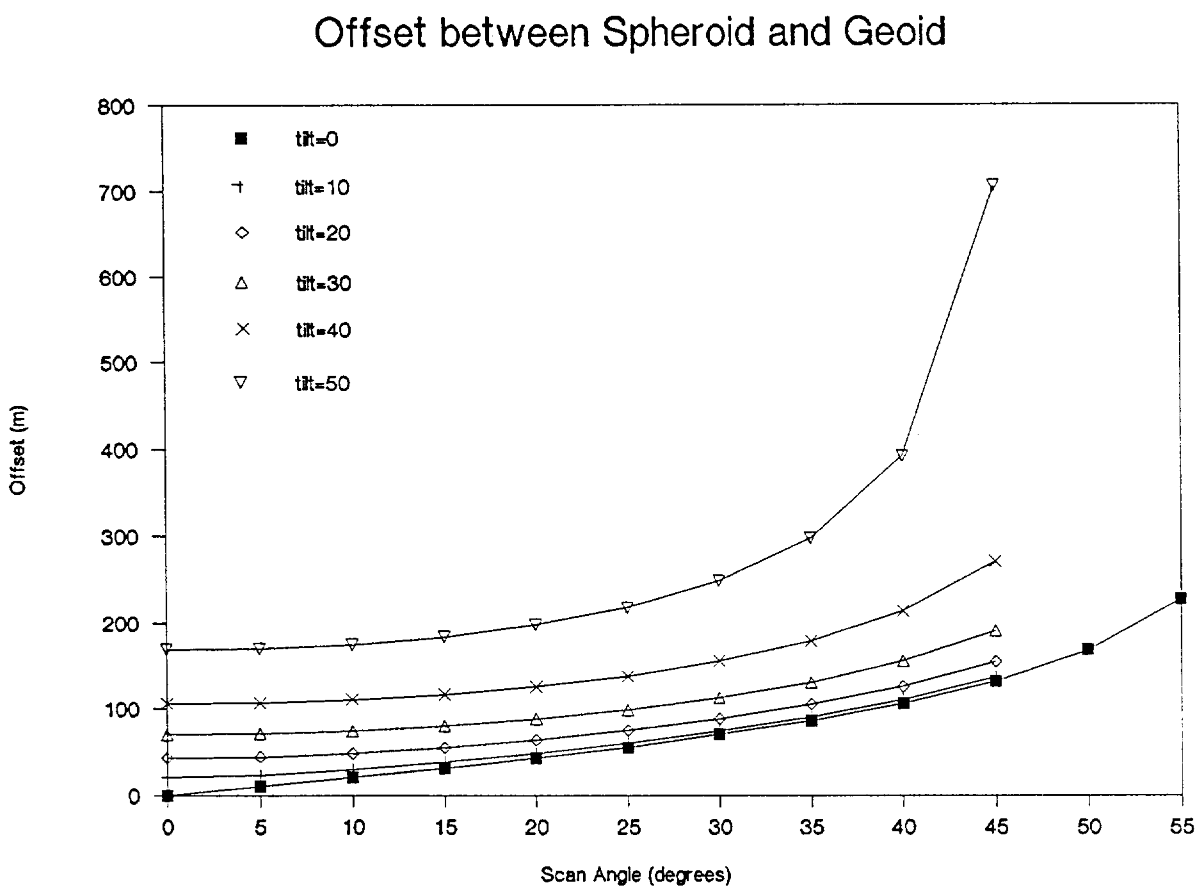

Offset between Spheroid and Geoid
Offset (m)
Scan Angle (degrees)
tilt=0
tilt=10
tilt=20
tilt=30
tilt=40
tilt=50
0
100
200
300
400
500
600
700
800
0
5
10
15
20
25
30
35
40
45
50
55

Fig. 2

APPENDIX TO

MODIS DATA STUDY TEAM PRESENTATION

DECEMBER 21, 1990

LEVEL-1A DATA FLOW DESIGN

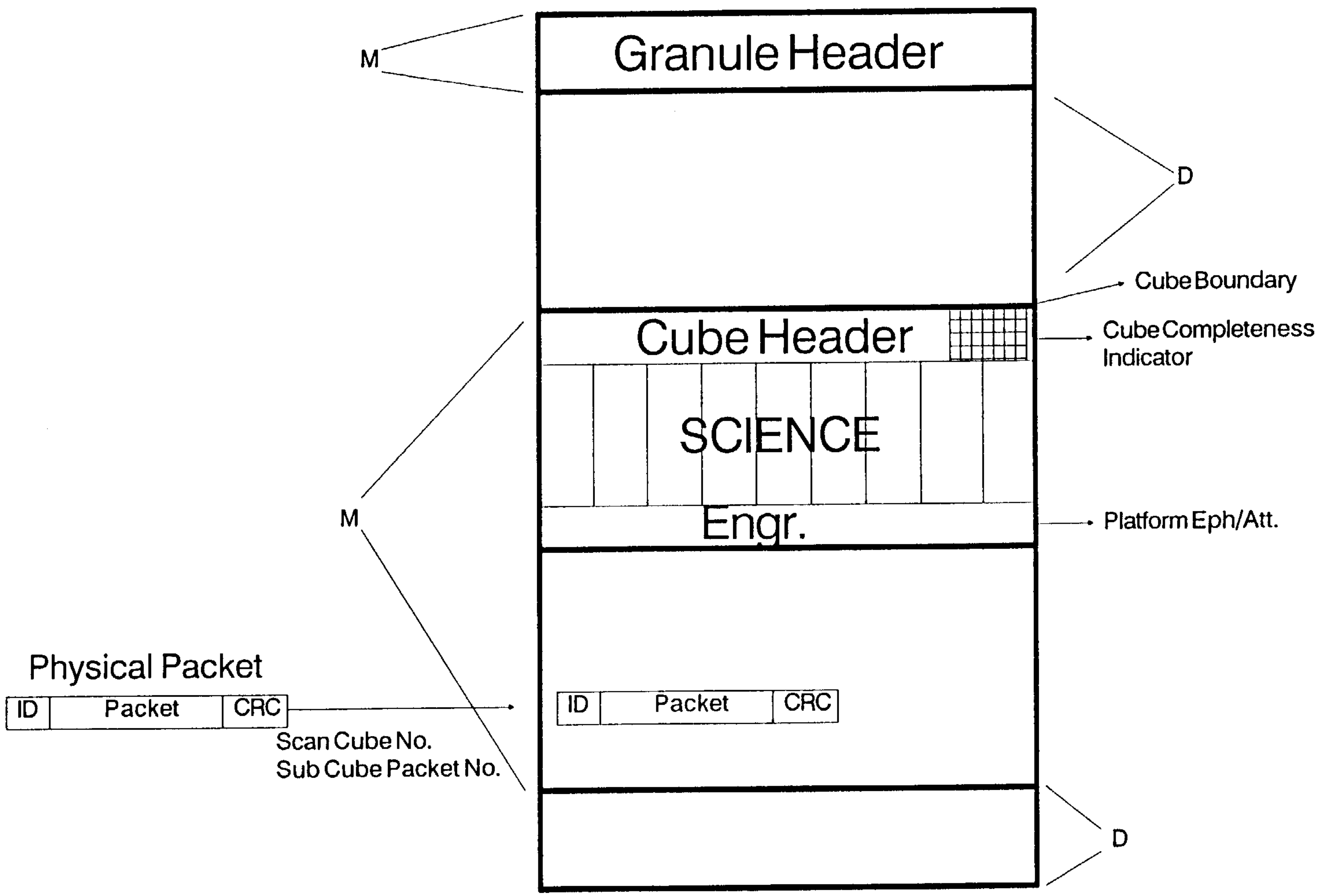
A Description of the Proposed MODIS Level-1A Granule Internal Data Structure.

The logical visualization of the granule structure contains an integer number of scan cubes. Each scan cube is composed of a cube header, a matrix of science (detector) data in a three dimensional representation, and ancillary data referenced as engineering data. The three dimensional science data corresponds to the across track line scan, along track multiple scan lines and depth corresponding to wavelength (bands). The present numbers for MODIS-T are 1040 pixels in the across track scan dimension, 30 scan lines along track, and 32 bands at differing center wavelengths . The data granule has a granule header appended at the begining of the granule structure. The size of a cube of data is expected to approach 2 megabytes with the size of a granule, composed of many cubes, being too large to fit into a reasonable amount of computer memory. To process the incoming granule of data, an implementation of a demand paging is proposed.

The computer memory for the data granule is sized to hold two cubes of data at the same time. The remaining cubes of data will be swapped between a disk backing store and the computer memory. It is assumed that the size of a data set granule will be known in advance of the processing and that sufficient disk storage can be pre-allocated before processing of incoming data begins. The packets of incoming data are expected to be approximately 1000 bytes in length thereby requiring approximately 2000 packets of data to fill a scan cube of information. The packets of data are generated at the instrument in a time ordered sequence but may be received at the EOSDIS facility in a slightly non-time ordered sequence due to the nature of the store and forwarding intermediate data transmission steps. In other words, the locality in time of the arrival of packets will be time ordered but will include a random small delta time offset. The probability that packets will be placed within one scan cube location in any time interval is large and the probability that sequential packets will be scattered across more than two scan cubes is extremely small. Therefore, keeping two scan cubes in memory at a time will allow an extremely high probability that the cube in which the packet belongs will be in memory.

The backing store is managed by the MODIS Level-1A program and consists of a disk file with random direct access. This disk file will contain the output data product at the completion of the processing and the ownership of this file can be passed to subsequent processors by name thereby eliminating an actual transfer of data. The metadata file will not have a backing store and must be passed directly.

GRANULE STRUCTURE



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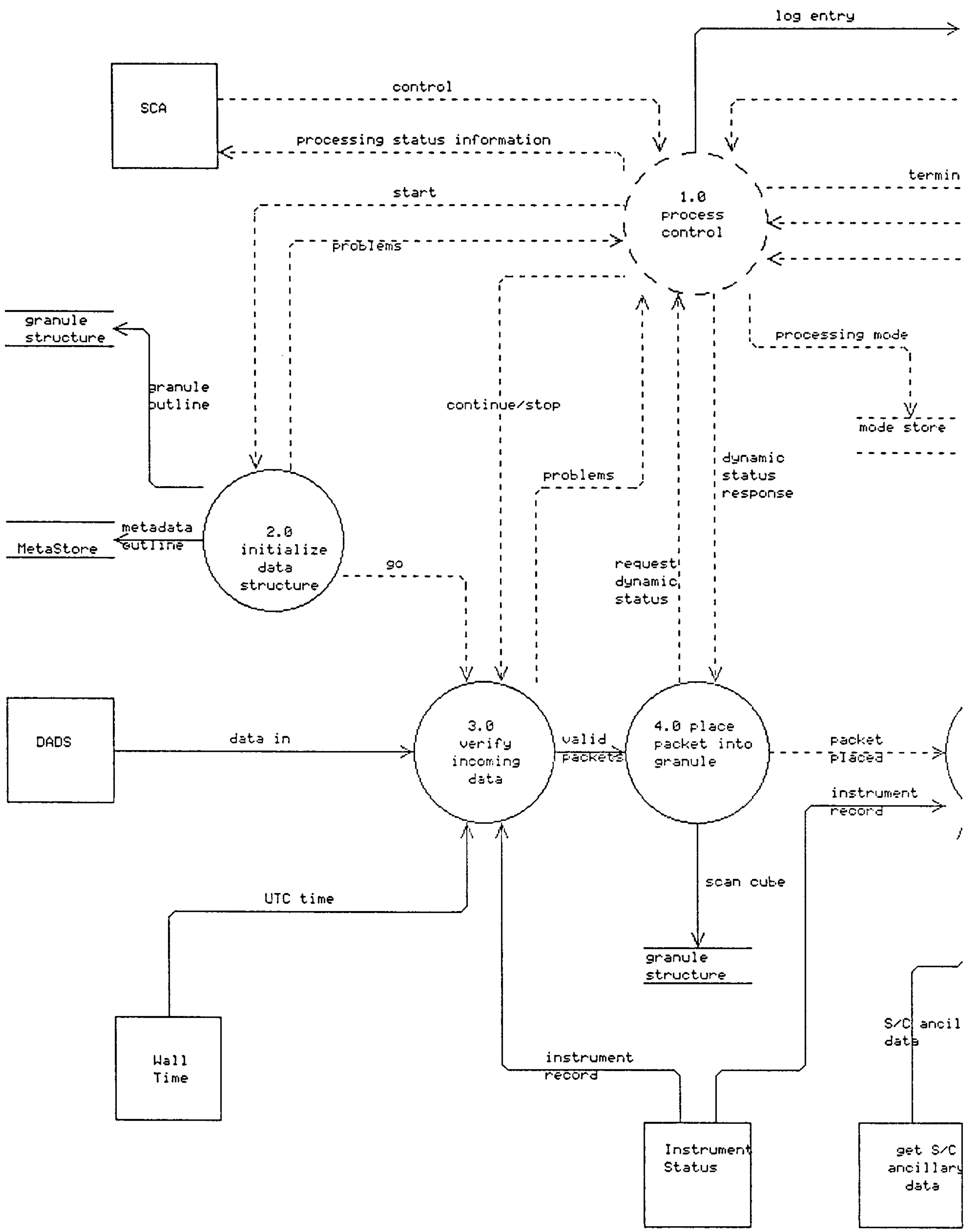
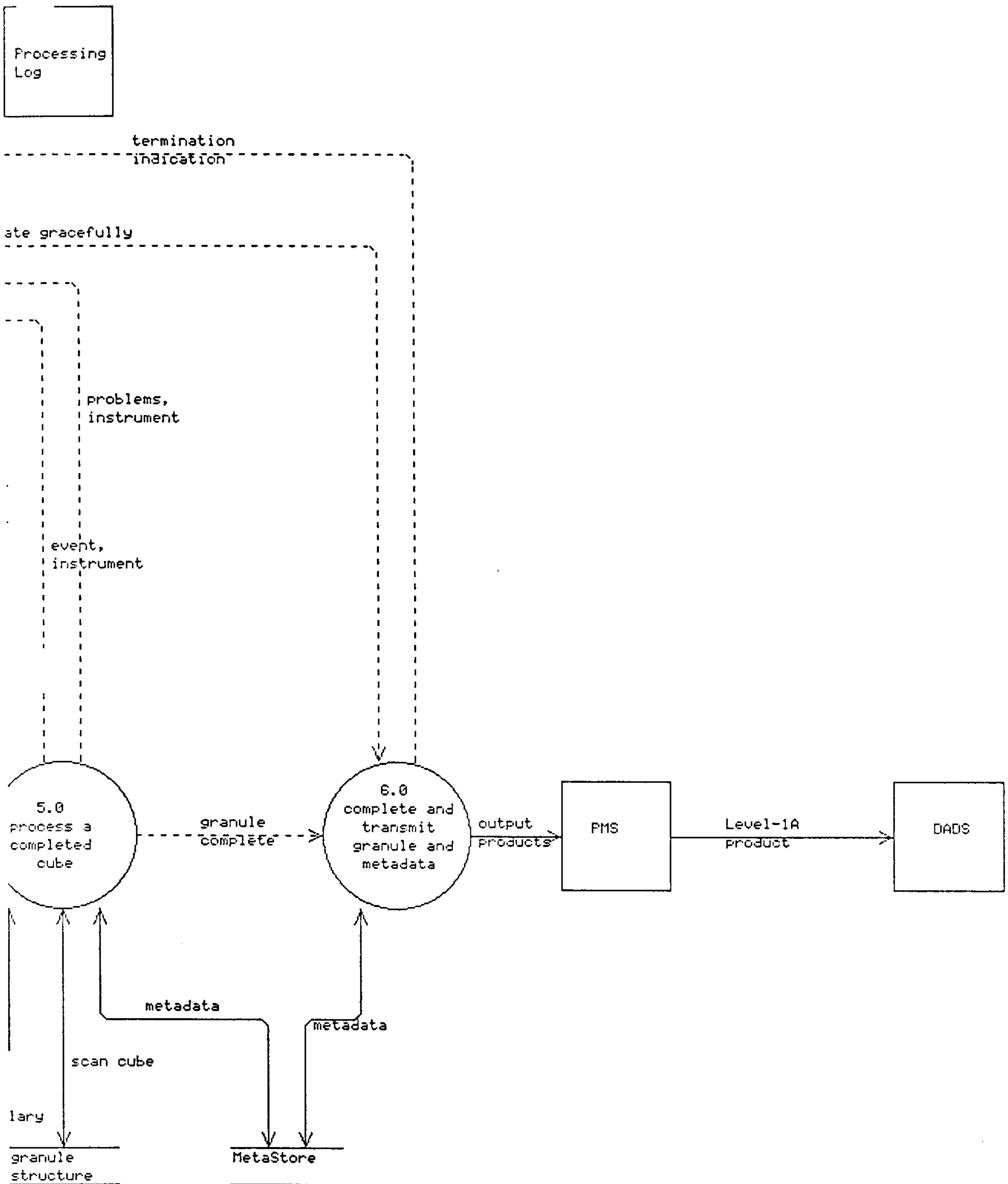
Last Modified : 12-20-1990




Processing Log
termination indication
ate gracefully
problems, instrument
event, instrument
5.0 process a completed cube
granule complete
6.0 complete and transmit granule and metadata
output products
PMS
Level-1A product
DADS
metadata
metadata
scan cube
lary
granule structure
MetaStore

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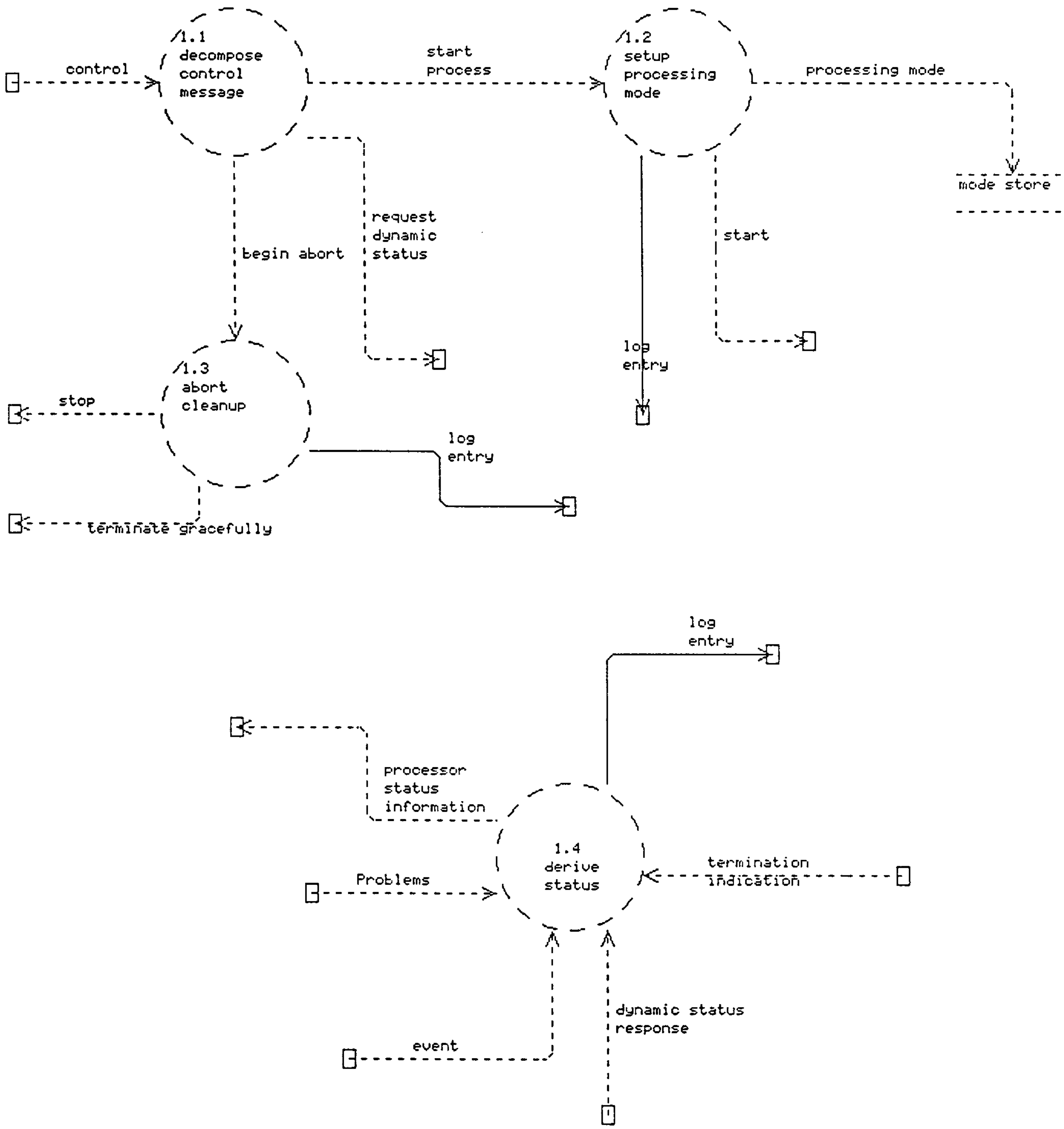

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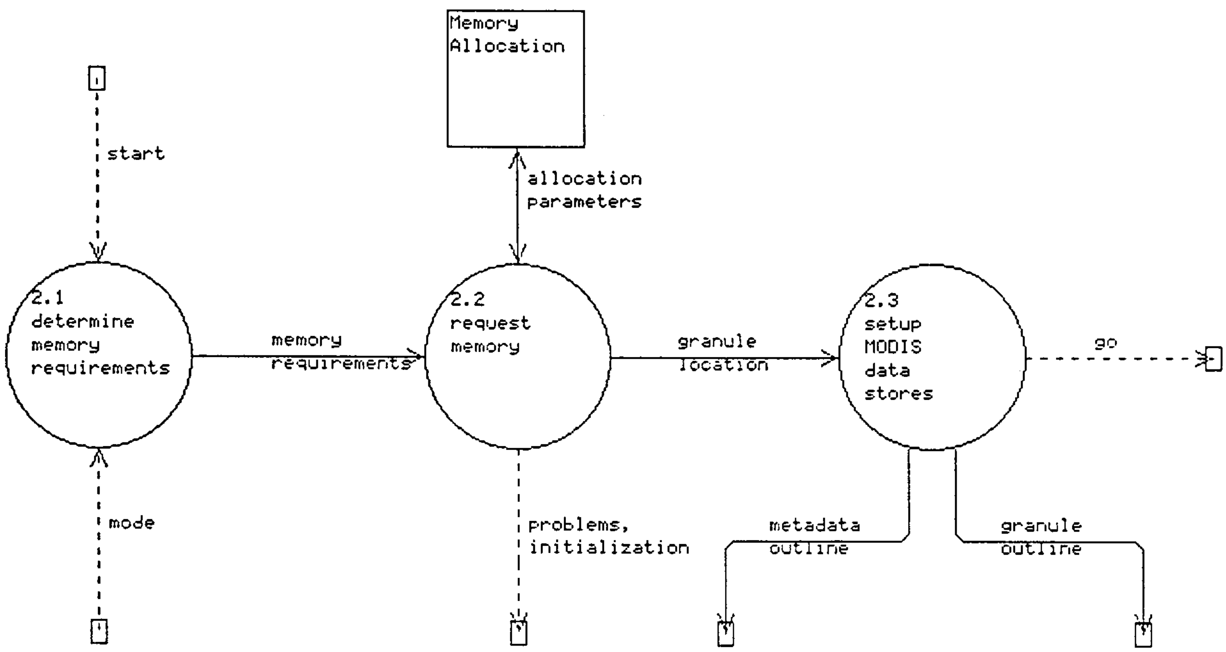

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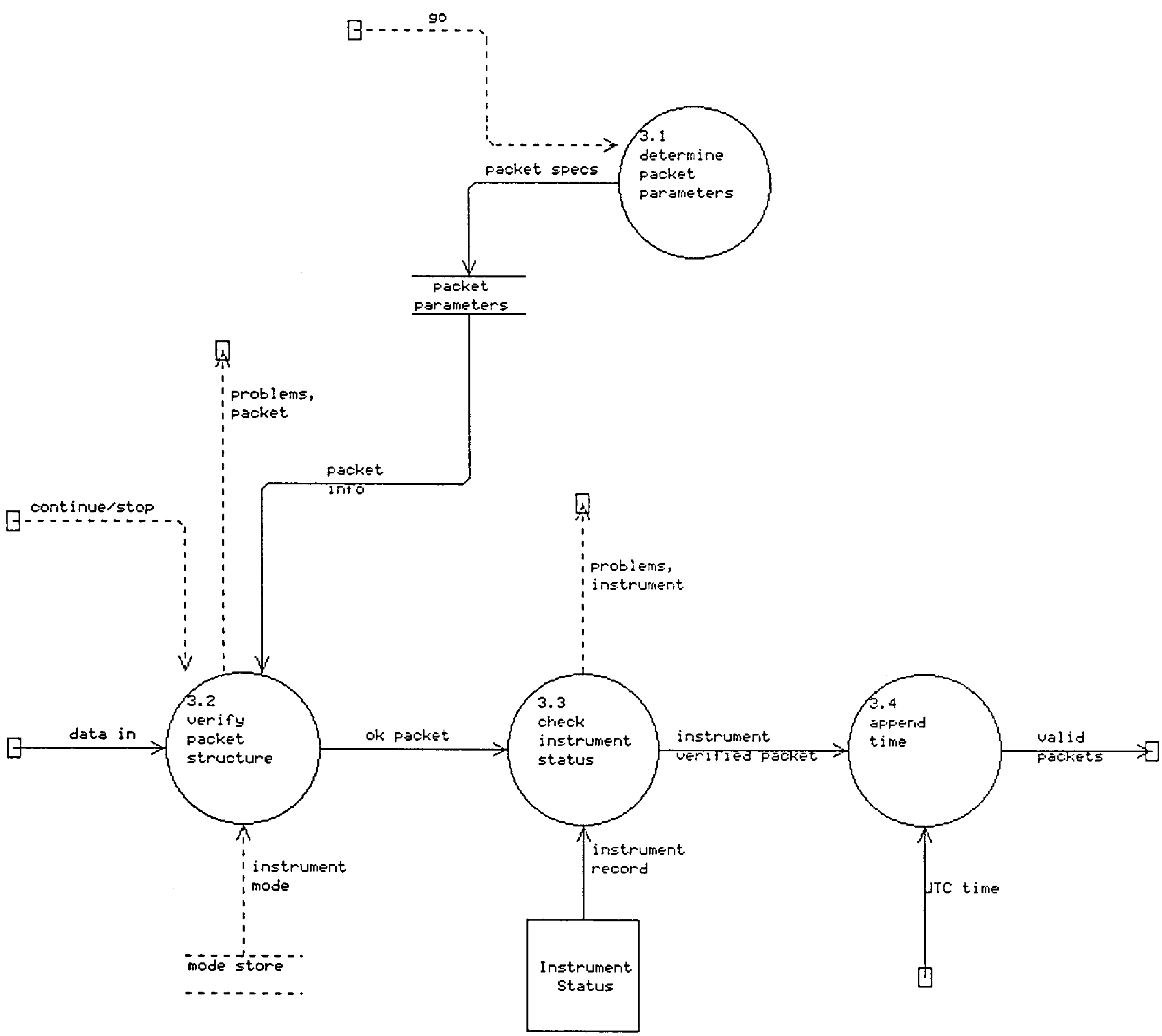

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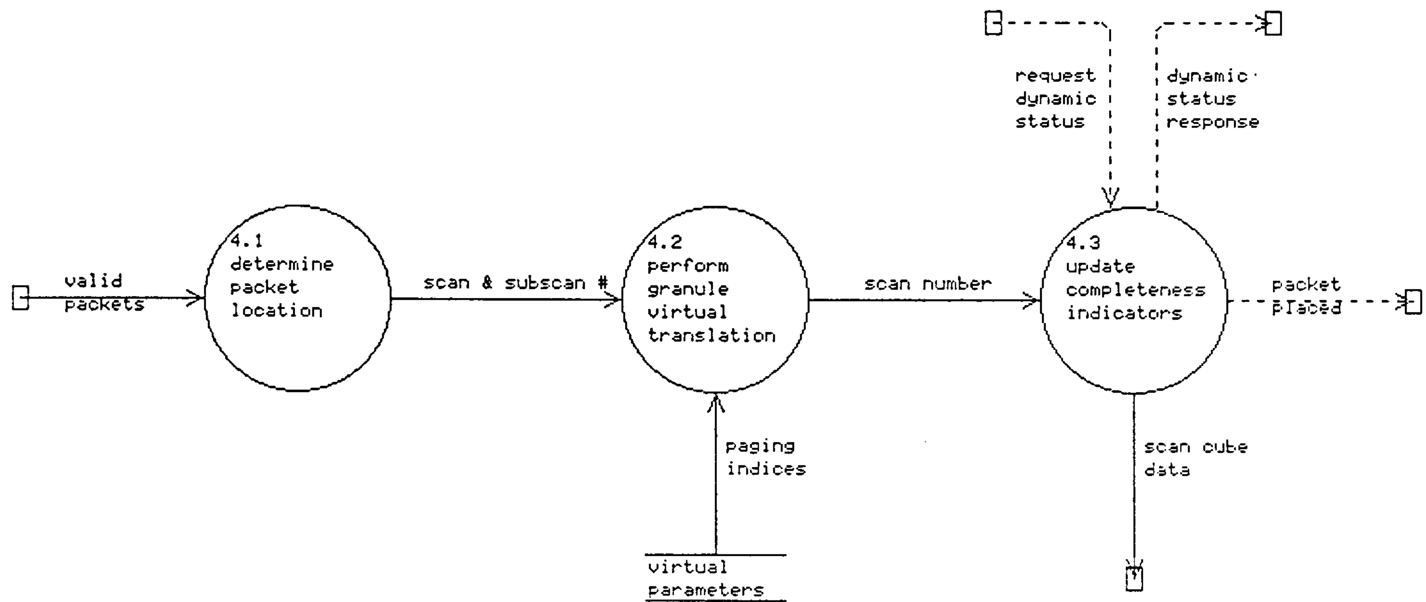

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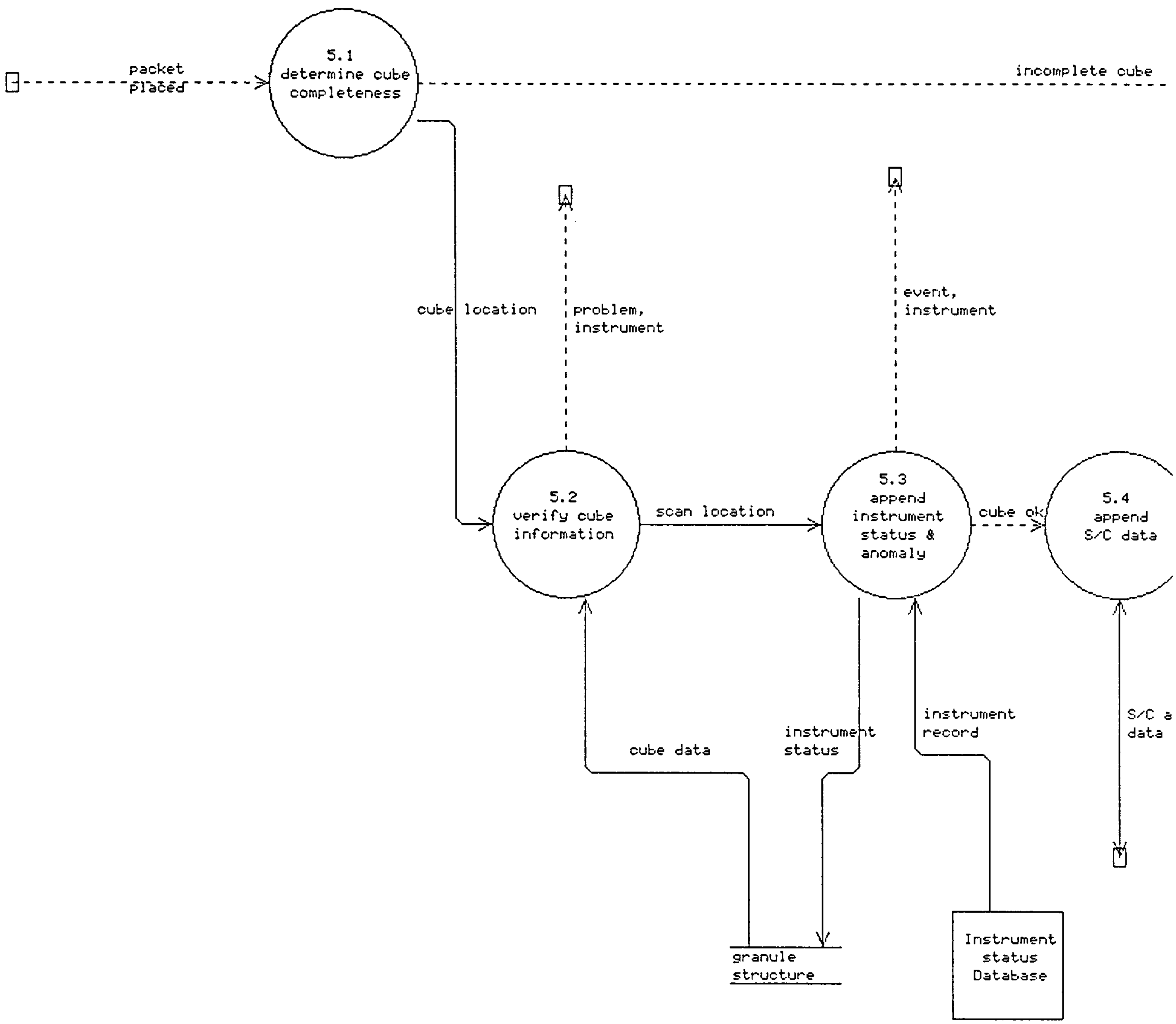
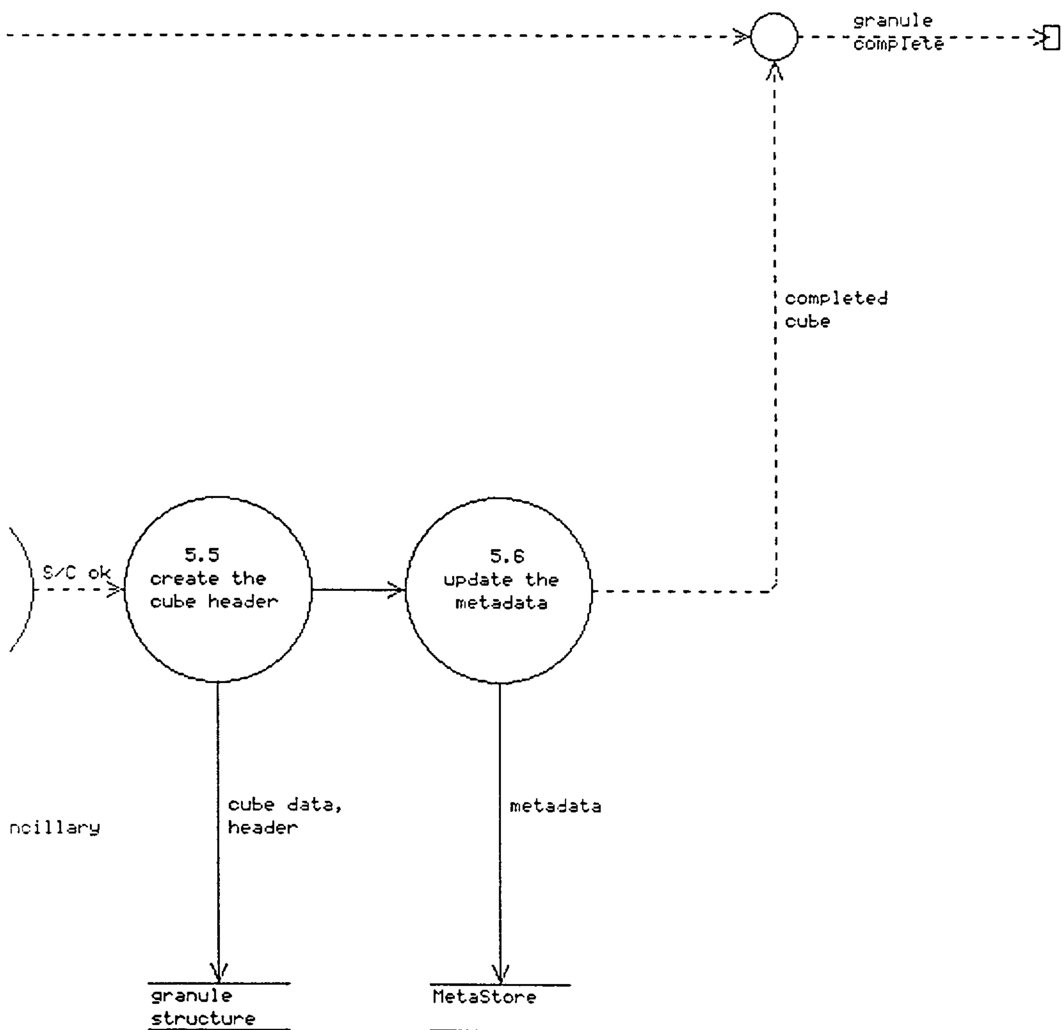
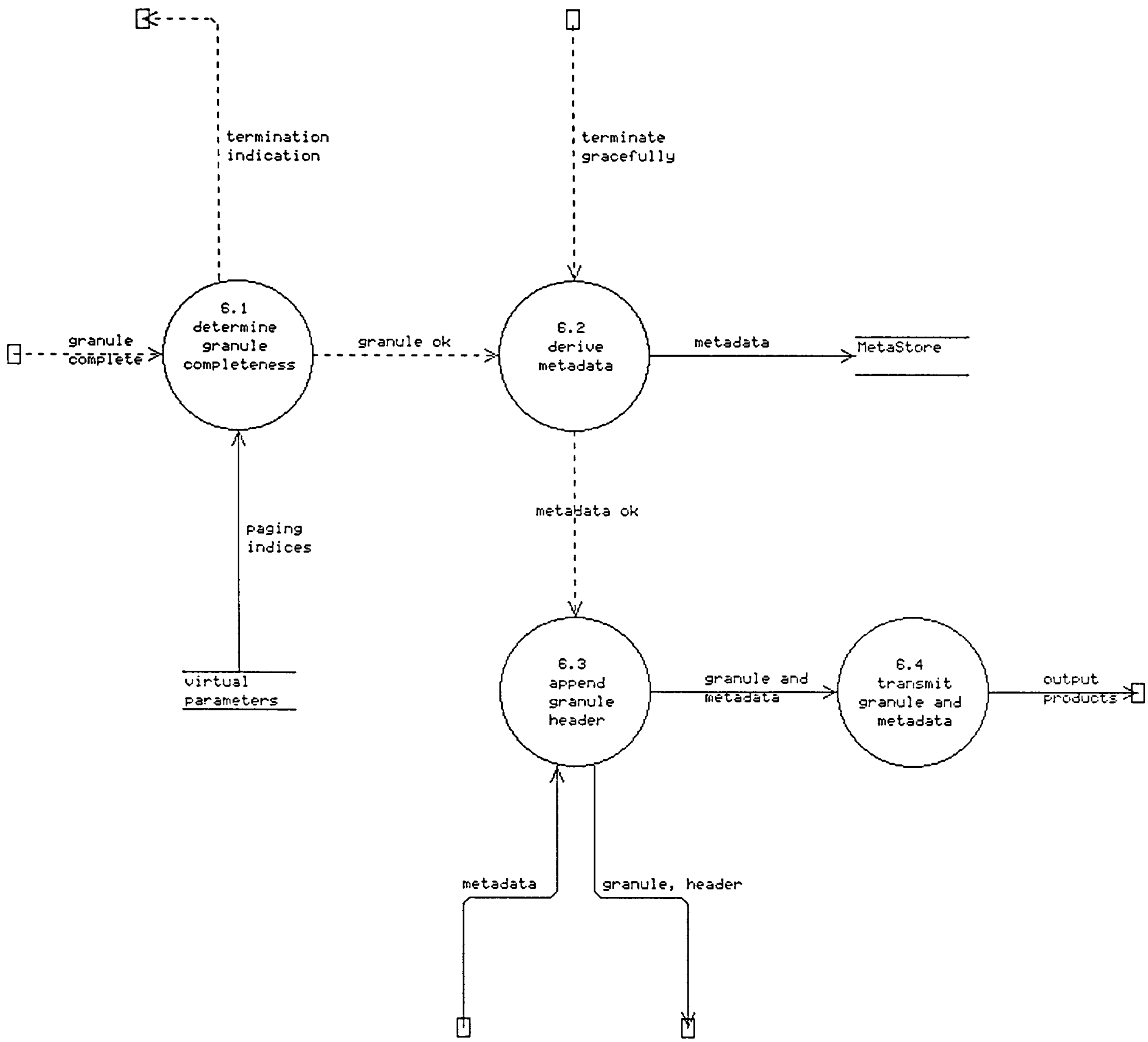




granule
complete
completed
cube
S/C ok
5.5
create the
cube header
5.6
update the
metadata
ncillary
cube data,
header
metadata
granule
structure
MetaStore

Project : \ECPLUS\MODIS\
Chart : 11a6
Filename : 11a6.trg
Last Modified : 12-20-1990



ASSUMPTIONS LIST FOR LEVEL 0 OF MODIS LEVEL-1A PROCESSING SYSTEM

1. Data will be broken out and stored as granules with a granule header. These granules are larger than the scan cube but no larger than an orbit.

Justification: Many data processing activities are facilitated by the creation of data granules of reasonable size -- memory and storage can allocated, and processing software is easier to write and handle. Metadata, a required output product, will be in granule format in order to describe a coherent part of the data. So granules must be created at Level-1A anyway. Reasonably-sized granules also facilitate the recovery of data quality information, particularly the important data completeness and existence parameters. Such granules have been used for many satellite sensors, with apparent success. Finally, and perhaps more importantly, reasonably-sized granules are convenient, both in the data system design but also to users, who are adjusted to operating with coherent sets of data.

2. MODIS processing should provide a running comparison between instrument operating status as determined from received Level-0 data and instrument status as determined from the instrument status data stores.

Justification: If a discrepancy exists, an investigation should be initiated to determine the source of the apparent error and the factual mode of instrument operation during the disputed period. Data users will need the factual information to interpret data. Instrument operations personnel may be able to use the information to modify control procedures and avoid future recurrences of the problem.

3. MODIS Quick Look data may require time ordering, redundancy elimination, and other quality control measures not required for routine MODIS data.

Justification: CDOS may not be able to provide routine processing services that meet Quick Look data timeliness constraints.

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

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[1] Packet address field as defined in "Packet Telemetry", CCSDS 102.0-B-2, CCSDS Secretariat, Code TS, NASA, Washington, D.C.

Justification: Data addressed to MODIS will not be retained by any other instrument service. Data not meeting quality standards may be needed to identify and correct data transmission or processing problems.

5. MODIS packets will be provided with a secondary header that includes a scan sequence counter (which increments once for each instrument scan), and a packet sequence counter that indicates the position of a data packet within the scan cube.

Justification: This information is required to insert packet data into the proper location in the granule structure.