Orbit/Attitude Data Dictionary of Data Elements (Part 1)

Byte Span	Word Span	Data Type	Data Name	Attitude record layout description.
1:16	1:4	Char	KEY	Date and time to millisecond <Primary key>.
17:20	5	I*4	Status	See description on same page.
21:24	6	I*4	Date	Date of Attitude point: YYDDD.
25:28	7	I*4	Time	Time of Attitude point in milliseconds.
29:30	8	I*2	Alphan	Right Ascension in radians.
31:32	8	I*2	DelTan	Declination in radians.
33:34	9	I*2	Psin	Azimuth angle in radians.
35:36	9	I*2	Filler	Will be used to define time to microsecond.
37:40	10	Real	OmegaZn	Spin angle in Radians per second.
41:1140				Up to 56 copies of words 5 through 10 inclusive.

KEY IS COMPUTED FROM LAST ATTITUDE POINT IN BLOCK. KEY FORMAT (YYDDDHHMMSSXXX) WHERE YY IS THE LAST 2 NUMERIC DIGITS OF YEAR, 'DDD' IS DAY OF THE YEAR, 'HH' IS HOUR OF DAY, 'MM' IS MINUTE OF DAY, 'SS' IS SECOND OF DAY, AND 'XXX' IS MILLISECOND OF DAY.

STATUS WORD CONTAINS THE FOLLOWING:

'RRSSPPPP' WHERE 'RR' IS THE RECORD COUNT FOR ATTITUDE BLOCK, 'SS' IS THE BLOCK STATUS, WHERE:

SS = 00 = Not last block
SS = 01 = Last block
SS = 02 = First block
SS = 03 = Only block

'PPPP' CONTAINS THE PASS NUMBER FOR THE BLOCK.

Byte Span	Word Span	Data Type	Data Name	Daily Orbit record layout description.
1:4	1	I*4	KEY	Date <Primary key>.
5:8	2	Real	SUNx	X component of Sun vector.
9:12	3	Real	SUNy	Y component of Sun vector.
13:16	4	Real	SUNz	Z component of Sun vector.
17:20	5	Real	MOONx	X component of Moon vector.
21:24	6	Real	MOONy	Y component of Moon vector.
25:28	7	Real	MOONz	Z component of Moon vector.
29:32	8	Real	SIDEREAL	Sidereal time.

KEY IS COMPUTED FROM DAILY ORBIT POINT IN RECORD. KEY FORMAT (YYDDDOOOO) WHERE YY IS THE LAST 2 NUMERIC DIGITS OF YEAR, 'DDD' IS THE DAY OF THE YEAR, AND 'OOOO' IS MINUTE OF DAY.

Orbit/Attitude Data Dictionary of Data Elements (Part 2)

Byte Span	Word Span	Data Type	Data Name	Orbit Level record layout description.
1:4	1	I*4	KEY	Date & Time to minute <Primary key>.
5:8	2	I*4	YYDDD	Year and date of data orbital item.
9:12	3	I*4	TIME	Millisecond of day for orbital item.
13:16	4	I*4	ORBIT	Orbit number <Secondary key>.
17:17	5	BYTE	COUNTER1	Number of ascending nodes.
18:18	5	BYTE	COUNTER2	Number of perigees.
19:19	5	BYTE	COUNTER3	Number of sun entrerances and exits.
20:20	5	BYTE	FILLER	Not used.
21:24	6	I*4	AST1	Assending node time 1 (not used = -1)
25:28	7	I*4	AST2	Assending node time 2 (not used = -1).
29:32	8	I*4	AST3	Assending node time 3 (not used = -1).
33:36	9	I*4	PT1	Perigee time 1 (not used = -1).
37:40	10	I*4	PT2	Perigee time 2 (not used = -1).
41:44	11	I*4	PT3	Perigee time 3 (not used = -1).
45:48	12	I*4	SET1	Sun entrance time 1 (not used = -1).
49:52	13	I*4	SET2	Sun entrance time 2 (not used = -1).
53:56	14	I*4	SET3	Sun entrance time 3 (not used = -1).
57:60	15	I*4	SLET1	Sun light exit time 1 (not used = -1).
61:64	16	I*4	SLET2	Sun exit time 2 (not used = -1).
65:68	17	I*4	SLET3	Sun exit time 3 (not used = -1).
69:72	18	I*4	PREDEF	Predictive/Definitive flag from Sigma 9.

Byte Span	Word Span	Data Type	Data Name	Timed Orbit record layout description.
1:4	1	I*4	KEY	Date & Time to minute <Primary key>.
5:8	2	R*4	PX	X Coordinate of satellite position vector Phi.
9:12	3	R*4	PY	Y Coordinate of satellite position vector Phi.
13:16	4	R*4	PZ	Z Coordinate of satellite position vector Phi.
17:20	5	R*4	MCINV	Inverse of Mcilwain's shell parameter.
21:24	6	R*4	IX	X component of ingress (north).
25:28	7	R*4	IY	Y component of ingress (north).
29:32	8	R*4	EX	X component of egress (south).
33:36	9	R*4	EY	Y component of egress (south).
37:40	10	R*4	BMAG1	First one minute magnitude in gauss GEI.
41:44	11	R*4	BX1	First minute X component.
45:48	12	R*4	BY1	First minute Y component.
49:52	13	R*4	BZ1	First minute Z component.
53:56	14	R*4	BMAG2	Second one minute magnitude in gauss GEI.
57:60	15	R*4	BX2	Second minute X component.
61:64	16	R*4	BY2	Second minute Y component.
65:68	17	R*4	BZ2	Second minute Z component.
69:72	18	R*4	BMAG3	Third one minute magnitude in gauss GEI.
73:76	19	R*4	BX3	Third minute X component.
77:80	20	R*4	BY3	Third minute Y component.
81:84	21	R*4	BZ3	Third minute Z component.
85:88	22	R*4	BMAG4	Forth one minute magnitude in gauss GEI.
89:92	23	R*4	BX4	Fourth minute X component.
93:96	24	R*4	BY4	Fourth minute Y component.
97:100	25	R*4	BZ4	Fourth minute Z component.

101:4324 Fourty four copies of words 2 through 25 inclusive.

Orbit/Attitude Data Dictionary of Data Elements (Part 3)

Byte Span	Word Span	Data Type	Data Name	Orbit Element record layout description.
1:4	1	I*4	Date	Primary key Date: 'YYDDD'.
5:8	2	I*4	Time	Transmission time in milliseconds.
9:12	3	R*4	Period	Period in minutes (time).
13:16	4	R*4	Inclination	Dimension less quantity.
17:20	5	R*4	Eccentricity	Dimension less quantity.
21:24	6	R*4	SemimajAxis	Semi Major Axis (Kilometers).
25:28	7	R*4	PerigeeArg	Argument of Perigee (Degrees).
29:32	8	R*4	RAAN	Ascending Node Right Ascension (Degrees).
33:36	9	R*4	ApogeeHeight	Apogee Height (Kilometers).
37:40	10	R*4	PerigeeAlt	Perigee Height (Kilometers).
41:44	11	R*4	PeriodRate	Period Change Rate (Minutes/Day).
45:48	12	R*4	PerigeeChg	Perigee Change Rate (Degrees/Day).
49:52	13	R*4	RAANCHG	Change Rate of RAAN (Degrees/Day).

There is a test driver for OAREAD subsystem. It acts like MVIDS and can extract OAREAD parameters for examination. The name of the test driver is OATYPE. It is provided in Compiled form as 'OATYPE.OBJ'. After linking the Driver with the OAREAD subsystem, you should have OATYPE.MNU in your directory. This data file contains menu structures for 'OATYPE'. To task build the driver with OAREAD subsystem do the following:

1] Make sure you have a copy of OATYPE.MNU in your Directory.

2] LINK OATYPE, OAREAD

After you have compleated the above you are ready to Execute OATYPE. Below is a typical run stream execution of OATYPE. A list of valid parameters are provided so that the user may understand how the data is arranged in OAREAD.

```
$ RUN OATYPE
 ORBIT / ATTITUDE DATA ACCESS ROUTINE

Enter the number of variables to be printed
II
01

Number of variables printed = 1
Is this correct (Y/N)
Y

Enter variable number 1
II
59

  3-by-3 rotation matrix for transformation
   from spacecraft coordinated.

Is this correct (Y/N)
Y
```

```
Enter the date and time at which you would like to have data printed.
Use the following format:
YYDDD MSOFDAYX
82065 50000000

DATE=82065 TIME=50000000
Is this correct (Y/N)
Y

The current increment between points is 500 ms.
Do you want to change this (Y/N)
N

Currently the no. of pts. printed is set to 1
Do you want to change this (Y/N)
N

Enter the satellite for which the data is to be obtained (A/B)
B

Would you like the data to be sent to a temporary file (Y/N)
N

Function sucessfully performed.
All requested data were returned.

 DATE = 82065     TIME = 50000000(13:53:20)

  3-BY-3 ROTATION MATRIX FOR TRANSFORMATION
  FROM SPACE CRAFT COORDINATES

          X                Y                Z
      -0.1124197       -0.9391413        0.3246159
       0.0144392        0.3251083        0.9455665
      -0.9935558        0.1109875       -0.0229881

Do you want to print the next 1 point(s) of data (Y/N)
N
Next date = 82065, Next time = 50000500
Do you want print data for another time period (Y/N)
N
Do you want a different set of variables (Y/N)
N
OATYPE ENDING. HAVE A NICE DAY
FORTRAN STOP
$
```

Parameter list of available return arguments from OAREAD (1 of 2)

OAREAD Parameter	Description	VAX OAREAD Availability
1	PREDICT/DEFINITIVE ORBIT FLAG Definitive=0, Predictive=1.	Available with OAREAD.
2	PERIOD IN MINUTES.	Available with OAREAD.
3	INCLINATION IN DEGREES.	Available with OAREAD.
4	ECCENTRICITY.	Available with OAREAD.
5	SEMIMAJOR AXIS IN KILOMETERS.	Available with OAREAD.
6	ARGUMENT OF PERIGEE IN DEGREES.	Available with OAREAD.
7	RIGHT ASCENSION OF ASCENDNG NODE IN DEGREES.	Available with OAREAD.
8	GEI VECTOR NORMAL TO ORBIT PLANE (UNIT VECTOR IN DIRECTION P X V).	Available with OAREAD.
11	APOGEE HEIGHT IN KILOMETERS.	Available with OAREAD.
12	PERIGEE HEIGHT IN KILOMETERS.	Available with OAREAD.
13	ORBIT NUMBER.	Available with OAREAD.
14	TIME FROM PERIGEE IN SECONDS.	Available with OAREAD.
15	SUNLIGHT/DARKNESS FLAG Darkness=0, Sunlight=1.	Available with OAREAD.
16	GREENWHICH SIDEREAL TIME IN RADIANS.	Available with OAREAD.
17	GEI VECTOR TOWARD SUN.	Available with OAREAD.
20	GEI VECTOR FROM SATELLITE TOWARD MOON.	Available with OAREAD.
23	GEI SATELLITE POSITION VECTOR.	Available with OAREAD.
26	GEI SATELLITE VELOCITY VECTOR.	Available with OAREAD.
29	GEI SATELLITE VELOCITY RELATIVE TO ROTATING ATMOSPHERE.	Available with OAREAD.
32	HIEGHT ABOVE SPHERIOD.(ALTITUDE)	Available with OAREAD.
33	GEODETIC,GEOCENTRIC,GEOMAGNETIC LATITUDE.	Available with OAREAD.
34	EAST LONGITUDE OF SATELLITE.	Available with OAREAD.
35	MINIMUM RAY HEIGHT.	Available with OAREAD.

Parameter list of available return arguments from OAREAD (2 of 2)

OAREAD Parameter	Description	VAX OAREAD Availability
36	MINIMUM RAY LATITUDE.	Available with OAREAD.
37	LOCAL APPARENT SOLAR TIME.	Available with OAREAD.
38	LOCAL MAGNETIC TIME.	Available with OAREAD.
39	MCILWAIN'S SHELL PARAMETER.	Available with OAREAD.
40	INVARIENT LATITUDE.	Available with OAREAD.
41	GEI FIELD STRENGTH.	Available with OAREAD.
42	GEI MAGNETIC FIELD VECTOR.	Available with OAREAD.
45	POLAR COMPONENTS OF MAGNETIC FIELD.	Available with OAREAD.
48	GEOCENTRIC MAGNETIC INCLINATION.	Available with OAREAD.
49	GEI COORDINATES OF INGRESS (NORTH).	Available with OAREAD.
52	GEI COORDINATES OF EGRESS (SOUTH).	Available with OAREAD.
55	GEODETIC LATITUDE AND LONGITUDE OF INGRESS POINT.	Available with OAREAD.
57	GEODETIC LATITUDE AND LONGITUDE OF EGRESS POINT.	Available with OAREAD.
59	3-BY-3 ROTATION MATRIX FOR TRANSFORMATION FROM SPACECRAFT COORDINATES.	Available with OAREAD.
68	GEI COORDINATES OF SPACECRAFT ANGULAR MOMEMTUM VECTOR.	Available with OAREAD.
71	PHASE ANGLE OF SPIN.	Available with OAREAD.
72	SPIN RATE WITH RESPECT to NADIR.	Available with OAREAD.
73	CONING ANGLE.	Available with OAREAD.
74	CONING RATE.	Available with OAREAD.
75	CONING PHASE.	Available with OAREAD.
76	Solar Zenith Angle.	Available with OAREAD.

Proposed O/A Data Base Organization

Introduction:

The Orbit/Attitude (O/A) data base is out-growing the capacity of an RA-81 drive (over 500MB) where it resides on-line. Updates to the O/A data base are accrewing (approximately) 100MB per year. The purpose of this note is to outline a long term solution to this over crouding disk space problem.

Methodology:

The "current" O/A data base will be divided into two parts. A "static" part till the end of 1986, and a "dynamic" part from the beginning of 1987 to the present. Static version of the O/A data base will be moved to optical disk and it will be re-created every 12 to 18 months. When a new new "static" version of O/A data base is produced on optical disk, it will contain data current to what was available on the Sigma-9 prior to the "bulk" conversion. The Dynamic or Current O/A data base beginning 1987 will be mantained as a tape resident data base (with updates in 3-6 month intervals). A seperate utility package will be used to load O/A from optical disk or tape to magnetic disk for the purpose of loading different segments. When a new complete update of O/A data base arrives, all of the segments on magnetic disk may be "purged" and new segments will be loaded as desired. Desired O/A information from optical disk or tape may be loaded using a "menu driven" O/A load program. As user requests are satisfied, O/A data may be purged by the user as a "TBD" basis. All queries will be made on user magnetic disk, no changes required for OAREAD.

Software required:

Loading software (from optical disk or mag tape) to insert O/A data to magnetic disk. Bulk conversion software to convert Sigma-9 O/A data base to Vax format (operator driven). User friendly VMS Optical disk system utilities (Initialize, mount, load, and copy).

A) Load magnetic disk (from optical disk) software.
B) Sigma-9 bulk O/A conversion to Vax software (Upgrade bulk transfer).
C) VMS optical disk system services (to be supplied by GSFC).

Impact on users:

Will free up over 300MB of user magnetic disk space from older method of keeping everything on-line. Optical disk procurement is required (same Optical drive selected by DE team).

Level	Subroutine/Function	Description
0	OAREAD	Orbit/Attitudem Subsystem.
1	ATTRTV	Obtain Attitude Data.
2	YDMS	Convert Date/Time into Year & Day.
1	DMFERR	Useless Stub, Will be removed.
1	ORBATT	Get 4 Minute data form orbit files.
2	CODES	Set all indicators to zero.
2	ORBIT	Retrieve data from the Orbit file.
3	FNINIT	File initialization routine.
3	IMOVE	Move full word into integer (Useless).
3	RAMIN2	Get last record from database.
3	RAMIN3	Get next record from database.
3	RAMIN4	Close out database.
3	RAMIN5	Set file to start of database.
3	SETERR	Set database error codes.
2	ORCOMP	Orbit parameter computation.
3	ATPROC	Compute all Attitude Map parameters.
4	ATCOMP	Quadratic or Linear curve fit.
5	FCROSP	Compute cross product.
5	FDOTP	Compute dot product.
5	INTERP	Interpolate fifth degree polynomial.
5	PVAL	Evaluate fifth degree polynomial.
5	PVELVL	Obtain polynonial velocity value.
5	VELPOL	Compute velocity coefficents.
3	CODES	Set all indicators to zero.
3	FDOTP	Compute dot product.
3	INTERP	Interpolate fifth degree polynomial.
3	PVAL	Evaluate fifth degree polynomial.
3	PVELVL	Obtain polynonial velocity value.
3	VELPOL	Compute velocity coefficents.
2	ORTIM	Get timed orbit data (DAILY etc...).
3	DMFERR	Useless Stub, Will be removed.
3	DMFVCK	Useless Stub, Will be removed.
3	FNINIT	File initialization routine.
3	IMOVE	Move full word into integer (Useless).
3	RAMIN2	Get last record from database.
3	RAMIN4	Close out database.
3	RAMINT	Open database file.
3	SETERR	Set database error codes.
3	TSTBIT	Test one bit for a 32 bit word field.
1	ORBELM	Obtain orbit element data.
2	FNINIT	File initialization routine.
2	IMOVE	Move full word into integer (Useless).
2	RAMIN2	Get last record from database.
2	RAMIN3	Get next record from database.
2	RAMIN4	Close out database.
2	RAMIN5	Set file to start of database.
2	SETERR	Set database error codes.

OAREAD MODULE INTERRELATION TABLE

Level	Subroutine/Function	Description
0	OAREAD	Orbit/Attitudem Subsystem.
1	OPENOA	Open needed ISAM files in the Base.
1	ATTRTV	Obtain Attitude Data.
2	YDMS	Convert Date/Time into Year & Day.
1	ORBATT	Get 4 Minute data form orbit files.
2	CODES	Set all indicators to zero.
2	ORBIT	Retrieve data from the Orbit file.
3	SETERR	Set database error codes.
2	ORCOMP	Orbit parameter computation.
3	ATPROC	Compute all Attitude Map parameters.
4	ATCOMP	Quadratic or Linear curve fit.
5	FCROSP	Compute cross product.
5	FDOTP	Compute dot product.
5	INTERP	Interpolate fifth degree polynomial.
5	PVAL	Evaluate fifth degree polynomial.
5	PVELVL	Obtain polynonial velocity value.
5	VELPOL	Compute velocity coefficents.
3	CODES	Set all indicators to zero.
3	FDOTP	Compute dot product.
3	INTERP	Interpolate fifth degree polynomial.
3	PVAL	Evaluate fifth degree polynomial.
3	PVELVL	Obtain polynonial velocity value.
3	VELPOL	Compute velocity coefficents.
2	ORTIM	Get timed orbit data (DAILY etc...).
1	ORBELM	Obtain orbit element data.
1	OAERROR	Optional call. Dumps written message.

Introduction:

The Orbit/Attitude (O/A) Data Base for the Dynamics Explorer Mission Has been growing on the average of a little over 100MB per year since 1985. The O/A Data Base grows as updates are applied. Since Update Processing is curtailed, a methodology must be established as to how we are to acomidate a growing Data Base in a cost effective manner. Our material resources are one Micro Vax, 1600/6250 BPI tape drive, and a 500MB magnetic disk drive. Currently the O/A Data Base is taking up 440MB of space. Orbit updates are current as of February 1987; however, Attitude updates are current upto May 1986. It has been calculated that 720MB will be required to bring the O/A Data Base current to December 1987. Insofar as plans to temporarly turn off DE-1 at the end of this fiscal year are concerned, Sigma-9 input processing will require about a year to catch up with all of the 1987 data received. Thus we do not expect a static Data Base until Sigma-9 input processing is finished. In preperation for a solution to the space problem I will discuss three methodologies. 1) Orbit Attitude segmentation. 2) Complete On-Line. 3) Optical Disk resident. Each methodology will cover operating assumptions advantage/disadvantage and 'impact' to the other users in the DE community.

1) Segment O/A Data Base.

A) On a yearly basis.

Operating assumption:

Each self-contained O/A segment will represent a years worth of data. The OAREAD subroutine takes as input the nine (9) O/A files for both space craft (DE-1 & DE-2). Each segment will contain two days before and after each year segment so that the OAREAD subroutine will satisfy the requests for data on the start of a year segment or the last day of the year.

Methodology:

Updating an O/A segment will require a check to see if the segment is On-Line. If the segment is not on line it must be brought On-Line and do an update. Then the segment can be rolled back to magnetic tape.

Advantage:

Minimal disk space is required for this method.

Disadvantage:

Software implementation costs may be prohibitive. Update processing will be costly to the users. As updates are applied the system resources are tied up.

Community Impact:

OAREAD systems currently running will not receive update software to perform segmented updates until they are 1) designed and integrated into the current OAREAD operations. 2) And delivered either through tape, or Vax network facilities.

B) To be determined basis.

Operating assumption:

Same as item 1A except the seperation points of the O/A Data Base is either monthly, quartely, semi-annualy...so on and so fourth.

Methodology:

Same as item 1A.

Advantage:

Same as item 1A, except many more segments can be On-Line.

Disadvantage:

Same as item 1A, except there may be a need to incorporate a catalog. And more data tapes will be required.

Community Impact:

Same as item 1A.

C) Two part seperation: (Static/Dynamic).

Operating assumption:

Same as item 1A except the seperation points are the static (or un-changing part) and dynamic (or changing part) segments.

Methodology:

Same as item 1A.

Advantage:

Only a 50% chance of missing desired data.

Disadvantage:

Same as 1A, except no need for a Data Base catalog.

Community Impact:

Same as 1A.

2) Large Magnetic disk (800MB) On-Line system.

A) For Micro Vax DEIO node.

Operating assumption:

One Micro Vax, One 1600/6250 magnetic tape drive, and one 800MB magnetic disk drive.

Methodology:

Same as the current OAREAD operation to date.

Advantage:

No software changes.

Disadvantage:

800MB Disk drive percurment.

Community Impact:

They will have to upgrade there own disk drive systems.

B) On other Vax system shared through network.

Operating assumption:

One Vax system with at least One 1600/6250 magnetic tape drive, and one dedicated 800MB magnetic disk drive. So that the O/A Data Base can be shared through the Vax network.

Methodology:

Same as current OAREAD operation except all processing is done on a host Vax.

Advantage:

Load releaved on DEIO Micro Vax node.

Disadvantage:

Greater network traffic on host Vax.

Community Impact:

Releaves them of the duty to perform there own updates.

3) Optical Disk resident O/A Data Base.

Operating assumption:

Static version of O/A Data base is contained on one 1000MB Optical Disk Platter. Dynamic version (changing) of O/A Data Base is on Magnetic Disk. Once the 500MB magnetic disk gets filled, a new optical disk gets created, and the magnetic disk gets space freed.

Methodology:

Effectivly split the O/A Data Base into two entities (Similar to 1C) except both segments are On-Line. Updates can be performed on the magnetic disk with current software.

Advantage:

Minimal software change. E.G. OAREAD checks which On-Line file it will open for a given segment of data.

Disadvantages:

As time proceeds, DE-1 Attitude file may exceed 500MB. Which means that other resourses may be required just to perform a bulk ISAM update on optical disk. E.G. We will need to procure or borrow a larger magnetic disk drive so that the new Optical Disk may be created. One Optical Drive is dedicated in the Vax system for each user.

Community Impact:

O/A Data Base is on a practical medium where copies can be made (given two Optical Disk drives). The users may or may not concern themselvs with O/A updates.