Rosetta
Mars Express
Venus Express

MaRS/ RSI/ VeRa

Archive Generation, Validation and Transfer Plan

Issue: 5
Revision: 27
Date: 30.11.2010
Document: MEX-MRS-IGM-IS-3019
ROS-RSI-IGM-IS-3079
VEX-VRA-IGM-IS-3007

Prepared by

Markus Fels

Approved by

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Document Change Record

Issue	Rev	Sec	Date	Changes	Author
1	0	All	11.10.2001		MF
1	1	2.5.1	24.3.2002	Changes in the Directory Structure of the Processed Data Volume	MF
1	2	Section 10	7.4.2002	Include Label files in Section 10	MF
1	3	All	06.09.2002	Some editing	MPA
1	4	2.5.1	22.10.2002	Include Diagrams for the Directory Structure of the Data Volumes	MF
2	0	All	27.11.2002	Include new sections about -Dataset and file format -standards used in data production -data validation -volume and dataset name specification Restructuring of the sections order and some editing	MF
3	0	All	17.12.2002	Updated to become a Rosetta / Mars Express / Venus Express common document	MF
3	1	All	24.2.2003	Editing after review	MPA
3	2	6.1 6.2	20.05.2003	MaRS: Data delivery dates updated Rosetta: general update	MF
3	3	2.3.1 4 All	21.5.2003	VeRa: Instrument modes updated MaRS/ VeRA:data flow figures updated ODR replaced by RSR and ATDF replaced by TNF	MF
3	4	4	22.05.2003	Data rates in section 4.4.2.1 and 4.4.2.2 specified	MF
3	5	6.1 5 1.2 and 7.1	28.5.2003	MaRS: Data Deliveries updated MaRS/ RSI/ VeRa: directory names changed into upper case	MF

				Applicable PDS standards version changed from 3.3 to 3.5	
3	6	4	6.6.2003	MaRS/ RSI/ VeRa: IFMS data flow updated	MF
3	7	1.2 2.1 2.2 2.3 4.1- 4.3 6.1.1 9.2.1	20.6.2003	Update list of referenced docs MaRS update RSI update VeRa update Included new Included new updated	MF
3	8	3.1 4 6.1	29.6.2003	revision complete revision of chapter 4 revised timeline	mpa
3	9	1.1	24.8.2003	Correlation between AGVTP and EAICD added	MF
4	0	8.3.2	27.8.2003	New Volume ID specification	MF
4	1	9.3.1-9.3.3 5.3.1-5.3.3	2.10.2003	Volume Name specification included Volume and Dataset ID update Volume Format update	MF
4	2	All 7.2-7.3	2.12.2003	Replace TNF by ODF Updates w.r.t. new target comet 67P/Churyumov-Gerasimenko Chapter about Time and Coordinate Systems included	MF
4	3	4.4.2	11.12.2003	New section	mpa
4	4	4.4.2 4.4.2.3.2 6.2.1 6.3.1 10.2.2	03.02.2004	Update New section New section New section deleted	mpa
4	5	9.3 10	11.02.2004	Section deleted; is contained and controlled in MEX-MRS-IGM-IS-3016 Section deleted; now as Appendix in document MEX-MRS-IGM-IS-3016	

4	6	5.1 all	5.3.2004	Update of all volume structures (move DOCUMENTS and ANCILLARY Folder to EXTRAS) Editing	mf
4	7	all beginning 4.3	18.3.2004	Editing Axel Hagermann deleted from distribution list CODMAC level definition added, Table 4-2 added	LC
4	8	all 4.4. 5.1.1.1.1 5.1.1.1.2. 5.1.1.2.1. 5.1.1.2.2. 5.1.1.3.1. 5.1.1.3.2.	13.7.2004	Editing description of data archive extended Table 5.1-1 updated Figure 5.1-1 updated Table 5.1-2 updated Figure 5.1-2 updated Table 5.1-3 updated Figure 5.1-3 updated	LC
5	0	 3.2 4.2 4.4 5.1 6.1 6.2 9.1	2.9.2004	After Review Table 3.2-1 updated Table updated Table updated Updated Updated Updated Updated	MP,MF,CS, LC
5	1	4.3.4 7.2. 9.2.1.1 9.2.3.2	13.9.04	keyword processing_level_id inserted Section 7.2. Time standards revised Data_set_id updated Figure 9-1 description added	LC
5	2	5.1	13.9.04	Changes in structure, some files added	CS
5	3	9.2 9.2.4.2 9.2.5. 9.2.5.1	21.9.04	Section and subsections updated new section added: Dataset name New section: Volume series New section: Volume series name	LC

5	4	7.2	29.9.04	Description of ephemeris time corrected	LC
5	5	5	27.10.04	Table and Figure 5.1-1 document directory shifted to root.	LC
5	6	9	08.11.04	Mission phases updated	CS
5	7	5.1	23.11.04	UPLINK_FREQ_CORRECT. TAB added	CS
5	8	9.2	29.11.04	Data_set_id and Data_set_name changed VOLUME_NAME updated	LC
5	9	5.1	22.12.04	New file Appendix A to File Naming Convention added in tables	CS
5	10	5	13.01.2004	Structure of volume updated	CS
5	11	5.1	31.01.2005	UPLINK_FREQ_CORRECT folder described. Some minor corrections in naming and dummy structure.	CS
5	12	5	15.04.2005	Structure of volume updated new screenshot	LC
5	13	5	18.04.2005	Structure of volume updated (added SRF and TNF files)	LC
5	14	5	06.07.2005	RSR structure added	CS
5	15	9.2.1.	03.02.2006	Data_set_id updated with instrument_host_id RO instead of ROS for Rosetta and update of mission phases	LC
5	16	9.2	04.05.2006	Update of mission phases for Rosetta	CS
5	17	6	18.08.2006	Update of Volume sizes for all missions	CS
5	18	all	19.07.2007	updated institution name replaced IGM with RIU	IA
5	19	all	27.9.2007	updated Rosetta volume convention	LC
5	20	4.4.2. 5.1 6.2+6.3 8	09.01.2008	PSA Validation added Documents updated for all missions	CS

5	21	All 9	17.01.2008	Overall update and control check Volume_Id and Volume_Set_Id updated Mission phases VEX	CS
5	22	Distribution List 8.2	09.09.2009	Markus Fels removed from distribution list PSA Validation chapter extended	MH
5	23	8	09.09.2009	included minor corrections	ST
5	24	9	24.11.2009	Updated and corrected volume_id, data_set_id	LC
5	25	4.2.1 4.2.3 4.4.1 5 6.1.1 6.3.1 9.2.1.1 9.2.1.1 9.2.1.2	07.10.2010	Updated Updated Updated Updated Table 6-1 updated Table 6-3 updated Table 9-1 updated Table 9-2 updated Table 9-3 updated, minor supplement	JO
5	26	8.2.1 9.2.4.2	13.10.2010	Fluctuation range of the residuals changed from 0.1 Hz to 0.2 Hz New values for the keyword VOLUME_SET_NAME for Venus Express added; Section “DATA DELIVERY SCHEDULE” removed	JO
5	27	8.2.1.2	30.11.2010	Table 8-3 updated	JO

DISTRIBUTION LISTS

Recipient	Institution	No. Of Copies
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Michel Denis	ESA	1
Joe Zender	ESA	1
Adriana Ocampo	ESTEC	1
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ACRONYMS

A/D	Analog/Digital
AGC	Automatic Gain Control
AGVTP	Archive Generation, Validation and Transfer Plan
AOL	Amplitude Open Loop
ATDF	Archival Tracking Data Format
CD-ROM	Compact Disk - Read Only Memory
CL	Closed-Loop
DDS	Data Delivery System
DSN	Deep Space Network
DVD	Digital Versatile Disk
ESA	European Space Agency
ESOC	European Space Operation Center
ESTEC	European Space Technology Center
FOL	Frequency Open Loop
G/S	Ground Station
HGA	High Gain Antenna
IFMS	Intermediate Frequency Modulation System
JPL	Jet Propulsion Laboratory
LCP	Left Circular Polarization
LGA	Low Gain Antenna
LOS	Line Of Sight
MaRS	Mars Express Radio Science Experiment
MGA	Medium Gain Antenna
MGS	Mars Global Surveyor
MSP	Master Science Plan
NASA	National Aeronautics and Space Administration
NNO	New Norcia
ODF	Orbit Data File
ODR	Original Data Record
OL	Open-Loop
ONED	one-way dual-frequency mode
ONES	One-way single-frequency mode
PDS	Planetary Data System (NASA)
POL	Polarization Open Loop
PSA	Planetary Science Archive (ESA).
RCP	Right Circular Polarization
RSI	Rosetta Radio Science Investigation
RSR	Radio Science Receiver

RX	Receiver
S/C	Spacecraft
SIS	Software Interface Specification
S-TX	S-Band Transmitter
SPICE	Space Planet Instrument C-Matrix Events
TBC	To Be Confirmed
TBD	To Be Determined
TNF	Tracking and Navigation File
TWOD	Two-way dual-frequency mode
TWOS	Two-way single-frequency mode
UBW	Universität der Bundeswehr München
USO	Ultra Stable Oszillator
VeRa	Venus Express Radio Science Experiment
VEX	Venus Express
X-TX	X-band Transmitter

Contents

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1 INTRODUCTION

1.1 Scope

This document and its content are consistent with the Experimenter to Archive Interface Control Document (EAICD) of ESA's Planetary Science Archive (PSA).
It presents the Archive Generation, Validation and Transfer Plan (AGVTP) for the Rosetta Orbiter Radio Science (RSI) Experiment, the Mars Express Orbiter Radio Science (MaRS) Experiment and the Venus Express Radio Science Experiment (VeRa).
It describes the data flow, the different data types and levels, the directory structures for the different data volumes, and the delivery and distribution plans. Further it contains information about the Volume, Dataset and File Formats, the used Standards in Data Product Generation (PDS, Time, Coordinates), the process of Data Validation, the Volume and Dataset Name Specifications and finally there are shown some Example PDS Label files for the different Data types of data level 1a, 1b and 2.

1.2 Referenced Documents

The following documents are referenced in the AGVTP and may be referred to if more information is needed.

Reference Number	Title	Issue Number	Date
ESA-MEX-TN-4008	Mars Express Archive Generation, Validation and Transfer Plan	1	12.6.2001
RO-EST-TN-3372	ROSETTA Archive Generation, Validation and Transfer Plan	2.0	27.10.2003
VEX-EST-TN-036	Venus Express Archive Conventions	1	11.05.2007
MEX-MRS-IGM-IS-3016 ROS-RSI-IGM-IS-3087 VEX-VRA-IGM-IS-3009	Radio Science File Naming Convention and Radio Science File Formats	3.0	4.6.2003
JPL D-7669, Part 2	Planetary Data System, Standards Reference	3.5	15.10.2002
GRST-TTC-GS-ICD-0518-TOSG	IFMS-to-OCC Interface Control Document	1.0	14-Mar-2000
JPL D-16765 (159-SCIENCE)	Radio Science Receiver RSR	Draft	5.2.2001
TRK-2-34	DSMS Tracking System Data Archival Data (Description of the TNF data files)	B	30.4.2000
TRK-2-18	Orbit Data File Interface	change 3	15.06.2000
RO-UoB-IF-1234	Experimenter To Planetary Science Archive Interface Control Document (EAICD)	Draft 5	7.11.2003
VEX-VERA-UBW-TN-3040	Reference Systems and Techniques Used for the Simulation and Prediction of Atmospheric and Ionospheric Sounding	2.3	12.11.2003

	Measurements at Planet Venus		

1.3 Document Overview

The AGVTP consists of ten major sections with several subsections that follow the introduction.

Section 2 Describes instruments and the science objectives

Section 3 Operational scenarios

Section 4 Data flow

Section 5 Archive structure and formats

Section 6 Data Delivery Schedules

Section 7 Standards used in Data Product Generation

Section 8 Data Validation

Section 9 MaRS, RSI and VeRa Volumes and Datasets Organization, Formats and Name Specification

2 INSTRUMENT OVERVIEWS

2.1 Mars Express Orbiter Radio Science Experiment

MaRS makes use of the onboard radio subsystem, which is primarily responsible for the communication link between the S/C and the ground stations on Earth.
Mars Express Orbiter is capable of receiving and transmitting radio signals via two dedicated antenna systems:
High Gain Antenna (HGA), a fixed parabolic dish of 1.80m diameter and two Low Gain Antennas (LGA), front and rear, S- Band only. The transponders consist of an S- band and X- band receiver and transmitter each. The S/C is capable of receiving two uplink signals at S- band (2100 MHz) via the LGAs , or non-simultaneously at either X- Band (7100 MHz) or S- Band via the HGA and transmit simultaneously two downlink signals at S- Band (2300 MHz) and X- Band (8400 MHz) or at S- Band only via the LGAs.
The HGA is the main antenna for receiving telecommands from and transmitting telemetry to the ground. The LGAs are used during the commissioning phase just after launch and for emergency operations.
A simultaneous and coherent dual-frequency downlink at X-band and S-band via the High Gain Antenna (HGA) is required to separate the contributions from the classical Doppler shift and the dispersive media effects caused by the motion of the spacecraft with respect to the Earth and the propagation of the signals through the dispersive media, respectively.
The experiment relies on the observation of the phase, amplitude, polarization and propagation times of radio signals transmitted from the spacecraft and received with ground station antennas on Earth. The radio signals are affected by the medium through which the signals propagate (atmospheres, ionospheres, interplanetary medium, solar corona), by the gravitational influence of the planet on the spacecraft and finally by the performance of the various systems involved both on the spacecraft and on ground.

2.1.1 Science objectives

As part of the Mars Express Orbiter payload, the Mars Express Orbiter Radio Science experiment (MaRS) will perform the following experiments:

a. radio sounding of the neutral Martian atmosphere (occultation experiment) to derive vertical density, pressure and temperature profiles as a function of height (height resolution better than 100 meter)
b. radio sounding of the ionosphere (occultation experiment) to derive vertical ionospheric electron density profiles and to derive a description of the global behavior of the Martian ionosphere through its diurnal and seasonal variations depending also on solar wind conditions
c. determination of dielectric and scattering properties of the Martian surface in specific target areas by a bistatic radar experiment

d. determination of gravity anomalies in conjunction with simultaneous observations using the camera HRSC as a base for three dimensional (3D) topography for the investigation of the structure and evolution of the Martian crust and lithosphere
e. radio sounding of the solar corona during the superior conjunction of the planet Mars with the Sun
f. the determination of the mass of Phobos

2.1.2 Instrument Modes

The MaRS experiment has four different operational modes:

1. **TWOD**: two-way, dual-frequency coherent mode:
   X- band uplink or S-band uplink
   S- and X- band downlink simultaneously.
   Applicable for science objective a), b), d),e)

2. **TWOS**: two-way, single-frequency mode:
   X- band uplink
   X- band downlink
   Applicable for science objective d), e) and f)

3. **ONED**: One-way, dual frequency mode:
   No uplink
   S- and X- band downlink simultaneously
   Applicable for science objective c)

4. **ONES**: One-way, single frequency mode:
   No uplink
   X- band downlink
   Applicable for science objective c)

The dual-frequency downlink at X-band and S-band is used to separate classical and dispersive Doppler shifts and therefore to correct the observed frequency shift by the plasma contribution due to the propagation through the interplanetary medium.

The different kind of data types with respect to the two different ground station systems are shown in the Table 2-1.

GROUND STATION SYSTEMS	**Description**	
IFMS (ESA)	CL	Closed-loop data: Doppler and Ranging at selected sample rates
	OL	Open-loop data: Downconverted received sky frequency A/D converted at very high sample rates RCP at two frequencies RCP and LCP at one frequency
DSN (NASA)	ODF	Orbit Data File(Closed-loop) Doppler and Ranging
	RSR	Radio- Science Receiver (Open-loop) 2 or 4 channels LCP & RCP polarizations

Table 2-1 : MaRS, RSI and VeRa data types

2.2 Rosetta Radio Science Investigation (RSI)

RSI makes use of the onboard radio subsystem, which is primarily responsible for the communication link between the s/c and the ground stations on Earth. The Rosetta radio subsystem is especially equipped with an Ultra- Stable Oscillator (USO), which significantly improves the sensitivity and accuracy of the one-way radio link measurements.
Rosetta is capable of receiving and transmitting radio signals via three dedicated antenna systems:
High Gain Antenna (HGA), a fully steer able parabolic dish of 2.20m diameter
Medium Gain Antenna (MGA), a fixed parabolic dish of 0.60m diameter
two Low Gain Antennas (LGA), front and rear, S- Band only
The transponders consist of an S- band and X- band receiver and transmitter each. The s/c is capable of receiving two uplink signals at S- band (2100 MHz) via the LGAs , or non-simultaneously at either X- Band (7100 MHz) or S- Band via the HGA and transmit simultaneously two downlink signals at S- Band (2300 MHz) and X-Band (8400 MHz) or at S- Band only via the LGAs.
The HGA is the main antenna for receiving telecommands from and transmitting telemetry to the ground. The LGAs are used during the commissioning phase just after launch and for emergency operations. The MGA is considered as a back-up.

2.2.1 Science objectives

The Rosetta RSI experiment has identified primary and secondary science objectives at the comet, the asteroids flybys and during cruise.
The science objectives are divided into categories:

a) cometary gravity field investigations
b) comet nucleus investigations
c) cometary coma investigations
d) asteroid mass and bulk density

as the prime science objectives, and as the secondary science objectives:

e) solar corona sounding
f) a search for gravitational waves

2.2.2 Instrument modes

The Rosetta RSI experiment has four different operational modes:

1. **TWOD**: two-way, dual-frequency coherent mode:

   X- band uplink; S-band uplink for objective e)
   S- and X- band downlink simultaneously.
   Applicable for science objective a), b), d),e) and f)

2. **TWOS**: two-way, single-frequency mode:

X- band uplink
X- band downlink
Applicable for science objective a)

3. **ONED**: One-way, dual frequency mode:

   No uplink
   S- and X- band downlink simultaneously
   Applicable for science objective c) (plasma and dust investigations of cometary's coma)

4. **ONES**: One-way, single frequency mode:

   No uplink
   X- band downlink
   Applicable for the bistatic radar experiment to determine the surface roughness of the comet

The different RSI data types are the same as for MaRS and VeRa and are shown in the Table 2-1.

2.3 Venus Express Radio Science Experiment (VeRa)

VeRa makes use of the onboard radio subsystem, which is very similar to the radio subsystem of Mars Express. The main difference is that Venus Express, like Rosetta, is especially equipped with an Ultra- Stable Oscillator (USO).

2.3.1 Science objectives

As part of the Venus Express payload, the Venus Express Radio Science experiment will perform the following experiments:

a. radio sounding of the neutral Venutian atmosphere (occultation experiment) to derive vertical density, pressure and temperature profiles as a function of height (height resolution better than 100 meter)
b. radio sounding of the ionosphere (occultation experiment) to derive vertical ionospheric electron density profiles and to derive a description of the global behavior of the Venutian ionosphere through its diurnal and seasonal variations depending also on solar wind conditions
c. determination of dielectric and scattering properties of the Venutian surface in specific target areas by a bistatic radar experiment
d. determination of gravity anomalies (tbc)
e. radio sounding of the solar corona during the superior conjunction of the planet Venus with the Sun

2.3.2 Instrument Modes

The VeRa experiment has four different operational modes:

1. **<u>TWOD</u>**: two-way, dual-frequency coherent mode:
   X- band uplink; S-band uplink
   S- and X- band downlink simultaneously.
   Applicable for science objective d) und e)

2. **<u>TWOS</u>**: two-way, single-frequency mode:
   X-band uplink
   X-band downlink
   Applicable for science objective e)

3. **<u>ONED</u>**: One-way, dual frequency mode:
   No uplink
   S- and X- band downlink simultaneously
   Applicable for science objective a) b) c)

4. **<u>ONES</u>**: One-way, single frequency mode:
   No uplink

X- band downlink
Applicable for science objective c)

The dual-frequency downlink at X-band and S-band is used to separate classical and dispersive Doppler shifts and therefore to correct the observed frequency shift by the plasma contribution due to the propagation through the interplanetary medium.

The different VeRa data types are the same as for MaRS and RSI and are shown in the Table 2-1.

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3 MARS, RSI AND VERA OPERATIONAL SCENARIOS

3.1 Data Processing

The MaRS, RSI and VeRa data processing depends on the ground station receiving system (DSN or NNO) and its raw data type (closed-loop or open loop):
The IFMS data from New Norcia (NNO) will be transferred to ESOC and stored at ESOC on the Data Delivery System (DDS). It will then be transferred via ftp from the DDS in Darmstadt to Cologne. The closed-loop IFMS data files are raw tracking data and contain Doppler and Ranging data recordings at selected sample rates. The exact format of the open-loop IFMS data is still tbd, but it consist of the down-converted and A/D converted received sky frequency at very high sample rates.
The data from the three different DSN ground stations will be collected by the JPL Radio-Science Group (RSG) and by the Stanford Radio Science Team for delivery to Cologne (data delivery from Stanford to Cologne as soon as available).
The DSN data are closed-loop Orbit Data Files (ODFs) and open-loop Radio-Science Receiver (RSR) files. The latter are very similar to the IFMS open-loop data files and consist of down-converted received sky frequency, A/D converted at very high sample rates (up to 50000 Hz). These data files will be sent via JPL to Stanford for processing up to level 2 and will be collected in Cologne for further archiving. The processed RSR files consist first of frequency resolution and intensity estimates probably at a sub-second resolution for radio occultations and second for surface scattering, there will be power spectra (and voltage cross-spectra when two polarizations are collected), averaged over a few seconds, for each band.

All raw tracking data files and the processed data up to level 2 will be collected in Cologne. After a final check the processed data will be delivered to the Co-Is and after the propriety phase to PSA.

The following scientific analysis and interpretation of the processed data product is up to the Co-I and his science objective. Lists of collaborating institutes for MaRS, RSI and VeRa are shown in the Table 3-1, Table 3-2 and Table 3-3.

3.2 Collaborating Institutes

3.2.1 MaRS

Name	Institute
M. Paetzold (PI)	Rheinisches Institut für Umweltforschung, Cologne, Germany
B. Häusler, S. Remus	Institut für Raumfahrttechnik, Universität der Bundeswehr, Munich, Germany
W. Ian Axford	Max- Planck- Institut für Sonnensystemforschung, Katlenburg- Lindau, Germany
J.-P. Barriot	Observatoire Midi Pyrenees, Toulouse, France
Jean- Claude Cerisier	CETP, 4 Ave. Neptune, Saint Maur Cedex, France
T. Hagfors	Max- Planck- Institut für Sonnensystemforschung, Katlenburg- Lindau, Germany
G.L. Tyler, R. Simpson, D. Hinson,	Dep. of Electrical Engineering, Stanford University, Palo Alto, USA
P. Janle	Institut für Geophysik, Universität zu Kiel, Kiel, Germany
G. Kirchengast	Institut für Geophysik u. Meteorologie, Karl-Franzens-Universität,Graz, Austria
V. Dehant	Observatoire Royale, Bruexelles

Table 3-1: List of collaborating institutes for MaRS

3.2.2 RSI

Name	Institute
M. Paetzold (PI)	Rheinisches Institut für Umweltforschung, Cologne, Germany
B. Häusler, S. Remus	Institut für Raumfahrttechnik, Universität der Bundeswehr, Munich, Germany
K. Aksnes	Insitute for Theoretical Astrophysics, University of Oslo, Norway
J.D. Anderson S.W. Asmar B.T. Tsurutani	Jet Propulsion Laboratory,California Institute of Technology, Pasadena, USA
J.-P. Barriot	Observatoire Midi Pyrenees, Toulouse, France
M.K. Bird	Radioastronomisches Institut, Universität zu Bonn, Bonn, Germany
H. Boehnhardt	Max- Planck- Institut für Sonnensystemforschung, Katlenburg- Lindau, Germany
N. Thomas	Universität Bern, Berne, Swizerland
E. Grün	Max- Planck- Institut für Kernphysik, Heidelberg, Germany
W.H. Ip	National Central University, Taipei, Taiwan
E. Marouf	Dep. of Electrical Engineering, San Jose State University, San Jose, California, USA
T. Morley	ESA-ESOC, Darmstadt, Germany

Table 3-2: List of collaborating institutes for RSI

3.2.3 **VeRa**

Name	Institute
B. Häusler (Principal Investigator), S. Remus	Institut für Raumfahrttechnik, Universität der Bundeswehr, Munich, Germany
M. Paetzold (Co-PI)	Rheinisches Institut für Umweltforschung an der Universität zu Köln, Cologne, Germany
G.L. Tyler, R. Simpson, D. Hinson,	Dep. of Electrical Engineering, Stanford University, Palo Alto, USA
M. Bird	Universität Bonn, Germany
R. Treumann	Max-Planck Institut für Extraterrestrische Physik, Garching, Germany

Table 3-3: List of collaborating institutes for VeRa

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4 MARS, RSI AND VERA DATA FLOW

4.1 Data Flow

The data flow for the MaRS, RSI and VeRa experiments is shown in Figure 4-1 to Figure 4-3.

4.2 Points of contact

4.2.1 Point of contact for PSA archiving

Cologne is the single point of contact for the PSA archive team.

Function	Name	Adress	E-mail	Telephone/ Fax
Principal Investigator (MaRS, RSI)	Martin Pätzold	Rheinisches Institut für Umweltforschung an der Universität zu Köln, Aachener Str. 201-209, 50931 Köln, Germany	mpaetzol@uni-koeln.de	phone: (49)-221-27781810 Fax: (49)-221-400-2320
Data Manager	Ludmila Carone	Rheinisches Institut für Umweltforschung an der Universität zu Köln, Aachener Str. 201-209, 50931 Köln, Germany	ludmila.carone@uni-koeln.de	phone: (49)-221-27781814 Fax: (49)-221-400-2320

4.2.2 Points of contact for data forwarding

site	Name	Adress	E-mail	Telephone/ Fax
Stanford University	Richard A. Simpson	Dept. of Electrical Engineering, Stanford University, Packard Building 350, Serra Mall, Stanford, CA 94305-9515, USA	rsimpson@magellan.stanford.edu	phone: (1)-650-723-3525 Fax: (1)-650-723-9251
JPL	Sami W. Asmar	Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena CA 91009, USA	sami.w.asmar@jpl.nasa.gov	phone: (1)-818-354-6288 Fax: (1)-818-393-9282
ESOC DDS	TBD	Esoc, Robert- Bosch- Str. 5, Darmstadt, Germany	mex.dds@esa.int (Mars Express) rosetta.dds@esa.int (Rosetta) TBD (Venus Express)	

4.2.3 Points of contact for data distribution

Function	Name	Adress	E-mail	Telephone/ Fax
Data Manager	Ludmila Carone	Rheinisches Institut für Umweltforschung an der Universität zu Köln, Aachenerstr. 201-209, D-50931 Köln, Germany	ludmila.carone@uni-koeln.de	phone: (49)-221-27781814 Fax: (49)-221-400-2320

4.3 Data Level Definition

4.3.1 Level 1a data

Level 1a raw tracking data (closed-loop and open-loop) will be recorded directly in the ground stations.

New Norcia (NNO):
Closed-loop IFMS data will be forwarded to the DDS at ESOC and ftped to the home institute in Cologne.
The open-loop IFMS data is retrieved also via ftp from DDS at ESOC.

Deep Space Network (DSN):
ODF (closed-loop) and RSR (open-loop) data will be collected by JPL and transferred to Stanford University and finally send to Cologne on CD-ROMs and per ftp.

4.3.2 Level 1b and 2 data

Level 1b data are processed from level 1a (raw tracking data) into an ASCII formatted file. Cologne is processing IFMS and ODF data, Stanford University processes RSR data up to level 2 and forwards raw and processed data to Cologne for archiving.

Level 2 data are calibrated data after further processing. The file format is in ASCII. This data level can be used for further scientific interpretation and will be available to the Co-Is along with the required ancillary data as soon as available with a propriety phase of at least six months.

Level 1a to level 2 data will be archived in Cologne once all tracking and ancillary data of a campaign are available. Target date for PDS delivery is six months after the last data of a specific campaign have been recorded.

4.3.3 Level 3 data

Derived scientific data products (see Table 4-1) by the Co-Is will be archived in Cologne. A certain scientific data set will be available to the public on request after the first major publication of this data set.

4.3.4 CODMAC level definition

In the keywords DATA_SET_ID and PROCESSING_LEVEL_ID within the data labels, CODMAC level are used instead of PSA level. In all other file names and documents we keep the PSA data level definition as described above. For a comparison between the two data level definition see Table 4-2.

	Science Data Product	**Description**
MaRS	Gravity	LOS accelerations
	Occultations	Atmospheric profiles Ionospheric profiles
	Bistatic radar	dielectric constant surface roughness
	Solar Corona	Doppler or phase time series Total electron content Change in electron content Electron density
RSI	Gravity	Low orbit LOS accelerations Gravity field coefficients LOS accelerations (asteroids)
	Mass flux	Doppler time series LOS accelerations Derived mass flux
	Occultations	Dust scatter spectra Ionospheric profiles
	Bistatic radar	dielectric constant surface roughness refractivity
	Solar Corona	Doppler or phase time series Total electron content Change in electron content Electron density
VeRa	Gravity	LOS accelerations
	Occultations	Atmospheric profiles Ionospheric profiles
	Bistatic radar	dielectric constant surface roughness
	Solar Corona	Doppler or phase time series Total electron content Change in electron content Electron density

Table 4-1: Examples for Science Data products (Data Level 3)

CODMAC level	PSA level	Description
1	1a	raw data
2	1b	edited raw data
3	2	calibrated data
5	3	derived scientific data

Table 4-2: Comparison between CODMAC level and PSA level

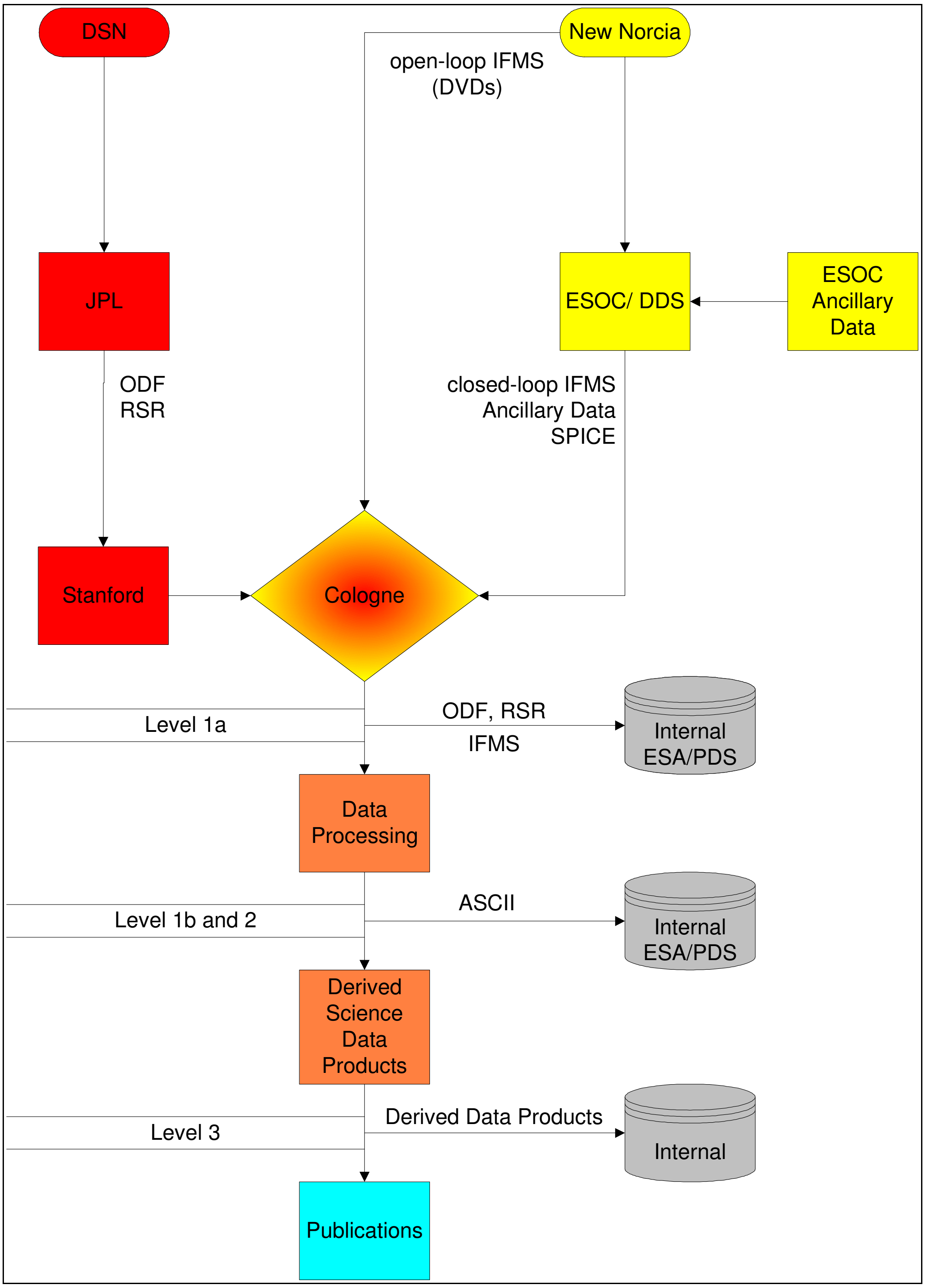

Figure 4-1: MaRS Data Flow

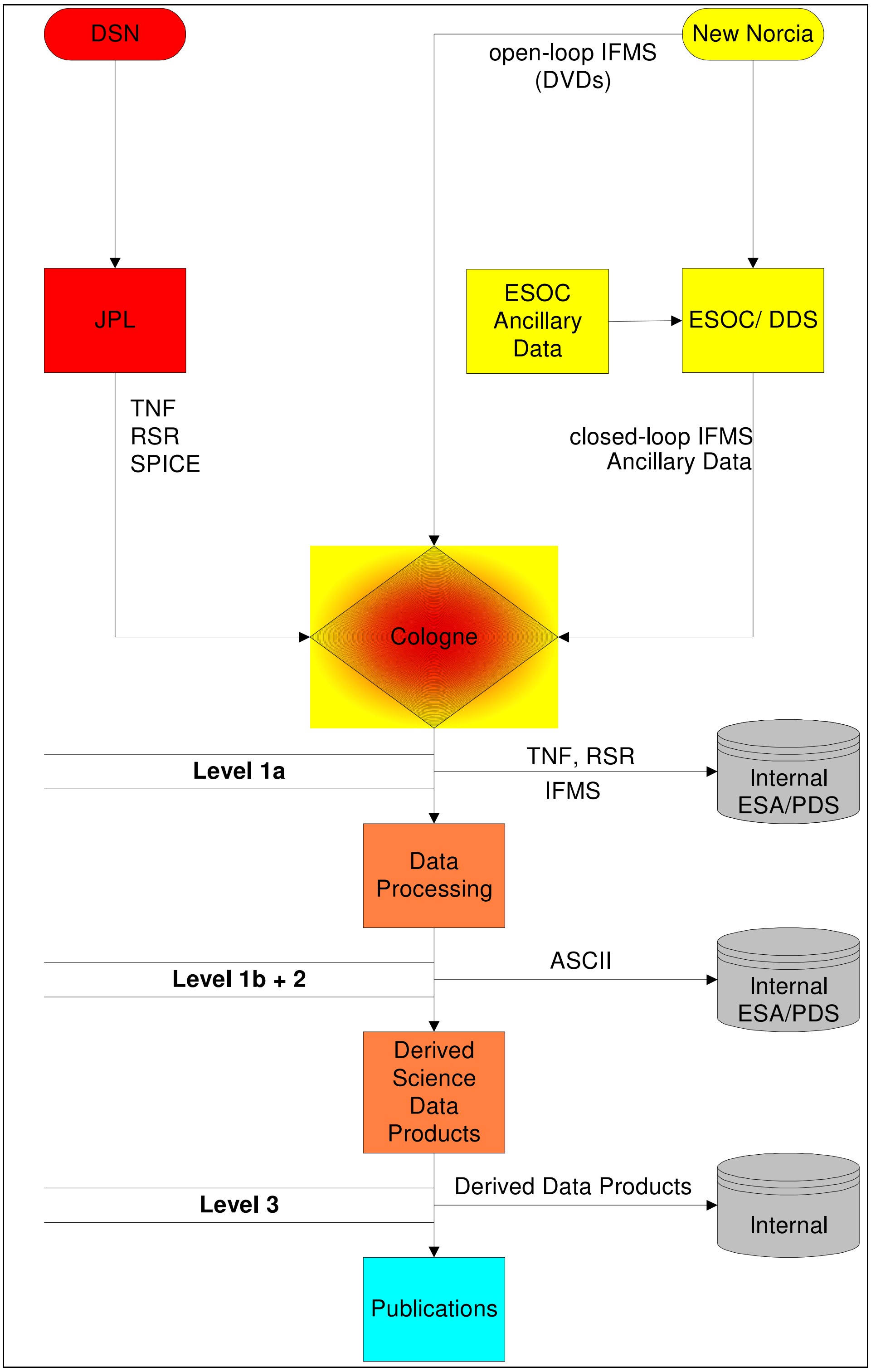

Figure 4-2: RSI Data Flow

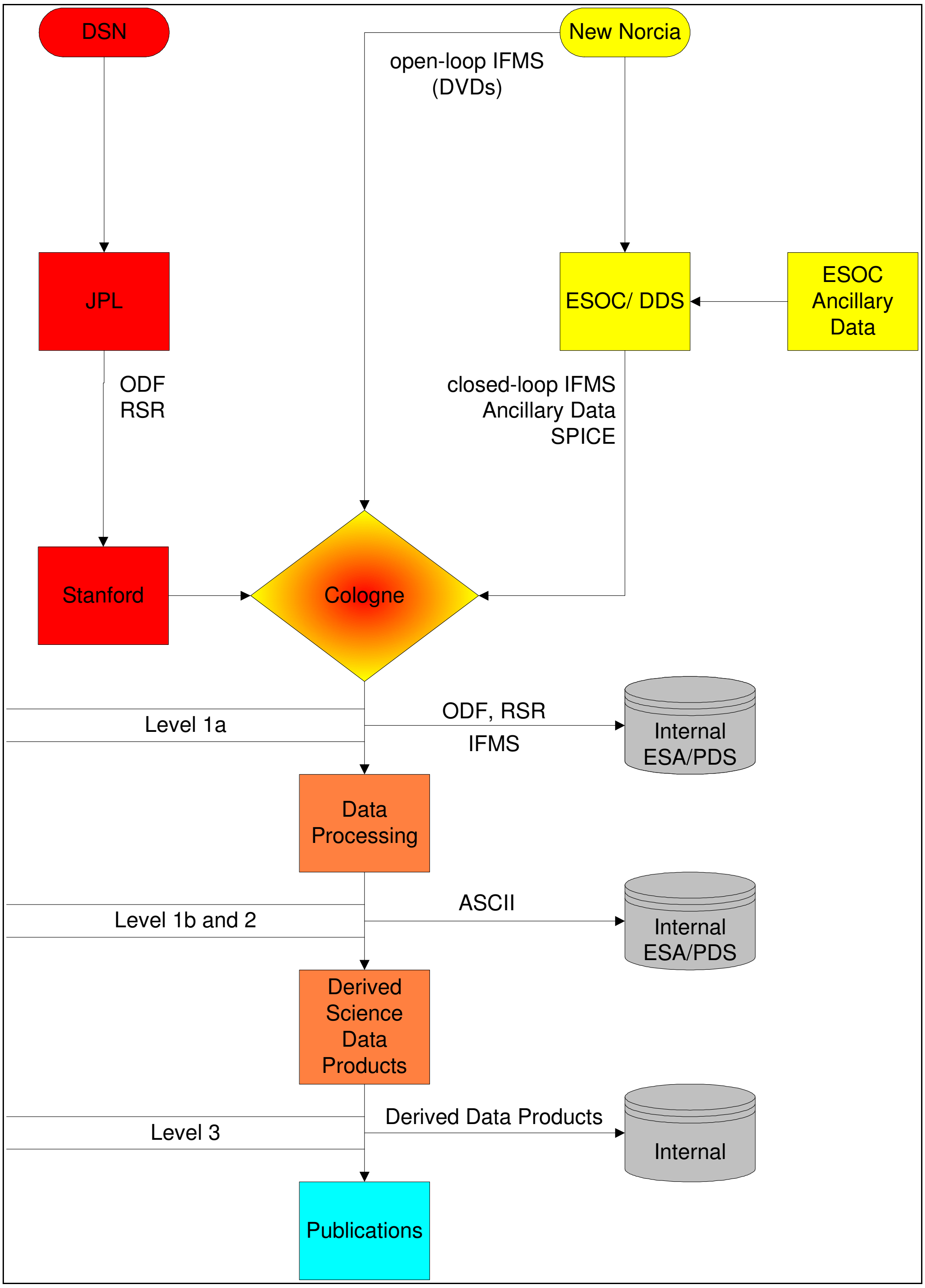

Figure 4-3: VeRa Data Flow

4.4 MaRS, RSI and VeRA Archiving Functions

4.4.1 Archive Content

The complete data set size of each investigation is expected to be approximately 500MB for MaRS, 1000GB for RSI and tbd for VeRa. The storage media of the archival data set are CD-ROMs, DVD-ROMs and hard disks. The data set will be divided in single volumes with respect to the science objectives. Level 1a, level 1b and level 2 data will be stored on the same medium (if medium space allows), separated into special data directories. All these directories will be separated again into directories for different types of data, e.g. open loop separate from closed loop and so on. Within directories, the data will be ordered by time. Please note that not all possible directories have to be present. For example, one data set may contain closed loop data but no open loop data thus there is no need for an open loop subdirectory. The same is true for data coming from IFMS and DSN.
Level 3 and higher Level data will be stored on separate data volumes.

4.4.2 Expected Number of file products

The following lists can only give an estimate and overview of the to be archived file products and file numbers. The MEX commissioning has shown that operational constraints and events will change the operations plan and will have an impact on the actual number of data takings.

4.4.2.1 Mars Express MaRS

4.4.2.1.1 ESA IFMS

Science Objective	Data Level	Number of data files	Number of Label files	number of expected file starts	number of files	number of files per data taking	number of data takings	total number of files to be archived
	L1a	15	15	4	120			
	L1b	30	15	4	180			
Commissioning 1	L2	4	4	3	24	324	5	1620
	L1a	15	15	4	120			
	L1b	30	15	4	180			
Commissioning 2	L2	4	4	3	24	324	1	324
	L1a	15	15	1	30			
	L1b	30	15	1	45			
Gravity	L2	4	4	1	8	83	300	24900
	L1a	15	15	5	150			
	L1b	30	15	5	225			
Occultation	L2	4	4	2	40	415	750	311250
	L1a	15	15	2	60			
	L1b	30	15	2	90			
Solar Conjunction	L2	4	4	1	8	158	120	18960

4.4.2.2 Rosetta RSI

4.4.2.2.1 ESA IFMS

Science Objective	Data Level	Number of data files	Number of Label files	number of expected file starts	number of files	number of files per data taking	number of data takings	total number of files to be archived
	L1a	15	15	8	240			
	L1b	30	15	8	360			
Commissioning 1	L2	6	6	5	60	660	9	5940
	L1a	12	12	6	144			
	L1b	24	12	6	216			
Commissioning 2	L2	6	6	2	24	384	2	768
	L1a	15	15	3	90			
	L1b	30	15	3	135			
Passive Checkout	L2	6	6	1	12	227	6 (so far)	1362
	L1a	15	15	4	120			
	L1b	30	15	4	180			
Solar Conjunction	L2	6	6	1	12	312	40 (so far)	12480
	L1a							
	L1b							
	L2							

4.4.2.3

4.4.2.4

4.4.2.5 Venus Express VeRa

4.4.2.5.1 ESA IFMS (only Closed Loop)

Science Objective	Data Level	Number of data files	Number of Label files	number of expected file starts	number of files	number of files per data taking	number of data takings	total number of files to be archived
	L1a	15	15	4	120			
	L1b	30	15	4	180			
Commissioning 2005	L2	6	6	3	36	336	2	672
	L1a	15	15	4	120			
	L1b	30	15	4	180			
Commissioning 2006	L2	6	6	3	36	336	9	3024
	L1a	11	11	4	88			
	L1b	22	11	4	132			
Occultation	L2	4	4	1	8	228	152 (planned so far)	34656
	L1a							
	L1b							
Solar Conjunction	L2							

Open Loop data is :tbd

4.4.3 **Single Raw Data File (level 1a) Volume**

4.4.3.1 Closed-loop

IFMS	Calculation (bytes)	One hour data recording @ 1 second sampling time
Overhead		18 kBytes
Ranging	110 x number of samples /hour	396 kBytes
Doppler	220 x number of samples/hour	792 kBytes
Meteo	100 x number of samples/hour	6 kbytes (1 min sampling time)

DSN ODF	Calculation (bytes)	One hour data recording @ 1 second sampling time
		1.11 MB/hour

4.4.3.2 Open-Loop

IFMS	Calculation (bytes)	Event volume
Occultation	6 bytes*5000 samples/s	54 Mbyte (2x15 min)
Bistatic radar	6 bytes*50000 samples/s	2160 Mbyte (2 hours)
Solar corona	6 bytes*5000 samples/s[1]	648 MByte (6 hours)

RSR	Calculation (bytes)	Event volume (tracking pass)
Occultations	0.5 Mbytes / minute each channel	15 Mbytes total (duration 2x 15 minutes) each channel
Bistatic radar	12.5 Mbytes / minute each channel	750 Mbytes total (duration 1 hour) each channel
Solar corona	0.5 Mbytes / minute each channel	195 Mbytes total (6.5 hours) each channel

[1] 1000 samples/s implemented in the Rosetta RSI user manual, but 5000 samples/s aspired

The number of available tracking passes for each science objective is given in Table 4-3.

Investigation	Science Objective	# of tracking passes	duration	Total data volume
MaRS	Gravity	TBD		
	Occultations	1500		
	Bistatic radar	200		
	Solar Corona	240		
RSI	Gravity	TBD		
	Mass flux	TBD		
	Occultations	TBD		
	Bistatic radar	TBD		
	Solar Corona	TBD		
VeRa	Gravity	TBD		
	Occultations	TBD		
	Bistatic radar	TBD		
	Solar Corona	TBD		

Table 4-3: Estimate for available tracking passes for each science objective

5 ARCHIVE STRUCTURE AND FORMATS

MaRS, RSI and VeRA will issue two kinds of data volumes:

a) Data level 1a and 1b: Observational data (level 1b) processed from the raw data (level 1a) as received and structured by the receiving system of the ground stations
   Data level 2: Calibrated data derived from the raw data (level 1a)
b) Data Level 3: Science Data derived from Level 2 data

Data of levels 1a, 1b and 2 will be stored on the same data volume separated into different subdirectories, if enough free capacity on the data volume is available. Level 3 and higher Level data will be stored on separate data volumes.

5.1 Volume format

5.1.1 MaRS

5.1.1.1 Top-Level Directory Structure for a MaRS level 1a, 1b and 2 data volume

5.1.1.1.1 Table

<table>
<tr><td rowspan="3">ROOT</td><td colspan="2">AAREADME.TXT</td><td colspan="2">description of volume contents</td></tr>
<tr><td colspan="2">ERRATA.TXT</td><td colspan="2">overview of anomalies and errors</td></tr>
<tr><td colspan="2">VOLDESC.CAT</td><td colspan="2">description of the contents of the logical volume</td></tr>
<tr><td>BROWSE</td><td colspan="2">BROWINFO.TXT</td><td colspan="2">Description of the BROWSE directory, which includes Quick Look Browse Plots of the data.</td></tr>
<tr><td rowspan="8">CATALOG</td><td colspan="2">CATINFO.TXT</td><td colspan="2">text description of the directory contents</td></tr>
<tr><td colspan="2">MISSION.CAT</td><td colspan="2">PDS catalog object for Mission</td></tr>
<tr><td colspan="2">INST.CAT</td><td colspan="2">brief description of the radio systems of the s/c and the ground stations</td></tr>
<tr><td colspan="2">INSTHOST.CAT</td><td colspan="2">brief description of the Instrument Host</td></tr>
<tr><td colspan="2">DATASET.CAT</td><td colspan="2">brief description of the reduced MaRS data</td></tr>
<tr><td colspan="2">PERSON.CAT</td><td colspan="2">description of key persons involved in MaRS</td></tr>
<tr><td colspan="2">REF.CAT</td><td colspan="2">collection of references used in the inst.cat and dataset.cat</td></tr>
<tr><td colspan="2">SOFT.CAT</td><td colspan="2">Dummy software catalog file</td></tr>
<tr><td rowspan="14">CALIB</td><td colspan="2">CALINFO.TXT</td><td colspan="2">text description of the directory contents</td></tr>
<tr><td rowspan="4">CLOSED_
LOOP</td><td>DSN</td><td colspan="2">Closed-loop calibration data of the DSN ground stations</td></tr>
<tr><td rowspan="3">IFMS</td><td>RCL</td><td>Range Calibration data files</td></tr>
<tr><td>DCL</td><td>Doppler Calibration data files</td></tr>
<tr><td>MET</td><td>Meteo data files</td></tr>
<tr><td rowspan="8">OPEN_
LOOP</td><td rowspan="5">DSN</td><td>BCAL</td><td>System temperature calibration files</td></tr>
<tr><td>ION</td><td>Ionospheric calibration file</td></tr>
<tr><td>MET</td><td>Meteo data files</td></tr>
<tr><td>TRO</td><td>Tropospheric calibration files</td></tr>
<tr><td>SRF</td><td>Surface Reflection Filter Files</td></tr>
<tr><td rowspan="3">IFMS</td><td>RCL</td><td>Range Calibration data files</td></tr>
<tr><td>DCL</td><td>Doppler Calibration data files</td></tr>
<tr><td>MET</td><td>Meteo data files</td></tr>
<tr><td colspan="2">UPLINK_FREQ_CORRECT</td><td colspan="2">Folder includes files which indicate wrong and corrected uplink frequency and their corresponding files.</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>DOCUMENT</td><td colspan="2">DOCINFO.TXT</td><td colspan="2">description of contents of the Document Directory</td></tr>
</table>

		M32ESOCL1B_RCL_021202_00.PDF/.ASC *Group delay stability specifications & measurements at New Norcia*
		M32ESOCL1B_RCL_030522_00.PDF/.ASC *Range calibrations at New Norcia and Kourou*
		M32UNBWL1B_RCL_030801_00.PDF/.ASC *Transponder group velocities (pdf in german, ASC in english)*
		MEX-MRS-IGM-IS-3019.PDF *MaRS Data Archive Plan (also available as ASC-file)*
		MEX-MRS-IGM-IS-3016.PDF *MaRS File Naming Convention (also available as ASC-file)*
		MEX-MRS-IGM-IS-3016_APP_A.ASC *MaRS File Naming Convention Appendix A, Example PDS labels*
		MEX-MRS-IGM-MA-3008.PDF MaRS User Manual
	MRS_DOC	MARS_OPS_LOGBOOK_04.PDF (or MARS_OPS_LOGBOOK_04_COM.PDF for commissioning). *status of all planned radio science operations for year 2004 (later for year 2005, …)*
		MEX_MRS_IGM_DS_3035.PDF *IFMS Doppler Processing and Calibration Software Documentation: Level 1a to Level 2*
		MEX_MRS_IGM_DS_3036.PDF *IFMS Ranging Processing and Calibration Software Documentation: Level 1a to Level 2.*
		MEX-MRS-IGM-DS-3037.PDF *ODF Processing and Calibration Software: Level 1a to Level 1b Documentation*
		MEX-MRS-IGM-DS-3038,PDF *ODF Doppler Processing and Calibration Software: Level 1b to Level 2 Documentation*
		MEX-MRS-IGM-DS-3039.PDF *Radio Science Predicted and Reconstructed orbit and Planetary Constellation Data: Specifications*
		MEX-MRS-IGM-DS-3043.PDF *ODF Ranging Processing and Calibration Software: Level 1b to Level 2 Documentation*

		MEX-MRS-UBW-TN-3045.PDF *Reference Systems and Techniques for Simulations and Prediction of Atmospheric and Ionospheric Sounding Measurements*
		MEX-MRS-IGM-LI-3028.PDF *List of MaRS Team members.*
		MEX-MRS-IGM-DS-3046.PDF *Radio Science Geometry and Position Index Software Design Specifications*
	ESA_DOC	IFMS_OCCFTP *documentation of IFMS data format*
		MEX_ESC_ID_5003_FDSICD.PDF *file format description of ESOC Flight Dynamics files (ancillary files)*
		MEX-ESC-IF-5003_APPENDIX_C *documentation of DDS configuration*
		MEX-ESC-IF-5003_APPENDIX_I *definition of XML-schema for the data delivery interface*
		MEX-ESC-IF-5003_APPENDIX_H *content description of ESOC Flight Dynamics files (ancillary files)*
		MEX-ESC-IF-5003_(DDID) *data delivery interface document*
		MEX_POINTING_MODE_DESC.TXT *Description of pointing modes*
		SOP-RSSD-TN-010.PDF *Planetary Science Data Archive Technical Note, Geometry and Position Information*
		ESA-MEX-TN-4009.PDF *Mars Express Archive Conventions*
	DSN_DOC	DSN_DESIGN_HB.PDF *Technical information and near future configurations of NASA DSN*
		DSN_ODF_TRK-2-18.PDF *Documentation of Tracking System Interfaces and Orbit Data File Interface*
		HGA_CALA.ASC *High Gain Antenna calibration*
		HGA_SBDA.PDF *S-band antenna patterns*
		HGA_XBDA *X-band antenna patterns*
		JPL_D-16765_RSR.PDF *Documentation of RSR data format*
		LIT_SIS.HTM *Software Interface Specification: Light Time File*

		M00DSN0L1A_DKF_....TXT (optional) *DSN Keyword File derived from SOE file and models of activities supported by the DSN*
		M00DSN0L1A_SOE_....TXT (optional) *Sequence of Events file*
		M00SUEL1A_ENB_....TXT (optional) *SUE Experimenter Notes*
		M00SUE0L1A_HEA_....TXT (optional) *DSN MEX Data Collection*
		M43DSN0L1A_NMC_....TXT (optional) *Network Monitor and Control Logfile*
		M43SUE0L1A_MFT_....TXT (optional) *Mars Express Manifest file*
		MEDIASIS.HTM *Media Calibration data : formats and contents*
		MON0158.ASC/.DOC/.PDF (optional) *Definition of format and distribution of the real-time, mission monitor data.*
		NMC_SIS.TXT *Contents of Network Monitor and Control Log.*
		OCCLOG??.TAB (optional) *Summary information of MEX radio science tests and experiments. ?? represents the sequence number.*
		OPTG_SIS.TXT *Software Interface Specification for the Orbit Propagation and Timing Geometry (OPTG) File.*
		Ryddd….ASC/.DOC/.PDF (optional) *Set of notes describing tests before and during radio science tests or operations or the progress of an experiment itself. y represents the year, ddd the DOY.*
		JPEG (only BSR) *Zip-folder with 4 sets of 24 jpeg-files, each from a different receiver, showing circularly polarized received power spectra averaged over 60 seconds. FILENAME: Rydddbca.jpg y:year, ddd:doy of year, b:X or S-band, c: Left or Right-Hand circulation, a:alphabetic numbering for each plot of 60 s.*

				SRX.TXT (optional, original MGS) *Software Interface Specification for Surface Reflection investigation files.*
				SUE_DMP.ASC/.DOC *Data Management Plan*
				TNF_SIS.TXT *Deep Space Mission System External Interface Specification*
				TRK_2_21.TXT *Software Interface Specification*
				TRK_2_23.TXT/ DSN_MEDIA_CAL_TRK_2_23.PDF *Specification of DSN media calibration data.*
				TRK_2_24.TXT/ DSN_WEA_FORMAT_TRK_2_24.PDF Specification of DSN weather file.
INDEX	INDXINFO.TXT			*description of the contents of the Index Directory*
	INDEX.LBL			*detached PDS label to describe INDEX.TAB*
	INDEX.TAB			*PDS table, listing all data files included in the volume*
	BROWSE_INDEX.LBL			*Detached PDS label to describe BROWSE_INDEX.TAB*
	BROWSE_INDEX.TAB			*PDS table, listing all files in the BROWSE directory*
EXTRAS	EXTRINFO.TXT			text description of the directory contents
	ANCILLARY	ESOC		*Relevant DDS files to describe the observation geometry*
		SPICE		*Relevant SPICE Kernels to describe the observation geometry*
		UNI_BW		*Relevant PREDICT files from the Uni BW Munich*
		MRS	LOG-FILES	*Logfiles of Level 2 processing*
		SUE	SPICE	*Modified Spice kernels combined with JPL DE405 and Phobos/Deimos ephemerides*
		DSN	EOP	*Earth Orientation Parameter files*
			OPT	*Orbit Propagation and Timing Geometry File*
			LIT	*Light Time File*
DATA	LEVEL1A	DSN	ODF	Orbit Data Files

		CLOSED_ LOOP		TNF	Tracking and Navigation files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	DSN	RSR	Radio-Science Receiver data files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
	LEVEL1B	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
	LEVEL2	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
			IFMS	DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	DSN	BSR	Bistatic radar power spectra
				SRG	Bistatic radar surface reflection geometry file
				DPX	Doppler X-Band file
				DPS	Doppler S-Band file
			IFMS	TBD	TBD

Table 5-1: Top-Level Directory Structure for a MaRS processed data volume (level 1a, 1b, 2)

The documents listed in Table 5.1-1 represent the maximum of available documents. Not all have to be present for one specific measurement. For IFMS (NNO) measurements refer mainly to MRS_DOC, for DSN measurements to DSN_DOC.

5.1.1.1.2 Diagram

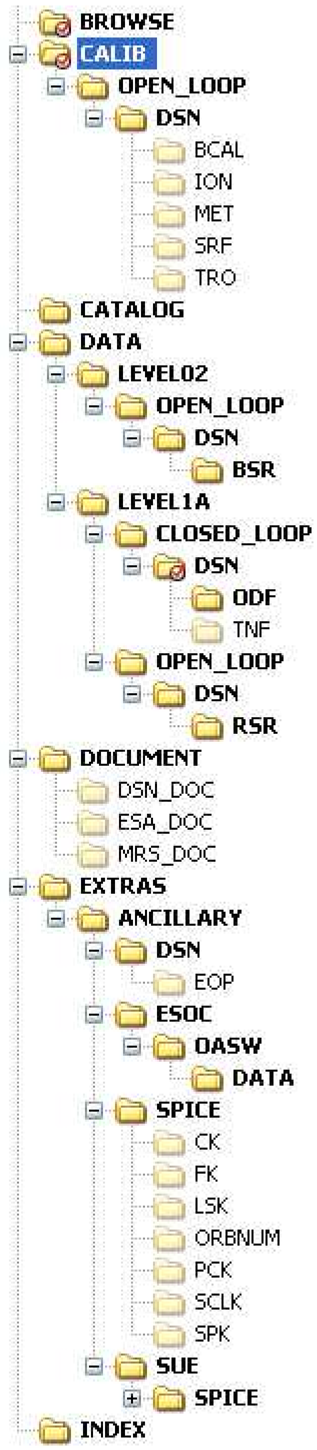

Figure 5-1: Top-Level Directory Structure for a MaRS processed data volume (level 1a, 1b, 2)

5.1.2 RSI

5.1.2.1 Top-Level Directory Structure for a RSI Level 1a, 1b and 2 data volume

5.1.2.1.1 Table

ROOT	AAREADME.TXT		*description of volume contents*	
	ERRATA.TXT		*overview of anomalies and errors*	
	VOLDESC.CAT		*description of the contents of the logical volume*	
BROWSE	BROWINFO.TXT		*Description of the BROWSE directory, which includes Quick Look Browse Plots of the data.*	
CATALOG	CATINFO.TXT		*text description of the directory contents*	
	MISSION.CAT		*PDS catalog object for Mission*	
	INST.CAT		*brief description of the radio systems of the s/c and the ground stations*	
	INSTHOST.CAT		*brief description of the Instrument Host*	
	DATASET.CAT		*brief description of the reduced RSI data*	
	PERSON.CAT		*description of key persons involved in RSI*	
	REF.CAT		*collection of references used in the inst.cat and dataset.cat*	
	SOFT.CAT		*Dummy software catalog file*	
CALIB	CALINFO.TXT		text description of the directory contents	
	CLOSED_ LOOP	DSN	Closed-loop calibration data of the DSN ground stations	
		IFMS	RCL	Range Calibration data files
			DCL	Doppler Calibration data files
			MET	Meteo data files
	OPEN_ LOOP	DSN	BCAL	System temperature calibration files
			ION	Ionospheric calibration file
			MET	Meteo data files
			TRO	Tropospheric calibration files
			SRF	Surface Reflection Filter Files
		IFMS	RCL	Range Calibration data files
			DCL	Doppler Calibration data files
			MET	Meteo data files
	UPLINK_FREQ_CORRECT		Folder includes files which indicate wrong and corrected uplink frequency and their corresponding files.	

DOCUMENT	DOCINFO.TXT	*description of contents of the Document Directory*
	RSI_DOC	M32ESOCL1B_RCL_021202_00.PDF/.ASC *Group delay stability specifications & measurements at New Norcia*
		M32ESOCL1B_RCL_030522_00.PDF/.ASC *Range calibrations at New Norcia and Kourou*
		M32UNBWL1B_RCL_030801_00.PDF/.ASC *Transponder group velocities (pdf in german, ASC in english)*
		ROS-RSI-IGM-IS-3079.PDF *RSI Data Archive Plan (also available as ASC-file)*
		ROS-RSI-IGM-IS-3087.PDF *RSI File Naming Convention (also available as ASC-file)*
		ROS-RSI-IGM-IS-3087_APP_A.ASC *RSI File Naming Convention Appendix A, Example PDS labels*
		ROS-RSI-IGM-MA-3081.PDF RSI User Manual
		RSI_OPS_LOGBOOK_04.PDF *status of all planned radio science operations for year 2004 (later for year 2005, …)*
		ROS_RSI_IGM_DS_3118.PDF *IFMS Doppler Processing and Calibration Software Documentation: Level 1a to Level 2*
		ROS_RSI_IGM_DS_3119.PDF *IFMS Ranging Processing and Calibration Software Documentation: Level 1a to Level 2.*
		ROS-RSI-IGM-DS-3121.PDF *Radio Science Predicted and Reconstructed orbit and Planetary Constellation Data: Specifications*
		ROS-RSI-IGM-LI-3116.PDF *List of RSI Team members.*
		ROS-RSI-IGM-DS-3126.PDF *Radio Science Geometry and Position Index Software Design Specifications*
	ESA_DOC	IFMS_OCCFTP *documentation of IFMS data format*
		RO_ESC_ID_5003_FDSICD.PDF *file format description of ESOC Flight Dynamics files (ancillary files)*

		RO-ESC-IF-5003_APPENDIX_C *documentation of DDS configuration*
		RO-ESC-IF-5003_APPENDIX_I *definition of XML-schema for the data delivery interface*
		RO-ESC-IF-5003_APPENDIX_H *content description of ESOC Flight Dynamics files (ancillary files)*
		RO-ESC-IF-5003_(DDID) *data delivery interface document*
		RO-EST-IF-5010 *specifications of operational interfaces and procedures*
		SOP-RSSD-TN-010.PDF *Planetary Science Data Archive TECHNICAL Note, Geometry and Position Information*
		RO-EST-TN-3372.PDF *Rosetta Archive Convention*
		ROS_POINTING_MODE_DESC.TXT *Rosetta Pointing mode description*
	DSN_DOC	DSN_DESIGN_HB.PDF *Technical information and near future configurations of NASA DSN*
		DSN_ODF_TRK-2-18.PDF *Documentation of Tracking System Interfaces and Orbit Data File Interface*
		JPL_D-16765_RSR.PDF *Documentation of RSR data format*
		LIT_SIS.HTM *Software Interface Specification: Light Time File*
		R00DSN0L1A_DKF_....TXT (optional) *DSN Keyword File derived from SOE file and models of activities supported by the DSN*
		R00DSN0L1A_SOE_....TXT (optional) *Sequence of Events file*
		R00SUEL1A_ENB_....TXT (optional) *SUE Experimenter Notes*
		R00SUE0L1A_HEA_....TXT (optional) *DSN RSI Data Collection*
		R43DSN0L1A_NMC_....TXT (optional) *Network Monitor and Control Logfile*
		R43SUE0L1A_MFT_....TXT (optional) *Rosetta Manifest file*
		MEDIASIS.HTM *Media Calibration data : formats and contents*

		MON0158.ASC/.DOC/.PDF (optional) *Definition of format and distribution of the real-time, mission monitor data.*
		NMC_SIS.TXT *Contents of Network Monitor and Control Log.*
		OPTG_SIS.TXT *Software Interface Specification for the Orbit Propagation and Timing Geometry (OPTG) File.*
		Ryddd….ASC/.DOC/.PDF (optional) *Set of notes describing tests before and during radio science tests or operations or the progress of an experiment itself. y represents the year, ddd the DOY.*
		JPEG (only BSR) *Folder with 4 sets of 24 jpeg-files, each from a different receiver, showing circularly polarized received power spectra averaged over 60 seconds. FILENAME: Rydddbca.jpg y:year, ddd:doy of year, b:X or S-band, c: Left or Right-Hand circulation, a:alphabetic numbering for each plot of 60 s.*
		SRX.TXT (optional) *Software Interface Specification for Surface Reflection investigation files.*
		TNF_SIS.TXT *Deep Space Mission System External Interface Specification*
		TRK_2_21.TXT *Software Interface Specification*
		TRK_2_23.TXT/ DSN_MEDIA_CAL_TRK_2_23.PDF *Specification of DSN media calibration data.*
		TRK_2_24.TXT/ DSN_WEA_FORMAT_TRK_2_24.PDF Specification of DSN weather file.
INDEX	INDXINFO.TXT	*description of the contents of the Index Directory*
	INDEX.LBL	*detached PDS label to describe INDEX.TAB*
	INDEX.TAB	*PDS table, listing all data files included in the volume*
	BROWSE_INDEX.LBL	*Detached PDS label to describe BROWSE_INDEX.TAB*
	BROWSE_INDEX.TAB	*PDS table, listing all files in the BROWSE directory*

EXTRAS	EXTRINFO.TXT				text description of the directory contents
	ANCILLARY	ESOC			*Relevant DDS files to describe the observation geometry*
		SPICE			*Relevant SPICE Kernels to describe the observation geometry*
		UNI_BW			*Relevant PREDICT files from the Uni BW Munich*
		MRS		LOG-FILES	*Logfiles of Level 2 processing*
		SUE		SPICE	*Modified Spice kernels combined with JPL DE405 and Phobos/Deimos ephemerides*
		DSN		EOP	*Earth Orientation Parameter files*
				OPT	*Orbit Propagation and Timing Geometry File*
				LIT	*Light Time File*
DATA	LEVEL1A	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
				TNF	Tracking and Navigation files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	DSN	RSR	Radio-Science Receiver data files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
	LEVEL1B	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files

				RNG	Ranging data files
		OPEN_ LOOP	IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
	LEVEL2	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
			IFMS	DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	DSN	BSR	Bistatic radar power spectra
				SRG	Bistatic radar surface reflection geometry file
				DPX	Doppler X-Band file
				DPS	Doppler S-Band file
			IFMS		

Table 5-2: Top-Level Directory Structure for a RSI processed data volume (level 1a, 1b,2)

The documents listed in Table 5-2 represent the maximum of available documents. Not all have to be present for one specific measurement. For IFMS (NNO) measurements refer mainly to RSI_DOC, for DSN measurements to DSN_DOC.

5.1.2.1.2. Diagram

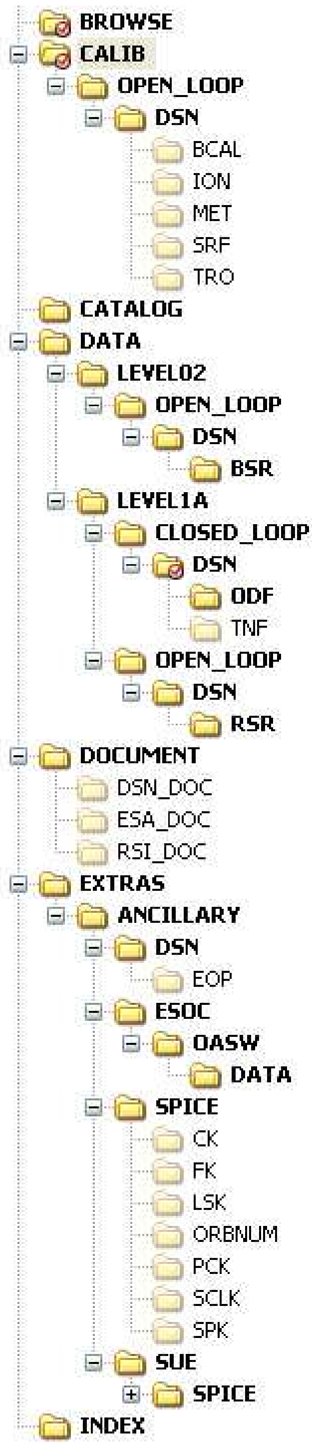

Figure 5-2: Top-Level Directory Structure for a RSI processed data volume (level 1a,1b ,2)

5.1.3 **VeRA**

5.1.3.1 Top-Level Directory Structure for a VeRa Level 1a, 1b and 2 data volume

5.1.3.1.1 Table

ROOT	AAREADME.TXT		*description of volume contents*	
	ERRATA.TXT		*overview of anomalies and errors*	
	VOLDESC.CAT		*description of the contents of the logical volume*	
BROWSE	BROWINFO.TXT		*Description of the BROWSE directory, which includes Quick Look Browse Plots of the data.*	
CATALOG	CATINFO.TXT		*text description of the directory contents*	
	MISSION.CAT		*PDS catalog object for Mission*	
	INST.CAT		*brief description of the radio systems of the s/c and the ground stations*	
	INSTHOST.CAT		*brief description of the Instrument Host*	
	DATASET.CAT		*brief description of the reduced VeRa data*	
	PERSON.CAT		*description of key persons involved in VeRa*	
	REF.CAT		*collection of references used in the inst.cat and dataset.cat*	
	SOFT.CAT		*Dummy software catalog file*	
CALIB	CALINFO.TXT		text description of the directory contents	
	CLOSED_ LOOP	DSN	Closed-loop calibration data of the DSN ground stations	
		IFMS	RCL	Range Calibration data files
			DCL	Doppler Calibration data files
			MET	Meteo data files
	OPEN_ LOOP	DSN	BCAL	System temperature calibration files
			ION	Ionospheric calibration file
			MET	Meteo data files
			TRO	Tropospheric calibration files
			SRF	Surface Reflection Filter Files
		IFMS	RCL	Range Calibration data files
			DCL	Doppler Calibration data files
			MET	Meteo data files
	UPLINK_FREQ_CORRECT		Folder includes files which indicate wrong and corrected uplink frequency and their corresponding files.	

DOCUMENT	DOCINFO.TXT	*description of contents of the Document Directory*
	VRA_DOC	M32ESOCL1B_RCL_021202_00.PDF/.ASC *Group delay stability specifications & measurements at New Norcia*
		M32ESOCL1B_RCL_030522_00.PDF/.ASC *Range calibrations at New Norcia and Kourou*
		M32UNBWL1B_RCL_030801_00.PDF/.ASC *Transponder group velocities (pdf in german, ASC in english)*
		VEX-VRA-IGM-IS-3007.PDF *VeRa Data Archive Plan (also available as text-file)*
		VEX-VRA-IGM-IS-3009.PDF *VeRa File Naming Convention (also available as text-file)*
		VEX-VRA-IGM-IS-3009_APP_A.ASC *VeRa File Naming Convention Appendix A, Example PDS labels*
		VEX-VRA-IGM-MA-3005.PDF VeRa User Manual
		VERA_OPS_LOGBOOK_06.PDF *status of all planned radio science operations for year 2006 (later for year 2007, …)*
		VEX_VRA_IGM_DS_3011.PDF *IFMS Doppler Processing and Calibration Software Documentation: Level 1a to Level 2*
		VEX_VRA_IGM_DS_3012.PDF *IFMS Ranging Processing and Calibration Software Documentation: Level 1a to Level 2.*
		VEX-VRA-IGM-DS-3014.PDF *Radio Science Predicted and Reconstructed orbit and Planetary Constellation Data: Specifications*
		VEX-VRA-UBW-TN-3040.PDF *Reference Systems and Techniques for Simulations and Prediction of Atmospheric and Ionospheric Sounding Measurements*
		VEX-VRA-IGM-LI-3013.PDF *List of VeRa Team members.*
		VEX-VRA-IGM-DS-5007.PDF *Radio Science Geometry and Position Index Software Design Specifications*

		VEX-VRA-IGM-DS-5008.PDF *ODF Processing and Calibration Software: Level 1a to Level 1b Documentation*
		VEX-VRA-IGM-DS-5009.PDF *ODF Doppler Processing and Calibration Software: Level 1b to Level 2 Documentation*
		VEX-VRA-IGM-DS-5010.PDF *ODF Ranging Processing and Calibration Software: Level 1b to Level 2 Documentation*
	ESA_DOC	IFMS_OCCFTP *documentation of IFMS data format*
		MISSION_PHASE.TXT *VEX Mission Phases*
		OBSERVATION_TYPE_DESC.TXT *VEX Observations types*
		SOP-RSSD-TN-010.PDF *Planetary Science Data Archive Technical Note Geometry and Position Information*
		VEX_ORIENTATION_DESC.TXT *VEX orientation description*
		VEX_POINTING_MODE_DESC.TXT *VEX pointing mode description*
		VEX_SCIENCE_CASE_ID_DESC.TXT *VEX description of science cases*
		VEX_ESC_ID_5003_FDSICD.PDF *file format description of ESOC Flight Dynamics files (ancillary files, original from Rosetta/Mars Express)*
		VEX-ESC-IF-5003_APPENDIX_C *PI Account details*
		VEX-ESC-IF-5003_APPENDIX_I *definition of XML-schema for the data delivery interface*
		VEX-ESC-IF-5003_APPENDIX_H *content description of ESOC Flight Dynamics files (ancillary files)*
		VEX-ESC-IF-5003_(DDID) *data delivery interface document*
		VEX-RSSD-IF-0002.PDF *specifications of operational interfaces and procedures*
		VEX-EST-TN-036.PDF *VEX Archive Conventions*
	DSN_DOC	DSN_DESIGN_HB.PDF *Technical information and near future configurations of NASA DSN*
		DSN_ODF_TRK-2-18.PDF *Documentation of Tracking System Interfaces and Orbit Data File Interface*

		JPL_D-16765_RSR.PDF *Documentation of RSR data format*
		LIT_SIS.HTM *Software Interface Specification: Light Time File*
		V00DSN0L1A_DKF_....TXT (optional) *DSN Keyword File derived from SOE file and models of activities supported by the DSN*
		V00DSN0L1A_SOE_....TXT (optional) *Sequence of Events file*
		V00SUEL1A_ENB_....TXT (optional) *SUE Experimenter Notes*
		V00SUE0L1A_HEA_....TXT (optional) *DSN Data Collection*
		V43DSN0L1A_NMC_....TXT (optional) *Network Monitor and Control Logfile*
		V43SUE0L1A_MFT_....TXT (optional) *Venus Express Manifest file*
		MEDIASIS.HTM *Media Calibration data : formats and contents*
		MON0158.ASC/.DOC/.PDF (optional) *Definition of format and distribution of the real-time, mission monitor data.*
		NMC_SIS.TXT *Contents of Network Monitor and Control Log.*
		OPTG_SIS.TXT *Software Interface Specification for the Orbit Propagation and Timing Geometry (OPTG) File.*
		Ryddd….ASC/.DOC/.PDF (optional) *Set of notes describing tests before and during radio science tests or operations or the progress of an experiment itself. y represents the year, ddd the DOY.*
		JPEG (only BSR) *Folder with 4 sets of 24 jpeg-files, each from a different receiver, showing circularly polarized received power spectra averaged over 60 seconds. FILENAME: Rydddbca.jpg y:year, ddd:doy of year, b:X or S-band, c: Left or Right-Hand circulation, a:alphabetic numbering for each plot of 60 s.*

				SRX.TXT	*Software Interface Specification for Surface Reflection investigation files.*
				TNF_SIS.TXT	*Deep Space Mission System External Interface Specification*
				TRK_2_21.TXT	*Software Interface Specification*
				TRK_2_23.TXT/ DSN_MEDIA_CAL_TRK_2_23.PDF	*Specification of DSN media calibration data.*
				TRK_2_24.TXT/ DSN_WEA_FORMAT_TRK_2_24.PDF	Specification of DSN weather file.
INDEX	INDXINFO.TXT				*description of the contents of the Index Directory*
	INDEX.LBL				*detached PDS label to describe INDEX.TAB*
	INDEX.TAB				*PDS table, listing all data files included in the volume*
	BROWSE_INDEX.LBL				*Detached PDS label to describe BROWSE_INDEX.TAB*
	BROWSE_INDEX.TAB				*PDS table, listing all files in the BROWSE directory*
EXTRAS	EXTRINFO.TXT				text description of the directory contents
	ANCILLARY	ESOC			*Relevant DDS files to describe the observation geometry*
		SPICE			*Relevant SPICE Kernels to describe the observation geometry*
		UNI_BW			*Relevant PREDICT files from the Uni BW Munich*
		VRA		LOG-FILES	*Logfiles of Level 2 processing*
		SUE		SPICE	*Modified Spice kernels combined with JPL DE405 and Phobos/Deimos ephemerides*
		DSN		EOP	*Earth Orientation Parameter files*
				OPT	*Orbit Propagation and Timing Geometry File*
				LIT	*Light Time File*
DATA	LEVEL1A	CLOSED_LOOP	DSN	ODF	Orbit Data Files
				TNF	Tracking and Navigation files

			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	DSN	RSR	Radio-Science Receiver data files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
	LEVEL1B	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
			IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	IFMS	AG1	Auto Gain Control 1 data files
				AG2	Auto Gain Control 2 data files
				DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
	LEVEL2	CLOSED_ LOOP	DSN	ODF	Orbit Data Files
			IFMS	DP1	Doppler 1 data files
				DP2	Doppler 2 data files
				RNG	Ranging data files
		OPEN_ LOOP	DSN	BSR	Bistatic radar power spectra
				SRG	Bistatic radar surface reflection geometry file
				DPX	Doppler X-Band file
				DPS	Doppler S-Band file
			IFMS	TBD	TBD

Table 5-3: Top-Level Directory Structure for a VeRa processed data volume (level 1a, 1b, 2)

The documents listed in Table 5-3 represent the maximum of available documents. Not all have to be present for one specific measurement. For IFMS (NNO) measurements refer mainly to RSI_DOC, for DSN measurements to DSN_DOC.

5.1.3.1.2 Diagram

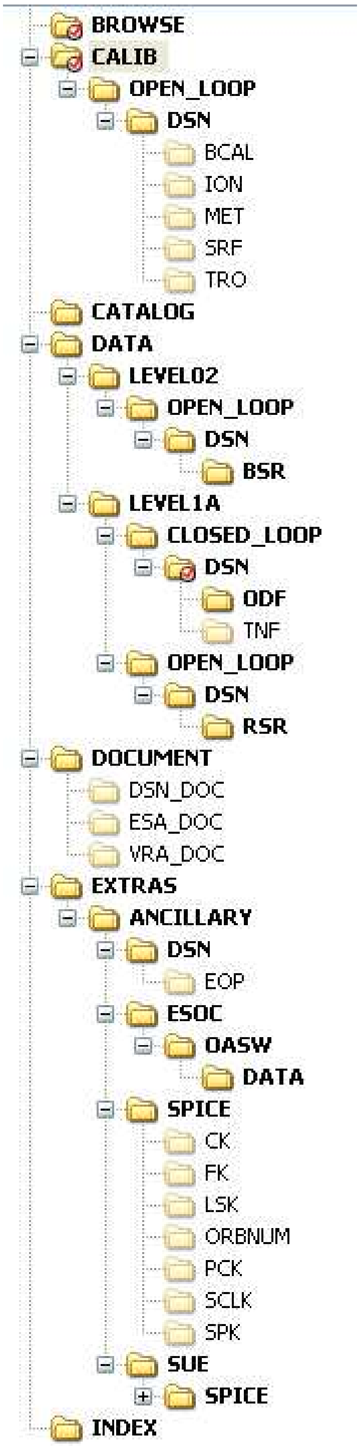

Figure 5-3: Top-Level Directory Structure for a VeRa processed data volume (level 1a, 1b, 2)

6 STANDARDS USED IN MARS, RSI AND VERA DATA PRODUCT GENERATION

6.1 PDS Standards

The Standards for generating and Validation of the Data Volumes and Datasets are based on the standards provided by the JPL's Planetary Data System Version 3.5. For further informations see Document *Planetary Data System, Standards Refere-nce, JPL D-7669, Part 2.*

6.2 Time Standards

MaRS, RSI and VeRa data products makes use of different Time and Reference system. For our data processing and archiving the most important Time Systems are:

1. Coordinated Universal Time (UTC)
2. Ephemeris Time (ET)

The scientific success of a Radio Science Experiment depends critically on a common understanding about the conventions for the reference and time systems. The following sections give an overview of the time standards necessary to understand the above mentioned Time systems and to convert to other common Time Systems. It should be noted that radio science data are generated and recorded at ground stations. Thus the times given in the data and label files are ground station and not onboard time.

6.2.1 Coordinated Universal Time (UTC)

Coordinated Universal Time (UTC) is obtained from atomic clocks running at the same rate as TT (see section 6.2.3.4) or TAI (see section 6.2.3.3). The UTC time scale is always within 0.7 seconds of UT1 (see section 6.2.3.6). By the use of leap seconds, care is taken to ensure that this difference is never exceeded. However, because of the introduction of the leap seconds it becomes clear that this time scale is not steady.
The International Earth Rotation Service (IERS) can add leap seconds and is normally doing this at the end of June or December of each year if necessary. The actual UTC can only be determined for a previous point in time but predictions for the future are published by the IERS. This fact should be noted when future missions are planned on the base of the UTC time standard.
UTC can be obtained by the difference of the predicted value DUT1 or the past value ΔUT between UT1 and UTC published in the IERS Bulletin A (http://maia.usno.navy.mil/) which contains previous leap seconds and predictions :

$$UTC = UT1 - DUT1 \quad \text{or} \quad UTC = UT - \Delta UT$$

This relation is needed to obtain UT1 (UT) from UTC.

6.2.2 Dynamical Time Scale T_{eph} for the JPL DE 405 Ephemeris

In a general relativistic framework, time is not an absolute quantity but depends on the location and motion of a clock. Therefor unlike UTC T_{eph} is not based on the rotation of the earth around its axis. T_{eph} refers to the center of mass of the solar system and is the independent variable of *barycentric planetary ephemerides*. It should be noted that during the years 1984 – 2003 the time scale of ephemerides referred to the barycenter of the solar system was the relativistic time scale Barycentric Dynamic Time TDB (see section 6.2.3.2).
From 2004 onwards this time scale for the JPL DE 405 ephemeris will be replaced by T_{eph}. For practical purposes the length of the ephemeris second can be taken as equal to the length of the TDB second. T_{eph} is approximately equal to TDB, but not exactly. On the other hand, T_{eph} is mathematically and physically equivalent to the newly-defined TCB (see section 6.2.3.8), differing from it by only an offset and a constant rate. Within the accuracy required by MaRS, RSI and VeRa we use: T_{eph} ~ TDB.
T_{eph} is then defined as seconds past J2000, with J2000 being 12 h 1 January TDB.

6.2.3 Other Time Standards

6.2.3.1

6.2.3.2 Barycentric Dynamic Time (TDB)

Since the differences compared to TT are fairly small, the corrections can be determined by the following approximation :

$$\mathrm{TDB} = \mathrm{TT} + 0.001658^{s} \cdot \sin g + 0.000014^{s} \cdot \sin(2g)$$

with g being the mean anomaly of the Earth in its orbit given by

$$g = 357.53 + 0.9856003 \cdot \left(\mathrm{JD}\left(\mathrm{UT1}\right) - 2451545.0\right) \quad [\mathrm{deg}]$$

6.2.3.3 International Atomic Time (TAI)

TAI provides the practical realization of a uniform time scale based on atomic clocks. This time is measured at the surface of the Earth. Since this time scale is a steady one, it differs from UTC by an integral number of leap seconds introduced up the current point in time:

$$\mathrm{TAI} = \mathrm{UTC} + \mathrm{LS}$$

where LS is the number of leap seconds. The unit of TAI is the SI second.

6.2.3.4 Terrestrial Dynamic Time (TT)

Terrestial Time (TT) – formerly Terrestrial Dynamical Time (TDT) - is to be understood as time measured on the geoid. It has conceptionally a uniform time scale. TT is the independent variable of *geocentric ephemerides*. TT replaced Ephemeris Time (ET) in 1984. The difference between TT and the atomic time scale (TAI) is a constant value of 32.184 seconds:

$$\mathrm{TT} = \mathrm{TAI} + 32.184^{s}$$

One therefore obtains also the relationship:

$$\mathrm{UTC} = \mathrm{TT} - 32.184^{s} - \mathrm{LS}$$

TT does not take into account relativistic corrections. It is used as an independent argument of geocentric ephemeris.

6.2.3.5 GMT (UT)

Time is traditionally measured in days of 86400 SI seconds. Each day has 24 hours counted from 0^h at midnight. The motion of the real sun was replaced by the concept of a fictitious mean sun that moves uniformly in right ascension defining the Greenwich Mean Time (GMT) or Universal Time (UT). Greenwich Mean Sidereal Time (GMST), however, is the Greenwich hour angle of the vernal equinox, i. e. it denotes the angle between mean vernal equinox of date and the Greenwich meridian.
The mean vernal equinox is based on a reference system which takes into account the secular effects, i.e. the precession of the Earth´s equator but not periodic effects such as the nutation of the Earth´s axis.
In terms of SI seconds, the length of a sidereal day (i. e. the Earth’s spin period) amounts 23^h 56^m $4^s.091 \pm 0^s.005$ (corresponding to a factor 1/1.00273790935) making it about four minutes shorter than a 24^h solar day. Hence, sidereal time and mean solar time have different “rates”.

6.2.3.6 Universal Time (UT1)

Universal Time UT1 is the presently adopted realization of a mean solar time scale (constant average length of a solar day of 24 hours) with UT1 = UT. As a result, the length of one second of UT1 is not constant because of the apparent motion of the sun and the rotation of the Earth. UT1 is therefore defined as a function of sidereal time.
For any particular day, 0 h UT1 is defined as the instant at which Greenwich Mean Sidereal Time (GMST) has the value:

$$\mathrm{GMST}\left(0^h\,\mathrm{UT1}\right) = 24110^s.54841 + 8640184^s.812866 \cdot T_o + 0^s.093104 \cdot T_o^2 - 0^s.0000062 \cdot T_o^3$$

For an arbitrary time of the day, the expression may be generalized to obtain the Greenwich hour angle GHA by multiplying this time with the factor 1.00273790935, adding this result to GMST and convert it into degrees (if so desired)

$$\mathrm{GMST}\ \left(\mathrm{UT1}\right) = 24110^s.54841 + 8640184^s.812866\mathrm{T_o} + 1.00273790935\mathrm{UT1} + 0^s.093104\mathrm{T}^2\ -\ 0^s.0000062 \cdot T^3$$

where T is the time in Julian centuries since the 1st of January 2000, 12 h, i.e. 2000 Jan. 1.5 :

$$\mathrm{T} = \frac{\mathrm{JD(UT1)} - 2451545}{36525}$$

and JD is the Julian Date.

Ecliptic and Earth equator at 2000 Jan 1.5 define the *J2000 system*.

The most useful relation for computer software is one that uses only JD (UT1):

$$GMST(°) = 280.46061837 + 360.98564736629 \cdot \left(JD - 2451545.0\right) + 0.000387933T^2 - T^3 / 38710000$$

The difference between UT1 and TT or TAI (atomic clock time, to be explained below) can only be determined retrospectively. This difference is announced by the International Earth Rotation Service (IERS) and is handled in practice by the implementation of leap seconds (maximum of two in one year).
The above formulae contain implicitly the Earth's mean angular rotation $\omega_\oplus$ in degrees per second [3.15].

$$\omega_\oplus\left(rad/s\right) = \left\{1.002737909350795 + 5.9006 \cdot 10^{-11} T - 5.9 \cdot 10^{-15} T^2\right\} \cdot \frac{2\pi}{86400s}$$

6.2.3.7 Geocentric Coordinate Time (TCG)

Geocentric Coordinate Time TCG represents the time coordinate of a four dimensional reference system and differs from TT by a constant scale factor yielding the relation

$$TCG = TT + L_G \cdot (JD - 2443144.5) \cdot 86400\ s$$

$L_G = 6.9692903 * 10^{-10}$

For practical reasons this equation can also be put into the following relation :

TCG = TT + 2.2 s/cy * (year-1977.0)

cy = century

6.2.3.8 Barycentric Coordinate Time (TCB)

The Barycentric Coordinate Time TCB has been introduced to describe the motion of solar system objects in a non rotating relativistic frame centered at the solar system barycenter. TCB and TCG exhibit a rate difference which depends on the gravitational potential of the Sun at the mean Earth-Sun distance 1 AU and the Earth´s orbital velocity. The accumulated TCB-TT time difference amounts to roughly 11 s around epoch J2000.

$$TCB = TCG + L_C \cdot (JD - 2443144.5) \cdot 86400\ s + P$$

(Mc Carthy 1996) and

$$\begin{aligned} P \approx &+0^s.0016568 \cdot \sin(35999°.37T + 357°.5) \\ &+0^s.0000224 \cdot \sin(32964°.5T + 246°) \\ &+0^s.0000138 \cdot \sin(71998°.7T + 355°) \\ &+0^s.0000048 \cdot \sin(3034°.9T + 25°) \\ &+0^s.0000047 \cdot \sin(34777°.3T + 230°) \end{aligned} \qquad (3.16)$$

$$T = (JD - 2451545.0)/36525$$

$L_c = 1.4808268457\ 10^{-8}$

The largest contribution is given by the first term. When neglecting the other terms we can approximate P by:

$P = 0.001658^{\,s} \sin(g) + 0.000014^{\,s} \sin(2g)$

6.2.3.9

6.2.3.10 Julian Date (JD)

In astronomical computations, a continuous day count is used which avoids the usage of a calendar. The Julian Date (JD) is the number of days since noon January 1, 4712 BC including fractions of the day.

6.2.3.11 Modified Julian Date (MJD)

Since the JD has become such a large number, the Modified Julian Date was introduced for convenience. JD was reset at November 17th 1858 which leads to the following equation :

$$\mathrm{MJD} = \mathrm{JD} - 2400000.5^{d}$$

Note that the count for MJD starts at midnight.

6.3 Coordinate Systems

MaRS, RSI and VeRa make use of different coordinate systems (so called *frames in SPICE) with respect to the* Target body and different science objectives.

There are four different frames classes:

6.3.1 Inertial Frames

Inertial frames do not accelerate with respect to the star background. They are the frames in which Newton's law's of motion apply.

SPICE ACRONYM	DESCRIPTION
J2000	Earth mean equator, dynamical equinox of J2000
MARSIAU	Mars Mean Equator and IAU vector of J2000. The IAU vector at Mars is the point on the mean equator of Mars where the equator ascends through the the eart mean equator. This vector is the cross of Earth mean north with Mars mean north

Table 6-1: Inertial Frames

6.3.2 Bodyfixed Frames

Body fixed frames are reference frames that do not move with respect to "surface" features of an object, but do move with respect to inertial frames. The orientation of this frame is typically determined from the International Astronomical Union (IAU) model for the body in question.

SPICE ACRONYM	DESCRIPTION
ITRF93	International Terrestrial Reference Frame 93
IAU_MARS IAU_MARS_BARYCENTER	Mars IAU frame Mars IAU frame (origin in barycenter)
IAU_VENUS IAU_VENUS_BARYCENTER	Venus IAU frame Venus IAU frame (origin in barycenter)
IAU_PHOBOS	Phobos IAU frame
IAU_DEIMOS	Deimos IAU frame

Table 6-2: Bodyfixed Frames

6.4 Earth Ellipsoid - Ground Station Coordinates

For the Earth the WGS-84 system is used as a reference ellipsoid to define the Ground Station coordinates. The equation below shows how to compute cartesian coordinates if the geodetic (= geocentric) longitude λ, the geodetic latitude φ and altitude *h* above the reference ellipsoid with a radius R_{ref} and a flattening *f* are given:

$$r = \begin{pmatrix} (N+h)\cos\varphi\cos\lambda \\ (N+h)\cos\varphi\sin\lambda \\ \left((1-f)^2\, N+h\right)\sin\varphi \end{pmatrix}$$

where

$$N = \frac{R_{ref}}{\sqrt{1-f\left(2-f\right)\sin^2\varphi}}$$

and 1/f = 298.257223563

The motion of a ground station in an inertial reference system is dominated by the Earth rotation with a velocity of 460 m/s at the equator and the translatory motion of the Earth around the solar system barycenter (~ 30 km/s). When the motion of the ground station is modeled in the inertial *International Celestial Reference System* ICRS, the position $\mathbf{r}_{ITRS}$ of the station in the *International Terrestrial Reference System* (ITRS) has to be transformed using SPICE.

6.4.1 **Venus and Mars Ellipsoids**

Venus has a spherical shape with an equatorial radius and polar radius of 6051.8 km. For Mars we assume a rotational symmetric ellipsoid. The polar and equatorial semi-major axis have a length of 3376.20 km and 3396.19 km, respectively [3.13].

6.5 Planetary Ephemeris and Planetary Coodinates

The position of the planets are calculated using the JPL/DE405 ephemeris model. The ephemeris data are given in the barycentric time basis TDB and in either the heliocentric or the geocentric J2000 system in a pure geometrical sense, i.e. assuming infinite speed of light.

7 DATA VALIDATION

7.1 PSA Validation Tools

ESA developed the ‘PSA Volume Verifier’ (PVV) tool which is used for the validation and delivery of a scientific dataset for ingestion to the Planetary Science Archive (PSA). The tool allows the instrument teams to check their datasets before delivering them to the PSA database.

The labels are verified for PDS compliance reasons and all aspects of the dataset structure / content are validated. The PSA team will systematically use PVV as well, before the data is ingested to the PSA.

The PVV can be downloaded using anonymous ftp from the site:

ssols01.esac.esa.int
cd /pub/software/pvv/

The latest updates of the software will be kept there, along with the document SOP-RDDS-UM-004, the PVV User Manual. Please refer to this document for further details.

7.2 Radio Science Validation Process

Several Quick-Look-plots of the retrieved data are generated during processing to Level 2. These plots are investigated to validate the measurement. Possible decisions are then to deliver the data to the official PSA Archive, to archive the data only internally or regard the measurement as failed.

The following section gives a short description of the Quick-Look-Plots and their meaning for the validation process. The plots can be found in the BROWSE folder. For more details refer to BROWINFO.TXT, also located in this folder. For the respective terms refer to the document MEX-MRS-IGM-DS-3035/ROS-RSI-IGM-DS-3118/VEX-VRA-IGM-IS-3011 (Doppler Processing and Calibration Software) in the DOCUMENT folder of this dataset.

7.2.1 Residuals

The residual ($frequency_{observed}$ - $frequency_{predicted}$) should fluctuate around 0 Hz with a maximum fluctuation range of approximately 0.1 HZ and since 2010-10-13 with a maximum fluctuation range of approximately 0.2 HZ. Steps, peaks or a gradient in the residual should be investigated to decide if the data can be used. But it depends on the individual measurement, if the data set is severely influenced by such data problems, and on the experienced user if he accepts the data.

The time measuring device at the IFMS ground station may produce so-called cycle-slips which can be seen in the observed frequency. This results in huge peaks in the residuals and the data can not be used, if the number of cycle-slips is too large.

7.2.2 AGC

The noise level of the data and the associated signal level (AGC) is dependent on the distance between the spacecraft and the Earth. For X-Band we usually have values of about -50/-70 dBm, for S-Band of about -70/-80 dBm. The fluctuation range should not exceed 1 dBm. If there is a high noise-level or the signal level is extremely low, the ground station receiver might have been unlocked or the spacecraft operated in a non-coherent mode. No gradient or peaks should be visible in the data. Steps can be seen if telemetry is switched on/off, but this is not a sign for a measurement error. In case of VEX occultations both, ingress and egress phases, can occur in one plot. A drop of about 40 dB representing the occultation then appears in the middle of the time interval.

7.2.3 Differential Doppler

The data should fluctuate around 0 Hz with a maximum fluctuation range of 0.1 Hz, depending on the distance between spacecraft and Earth. The Differential Doppler is important in solar corona sounding measurements especially.

7.2.4 Calibration

7.2.4.1 Occultation

Calibration is done for occultation measurements using a Klobuchar model for the Earth ionosphere. Besides, Meteo-files derived at the groundstation are used for the tropospheric correction. The calibration data should show a smooth curve with small values without any steps.

7.2.4.2 Gravity

Until begin of 2007 calibration of gravity measurements is done using the Differential Doppler data. This calibration step corrects the effects induced by the interplanetary plasma . This can only be done if two downlink frequencies have been recorded. The Meteo-files derived at the groundstation are used for the tropospheric correction. If the Differential Doppler noise is too high, Earth ionosphere calibration is done via the Klobuchar-Coefficients. The calibration data should then show a smooth curve of small values without any steps. If the Differential Doppler is used, the high frequency plasma noise superposes the calibration curve. The overall appearance depends on the observation geometry.
Since begin of 2007 calibration is always done using the Klobuchar model for Earth ionosphere. The Meteo-files derived at the groundstation are used for the tropospheric correction. The calibration data should show a smooth curve without steps and small values.

7.2.4.3 Solar Conjunction

Calibration is done for Solar Conjunction measurements with Klobuchar-Coefficients for the Earth Ionosphere. The Meteo-files derived at the groundstation are used for the tropospheric correction. The calibration data should show a smooth curve with small values without any steps.

8 MARS, RSI AND VERA VOLUMES AND DATASETS ORGANIZATION, FORMATS AND NAME SPECIFICATION

8.1 Definitions and General Concept

8.1.1 Definitions

8.1.1.1 Data Product

A labelled grouping of data resulting from a scientific observation. Examples of data products include spectrum tables and time series tables. A data product is a component of a data set.

8.1.1.2 Data Set

The accumulation of data products, secondary data, software and documentation, that completely document and support the use of those data products. A data set is part of a data set collection.

8.1.1.3 Data Set Collection

A data set collection consists of data sets that are related by observation type, discipline, target, or time, and therefore are treated as a unit, archived and distributed as a group (set) for a specific scientific objective and analysis.

8.1.1.4 Volume

A physical unit used to store or distribute data products (e.g. a CD_ROM or DVD disk) which contain directories and files. The directories and files include documentation, software, calibration and geometry information as well as the actual science data. A volume is part of a volume set. A volume equals a data set.

8.1.1.5 Volume Set

A volume set consists of one or more data volumes containing a single data set or collection of related data sets. In certain cases, the volume set can consists of only one volume.

8.1.2 Data- and Volume Set Organization

The general concept for the MaRS, RSI and VeRa Data- and Volume Set Design is shown in Figure 8-1.

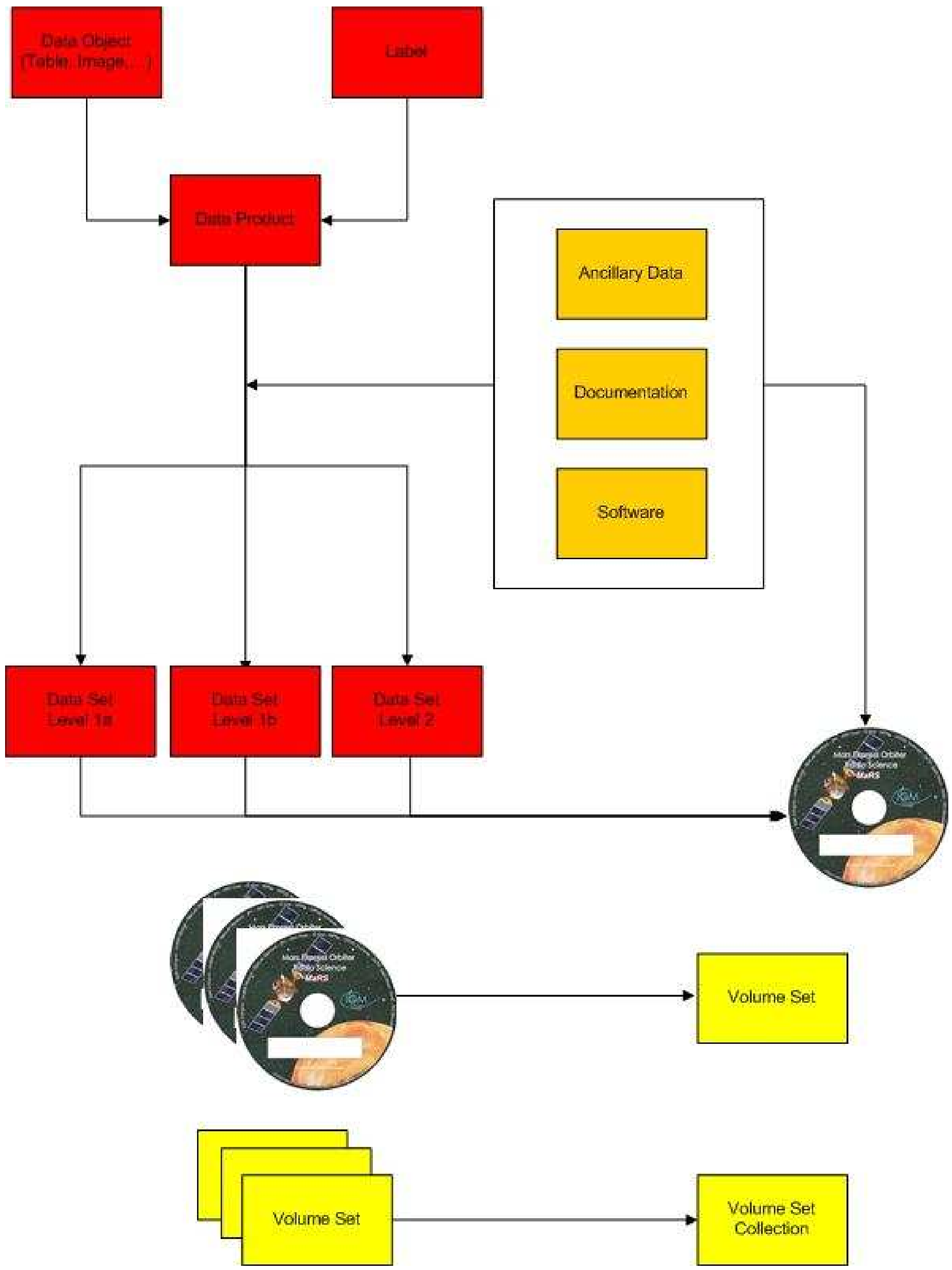

Figure 8-1: Data Set Collection, Data Sets and Data Products

8.2 Volume and Dataset Name Specification

8.2.1 Dataset

8.2.1.1 Dataset ID

The Data Set ID is a unique alphanumeric identifier for the MaRS, VeRa and RSI data products. One data set corresponds to one physical data volume and both have the same four digit sequence number. See Table 8-1 for more information.

XXX-Y-ZZZ-U-VVV-NNNN-WWW

Acronym	Description	Example
XXX	Instrument Host ID	MEX RO VEX
Y	Target ID	M (Mars) V (Venus) C (Comet Churyumov-Gerasimenko) L (asteroid Lutetia) S (asteroid Steins) X (for checkout, Sun) CAL (for calibration)
ZZZ	Instrument ID	MRS RSI VRA
U	Data level[1] (CODMAC Level)	1 raw data/ESOC/DDS 2 edited raw data 3 calibrated data 5 derived/scientific data 1/2/3 (Data set contains raw, edited and calibrated data)
VVV	Data description Mission phases for level 1/2/3 data (MaRS mission phases deviate from the official MEX mission phases; see below)	CVP commissioning CR1 cruise first part PRM prime mission NMP nominal mission phase EXT1 extended mission
NNNN	A 4 digit sequence number which is identical to the sequence number in the corresponding volume's Radio Science VOLUME_ID	0123

[1] In the keyword DATA_SET_ID the CODMAC-levels are used instead of PSA-level. In all other file names and documents we keep PSA-level.

WWW	Version number	V1.0

Table 8-1: Dataset ID

Examples:

MEX-M-MRS-1/2/3-PRM-1144-V1.0
RO-C-RSI-1/2/3-MCO-0099-V2.0
VEX-V-VRA-1/2/3-NMP-0124-V1.0

It should be noted that the MaRS mission phase names used in the data_set_id **do not** correspond to the mission phase names as defined from ESA for Mars Express. However, since the radio science team tries to archive data for Mars Express as well as for Venus Express and Rosetta, it was granted the use of spacecraft-independent mission phase names which can be used for all three missions. Nevertheless, for Venus Express the ESA-defined mission phases will be used.

For the mission_phases definition see Table 8-2.

Acronym	**Description**	**Timespan**
For Mars Express		
NEV	Near Earth Verification	2003-06-02 at 00:00:00 UTC to 2003-07-31 at 23:59:59 UTC
CR1	Cruise 1	2003-08-01 at 00:00:00 UTC to 2003-12-25 at 23:59:59 UTC
MCO	Mission Commissioning	2003-12-26 at 00:00:00 UTC to 2004-06-30 at 23:59:59 UTC
PRM	Prime Mission	2004-07-01 at 00:00:00 UTC to 2005-12-31 at 23:59:59 UTC
EXT1	Extended Mission 1	2006-01-01 at 00:00:00 UTC to 2007-09-30 at 23:59:59 UTC
EXT2	Extended Mission 2	2007-10-01 at 00:00:00 UTC to TBD

Acronym	Description	Timespan
	For Rosetta	
GRND	GROUND	*** to 2004-03-02 at 23:59:59 UTC
LEOP	LAUNCH	2004-03-03 at 00:00:00 UTC to 2004-03-04 at 23:59:59 UTC
CVP1	Commissioning 1	2004-03-05 at 00:00:00 UTC to 2004-06-06 at 23:59:59 UTC
CR1	Cruise 1	2004-06-07 at 00:00:00 UTC to 2004-09-05 at 23:59:59 UTC
CVP2	Commissioning 2	2004-09-06 at 00:00:00 UTC to 2004-10-16 at 23:59:59 UTC
EAR1	EARTH SWING-BY 1	2004-10-17 at 00:00:00 UTC to 2004-04-04 at 23:59:59 UTC
CR2	Cruise 2	2005-04-05 at 00:00:00 UTC to 2006-07-28 at 23:59:59 UTC
MARS	MARS SWING-BY	2006-07-29 at 00:00:00 UTC to 2007-05-28 at 23:59:59 UTC
CR3	Cruise 3	2007-05-29 at 00:00:00 UTC to 2007-09-12 at 23:59:59 UTC
EAR2	EARTH SWING-BY 2	2007-09-13 at 00:00:00 UTC to 2008-01-27 at 23:59:59 UTC
CR4A	Cruise 4-1	2008-01-28 at 00:00:00 UTC to 2008-08-03 at 23:59:59 UTC
AST1	STEINS FLY-BY	2008-08-04 at 00:00:00 UTC to 2008-10-05 at 23:59:59 UTC
CR4B	Cruise 4-2	2008-10-06 at 00:00:00 UTC to 2009-09-13 at 23:59:59 UTC
EAR3	EARTH SWING-BY 3	2009-09-14 at 00:00:00 UTC to 2009-12-13 at 23:59:59 UTC
CR5	Cruise 5	2009-12-14 at 00:00:00 UTC to 2010-05-16 at 23:59:59 UTC
AST2	LUTETIA FLY-BY	2010-05-17 at 00:00:00 UTC to 2010-09-03 at 23:59:59 UTC
RVM1	RENDEZVOUS MANOEUVRE 1	2010-09-04 at 00:00:00 UTC to 2011-07-13 at 23:59:59 UTC
CR6	Cruise 6	2011-07-14 at 00:00:00 UTC to 2014-01-22 at 23:59:59 UTC
RVM2	RENDEZVOUS MANOEUVRE 2	2014-01-23 at 00:00:00 UTC to 2014-08-17 at 23:59:59 UTC
	GLOBAL MAPPING AND CLOSE OBSERVATION	2014-08-18 at 00:00:00 UTC to 2014-10-19 at 23:59:59 UTC
	LANDER DELIVERY	2014-10-20 at 00:00:00 UTC to 2014-11-16 at 23:59:59 UTC
	COMET ESCORT	2014-11-17 at 00:00:00 UTC to 2015-12-31 at 23:59:59 UTC
	Extended Mission	TBD

Acronym	Description	Timespan
	For Venus Express	
NMP	Nominal Mission Phase	2005-11-09 to 2007-10-02
EXT1	Extended Mission 1	2007-10-03 to 2009-05-31
EXT2	Extended Mission 2	2009-06-01 to TBD

Table 8-2: Mission phase description

The mission phases and their abbreviations for Venus Express will be used in the DATA_SET_ID and DATA_SET_NAME. In the data labels, however, the value of the keyword MISSION_PHASE_NAME is fixed and have other definitions, belonging to defined subphases. These subphases can be found in the MISSION.CAT (CATALOG folder of the Venus Express dataset) or in the MISSION_PHASE.TAB document (DOCUMENT/ESA_DOC folder).

For higher science data products data_set_id please refer to the higher science file naming convention document MEX-MRS-RIU-IS-3050.

8.2.1.2 Dataset name

The dataset name is the full name of the dataset already identifiable by a dataset id. Dataset names shall be at most 60 characters in length and must be in upper case. See Table 8-3 for more information.

Description	Example
Instrument Host Name	MARS EXPRESS ROSETTA ORBITER VENUS EXPRESS
Target name	MARS VENUS 67P (for Comet Churyumov-Gerasimenko) LUTETIA STEINS SKY (commissioning VEX) CHECK (commissioning Rosetta)
Instrument id	MRS RSI VRA
CODMAC data level	1/2/3

Data description mission phases for level 1/2/3: (MaRS misson phases can deviate from the MEX official phase names. See above) For higher science data: Measurement type	MISSION COMMISSIONING CRUISE 1 PRIME MISSION NMP EXTENDED MISSION
A 4 digit sequence number which is identical to the sequence number in the corresponding volume's Radio Science VOLUME_ID	0123
Version number	V1.0

Table 8-3: Dataset name

In order to not exceed 60 characters for the Dataset name during the Venus Express nominal mission phase, the abbreviation 'NMP' will be used for the mission phase within the Dataset name instead of 'NOMINAL MISSION PHASE'.

Examples:

MARS EXPRESS MARS MRS 1/2/3 MISSION COMISSIONING 0123 V1.0
VENUS EXPRESS VENUS VRA 1/2/3 NMP 0099 V2.0
ROSETTA-ORBITER CHECK RSI 1/2/3 CRUISE 1 1144 V3.0

8.2.2 Dataset Collection

8.2.2.1 Dataset Collection ID

The data set collection ID element is a unique alphanumeric identifier for a collection of related data sets or data products. The data set collection is treated as a single unit, whose components are selected according to a specific scientific purpose. Components are related by observation type, discipline, target, time, or other classifications. See Table 8-4 for more information.

XXX_Y_ZZZ_U_VVV_IIIIIIIII_TTT

Acronym	Description	Example
XXX	Instrument Host ID	MEX RO VEX
Y	Target ID	M (Mars) V (Venus) C (Comet P/Churyumov-Gerasimenko) A (asteroid tbd) X (Sun)
ZZZ	Instrument ID	MRS RSI VRA
U	Data Level[2]	1 (Raw data) 2 (Edited raw data) 3 (Calibrated Data) 5 (Higher Science Data) 1/2/3 (Data set contains raw, edited and calibrated data)
VVV	Data Description (Acronym)	MCO commissioning CR1 cruise first part PRM prime mission EXT extended mission
IIIIIIIII	Data Description (Detailed)	ROCC Occulation Profiles GRAV Gravity Data RANG Apocenter Ranging BSR Bistatic Radar Spectra PHOBOS Phobos Flyby SUPCON superior solar conjunction INFCON inferior solar conjunction
TTT	Version Number	V1.0

[2] In the keyword DATA_COLLECTION_ID the CODMAC-levels are used instead of PSA-level. In all other file names and documents we keep PSA-level.

Table 8-4: Dataset Collection ID

Examples:

MEX-M-MRS-5-PRM-ROCC-V1.0
RO-C-RSI-5-MCO-GRAV-V2.0
VEX-V-VRA-5-MCO-BSR-V1.0

8.2.3 Volume

8.2.3.1 Volume ID

The Volume ID provides a unique identifier for a single MaRS, RSI or VeRa data volume, typically a physical CD-ROM or DVD. The volume ID is also called "volume label" by the various CD-ROM recording software packages. The Volume ID is formed using a mission identifier, an instrument identifier of 3 characters, followed by an underscore character, followed by a 4 digit sequence number. In the 4-digit number, the first one represents the volume set, the remaining digits define the range of volumes in the volume set. For Mars Express level 1/2/3 data and measurements taken before 1.1.2006 the first digit U is not defined after the kind of measurement (see below for Rosetta and VEX), but after the Mission phase (see Table 8-8).

0000: Commissioning
1000: Occultation
2000: Gravity
3000: Solar Conjunction
4000: Bistatic Radar
5000: Passive/Active Checkouts
6000: Swing-bys/Fly-bys
7000: Cometary Coma Observations

U =
0: Commissioning
1: Occultation
2: Gravity
3: Solar Conjunction
4: Bistatic Radar
5: Passive/Active Checkouts
6: Swing-bys/Fly-bys
7: Cometary Coma Observations
9: Higher Science data

Important note: the here defined ESA PSA Volume_Id is not identical with the Radio Science Volume_Id. The Radio Science Volume_Id is a number which is incremented measurement by measurement, independent what kind of measurement was conducted. The Radio Science Volume_Id belonging to one single measurement can be found in the Logbook, located in the folder DOCUMENT/MRS_DOC (or RSI_DOC or VRA_DOC). The ESA PSA Volume_Id in contrast is incremented by measurement types. MEXMRS_4021, for example, denotes the 21th archived Bistatic radar measurement recorded by the Mars Express MRS instrument since implementation of this guideline. It is applied to measurements recorded after the 1.1.2006. For measurements that were recorded earlier in general the radio science volume_id was used.

XXXXXX_UZZZ

Acronym	Description	Example
XXXXXX	Mission and Instrument ID	MEXMRS ROSRSI VEXVRA
UZZZ	4 digit sequence number	1001

Table 8-5: Volume ID

Examples:

MEXMRS_1001
ROSRSI_2999
VEXVRA_3508

8.2.3.2 Volume Version ID

There can be several version of the same volume, if for example the archiving software changed during the archiving process or errors occurred during the initial production. This is indicated by the Volume Version ID, a string, which consists of a ‘V’ for Version followed by a sequence number indicating the revision number.

VV.V

Acronym	Description	Example
VV.V	Volume Version ID	V1.0

Table 8-6: Volume Version Id

If a volume is redone because of errors in the initial production or because of a change in the archiving software during the archiving process, the volume ID remains the same, and the Volume Version ID will be incremented.

8.2.3.3 Volume Name

The VOLUME NAME (formatted according to Table 8-7) contains the name of the physical data volume (typically a CD-ROM or DVD) already identifiable by its VOLUME ID. Both the VOLUME ID and the VOLUME NAME are printed on the CD-ROM or DVD label (see Figure 8-2).

xxxxxx_zzzz_yyyy_ddd_vv.v

Acronym	Description	Example
xxxxxx	Mission and Instrument ID	MEXMRS RORSI VEXVRA
zzzz	Radio Science Volume_Id	0001
yyyy	Year of measurement	2004
ddd	Day of year of measurement	180
vv.v	Volume version ID	V1.0

Table 8-7: Volume name definition

Examples:

MEXMRS_0001_2003_180_V1.0
RORSI_0999_2016_355_V1.0
VEXVRA_0508_2008_190_V1.0

8.2.4 **Volume Set**

A volume set consists of a number of volumes.

8.2.4.1 Volume Set ID

The VOLUME SET ID identifies a data volume or a set of volumes. Volume sets are considered as a single orderable entity. VOLUME SET ID shall be at most 60 characters in length, must be in upper case and separated by underscores. See Table 8-8 for more information.

XXX_YYYY_ZZZ_WWW_UVVV

Acronym	Description	Example
XXX	Abbreviation of the country of origin	GER USA
YYYY	The government branch	UNIK NASA
ZZZ	Discipline within branch	IGM RIU
WWW	Mission and Instrument ID	MEXMRS RORSI VEXVRA
UVVV	A 4 digit sequence identifier The "U" digit is be used to represent the volume set Only MEX: U = 0 commissioning / cruise = 1 flybys = 2 prime missions = 3 extended missions For ROS/VEX see chapter 8.2.3.1 the trailing "V"s are wildcards that represent the range of volumes in the set and are set to X as long as the number of volumes per set are not fixed For measurements taken after 1.1.2006 the first digit U represents the measurement type:	0099

Table 8-8: Volume Set ID

Examples:

GER_UNIK_IGM_MEXMRS_0099
USA_NASA_JPL_MEXMRS_0098

8.2.4.2 Volume Set Name

The VOLUME SET NAME provides the full, formal name of a group of data volumes containing a data set or a collection of related data sets. Volume set names shall be at most 60 characters in length and must be in upper case. Volume sets are considered as a single orderable entity. In certain cases, the volume set name can be the same as the volume name, such as when the volume set consists of only one volume.

Spacecraft	**Example**
Mars Express	MEX: RADIO SCIENCE OCCULTATION MEX: RADIO SCIENCE GLOBAL GRAVITY MEX: RADIO SCIENCE TARGET GRAVITY MEX: RADIO SCIENCE SOLAR CONJUNCTION MEX: RADIO SCIENCE PHOBOS FLYBY MEX: RADIO SCIENCE COMMISSIONING
Venus Express	VEX: RADIO SCIENCE OCCULTATION VEX: RADIO SCIENCE TARGET GRAVITY VEX: RADIO SCIENCE SOLAR CONJUNCTION
Rosetta	RO: RADIO SCIENCE COMMISSIONING

Table 8-9: Volume Set Name

Examples:

MEX: RADIO SCIENCE OCCULTATION
MEX: RADIO SCIENCE GLOBAL GRAVITY

Both the VOLUME SET ID and the VOLUME SET NAME are printed on the CD-ROM or DVD label (see Figure 8-2:).

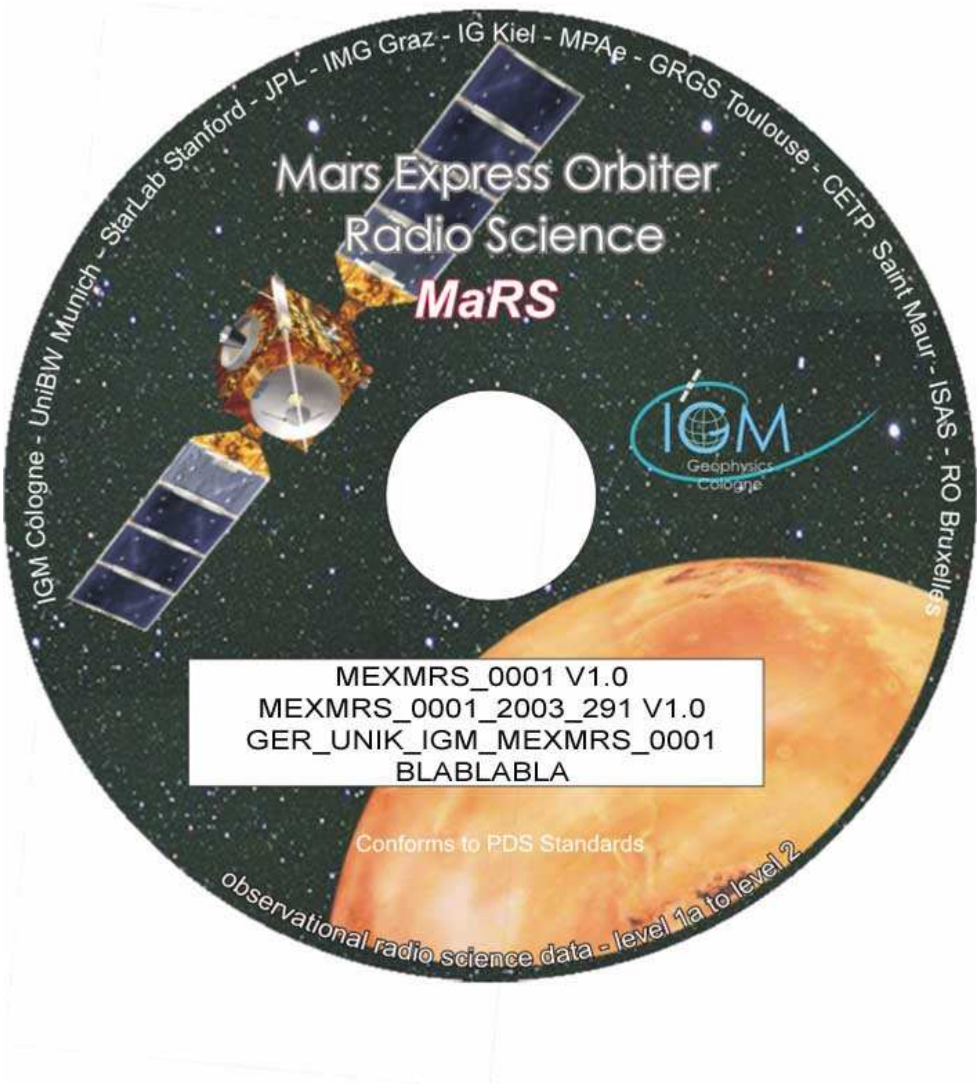

Figure 8-2: Example of a physical archive data volume (CD-ROM or DVD) with appropriate designations printed on the volume label sticker. On the sticker is printed: line 1: Volume_id + Volume_Version_ID, line 2: Volume_name, line 3: Volume_set_id, Line 4:Volume_set_name.

8.2.5 **Volume Series**

A volume series consists of one or more volume sets that represent data from one or more missions or campaigns.

8.2.5.1 Volume Series Name

The volume_series_name element provides a full, formal name that describes a broad categorization of data products or data sets related to a planetary body or a research campaign. See Table 8-10 for details.

Spacecraft	**Example**
Mars Express	MISSION TO MARS
Venus Express	MISSION TO VENUS
Rosetta	MISSION TO SMALL BODIES

Table 8-10: Volume Series Name

Examples:

MISSION TO MARS
MISSION TO VENUS
MISSION TO SMALL BODIES

8.3 Formats

8.3.1 Datasets

8.3.1.1 MaRS

See Document *MEX-MRS-IGM-IS-3016* (Radio Science File Naming Convention and Radio Science File Formats)

8.3.1.2 RSI

See Document *ROS-RSI-IGM-IS-3087* (Radio Science File Naming Convention and Radio Science File Formats)

8.3.1.3 VeRa

See Document *VEX-VRA-IGM-IS-3009* (Radio Science File Naming Convention and Radio Science File Formats)

8.3.2 Data Files

For information about the MaRS, RSI and VeRa Level 1a, 1b and 2 Data File Formats see Document *MEX-MRS-IGM-IS-3016/ ROS-RSI-IGM-IS-3087/ VEX-VRA-IGM-IS-3009* (Radio Science File Naming Convention and Radio Science File Formats)

For information about the MaRS level 4 and 4 data file formats see Document *MEX_MRS_RIU_IS_3050.PDF* (File naming convention for Higher Science Products).