BS ISO 13537:2010

BSI Standards Publication

Space data and information transfer systems — Reference architecture for space data systems

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

raising standards worldwide™

Full document details: BS ISO 13537:2010

National foreword

This British Standard is the UK implementation of ISO 13537:2010.

The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© BSI 2010

ISBN 978 0 580 68124 0

ICS 49.140

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2010.

Amendments issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

INTERNATIONAL STANDARD

ISO 13537

First edition
2010-10-01

Space data and information transfer systems — Reference architecture for space data systems

Systèmes de transfert des informations et données spatiales — Architecture de référence pour les systèmes de données spatiales

Reference number
ISO 13537:2010(E)

Documents
Document Sharing Hub

© ISO 2010

Full document details: BS ISO 13537:2010

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

COPYRIGHT PROTECTED DOCUMENT

© ISO 2010

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13537 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 311.0-M-1, September 2008) and was adopted (without modifications except those stated in Clause 2 of this International Standard) by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*.

Documents
Document Sharing Hub

© ISO 2010 – All rights reserved

Full document details: BS ISO 13537:2010

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

INTERNATIONAL STANDARD ISO 13537:2010(E)

Space data and information transfer systems — Reference architecture for space data systems

1 Scope

This International Standard presents a reference architecture for space data systems (RASDS). The RASDS is intended to provide a standardized approach for description of data system architectures and high-level designs, which individual CCSDS working groups may use within CCSDS. This approach is aligned with current practices in the fields of system and software architecture and is specifically adapted for the space domain. While it is intended for use within CCSDS, it is also suitable for use by mission and project design teams to describe system architectures and designs within the space domain. It does not propose any specific formal modeling method or tool, but can be adapted to use methods like UML or SysML.

The scope and field of application are furthermore detailed in subclauses 1.2 and 1.3 of the enclosed CCSDS publication.

2 Requirements

Requirements are the technical recommendations made in the following publication (reproduced on the following pages), which is adopted as an International Standard:

CCSDS 311.0-M-1, September 2008, *Reference architecture for space data systems*

For the purposes of international standardization, the modifications outlined below shall apply to the specific clauses and paragraphs of publication CCSDS 311.0-M-1.

Pages i to v

This part is information which is relevant to the CCSDS publication only.

Page 1-5

Correct the following references to:

[1] *Information Technology —Open Distributed Processing —Reference model: Architecture.* International Standard, ISO/IEC 10746-3:2009. Geneva: ISO, 2009.

[15] *Information Technology —Open Distributed Processing —Use of UML for ODP System Specifications*. International Standard, ISO/IEC 19793:2008. Geneva: ISO, 2008.

3 Revision of publication CCSDS 311.0-M-1

It has been agreed with the Consultative Committee for Space Data Systems that Subcommittee ISO/TC 20/SC 13 will be consulted in the event of any revision or amendment of publication CCSDS 311.0-M-1. To this end, NASA will act as a liaison body between CCSDS and ISO.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

(blank page)

© ISO 2010 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

The Consultative Committee for Space Data Systems

Recommendation for Space Data System Practices

REFERENCE ARCHITECTURE FOR SPACE DATA SYSTEMS

RECOMMENDED PRACTICE

CCSDS 311.0-M-1

MAGENTA BOOK
September 2008

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

(blank page)

© ISO 2010 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

AUTHORITY

Issue:	Recommended Practice, Issue 1
Date:	September 2008
Location:	Washington, DC, USA

This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS documents is detailed in the *Procedures Manual for the Consultative Committee for Space Data Systems*, and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

This document is published and maintained by:

CCSDS Secretariat
Space Communications and Navigation Office, 7L70
Space Operations Mission Directorate
NASA Headquarters
Washington, DC 20546-0001, USA

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of its members. The Committee meets periodically to address data systems problems that are common to all participants, and to formulate sound technical solutions to these problems. Inasmuch as participation in the CCSDS is completely voluntary, the results of Committee actions are termed **Recommendations** and are not in themselves considered binding on any Agency.

CCSDS Recommendations take two forms: **Recommended Standards** that are prescriptive and are the formal vehicles by which CCSDS Agencies create the standards that specify how elements of their space mission support infrastructure shall operate and interoperate with others; and **Recommended Practices** that are more descriptive in nature and are intended to provide general guidance about how to approach a particular problem associated with space mission support. This **Recommended Practice** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommended Practice** is entirely voluntary and does not imply a commitment by any Agency or organization to implement its recommendations in a prescriptive sense.

No later than five years from its date of issuance, this **Recommended Practice** will be reviewed by the CCSDS to determine whether it should: (1) remain in effect without change; (2) be changed to reflect the impact of new technologies, new requirements, or new directions; or (3) be retired or canceled.

In those instances when a new version of a **Recommended Practice** is issued, existing CCSDS-related member Practices and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each member to determine when such Practices or implementations are to be modified. Each member is, however, strongly encouraged to direct planning for its new Practices and implementations towards the later version of the Recommended Practice.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

FOREWORD

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Practice is therefore subject to CCSDS document management and change control procedures, which are defined in the *Procedures Manual for the Consultative Committee for Space Data Systems*. Current versions of CCSDS documents are maintained at the CCSDS Web site:

http://www.ccsds.org/

Questions relating to the contents or status of this document should be addressed to the CCSDS Secretariat at the address indicated on page i.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

At time of publication, the active Member and Observer Agencies of the CCSDS were:

Member Agencies

- Agenzia Spaziale Italiana (ASI)/Italy.
- British National Space Centre (BNSC)/United Kingdom.
- Canadian Space Agency (CSA)/Canada.
- Centre National d' Etudes Spatiales (CNES)/France.
- China National Space Administration (CNSA)/People' s Republic of China.
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)/Germany.
- European Space Agency (ESA)/Europe.
- Federal Space Agency (FSA)/Russian Federation.
- Instituto Nacional de Pesquisas Espaciais (INPE)/Brazil.
- Japan Aerospace Exploration Agency (JAXA)/Japan.
- National Aeronautics and Space Administration (NASA)/USA.

Observer Agencies

- Austrian Space Agency (ASA)/Austria.
- Belgian Federal Science Policy Office (BFSPO)/Belgium.
- Central Research Institute of Machine Building (TsNIIMash)/Russian Federation.
- Centro Tecnico Aeroespacial (CTA)/Brazil.
- Chinese Academy of Sciences (CAS)/China.
- Chinese Academy of Space Technology (CAST)/China.
- Commonwealth Scientific and Industrial Research Organization (CSIRO)/Australia.
- Danish National Space Center (DNSC)/Denmark.
- European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)/Europe.
- European Telecommunications Satellite Organization (EUTELSAT)/Europe.
- Hellenic National Space Committee (HNSC)/Greece.
- Indian Space Research Organization (ISRO)/India.
- Institute of Space Research (IKI)/Russian Federation.
- KFKI Research Institute for Particle & Nuclear Physics (KFKI)/Hungary.
- Korea Aerospace Research Institute (KARI)/Korea.
- MIKOMTEK: CSIR (CSIR)/Republic of South Africa.
- Ministry of Communications (MOC)/Israel.
- National Institute of Information and Communications Technology (NICT)/Japan.
- National Oceanic and Atmospheric Administration (NOAA)/USA.
- National Space Organization (NSPO)/Chinese Taipei.
- Naval Center for Space Technology (NCST)/USA.
- Space and Upper Atmosphere Research Commission (SUPARCO)/Pakistan.
- Swedish Space Corporation (SSC)/Sweden.
- United States Geological Survey (USGS)/USA.

Documents
Document Sharing Hub
© ISO 2010 – All rights reserved

Full document details: BS ISO 13537:2010

DOCUMENT CONTROL

Document	Title	Date	Status/Remarks
CCSDS 311.0-M-1	Reference Architecture for Space Data Systems, Recommended Practice, Issue 1	September 2008	Original issue

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

CONTENTS

Section Page

1 INTRODUCTION 1-1

1.1 SCOPE 1-1
1.2 PURPOSE 1-1
1.3 APPLICABILITY 1-1
1.4 RATIONALE 1-2
1.5 MANDATORY SECURITY SECTION 1-3
1.6 DOCUMENT STRUCTURE 1-4
1.7 REFERENCES 1-4

2 OVERVIEW 2-1

2.1 GENERAL 2-1
2.2 VIEWPOINTS AND VIEWPOINT SPECIFICATIONS 2-1
2.3 OVERVIEW OF VIEWPOINTS 2-2
2.4 ENTERPRISE VIEWPOINT 2-3
2.5 FUNCTIONAL VIEWPOINT 2-5
2.6 CONNECTIVITY VIEWPOINT 2-6
2.7 COMMUNICATIONS VIEWPOINT 2-8
2.8 INFORMATION VIEWPOINT 2-11
2.9 CORRESPONDENCES BETWEEN VIEWPOINTS 2-12

3 BASIC CONCEPTS 3-1

3.1 GENERAL 3-1
3.2 DEFINITIONS 3-1
3.3 GRAPHICAL REPRESENTATIONS 3-6
3.4 CHARACTERISTICS OF OBJECTS 3-6

4 ENTERPRISE VIEWPOINT 4-1

4.1 OVERVIEW 4-1
4.2 CONCEPTS 4-1
4.3 ENTERPRISE OBJECTS 4-2
4.4 CHARACTERISTICS OF ENTERPRISE OBJECTS 4-3
4.5 EXAMPLES OF SPACE DATA SYSTEMS DESCRIBED WITH ENTERPRISE VIEWPOINT 4-5
4.6 SECURITY ISSUES IN THE ENTERPRISE VIEWPOINT 4-7

Documents
Document Sharing Hub
© ISO 2010 – All rights reserved

Full document details: BS ISO 13537:2010

CONTENTS (continued)

Section Page

5 FUNCTIONAL VIEWPOINT 5-1

5.1 OVERVIEW 5-1
5.2 CONCEPTS 5-1
5.3 FUNCTIONAL OBJECTS 5-2
5.4 CHARACTERISTICS OF FUNCTIONAL OBJECTS 5-4
5.5 EXAMPLE OF A SPACE DATA SYSTEM DESCRIBED FROM THE FUNCTIONAL VIEWPOINT 5-6
5.6 EXAMPLE OF SPACE DATA SYSTEM WITH INFORMATION MANAGEMENT INFRASTRUCTURE 5-7
5.7 SECURITY ISSUES IN THE FUNCTIONAL VIEWPOINT 5-8

6 CONNECTIVITY VIEWPOINT 6-1

6.1 OVERVIEW 6-1
6.2 CONCEPTS 6-1
6.3 CHARACTERISTICS OF CONNECTIVITY OBJECTS 6-2
6.4 NODES 6-6
6.5 LINKS 6-7
6.6 EXAMPLES OF SPACE DATA SYSTEMS DESCRIBED WITH CONNECTIVITY VIEWS 6-8
6.7 SECURITY ISSUES IN THE CONNECTIVITY VIEWPOINT 6-13

7 COMMUNICATIONS VIEWPOINT 7-1

7.1 OVERVIEW 7-1
7.2 CONCEPTS 7-1
7.3 CHARACTERISTICS OF COMMUNICATIONS OBJECTS 7-2
7.4 PROTOCOL ENTITIES 7-5
7.5 EXAMPLES OF SPACE DATA SYSTEMS DESCRIBED WITH COMMUNICATIONS VIEWPOINT 7-6
7.6 PROTOCOL REPRESENTATIONS IN THE COMMUNICATIONS VIEWPOINT 7-7
7.7 SECURITY ISSUES IN THE COMMUNICATIONS VIEWPOINT 7-8

8 INFORMATION VIEWPOINT 8-1

8.1 OVERVIEW 8-1
8.2 CONCEPTS 8-1
8.3 CHARACTERISTICS OF INFORMATION OBJECTS 8-2

© ISO 2010 – All rights reserved

Documents Document Sharing Hub
Full document details: BS ISO 13537:2010

CONTENTS (continued)

Section Page

8.4 INFORMATION OBJECT VIEWS 8-4
8.5 EXAMPLE OF SPACE DATA SYSTEM FUNCTIONS WITH INFORMATION VIEWPOINT 8-5

9 DERIVING OTHER VIEWS FROM THE BASIC VIEWPOINTS 9-1

9.1 GENERAL 9-1
9.2 CROSS SUPPORT SERVICE VIEWS 9-1
9.3 LAYERED VIEW EXAMPLE 9-3
9.4 EXAMPLE MAPPING FUNCTIONAL TO CONNECTIVITY VIEW 9-5

ANNEX A NOTES ON USE OF RASDS A-1
ANNEX B FORMAL METHODS AND TOOLS B-1
ANNEX C RASDS AND DODAF COMPARISON C-1
ANNEX D GLOSSARY AND ACRONYMS D-1

Figure

2-1 Simple Example of Enterprise View 2-5
2-2 Simple Example of a Functional View 2-6
2-3 Simple Connectivity View Example 2-7
2-4 Example Connectivity View Showing Implemented Functions 2-8
2-5 Simple Example of Communications View 2-10
2-6 Communications View with Protocol Entities and Engineering Objects 2-11
2-7 Example of Information View Showing Basic Object Model 2-12
2-8 RASDS Top Level Object Relationships 2-13
3-1 Icons Used in This Document 3-6
3-2 Representation of Objects 3-7
4-1 Attributes of Enterprise Objects 4-4
4-2 Example of an Enterprise View (Mission A) 4-6
4-3 Example of Multi-Agency Enterprise View (Mission Q) 4-7
5-1 Functional Object Interfaces 5-4
5-2 Example of Functional View (Functional Objects and Interactions) 5-6
5-3 Example of Information Flows between Objects 5-7
5-4 Representative Functional Objects and Information Management Infrastructure Elements 5-8
6-1 Attributes of Nodes 6-2
6-2 Example of Connectivity View (Nodes for Mission A) 6-8
6-3 Example of Connectivity View (Nodes for Mission Q) 6-9
6-4 Example of Connectivity View (Node Decomposition) 6-10

Documents
Document Sharing Hub
© ISO 2010 – All rights reserved

Full document details: BS ISO 13537:2010

CONTENTS (continued)

Figure Page

6-5 Example of Connectivity View with Allocated Engineering Objects 6-11
6-6(a) Functional View of Image Compression 6-12
6-6(b) Connectivity View of Software Compression Approach..... 6-12
6-6(c) Connectivity View of Hardware-Only Compression Approach..... 6-12
7-1 Attributes of Protocol Entities 7-2
7-2 Example of Communications View Showing Protocol Stack and Nodes 7-6
7-3 PDU Example, Space Packet Protocol 7-7
7-4 Example State Machine Diagram—SLE RCF..... 7-8
8-1 Attributes of Information Objects..... 8-2
8-2 Information Object Representations 8-4
8-3 Example of Functional View with Representation of Information Objects 8-6
9-1(a) Enterprise View of a Cross Support Service 9-1
9-1(b) Connectivity View of a Cross Support Service 9-2
9-1(c) Communications View of a Cross Support Service..... 9-3
9-2 Simple Example of Layered View..... 9-4
9-3 Example of Functional View of Framing and Coding..... 9-5
9-4 Example of Trade Study Mapping Functional to Connectivity View 9-6
B-1 SysML Diagram Types (SysML Partners) B-3
C-1 DoDAF Elements and Relationships (Partial).....C-6
C-2 DoDAF and RASDS.....C-8

Table

4-1 Example Enterprise Objects 4-3
5-1 Example Functional Objects..... 5-3
5-2 Typical Infrastructure Objects 5-4
6-1 Typical Nodes..... 6-6
6-2 Typical Links 6-8
7-1 Typical Protocol Entities 7-5
C-1 DoDAF Views and Products and RASDS Viewpoints C-3

© ISO 2010 – All rights reserved

Documents Document Sharing Hub
Full document details: BS ISO 13537:2010

(blank page)

© ISO 2010 – All rights reserved
Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

1 INTRODUCTION

1.1 SCOPE

This document presents a Reference Architecture for Space Data Systems (RASDS). The RASDS is intended to provide a standardized approach for description of data system architectures and high-level designs, which individual CCSDS working groups may use within CCSDS. This approach is aligned with current practices in the fields of system and software architecture and is specifically adapted for the space domain. While it is intended for use within CCSDS, it is also suitable for use by mission and project design teams to describe system architectures and designs within the space domain. It does not propose any specific formal modeling method or tool, but can be adapted to use methods like UML or SysML.

1.2 PURPOSE

Within CCSDS the RASDS will be used for the following purposes:

a) to establish an overall CCSDS recommended methodology for defining and developing domain-specific architectures;

b) to define a common language, taxonomy, and representation so that challenges, requirements, and solutions in the area of space data systems can be readily communicated;

c) to provide a kit of architect's tools that domain experts may use to describe different specific complex space system architectures;

d) to facilitate development of CCSDS Recommended Standards in a consistent way so that any standard can be used with other appropriate standards in a space data system;

e) to provide a framework and guidelines for presenting the Recommended Standards developed by CCSDS in a systematic way so that their functionality, applicability, interrelationships, and interoperability may be clearly understood.

1.3 APPLICABILITY

The methodology described in this Recommended Practice may be used by individual working groups for the description of data system architectures in any relevant CCSDS documents. The use of RASDS is completely voluntary, and CCSDS architectures are not required to be expressed in RASDS-compliant notation. However, individual working groups who are looking for guidance or good engineering practice are likely to find it useful.

Note that not all Viewpoints are needed for every task. The Viewpoint Specifications and representational methodologies may be used where applicable, but only those Viewpoints that are needed for the specific purpose should be used. In many instances, only the Functional and Connectivity Viewpoints may be needed. The methodology provided in this

© ISO 2010 – All rights reserved

Documents Document Sharing Hub
Full document details: BS ISO 13537:2010

document may be used in describing mission space data systems—and system of systems—architectures, but its use is not required.

As a Recommended Practice, this document is not binding upon CCSDS. However, its use is encouraged in all CCSDS documents where system or reference architecture descriptions must be provided, and where the analytical and descriptive methodologies provided in this document are useful. New views using these concepts may be assembled as needed, and alternative representations may be adopted where they improve alignment with current practices in specialized subdomains.

1.4 RATIONALE

A number of different standard methods are currently in use or are being developed for description of software-intensive systems architectures. These include the ISO Reference Model of Open Distributed Systems (RM-ODP, reference [1]), the Recommended Practice for Architectural Descriptions of Software-Intensive Systems (IEEE 1471-2000, reference [2]) and Standard for Application and Management of the System Engineering Process (IEEE 1220-2005, reference [3]), OMG Unified Modeling Language (UML, references [6], [7], and [8]), Systems Modeling Language (SysML, references [9] and [10]), DoD Architecture Framework (DoDAF, reference [11]), the Open Group Architecture Framework (TOGAF, reference [12]), the ISO Basic Reference Model (ISO-BRM, reference [14]), and others. All of these share the concepts of developing a consistent set of elements, terminology, viewpoints, views, and specifications with which to describe systems and their architectures.

All of these standard methods typically assume that the elements of these systems are fixed in place and that they are in continuous communication over what are nominally error-free communications channels that suffer only occasional disruptions.

Space data systems violate all of these assumptions.

RASDS, on the other hand, provides guidelines for the description of space data systems that take into account the realities of operating in the space environment. This is a domain-specific architectural approach adapted to the requirements of space data systems. RASDS directly addresses the fact that some elements of these distributed systems will be operated at great distances from one another with one-way light times measured in tens of minutes or hours, not milliseconds. These elements may only occasionally be in contact with one another, typically require use of very expensive and over-subscribed ground communications assets, and are strongly affected by the physical environment in which they have to operate. These environmental issues affect what must be done to provide reliable communications between elements, how control interactions may be designed, and how these systems may be operated.

RASDS introduces a set of conventions for representing space data systems from several viewpoints. These drawing conventions have been chosen to ensure that the diagrams for any View can be unambiguously interpreted. Other representations are possible, and some of the methods mentioned above use different representations. However, this document provides a consistent approach that provides the structure for a full formal representation of

Documents
Document Sharing Hub
© ISO 2010 – All rights reserved

Full document details: BS ISO 13537:2010

space data systems such as might be developed in a UML or SysML tool. Development of a formal representation using a method such as SysML is the subject of proposed future work. An introduction to this topic is provided in annex B.

1.5 MANDATORY SECURITY SECTION

The CCSDS Management Council (CMC) has mandated that security topics be addressed in all CCSDS normative documents and include the following information: security background/introduction; statements of security concerns with respect to the CCSDS document; data privacy and integrity; authentication of communicating entities; control of access to resources; availability of resources; auditing of resource usage; potential threats and attack scenarios, consequences of not applying security to the technology (e.g., loss of life, loss of mission).

This document is a reference architecture framework and does not address these technical security topics directly. However, it provides guidance to CCSDS document (and mission) developers on how to describe all of these security topics in the context of system architecture, and each Viewpoint provides the means to address the security issues that are relevant in that Viewpoint. Security topics pertinent for each Viewpoint are identified and briefly addressed in each section. Detailed explanations of security topics and approaches are treated separately in the Security Architecture and related documents (references [4], [17], and [18]).

NOTES

1 RASDS is consistent with IEEE 1471-2000 (reference [2]), the Recommended Practice for Architectural Description of Software Intensive Systems. Where IEEE 1471-2000 describes best practices for defining software architectures and defines the meaning of Viewpoint and View, it does not provide instances of these. These are to be defined to meet stakeholder concerns in the domain to which this approach is to be applied. The Reference Model of Open Distributed Processing (RM-ODP) takes this a step further and defines a specific set of Viewpoints for the domain of open distributed systems. The RASDS methodology goes further still and extends RM-ODP to provide a concrete description of how to develop architectural descriptions for the space data system domain.

2 Other systems architecture methodologies have also been considered in constructing this Recommended Practice. These include the DoD Architecture Framework (DoDAF), The Open Group Architecture Framework (TOGAF), the Unified Modeling Language (UML) and the System Modeling Language (SysML). UML, and SysML which has been derived from it, provide formalisms that are appropriate for use in the RASDS problem domain. However, even these need to be adapted to define the needed Viewpoints, Views, Objects, relationships, etc., that are relevant to the space data system domain, since these methods do not provide them in their native form.

© ISO 2010 – All rights reserved

Documents Document Sharing Hub
Full document details: BS ISO 13537:2010

1.6 DOCUMENT STRUCTURE

Section 2 provides an overview of RASDS in a narrative style and introduces Viewpoints and Views.

Section 3 introduces basic concepts and defines specific terms that are used throughout this document.

From section 4 through 8, RASDS is presented in detail for each of the Viewpoints introduced in section 2, and other special terms are defined as needed.

Section 9 presents some examples of how to extend RASDS, using the basic concepts, to describe new views on a system.

Annexes A-D provide additional information on use of RASDS, its relationship to other methods, including UML, SysML, and DoDAF, and a summary of the terminology and acronyms used in the document.

1.7 REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of this Recommended Practice. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Recommended Practice are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS Documents.

[1] *Information Technology—Open Distributed Processing—Reference Model: Architecture*. International Standard, ISO/IEC 10746-3:1996. Geneva: ISO, 1996.

[2] *IEEE Recommended Practice for Architectural Description of Software-Intensive Systems*. IEEE Std 1471-2000. New York: IEEE, 2000.

[3] *IEEE Standard for Application and Management of the Systems Engineering Process*. IEEE Std 1220-2005. New York: IEEE, 2005.

[4] *Security Architecture*. Draft Report Concerning Space Data System Standards, CCSDS 350.5-G-0. Draft Green Book. Issue 0. Washington, D.C.: CCSDS, n.d.

[5] *Reference Architecture for Space Information Management*. Draft Report Concerning Space Data System Standards, CCSDS 312.0-G-0. Draft Green Book. Issue 0. Washington, D.C.: CCSDS, n.d.

[6] *Unified Modeling Language (UML)*. Version 1.5, formal/2003-03-01. Needham, Massachusetts: Object Management Group, March 2003. <http://www.omg.org/technology/documents/modeling_spec_catalog.htm>

Documents
Document Sharing Hub
© ISO 2010 – All rights reserved

Full document details: BS ISO 13537:2010

[7] *Unified Modeling Language: Infrastructure*. Version 2.0, formal/05-07-05. Needham, Massachusetts: Object Management Group, March 2006. <http://www.omg.org/technology/documents/formal/uml.htm>

[8] *Meta Object Facility (MOF) Core Specification*. Version 2.0, formal/06-01-01. Needham, Massachusetts: Object Management Group, January 2006. <http://www.omg.org/technology/documents/formal/uml.htm>

[9] *OMG Systems Modeling Language (OMG SysML™), V1.0* . OMG Document Number: formal/2007-09-01. Needham, Massachusetts: Object Management Group, September 2007. <http://www.omg.org/spec/SysML/1.0/PDF>

[10] *UML for Systems Engineering*. Request For Proposal. OMG Document: ad/03-03-41. Needham, Massachusetts: Object Management Group, March 2003. <http://www.omg.org/public_schedule/>

[11] "DoD Architecture Framework (DoDAF)." Version 1.0. Applied Information Technology Center (AITC). <http://www.aitcnet.org/dodfw/>

[12] *The Open Group Architecture Framework (TOGAF)*. Version 8.1 Enterprise Edition. San Francisco: The Open Group, n.d. <http://www.opengroup.org/architecture/togaf/>

[13] "xADL 2.0." *Institute for Software Research (ISR)*. University of California, Irvine. <http://www.isr.uci.edu/projects/xarchuci/>

[14] *Information Technology—Open Systems Interconnection—Basic Reference Model: The Basic Model*. International Standard, ISO/IEC 7498-1:1994. 2nd ed. Geneva: ISO, 1994.

[15] *Information Technology—Open Distributed Processing—Use of UML for ODP System Specifications*. Committee Draft, ISO/IEC CD 19793. Geneva: ISO, 2005.

[16] *Overview of Space Link Protocols*. Report Concerning Space Data System Standards, CCSDS 130.0-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, June 2001.

[17] *The Application of CCSDS Protocols to Secure Systems*. Report Concerning Space Data System Standards, CCSDS 350.0-G-2. Green Book. Issue 2. Washington, D.C.: CCSDS, January 2006.

[18] *Security Threats against Space Missions*. Report Concerning Space Data System Standards, CCSDS 350.1-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, October 2006.

[19] *Prioritized Requirements for RASDS*. Draft Record Concerning Space Data System Standards, CCSDS 311.1-Y-0. Draft Yellow Book. Issue 0. Washington, D.C.: CCSDS, May 2006.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

[20] P. Shames and J. Skipper. "Toward a Framework for Modeling Space Systems Architectures." In *Proceedings of the Ninth International Conference on Space Operations (SpaceOps 2006)* (Rome, Italy). SpaceOps, 2006. <http://www.aiaa.org/spaceops2006/presentations/57418.ppt>

[21] M. Maier. "Architecting Principles for Systems-of-Systems." *Systems Engineering* 1, no. 4 (February 1999): 267-284.

[22] M. Maier, D. Emery, and R. Hilliard. "ANSI/IEEE 1471 and Systems Engineering." *Systems Engineering* 7, no. 3 (June 2004): 257-270.

[23] P. Kruchten. "The 4+1 View Model of Architecture." *IEEE Software* 12, no. 6 (November 1995): 42-50.

[24] "Rational Unified Process® for Systems Engineering, RUP® SE1.1: A Rational Software White Paper." TP 165A, 5/02. Cupertino, CA: Rational, 2002. <http://www3.software.ibm.com/ibmdl/pub/software/rational/web/whitepapers/2003/TP165.pdf>

[25] *UML Profile and Metamodel for Services (UPMS)*. Revised Submission. OMG document: ad/2007-11-02. Needham, Massachusetts: Object Management Group, December 2007. <http://www.omg.org/cgi-bin/doc?ad/07-11-02>

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

2 OVERVIEW

2.1 GENERAL

This overview section of the document introduces the basic modeling terminology and concepts in a narrative form. Most of these terms will be familiar, but some have special meanings in RASDS. Please refer to the Glossary, annex D, as needed for specific definitions of terms. This section is not normative.

2.2 VIEWPOINTS AND VIEWPOINT SPECIFICATIONS

Space data systems are complex entities that have many different aspects, and it is not easy to depict these aspects with a single view or in a single framework. Therefore the architecture of a space data system must often be described from multiple Viewpoints, each focusing on different concerns associated with the system. The RASDS reference architecture defines a specific set of Viewpoint Specifications to present architectures of space data systems.

A Viewpoint Specification is an abstraction that uses a selected set of architectural concepts and structuring rules in order to focus on particular concerns within a space data system. Each Viewpoint Specification is intended to be orthogonal to the others, but some specific areas of overlap exist to allow the elements in different Viewpoints to be related. Each exposes a different set of design concerns and issues, and each provides the means for reasoning about that aspect of the system.

Each Viewpoint Specification describes the space data system in question as a set of Objects and interactions among them. An Object is an abstract model of an entity in the system. Objects have behavior and state and are distinct from any other objects. Objects defined in their primary Viewpoint often have corresponding objects in other Viewpoints. A Viewpoint Specification defines the rules for constructing Views of the system.

Viewpoint Specifications are described in terms of the objects that may appear in them, their attributes, and the relationships among them. An object is a representation of an entity in the real world. It contains information and may offer services. A system is composed of interacting objects. An object is characterized by whatever distinguishes it from other objects and by encapsulation, abstraction, and behavior. Encapsulation is the property that the information contained in an object is accessible only through interactions at the interfaces supported by the object. Because objects are encapsulated, there are no hidden side effects of interactions. That is, an interaction with one object cannot affect the state of another object without some secondary interaction taking place with that object. Thus, any change in the state of an object can only occur as a result of an external request of an object, an internal action of the object, or an interaction of the object with its environment.

To describe the architecture of space data systems, RASDS defines five Viewpoint Specifications, which are explained in the following subsections. The user may decide which of these Viewpoints to use to describe a particular space data system if that system can

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

be characterized with fewer than five Viewpoints. Often only two or three Viewpoints are needed to define simple system architectures.

A View is a representation of a specific system from the perspective of a set of concerns.

Views are themselves modular and well-formed; each View is intended to correspond to exactly one Viewpoint and is constructed using the rules defined by that Viewpoint Specification. Sometimes a Viewpoint Specification will contain objects that are representations of related objects in another Viewpoint. The user may also define a new Viewpoint Specification using the basic concepts defined in section 3 if it is impossible to capture all the important aspects of the system with objects described in the five Viewpoint Specifications defined here. Some aspects of a system design may benefit from being examined from two or more Views simultaneously, and some examples of this are provided in 2.9. In many of the examples used in this document, color is used to distinguish different classes of objects. RASDS does not assign any particular meaning to the use of color, and the user is free to employ it wherever it assists in clarifying the representation of the architecture or bringing consistency to a set of diagrams.

NOTE – The following Viewpoint Specifications are derived from RM-ODP Viewpoints (with some modifications), but the Connectivity Viewpoint was newly created in order to address issues and constraints related to the space data system physical environments, which are distinct from those encountered in typical terrestrial distributed systems. Challenges from the physical environment in which these systems operate, particularly the motion, discontinuous connectivity, and extremely distant and broad distribution of physical elements, require specialized protocols and systems design. The RASDS approach also has its focus on describing architecture rather than implementation. As a result, only certain subsets of the Engineering and Technology Viewpoints in RM-ODP are treated by RASDS in the Connectivity and Communications Viewpoints. For those aspects of the RM-ODP Viewpoints that are not treated directly in RASDS, the RM-ODP approaches may be used directly.

2.3 OVERVIEW OF VIEWPOINTS

Each Viewpoint is a particular perspective on the specification of a complete system, established to model those aspects of a system relevant to the identified area of concern during the design of the system. The Viewpoints are sufficiently independent to simplify reasoning about the complete specification. Mutual consistency among the Viewpoint Specifications is ensured by the architecture descriptions defined by RASDS and the use of a common object model that binds them all together.

The RASDS framework extends the RM-ODP framework and provides five specific and complementary viewpoints on the system and its environment:

– The **Enterprise Viewpoint** focuses on the purpose, scope, and policies for the space data system. It describes the organizational entities and relationships; their roles, requirements, goals, objectives, scenarios, constraints; and how to meet them.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

- The **Functional Viewpoint** describes the functional decomposition of the space data system into abstract objects that interact at interfaces. It describes the functionality provided by the space data system, the behavior of the functional elements, and their functional decomposition.

- The **Connectivity Viewpoint**, which is new in RASDS, describes the engineered decomposition of the space data system into components (nodes) that interact across connectors (links). The Connectivity Viewpoint describes the physical aspects of the space data system and the external environment within which it operates, the physical behavior (and motion) of the nodes, and their physical decomposition. The links may be manifestly physical (network or data cables), or they may be more ethereal (RF and optical signals). The Connectivity Viewpoint also addresses the allocation of implemented functions (as engineered software or hardware objects) to these Nodes. Note that RASDS addresses only data system components, but a full space system design would include other classes of components and connectors not addressed here.

- The **Communications Viewpoint** focuses on the mechanisms and functions required to engineer and implement the protocols and communications standards for the space data system, including implementation choices and specifications, and allocation of communications functionality to engineered components of the system. This Viewpoint is a subset of the RM-ODP Engineering and Technical Viewpoints, but it is treated separately in RASDS because it is central to describing how to handle many communication issues in space data systems.

- The **Information Viewpoint** focuses on the kinds of information handled by the system, the semantics of the information, and the interpretation of that information. It describes the information managed by the space data system along with the structure, content, semantics, type, relationships, and constraints on the data used within the system.

Although separately specified, the Viewpoint Specifications are not completely independent; key items in each are related to items in the other Viewpoints.

2.4 ENTERPRISE VIEWPOINT

The Enterprise Viewpoint describes the organizations involved in a space data system and the relationships and interactions among them. It allows description of the complex organizational relationships among the stakeholders: scientists, staff, and contractors that are distributed among multiple organizations (space agencies, science institutes, companies, etc.) in typical space data systems. The stakeholders own, operate, or use the facilities that make up the system: spacecraft, instruments, and various ground systems. The Enterprise Viewpoint is used to address these aspects of space data systems.

The relationships among the organizations are described in terms of their roles; responsibilities and policies of the organizations, and the interactions among the organizations are described in terms of agreements and contracts. Stakeholders may include: funding organizations, developers, designers, operators, maintainers, subcontractors, or users, as well as the architects and system engineers themselves. The Enterprise Viewpoint

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

may also include stakeholder concerns, such as requirements, operations concepts, scenarios, lifecycle, and mission phases. However, specific formalisms for representing these last aspects are not provided at this time.

The Enterprise Viewpoint also includes facilities that are owned, operated, or used by these organizations. These facilities may be spacecraft of various types, e.g., orbiters, landers, or rovers, used for various activities, e.g., relay communications, mappers, observatories, or sample return missions. Facilities may also include ground station networks, mission and ground system control centers, and a variety of mission and science facilities. Instruments may also be modeled as separate facilities in an Enterprise View, especially when they belong to a different organization from the one that owns the spacecraft that carries them.

The primary elements in the Enterprise Viewpoint are Enterprise Objects and the interactions among them. One type of basic Enterprise Object is an abstract model of an organization involved in a space data system. This Enterprise Object represents an independent Enterprise (such as a space agency, a government institute, a university, or a private company) or a department or an organization of an Enterprise (such as a tracking network team, a control center team, a science team, or a research group). An Enterprise Object may be composed of other Enterprise Objects. A formal or informal group of Enterprise Objects that plays some role in a space data system (such as a community, a committee, or a joint project) can also be an Enterprise Object. Certain information objects, such as contracts, policies, scenarios, may also appear in the Enterprise Viewpoint.

Another primary type of Enterprise Object that may appear in an Enterprise View is a facility that is owned, operated, or used by an organizational Enterprise Object. These objects may also be composed of other Enterprise Objects, and this composition may be shown in an Enterprise View. Typically, however, all of the detailed compositional aspects of the system elements are shown in an engineering view such as a Connectivity View, and only those needed to clarify Enterprise issues, such as roles and responsibilities, are shown in an Enterprise View.

Each Viewpoint Specification has a specific set of concerns that are addressed. For the Enterprise Viewpoint these include things like Objectives, Roles, Policies, Activities, Lifecycles/Phases, Configuration, Contracts, and Requirements.

A simple example of an Enterprise View is shown in figure 2-1, in which two Enterprise Objects (Enterprises P and Q) are shown as dotted boxes.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

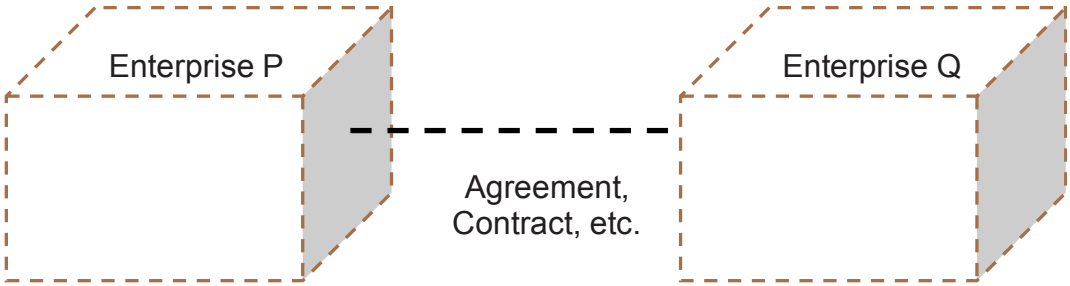

Figure 2-1: Simple Example of an Enterprise View

Systems in a RASDS model are represented as a set of elements, e.g., people, engineered objects (hardware and software), facilities, equipment, material and processes (automated as well as manual procedures) that are related and whose behavior satisfies customer/operational needs. As such, a System is an abstract object that may be described in RASDS by a set of Enterprise, Functional, or Connectivity Views. The organizations and facilities that are part of a system are addressed in an Enterprise View.

2.5 FUNCTIONAL VIEWPOINT

The primary elements in the Functional Viewpoint Specification are Functional Objects and the logical interactions among them. A Functional Object is an abstract model of a functional entity that receives requests, performs actions, and generates or processes data in a space data system. Functional objects that only transport data are called Protocol Entities in RASDS; these are treated explicitly in the Communications Viewpoint (see 2.7). A Functional Object may also be composed of other Functional Objects. A Functional Object may be realized (implemented) by people, but most of them are implemented as basic Engineering Objects, either software and/or hardware, and these basic Engineering Objects are described in the Connectivity Viewpoint.

The Functional Viewpoint shows functional elements and their logical interactions separately from the engineering concerns of how the functions are implemented, where they are allocated, how they are connected, which protocols are used, or what language or hardware is used to implement them. The Functional Viewpoint Specification describes the functional composition of a space data system, its interfaces, actions, and behaviors, and how functions interact with each other. The Functional Viewpoint is used to address these abstract functional aspects of space data systems.

A Functional Object may provide a service to one or more other Functional Objects, use a service provided by another Functional Object, or perform actions jointly with other Functional Objects. These interactions are described in the Functional Viewpoint.

In the Functional Viewpoint Specification the Concerns include: Functional Behavior (actions), Interactions, Interfaces, and Constraints.

A simple example of a Functional View is shown in figure 2-2, in which three Functional Objects (Functions A, B, and C) are represented as ovals, and the functional interactions are

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

represented by dashed lines. These interactions take place at the interfaces of these objects, and representations of information objects, described more fully in 2.7, are exchanged across these logical links.

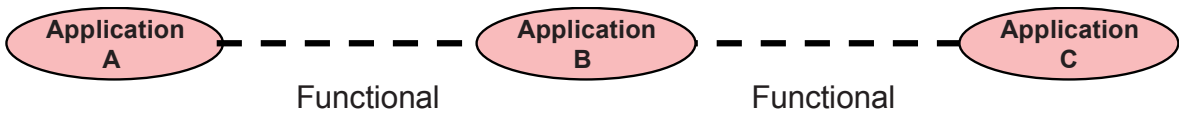

Figure 2-2: Simple Example of a Functional View

A Functional Object may be composed of other Functional Objects. A formal or informal group of Functional Objects that provides some services in a space data system, such as a related set of navigation or data processing services, may be modeled as a higher-level element in a Functional View. The decomposition of these elements may also be shown in related Views. The information objects that are exchanged across the interfaces between Functional Objects may also appear in a Functional View.

The Functional Viewpoint may also be used to describe a class of Functional Objects called Information Management Functional Objects that support the location, access, delivery, and management of Information Objects. These Information Management Functional Objects support the operations of an Information Infrastructure, which is described in detail in the Reference Architecture for Space Information Management (RASIM, reference [5]). Other sets of high-level functionality may also be defined in the future.

2.6 CONNECTIVITY VIEWPOINT

The Connectivity Viewpoint shows how space data systems are made up of physical elements that must operate in space, and the connections between elements, the physics of motion, and external environmental forces that must be considered. Some space data system elements are in motion through space. Consequently, connectivity issues associated with pointing, scheduling, long Round-Trip Light Times (RTLTs), and low signal-to-noise ratios require special protocols and functionality. The Connectivity Viewpoint Specification is used to address these aspects of space data systems, along with the interactions with the ‘fixed’ external world.

For analysis of complete space systems, other physical aspects, including the propulsion, power, thermal, and structural aspects associated with them, must be considered and represented in what might be called a Physical Viewpoint. However, for the description of space *data* systems, focus is on the Connectivity Viewpoint, where consideration is given to nodes, links, external forces, implementation of functionality as basic Engineering Objects (software or hardware), and other considerations related to the engineering of data system functionality and performance.

In addition to describing the physical structure, behavior and environment of a space data system and the physical connections among elements, the Connectivity Viewpoint also

© ISO 2010 – All rights reserved
Documents Document Sharing Hub
Full document details: BS ISO 13537:2010

describes the allocation and engineering of elements that are defined in the Functional Viewpoint and are implemented as hardware and software basic Engineering Objects.

The primary elements in the Connectivity Viewpoint are Nodes, Links, and basic Engineering Objects. A Node is an abstract model of a physical entity that is used in a space data system and is operating in a physical environment. A Node is a configuration of hardware Engineering Objects forming a single unit for the purpose of location in space and embodying a set of processing, storage, and communication functions. A Node represents a system entity (such as a spacecraft, a tracking system, or a control system) or an individual physical entity of a system (such as an instrument, a computer, or a piece of communications equipment). A Node may be composed of other Nodes. Each Node has one or more Ports where connections to other Nodes are made. For purposes of system analysis, people may also be modeled as Nodes that have functional responsibilities assigned to them.

A Link is a physical connection between or among Nodes. A Link represents an RF or optical link, a hardwired link, or a network of some kind (such as the Internet, a LAN, or a bus). Links connect to Nodes at one of the Ports of the Node. Ports are not always modeled explicitly, but ports are the physical interfaces of Nodes where Links attach. Links are themselves physical Engineering Objects, and they may be hardware (an Ethernet cable) or an RF or optical signal.

For the Connectivity Viewpoint Specification, the Concerns include Distribution, Communication, Physical Environment and interactions, Behavior, Allocation, Performance, Constraints, and Configuration.

A simple example of the Connectivity View is shown in figure 2-3, where three 3-D boxes represent Nodes and two Links are shown as solid lines. This 3-D representation of Nodes is used because this view deals with physical objects. The other primary elements that appear in the Connectivity Viewpoint are software and hardware Engineering Objects that have correspondences to Functional Objects defined in a related Functional View.

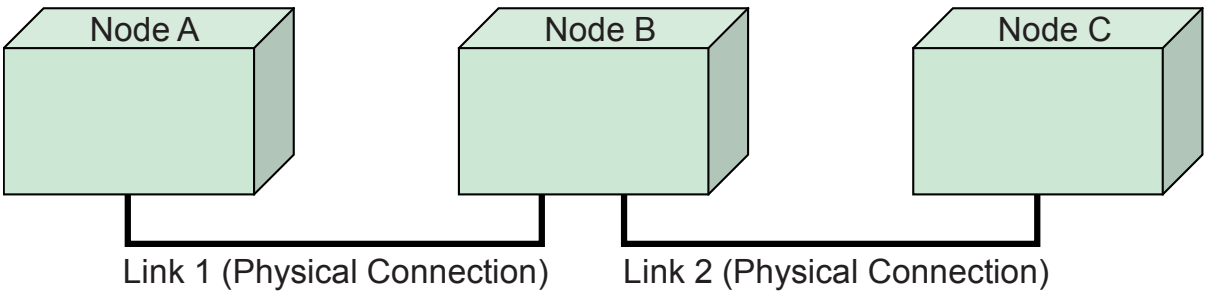

Figure 2-3: Simple Connectivity View Example

As part of the engineering process of designing the system, functions are allocated to physical nodes and implementation choices are made about use of software or hardware. It is also possible, for purposes of system analysis, that Functional Object responsibility may also

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

be assigned to people. In the Connectivity Viewpoint, representations of Functional Objects are shown as Engineering Objects, either as physical hardware (Nodes or hardware Engineering Objects) or as software (software Engineering Objects) that are allocated to the Nodes of the system.

When this level of detail is required to be described, the allocation of Software Engineering Objects (software or applications) is shown by overlaying a representation of the implemented Functions on the Nodes shown in a Connectivity View. Such an example is shown in figure 2-4, in which engineered versions of the Functional Objects from figure 2-2 are shown overlaid on the Connectivity View objects shown in figure 2-3.

The allocation of Hardware Engineering Objects (hardware) may be shown using the Node 3-D representation, if they are major components in the system, or they may be shown as simply an oval representing the function performed by minor hardware elements.

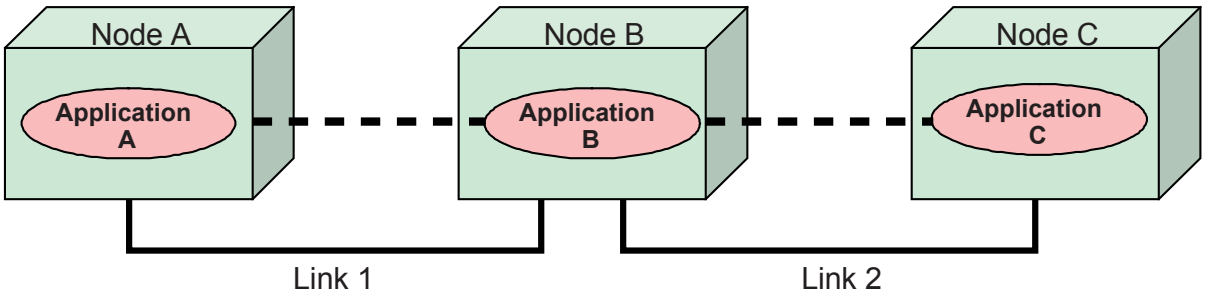

Figure 2-4: Example Connectivity View Showing Implemented Functions

A Node in the Connectivity View may represent a computer and its software (including the operating system and applications). A node may have internal structure such as the operating system, processing, storage, and communications functions provided for use by other Engineering Objects within the node to which it belongs. This internal structure may not be of concern in many Connectivity Views, but these elements may also be modeled and described explicitly in a more detailed view where it is useful to do so. A layered view of operating system elements is often used where this detail is required, but RASDS does not prescribe any particular representation for this.

2.7 COMMUNICATIONS VIEWPOINT

The Communications Viewpoint is used to describe the layered sets of communications protocols that support communications among the Nodes in the system. These protocols must meet the requirements imposed by the actual physical connectivity in the deployed system and the operational challenges of communicating in space. The communications protocol data units are sometimes called the ‘wire protocol’ and are often associated with the Link that is used to carry them, but they are generated and consumed by protocol peer entities that are operating in the connected Nodes. The Communications Viewpoint is used to address these protocol aspects of space data systems.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

The Communications Viewpoint Specification describes the mechanisms that support information transfer among system elements (i.e., hardware or software Engineering Objects) in a space data system. These protocol 'stacks' are directly associated with the physical Links that exist between the Nodes of a system, and they have responsibility for transporting data across these links.

NOTE – The Communications Viewpoint is actually a subset of the RM-ODP Engineering and Technology Viewpoints. The objects modeled in the Communications Viewpoint might properly be called Communications Objects for consistency with the rest of the RASDS. However, to provide familiar terminology for protocol designers, and for consistency with the widely used ISO/IEC Basic Reference Model (ISO-BRM, reference [14]), they are here called Protocol Entities.

Protocol Entities (Communications Objects) support information transfer between or among Engineering Objects. A Protocol Entity is an abstract entity that implements a communications protocol. A Protocol Entity may be realized as software and/or hardware. A stack of one or more Protocol Entities is used to support information transfer from one Engineering Object to another Engineering Object to allow them to interact. In the stack, the topmost Protocol Entity directly supports some application Engineering Object, and the bottommost Protocol Entity interfaces to the Physical Link (i.e., the physical connection between or among Nodes). Protocol Entities offer services that are exposed at a Service Access Point (SAP).

Each Protocol Entity implements one or more Protocols, which are most often defined by the Protocol Data Units (PDUs) that are exchanged between peer entities and the actions performed by those Protocol Entities when they receive any of several defined PDUs. Activities within Protocol Entities may also be triggered by reception of service requests from users, by external management requests, and by internal events such as time-outs or in-line management requests.

For the Communications Viewpoint Specification the Concerns include Standards, Technology, Functionality, and Suitability.

A simple example of a Communications View is shown in figure 2-5, in which two stacks of Protocol Entities (implementing Protocols 1, 2, and 3) are represented as two groups of rectangles. Each rectangle represents a Protocol Entity that implements services for a Layer in the protocol stack. Each Protocol Entity offers services to the N+1 layer entity that is above it and uses the services of the N-1 layer that is below it. Each N-layer Entity participates in an exchange of protocol data units with its peer N-layer Entity.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010

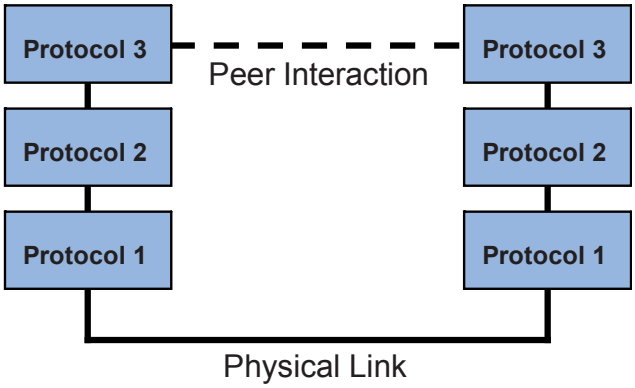

Figure 2-5: Simple Example of a Communications View

The selection of specific protocols to support information transfer between application Engineering Objects depends heavily on the characteristics of the functions being performed, the Nodes, the Link, and the characteristics of the communications environment within which they are operating. To define all these relationships, the Protocol Entities are typically shown altogether along with representations of the application Engineering Objects, the Nodes, and the Link. Such an example is shown in figure 2-6, in which the Protocol Entities are shown in relationship with representations of Nodes, Links, and other Engineering Objects, identified as Applications A and B.

In descriptions of Protocol Entities in a Communications View, the terms in the ISO-BRM are used by preference. This document has adopted the ISO-BRM seven-layer model that starts with the Physical layer and ends with the Application layer. Not all layers are required or used in space data systems, many of which have traditionally been constructed with applications interfacing directly to a Data Link layer SAP. Furthermore, in space data systems, it is typical to show the ISO Physical layer with separate modulation and coding sublayers, which are specialized in CCSDS for space communication. Where a messaging service is provided, which was not a defined service when the ISO-BRM was specified (1979), it is included with other Application layer services in layer 7 of the stack.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

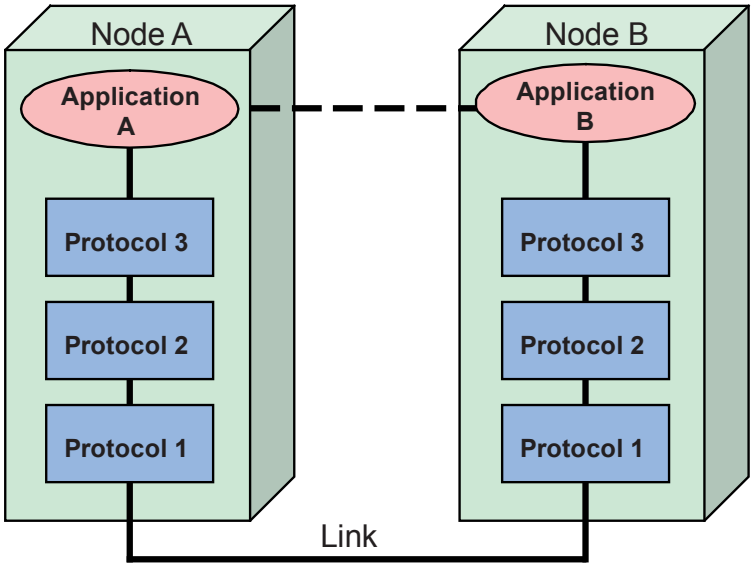

Figure 2-6: Communications View with Protocol Entities and Engineering Objects

NOTE – RM-ODP addresses communications protocols as part of its Engineering and Technical Viewpoint specifications. Use of the ISO/IEC Basic Reference Model (ISO-BRM) to describe this Viewpoint is entirely consistent with RM-ODP and is adopted here. In RM-ODP communications protocols are treated as just one of several Engineering and Technology Viewpoint choices that an architect must make in designing a system. The separate Communications Viewpoint is introduced in RASDS because communications protocols are a core element in the CCSDS body of standards and are an essential part of end-to-end design trades when designing systems to operate in space.

2.8 INFORMATION VIEWPOINT

The Information Viewpoint of space data systems describes how data objects and their structures, relationships, metadata, and constraints are defined and configured within the system.

The Information Viewpoint looks at space data systems from the perspective of the Information Objects that are defined and managed. It includes descriptions of Information Objects (their structure and syntax), information about the meaning and use of these Objects (contents and semantics), the relationships among Information Objects (the data model), rules that define constraints on their use transformation and retention, and policies on access. The basic relationships among Information Objects are shown in figure 2-7.

© ISO 2010 – All rights reserved

Documents Document Sharing Hub
Full document details: BS ISO 13537:2010

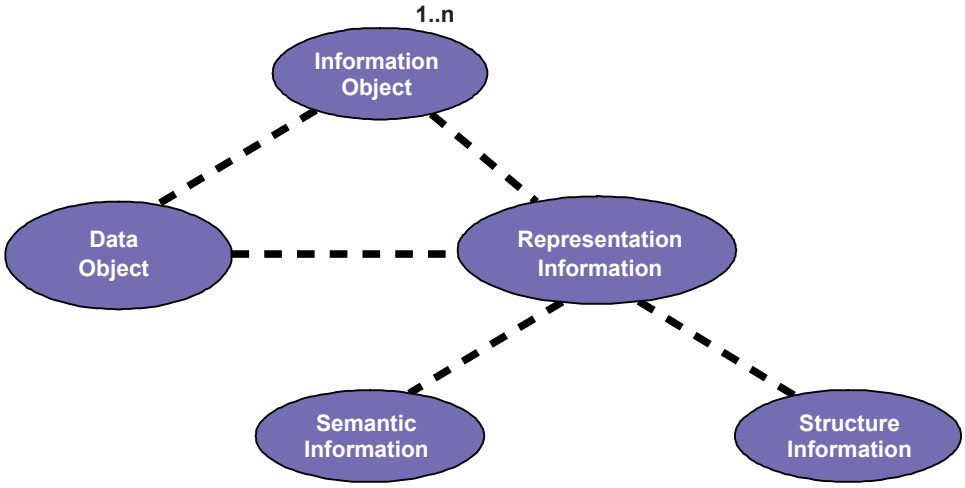

Figure 2-7: Example of Information View Showing Basic Object Model

For the Information Viewpoint Specification, the Concerns include Structure, Semantics, Relationships, Constraints, Permanence, and Rules.

The primary elements in the Information Viewpoint Specification are Data Objects and their logical links or relationships. Data Objects may be composed of other Data Objects. They may also have associated metadata, or data about data, that describes the syntax, semantics, and structure of the data and rules on its use. The Information Objects that are used in the system may have an explicit formal representation in a Data Architecture, or they may appear simply as Data Models or schema that have explicit representation in a Connectivity View as part of a database definition or data structure specification.

In this same context, an Information Object corresponds to a set of Connectivity Objects, a static schema of an Information Object corresponds to possible states of the Connectivity Objects. Every change in state of an Information Object corresponds either to some set of interactions between Connectivity Objects or to an internal action of a Connectivity Object. The schema of the Information Object corresponds to the behavior, state, and environmental interactions of the Connectivity Objects. Details of the information Viewpoint are addressed much more completely in the companion document, Reference Architecture for Space Information Management (reference [5]).

2.9 CORRESPONDENCES BETWEEN VIEWPOINTS

Each of the RASDS Viewpoint Specifications is intended to be orthogonal to the others, and a description of a given system from any one Viewpoint will be self-consistent. However, most of the objects defined in their home RASDS Viewpoint Specification also have identifiable relationships or correspondences with objects defined in other Viewpoint Specifications. This is an essential element of the methodology. In figure 2-8 the relationships among the core set of objects defined in RASDS are shown graphically.

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub

Full document details: BS ISO 13537:2010

In figure 2-8 only the top-level (or core) objects and attributes in RASDS are shown, those most central to understanding how core objects from different Viewpoints are related. Each of these core objects represents a class of objects, as described in prior sections. These classes may have subclasses and an associated set of attributes. A much longer list of attributes for each of these objects and their classes is not shown here. Finally, figure 2-8 captures only the static relationships among objects; it does not capture any of the dynamic behavior of objects, in either a functional or physical sense.

The element called 'Perspective' in the figure 2-8 represents the RASDS Viewpoint Specifications, Views, and associated user concerns. Each Viewpoint Specification can be thought of as a perspective on a system that defines the objects and rules for constructing views and that permits only a subset of objects and representations relevant for a given concern to be analyzed. Each of these top-level objects is defined in a 'home' Viewpoint in RASDS, but many of them will have representations or correspondences in other Viewpoints. Thus the 'home' Viewpoint for Information Objects is the Information Viewpoint, but representations of Information Objects may appear in the Enterprise, Functional, and Connectivity Viewpoints. Similarly, abstract Functional Objects defined in the Functional Viewpoint have correspondences with implemented Engineering Objects (hardware or software) in the Connectivity Viewpoint.

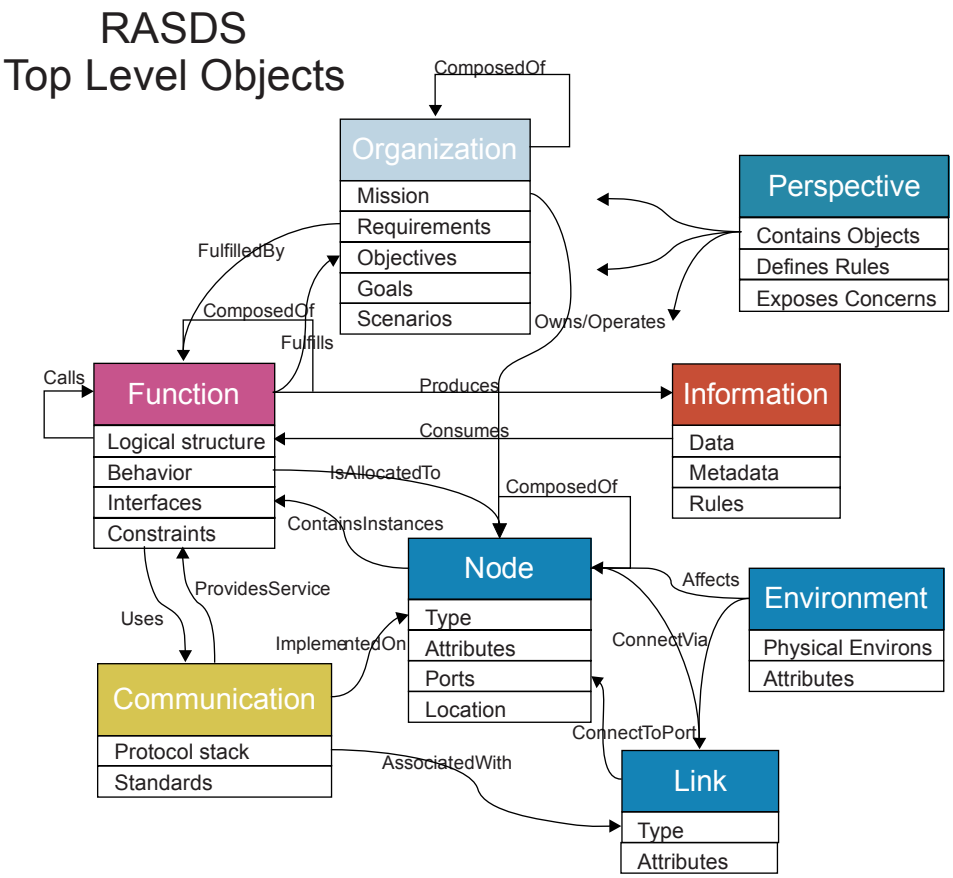

Figure 2-8: RASDS Top Level Object Relationships

© ISO 2010 – All rights reserved

Documents
Document Sharing Hub
Full document details: BS ISO 13537:2010