INTERNATIONAL STANDARD

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Information technology — Open Distributed Processing — Reference Model: Architecture

Technologies de l'information — Traitement distribué ouvert — Modèle de référence: Architecture

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Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 10746-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 21, *Open Systems Interconnection, data management and open distributed processing*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.903.

ISO/IEC 10746 consists of the following parts, under the general title *Information technology — Open Distributed Processing — Reference Model*:

— *Part 1: Overview*

— *Part 2: Foundations*

— *Part 3: Architecture*

— *Part 4: Architectural semantics*

Annex A forms an integral part of this part of ISO/IEC 10746.

Introduction

The rapid growth of distributed processing has led to a need for a coordinating framework for the standardization of Open Distributed Processing (ODP). This Reference Model provides such a framework. It creates an architecture within which support of distribution, interworking and portability can be integrated.

The Reference Model of Open Distributed Processing, ITU-T Recs. X.901 to X.904 | ISO/IEC 10746, is based on precise concepts derived from current distributed processing developments and, as far as possible, on the use of formal description techniques for specification of the architecture.

The Reference Model consists of:

– ITU-T Rec. X.901 | ISO/IEC 10746-1: **Overview**: Contains a motivational overview of ODP giving scoping, justification and explanation of key concepts, and an outline of the ODP architecture. It contains explanatory material on how this Reference Model is to be interpreted and applied by its users, who may include standards writers and architects of ODP systems. It also contains a categorization of required areas of standardization expressed in terms of the reference points for conformance identified in this Recommendation | International Standard. This part is not normative.

– ITU-T Rec. X.902 | ISO/IEC 10746-2: **Foundations**: Contains the definition of the concepts and analytical framework for normalised description of (arbitrary) distributed processing systems. It introduces the principles of conformance to ODP standards and the way in which they are applied. This is only to a level of detail sufficient to support this Recommendation | International Standard and to establish requirements for new specification techniques. This part is normative.

– ITU-T Rec. X.903 | ISO/IEC 10746-3: **Architecture**: Contains the specification of the required characteristics that qualify distributed processing as open. These are the constraints to which ODP standards must conform. It uses the descriptive techniques from ITU-T Recommendation X.902 | ISO/IEC 10746-2. This part is normative.

– ITU-T Rec. X.904 | ISO/IEC 10746-4: **Architectural semantics**: Contains a formalization of the ODP modelling concepts defined in ITU-T Recommendation X.902 | ISO/IEC 10746-2, clauses 8 and 9. The formalization is achieved by interpreting each concept in terms of the constructs of the different standardized formal description techniques. This part is normative.

This Recommendation | International Standard contains one annex (this annex forms an integral part of the Reference Model).

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INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN DISTRIBUTED PROCESSING – REFERENCE MODEL: ARCHITECTURE

1 Scope

This ITU-T Recommendation | International Standard:

- defines how ODP systems are specified, making use of concepts in ITU-T Recommendation X.902 | ISO/IEC 10746-2;
- identifies the characteristics that qualify systems as ODP systems.

It establishes a framework for coordinating the development of existing and future standards for ODP systems and is provided for reference by those standards.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunications Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

- ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.*
- ITU-T Recommendation X.810 (1995) | ISO/IEC 10181-1:1996, *Information technology – Open Systems Interconnection – Security frameworks for open systems: Overview.*
- ITU-T Recommendation X.811 (1995) | ISO/IEC 10181-2:1996, *Information technology – Open Systems Interconnection – Security frameworks for open systems: Authentication framework.*
- ITU-T Recommendation X.812 (1995) | ISO/IEC 10181-3:1996, *Information technology – Open Systems Interconnection – Security frameworks for open systems: Access control framework.*
- ITU-T Recommendation X.813[1)] | ISO/IEC 10181-4...[1)], *Information technology – Open Systems Interconnection – Security frameworks for open systems: Non-repudiation framework.*
- ITU-T Recommendation X.814 (1995) | ISO/IEC 10181-5:1996, *Information technology – Open Systems Interconnection – Security frameworks for open systems: Confidentiality framework.*
- ITU-T Recommendation X.815 (1995) | ISO/IEC 10181-6:1996, *Information technology – Open Systems Interconnection – Security frameworks for open systems: Integrity framework.*
- ITU-T Recommendation X.816 (1995) | ISO/IEC 10181-7:1996, *Information technology – Open Systems Interconnection – Security frameworks for open systems: Security audit framework.*
- ITU-T Recommendation X.902 (1995) | ISO/IEC 10746-2:1996, *Information technology – Open distributed processing – Reference Model: Foundations.*

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1) Presently at the stage of draft.

2.2 Paired Recommendations | International Standards equivalent in technical content

- CCITT Recommendation X.800 (1991), *Security architecture for Open Systems Interconnection for CCITT Applications.*

  ISO 7498-2:1989, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 2: Security Architecture.*

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.1 Descriptive definitions

This Reference Model makes use of the following term defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

- transfer syntax.

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.811 | ISO/IEC 10181-2:

- claimant;
- exchange authentication information;
- principal;
- trusted third party.

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.812 | ISO/IEC 10181-3:

- access control information;
- access decision function;
- access enforcement function;
- initiator;
- target.

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec X.813 | ISO/IEC 10181-4:

- evidence generator;
- evidence user;
- evidence verifier;
- (non-repudiable data) originator;
- (non-repudiable data) recipient;
- non-repudiation evidence;
- non-repudiation service requester;
- notary.

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.814 | ISO/IEC 10181-5:

- confidentiality-protected data;
- hide;
- originator;
- recipient;
- reveal.

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.815 | ISO/IEC 10181-6:

- integrity-protected data;
- originator;
- recipient;
- shield;
- validate.

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.816 | ISO/IEC 10181-7:

- alarms collector function;
- alarm examiner function;
- audit trail examiner function;
- audit trail archiver function;
- audit recorder function;
- audit trail examiner function;
- audit trail collector function.

This Recommendation | International Standard makes use of the following terms defined in ISO/IEC 11170-1 Key Management Framework:

- key generation;
- key registration;
- key certification;
- key deregistration;
- key distribution;
- key storage;
- key archiving;
- key deletion.

This Reference Model makes use of the terms defined in ITU-T Rec. X.902 | ISO/IEC 10746-2 shown in Figure 1.

3.2 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

ODP Open Distributed Processing.

OSI Open Systems Interconnection.

4 Framework

This Reference Model defines a framework comprising:

- five *viewpoints*, called enterprise, information, computational, engineering and technology which provide a basis for the specification of ODP systems;
- a *viewpoint language* for each viewpoint, defining concepts and rules for specifying ODP systems from the corresponding viewpoint;
- specifications of the *functions* required to support ODP systems;
- *transparency prescriptions* showing how to use the ODP functions to achieve distribution transparency.

The architecture for ODP systems and the composition of functions is determined by the combination of the computational language, the engineering language and the transparency prescriptions.

abstraction;
action;
activity;
architecture;
atomicity;
behaviour;
binding;
class;
client object;
communication;
communications management;
composition;
configuration;
conformance point;
consumer object;
contract;
creation;
data;
decomposition;
deletion;
distributed processing;
distribution transparency;
<x> domain;
entity;
environment;
error;
establishing behaviour;
failure;
fault;
<x> group;
identifier;
information;
initiating object;
instance;
instantiation;
interaction;
interchange reference point;
interface;
interface signature;
interworking reference point;
introduction;
invariant;
liaison;
location in space;
location in time;
name;
naming context;
naming domain;
notification;
object;
obligation;
ODP standards;
ODP system;
open distributed processing;
perceptual reference point;
permission;
persistence;
policy;
producer object;
programmatic reference point;
prohibition;
Quality of Service;
reference point;
refinement;
role;
server object;
spawn action;
stability;
state;
subdomain;
subtype;
supertype;
system;
<x> template;
term;
thread;
trading;
type;
viewpoint.

Figure 1 – Terms taken from ITU-T Rec. X.902 | ISO/IEC 10746-2

4.1 Viewpoints

4.1.1 Concepts

4.1.1.1 Enterprise viewpoint: A viewpoint on an ODP system and its environment that focuses on the purpose, scope and policies for that system.

4.1.1.2 Information viewpoint: A viewpoint on an ODP system and its environment that focuses on the semantics of information and information processing.

4.1.1.3 Computational viewpoint: A viewpoint on an ODP system and its environment which enables distribution through functional decomposition of the system into objects which interact at interfaces.

4.1.1.4 Engineering viewpoint: A viewpoint on an ODP system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system.

4.1.1.5 Technology viewpoint: A viewpoint on an ODP system and its environment that focuses on the choice of technology in that system.

4.1.2 Using viewpoints

The enterprise, information, computational, engineering and technology viewpoints have been chosen as a necessary and sufficient set to meet the needs of ODP standards. Viewpoints can be applied, at an appropriate level of abstraction, to a complete ODP system, in which case the environment defines the context in which the ODP system operates. Viewpoints can also be applied to individual components of an ODP system, in which case the component's environment will include some abstraction of both the system's environment and other system components.

NOTE – The process of abstraction might be such that the system's environment and the other system components are composed into a single object.

4.2 ODP viewpoint languages

4.2.1 Concept

4.2.1.1 <Viewpoint> language: Definitions of concepts and rules for the specification of an ODP system from the <viewpoint> viewpoint; thus: **engineering language**: definitions of concepts and rules for the specification of an ODP system from the engineering viewpoint.

4.2.2 Using viewpoint languages

This Reference Model defines a set of five languages, each corresponding to one of the viewpoints defined in 4.1.1. Each language is used for the specification of an ODP system from the corresponding viewpoint. These languages are:

- the enterprise language (defined in clause 5);
- the information language (defined in clause 6);
- the computational language (defined in clause 7);
- the engineering language (defined in clause 8);
- the technology language (defined in clause 9).

Each language uses concepts taken from ITU-T Rec. X.902 | ISO/IEC 10746-2, and introduces refinements of those concepts, prescriptive rules and additional viewpoint-specific concepts relevant to the nature of the specifications concerned. These additional concepts are, in turn, defined using concepts from ITU-T Rec. X.902 | ISO/IEC 10746-2.

A system specification comprises one or more viewpoint specifications. These specifications must be mutually consistent. Rules for the consistent structuring of viewpoint specifications are given in clause 10. The specifier must demonstrate by other means that terms in the specifications are used consistently. A specification of a system using several viewpoint specifications will often restrict implementations more than a specification using fewer viewpoint specifications. Objects identified in one viewpoint can be specified using the viewpoint language associated with that viewpoint or using the viewpoint languages associated with other viewpoints. It is not necessary to specify an object fully from every viewpoint in order to achieve a mutually consistent set of viewpoint specifications.

NOTES

1 The list of terms taken from ITU-T Rec X.902 | ISO/IEC 10746-2 are listed in Figure 1.

2 The qualification of a term from ITU-T Rec X.902 | ISO/IEC 10746-2 by the name of a viewpoint (e.g. as in "**computational** object") is interpreted as using of the term from ITU-T Rec X.902 | ISO/IEC 10746-2, subject to whatever additional provisions are specified in the identified viewpoint language.

3 The unqualified use of a term from ITU-T Rec X.902 | ISO/IEC 10746-2 in a viewpoint specification (e.g. "interface") is interpreted as if the term had been qualified by the name of the viewpoint (i.e. "computational interface"), if the associated viewpoint language places additional constraints on the term.

4.3 ODP functions

4.3.1 ODP function: A function required to support Open Distributed Processing.

4.3.2 Using ODP functions

This Reference Model specifies, in clauses 11 to 15, the functions required to achieve Open Distributed Processing.

Each ODP function description contains:

- an explanation of the use of the function for open distributed processing;
- prescriptive statements, about the structure and behaviour of the function, sufficient to ensure the overall integrity of the Reference Model;
- a statement of other ODP functions upon which it depends.

4.4 ODP distribution transparencies

4.4.1 Concepts

4.4.1.1 Access transparency: A distribution transparency which masks differences in data representation and invocation mechanisms to enable interworking between objects.

4.4.1.2 Failure transparency: A distribution transparency which masks, from an object, the failure and possible recovery of other objects (or itself), to enable fault tolerance.

4.4.1.3 Location transparency: A distribution transparency which masks the use of information about location in space when identifying and binding to interfaces.

4.4.1.4 Migration transparency: A distribution transparency which masks, from an object, the ability of a system to change the location of that object. Migration is often used to achieve load balancing and reduce latency.

4.4.1.5 Relocation transparency: A distribution transparency which masks relocation of an interface from other interfaces bound to it.

4.4.1.6 Replication transparency: A distribution transparency which masks the use of a group of mutually behaviourally compatible objects to support an interface. Replication is often used to enhance performance and availability.

4.4.1.7 Persistence transparency: A distribution transparency which masks, from an object, the deactivation and reactivation of other objects (or itself). Deactivation and reactivation are often used to maintain the persistence of an object when a system is unable to provide it with processing, storage and communication functions continuously.

4.4.1.8 Transaction transparency: A distribution transparency which masks coordination of activities amongst a configuration of objects to achieve consistency.

4.4.2 Using distribution transparency

Distribution transparency is an important end-user requirement in distributed systems. This Reference Model defines a set of distribution transparencies which make it possible to implement ODP systems which are distribution transparent from the point of view of users of those systems. Distribution transparency is selective; the Reference Model includes rules for selecting and combining distribution transparencies in ODP systems.

This Reference Model contains, for each distribution transparency defined in 4.4.1.1 to 4.4.1.8, definitions of both:

- a schema for expressing requirements for the particular transparency;
- a refinement process for transforming a specification which contains requirements for the particular distribution transparency to a specification which explicitly realizes the masking implied by that transparency.

NOTES

1 In some cases (e.g. access transparency) the schema is null; in others (e.g. transaction transparency) the schema contains one or more parameters dictating the precise form of transparency required.

2 The refinement process typically involves introducing additional behaviour, including the use of one or more ODP functions into the specification.

The specifications of the refinement processes in clause 16 are prescriptive to the level required to ensure overall integrity of the Reference Model.

4.5 Standards derived from the framework

This Reference Model provides a framework for the definition of new standards and the use of existing standards as ODP standards.

ODP standards are any of:

- standards for components of ODP systems;
- standards for composing ODP system components;
- standards for modelling and specifying ODP systems.

ODP standards:

- use the enterprise language to specify policies;
- use the information language to specify consistent use and interpretation of information in, and between, standards;
- use the computational language to specify the configuration and behaviour of interfaces;
- use the engineering language to specify the infrastructures they require;
- use the technology language to specify conformance to international, private, or consensual specifications.

Standards for methodology, modelling, programming, implementation and testing of ODP systems use the framework as a whole.

ODP standards can be based on a subset of this Reference Model (e.g. by excluding some forms of interaction, particular functions or transparencies). Such standards can also extend upon this Reference Model, provided that the extensions they introduce do not change or contradict its provisions. Extensions will relate new terms to terms defined in this Reference Model: for example, by introducing new types and new type rules.

ODP standards comply with all the prescriptive statements in this Reference Model.

4.6 Conformance

The enterprise, information, computational and engineering languages are used to specify the conformance requirements for ODP systems. The technology language can be used to assert conformance to ODP standards in ODP systems. Each interface which is defined as a conformance point has an information specification to enable interpretation of interactions of that interface. The rules for identifying conformance points are given in the computational and engineering languages.

An ODP system conforms to an ODP standard if it satisfies the conformance requirements of that standard.

5 Enterprise language

The enterprise language comprises concepts, rules and structures for the specification of an ODP system from the enterprise viewpoint.

An enterprise specification defines the purpose, scope and policies of an ODP system.

In this Reference Model, prescription in the enterprise viewpoint is restricted to a small basic set of concepts and rules addressing the scope and nature of enterprise specifications.

5.1 Concepts

The enterprise language contains the concepts of ITU-T Rec. X.902 | ISO/IEC 10746-2 and those defined here, subject to the rules of 5.2.

5.1.1 Community: A configuration of objects formed to meet an objective. The objective is expressed as a contract which specifies how the objective can be met.

5.1.2 <X> federation: A community of <x> domains.

5.2 Structuring rules

An enterprise specification defines, and the enterprise language is able to express, the purpose, scope and policies of an ODP system in terms of each of the following items:

- roles played by the system;
- activities undertaken by the system;
- policy statements about the system, including those relating to environment contracts.

In an enterprise specification, an ODP system and the environment in which it operates are represented as a community. At some level of description the ODP system is represented as an enterprise object in the community. The objectives and scope of the ODP system are defined in terms of the roles it fulfils within the community of which it is part, and policy statements about those roles. A community is defined in terms of each of the following elements:

- the enterprise objects comprising the community;
- the roles fulfilled by each of those objects;
- policies governing interactions between enterprise objects fulfilling roles;
- policies governing the creation, usage and deletion of resources by enterprise objects fulfilling roles;
- policies governing the configuration of enterprise objects and assignment of roles to enterprise objects;
- policies relating to environment contracts governing the system.

A role is defined in terms of the permissions, obligations, prohibitions and behaviour of the enterprise object fulfilling the role. An enterprise object can fulfil one or more roles in a community, and the roles which it can fulfil are determined by the contract on which the community is based. While it is part of one community the enterprise object can