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Information technology for learning, education and training — Information model for competency —

Part 1:
Competency general framework and information model

Technologies de l'information pour l'apprentissage, l'éducation et la formation — Modèle d'information pour les compétences —

Partie 1: Cadre général des compétences et modèle d'information

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

ISO/IEC 20006 consists of the following parts, under the general title *Information technology for learning, education and training — Information model for competency*:

— *Part 1: Competency general framework and information model*

— *Part 2: Proficiency level information model*

— *Part 3: Guidelines for aggregation of competency information and data*

Introduction

From the late 1990s, some industrial and academic organizations have developed information technology standards in the skills and competency domain, such as human resources, on a global level to address the interoperability requirements and environmental complexities of management and sharing of competency information amongst different organizations. Some examples include work spearheaded by the following organizations: the IMS Global Learning Consortium Inc., HR-XML Consortium, IEEE-LTSC, OMG, CEN TC353 and also ISO/IEC JTC 1/SC 36 itself. Some typical problems encountered by stakeholders as well as ITLET systems dedicated to the management and exchange of competency information and where these issues may be encountered are provided in examples below:[2]

Example 1: Technical - Competency and associated information cannot always be selected and shared between different ITLET systems (e.g. learning management, HR, and other related platforms);

Example 2: Organizational - Competency and associated information is not easily used in human development activities, because skills and competency information may be detailed or expressed differently in various ITLET systems (e.g. learning management, HR, national occupational classification, and other related systems);

Example 3: Information exchange - Skills and competency proficiency information, such as individual status or degrees acquired, cannot be shared easily amongst different ITLET systems (e.g. HR, learning management, national occupational classification, and other related systems);

Example 4: Individual learner - Individual developmental learning, education, and training paths cannot easily migrate or be exchanged amongst ITLET systems;

Example 5: Systems perspective (where systems include individuals, organizations, and the technologies that support them) - Individuals and organizations cannot easily design and integrate informal and formal learning, education, and training opportunities to support life goals, career strategies, and career paths using existing common dimensions within ITLET systems;

Example 6: Practical analytics - The ability to access, extract, and analyse competency and associated information can provide evidence as to whether learning, education and training information needs are being met in order to analyse lifelong learning, thus where competency information must be drawn from different systems and where non-interoperable format and definitions are used;

Example 7: Assessment and evaluation - ITLET systems (e.g. acknowledgement and consideration are needed regarding evaluation biases in human assessment, the use of varying methods and metrics to evaluate human performance, and the need to conduct accurate skill gap analysis), where ITLET systems that use different competency digital schema are involved; and,

Example 8: Overarching goals and outcomes - Human assessment and support for the development of human potential requires ITLET systems that provide a more flexible, holistic integration and exchange of competency and associated information beyond individual learning opportunities, everyday operation, and work performance. Competency data must be generated.

Some of these identified problems have been addressed on a limited basis by the standards and specifications produced by the organizations mentioned above. Not only is it difficult to use these standards and specifications, however, but also the unsolved problems are still critical. It is still confusing for stakeholders to implement and use these standards and specifications. Also, various problems associated with ITLET related systems, which should be solved by or supported with information technology, still remain.

Currently, organizations, such as schools, universities, institutes, and companies, use different ITLET systems to support the use of learning content, to enable and enhance various learning activities, and to provide other services. To meet their mission and goals, such organizations may rely on in-house developers, others such as ITLET vendors or suppliers, or a combination of both to provide and operate IT systems to support LET. This means ITLET operations and other organizational systems that deal with skills and competency information, such as interrelated human resources (HR) information

systems, need to be interoperable to allow for communication between organizations, their employees, and outsourcing ITLET providers or suppliers.

The purpose of this multi-part International Standard is to provide a framework, models, system architecture used for competency and proficiency information, and a way to aggregate competency information. This standard will provide a general framework and information model to manage and exchange information about knowledge, skills, ability, attitude, and educational objectives. Especially this International Standard will focus on extending the concepts contained within ISO/IEC TR 24763 by providing more detailed information regarding competency information and its information aggregation. This multi-part standard may be used by software developers and implementers, instructional designers and test designers, and others to ensure that learning, education and training environments satisfy learners' and organizations' competency needs. In addition, this International Standard will provide definitions of several types of competency information aggregation, which will provide guidance for all stakeholders to better understand and support the development of interoperable systems that will enable competency information exchange.

Information technology for learning, education and training — Information model for competency —

Part 1:
Competency general framework and information model

1 Scope

1.1 General

This part of ISO/IEC 20006 provides:

— a general framework for dealing with competency information in information technology for learning, education, and training (ITLET) contexts;

— a system architecture for managing and exchanging competency information and its related objects;

— an information model for expressing competency and its related objects that includes an introduction to the composition of competency;

— use cases used to support the development of the general framework and competency information model.

This standard is for those who design and use learning systems and human resources systems to support management and exchange of competency information using ITLET systems.

NOTE   This International Standard is related to the Conceptual Reference Model developed in ISO/IEC TR 24763. Information regarding the relationships between the ISO/IEC 20006 and ISO/IEC TR 24763 is provided in this standard.

This multi-part International Standard also includes the following parts:

ISO/IEC 20006-2:—, *Information technology for learning, education and training – Information model for competency – Part 2: Proficiency level information model*, which provides

— information model for expressing semantics of competency proficiency and its levels, and

— use cases used to support the development of the competency proficiency level information model;

ISO/IEC TS 20006-3:—, *Information technology for learning, education and training – Information model for competency – Part 3: Guidelines for aggregation of competency information and data*, which provides

— guidelines and a data driven architecture for the development of specific data models managing aggregation of competency information and related objects,

— ways to aggregate competency information and its related object data, and

— use cases used to support the development of the guidelines for aggregation of competency information and competency data.[1]

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1)   The terms competency information and competency data will be defined in ISO/IEC TS 20006-3.

1.2 Exclusions

The scope of this International Standard does not include an in-depth technical review of issues related to:

— adaptability to culture, language, and human functions;

— security;

— authentication;

— privacy;

— accessibility.

1.3 Areas not addressed

This International Standard currently does not address the following items:

— e-Profiles, which are a set of records that pertain to an individual (e.g. personnel records, student information system records);

— evidence information;

— assessment methods and metrics information

— ISO/IEC 20006 has been developed to support competency information and data management and exchange based on IT systems that are currently in use in Asia, Europe and North America. It is based on standardization that has occurred at transnational, national and regional levels in IT systems that are used to support human development including but not limited to:

   — university, college, secondary school curricula development;

   — learning activities supported by IT systems such as LMSs;

   — IT systems that support LET and Human Resources that are based on a National Occupational Classification system (e.g. learning activity development, job banks, etc.);

   — sector specific standardization in the area of IT and embedded skills;

   — IT systems that support LET and human resource quality management and development activities.

Further work may be needed to ensure that these standards support deeper IT integrations across various sectors and in other regions of the world.

It is anticipated that some or all of these requirements will be addressed in future editions of ISO/IEC 20006, or in companion International Standards, Technical Specifications and Technical Reports.

2 Conformance

The objective of this part of ISO/IEC 20006 is to support the management and exchange of competency information in a way that will promote interoperability and integration. To support competency management and development, competency information needs to be structured and described consistently to promote understanding, mutual communication and agreement.

The general framework and information model are based on the Conceptual Reference Model for Competency Information and Related Objects (CRM) (defined by ISO/IEC TR 24763). The CRM provides a toolkit that can be used to abstract and identify concepts used within IT systems to support the management and exchange of competency information across different HR, learning and training contexts. ISO/IEC 20006 builds upon the conceptual and abstract focus of ISO/IEC TR 24763 to

provide a general framework, information architecture, competency information model and additional components.

Competency information should be detailed in a way that is semantically robust and extensible. For the purposes of this standard, competency information is conformant with this International Standard if it adopts the information model and the element notations specified in this International Standard. (The element notations are defined in Clauses 6.4 – 6.5 and Clause 7).

A conforming notation may contain descriptions of meaning and context of competency information. In other words, it is intended to be extensible and may contain additional information elements of ISO/IEC TR 24763. For conformance to ISO/IEC TR 24763, classes for defining a competency in CRM competency are indicated with the following notation [E*n*] where *n* is a number that refers to a class defined in ISO/IEC TR 24763 to assist with understanding the linkages and relationships between the CRM and this standard. For example, as noted in ISO/IEC TR 24763, E1 = Action, E2 = Actor, E3 = Competency, and so on).

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 2382-36 (E/F), *Information technology — Vocabulary — Part 36: Learning, education and training*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382-36 and the following apply.

4.1
competency
ability of an actor to perform (a) necessary action(s) in (a) given context(s) to achieve (a) specific outcome(s)

[SOURCE: ISO/IEC TR 24763:2011, 2.2, modified — the words "observable or measurable" were deleted to allow for more general usage and application.]

4.2
competency aggregation
collection of *competency expressions* (4.4) that is in any structure

4.3
competency composition
unit and one of aggregation type that consists of definition and/or structured relationships of elements and attributes used to define contents of *competency* (4.1) as *competency expression* (4.4)

Note 1 to entry: For example, this may include information related to competency such as identification, semantics, context, and supplemental.

4.4
competency expression
any form of digitalized information regarding *competency representation* (4.7)

4.5
competency organization
digitized expression or map of aggregation type(s), that defines a designated unit as a set of *competencies* (4.1)

Note 1 to entry: This may include structured sub-competencies (e.g. competency information expressed as parent-child relationships). The form of competency organization structure is formulated as a tree structure or network structure with competencies.

Note 2 to entry: Competencies may be organized as competency definitions, competency frameworks, maps of aggregation type(s), and other forms of digitalized competency expressions.

4.6
competency package
standardized way to identify and exchange a set of data regarding *competency* (4.1) among different systems or application tools

Note 1 to entry: This standardized way may involve one of many aggregation types such as information regarding job, task, role and so on, in order to implement into LMS, HRIS, e-Profile, SIS and so on - because a competency may not only be expressed by competency content in practice, it also may be used with or by other information such as job, task, or role.

4.7
competency representation
image and idea of *competency* (4.1) that occurs in a human mind

Note 1 to entry: This is the real-world or portrayal or image or idea of competency as it is perceived by the human mind; whereas, the competency expression is the actual digital manifestation, notation, statement of competency. Representations include many different expressions.

4.8
conceptual reference model
common structure and definitions for describing the concepts and relationships within a system

[SOURCE: ISO/IEC TR 24763:2011, 2.8, modified.]

4.9
data model
graphical or lexical representation of data, specifying their properties, structure and inter-relationships

[SOURCE: ISO/IEC 11179-3:2003, 3.2.11, modified.]

4.10
framework
structure composed of related parts that are designed to support something

4.11
information model
expression of concepts, relationships, constraints, rules, and operations to specify data *semantics* (4.16) for a chosen domain of discourse

Note 1 to entry: An information model can provide sharable, stable, and organized structure of information requirements for the domain context.

4.12
information technology for learning, education and training system
ITLET system
set of one or more computers, devices, associated software, peripherals, terminals, human operations, physical processes, personal needs and preferences profiles, information transfer means, that form an autonomous whole, capable of performing information processing or information transfer to support learning, education or training

[SOURCE: ISO/IEC 14662:2010, 3.13, modified.]

4.13
method for competency assessment
instrument or tool to judge and/or to assess an acquired or demonstrated *competency* (4.1)

Note 1 to entry: Methods include physical methods and abstract or conceptual methods. There are various types of methods from the subjects of management science, pedagogy, psychology, engineering, statistics, biology and others.

Note 2 to entry: "Measurement method" is a generic description of a logical sequence of operations used in a measurement [ISO/IEC Guide 99:2007].

Note 3 to entry: This definition is associated with ISO/IEC 19796-3 [ISO/IEC 19796-3:2009].

4.14
metrics for competency assessment
material measure used to determine the value of specific aspects or characteristics of *competency* (4.1)

Note 1 to entry: In other words, it is done as a way of assigning a certain value using methods of measuring or testing in order to quantify a quality object from the standpoint of quality characteristics, such as scale, criterion, degree, weight, magnitude, interval, ratio, standard rate, or others.

Note 2 to entry: "Material measure" is defined as device reproducing or supplying, in a permanent manner during its use, quantities of given kinds, each with an assigned value [ISO/IEC Guide 99:2007].

Note 3 to entry: In ISO/IEC 15939:2002, the metric is defined as "the defined measurement methods and the measurement scale". However metric shall be clearly divided between the terms of method and scale to support implementation for audit assessment and evaluation.

Note 4 to entry: This definition is associated with ISO/IEC 19796-3 [ISO/IEC 19796-3:2009].

4.15
proficiency
<ITLET competency> level or degree of a *competency* (4.1) by judgment or measurement

Note 1 to entry: Proficiency can be used to ascertain or to identify progress, advancement or improvement in a competency, such as skill, knowledge, and other competency-related concepts.

4.16
semantics
branch of linguistic science that deals with the meanings of words

[SOURCE: ISO/IEC 11179-5:2005, 3.13]

5   Symbols and abbreviated terms

CIDA	Information Model for Competency – Guidelines for Competency Information and Data Aggregations
CMS	Content Management System
communi.	communication
HR	Human Resources
HRD	Human Resources Development
HRM	Human Resources Management
HRIS	Human Resources Information System
HRMLs	The Society for Human Resource – Markup Language

HR-XML	Human Resources - eXtensible Markup Language
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IMS	IMS Global Learning Consortium, Inc.
info	Information
IT	Information technology
ITLET	Information technology for learning, education and training
LET	Learning, Education and Training
LMS	Learning Management System
MLR	Metadata for Learning Resources
PLIM	Information Model for Competency – Proficiency Level Information Model
RCD	Reusable Competency Definition
RDCEO	Reusable Definition of Competency or Educational Objective
SIS	Student Information System

6 Competency general framework

6.1 Introduction

This international standard provides a general framework that supports the construction and management of information architectures, systems and database implementations for ITLET systems that are used to support the management and exchange competency information. This international standard enables the management and exchange of competency information by various types ITLET systems (e.g. learning management systems (LMS) and human resource management (HRM) systems (also known as personnel management systems), and planning for quality management of ITLET).

There are several aspects for implementation of competency information, this clause focuses on four aspects as noted below.

a) **Information architecture view:** There are many different types of information architecture that are used in these types of systems (see Clause 6.2). As noted in this clause, various information architectures are used not only in competency management applications, but also in other ITLET systems (e.g. learning management, HRM systems).

b) **Hierarchical and structural view:** Competency organization of this type of information also varies from system to system (see Clause 6.3). A competency may be structured in various ways and may have relationships to other competencies. A competency can be designed in a self-contained competency structure or as a part of a larger more complex competency structure.

c) **Element view:** For the element view within a competency (provided in Clause 6.4), competency information can be defined and specified by several compositions of standardized elements. This third aspect is the main target of this standard.

d) **Semantic view: This is a detailed view of element view focusing on competency semantics.** For the semantic view within a competency (provided in Clause 6.5), competency information has to include two semantic elements in competency expressions: the "competency meaning information" and the "competency situation information".

6.2   Information architecture view to support the management and exchange of competency information

Competency information within IT systems may be configured in various ways and express many different relationships and concepts. Competency information either only title or detailed explanation is used in variety systems and application tools, such as e-Profile, LMS, HRIS, CMS and others ([Figure 1](#)). Depended on each system, competency information is implemented with variety ways and with other information into these systems. Simplest packaging way is to implement directly its system using only competency title label. The second simplest way is to implement directly its system using competency title label and some related information (see Appendix C case 1). Information regarding competency is implemented more and more, competency information may be managed with its specific data table or database system. Furthermore competency database system and/or competency management system are needed for complex information. These aggregation patterns to implement a set of competency information into systems and application tools are called competency package. It may be included data interface, URL or SQL in order to refer to other data table or database system using. It should be expressed to use competency information interoperability.

ITLET systems (such as LMSs and HRM systems) have to deal with competency label data. Whether the definition of a skill is clear or not, and also whether the definition exists or not, the data may need to be exchanged among many stakeholders, organizations and the other ITLET systems and applications. This competency related information should be consistent and well formed in implementations being used for managing and exchanging data. For the purpose of managing and exchanging, identifiable information elements, such as identifier, name, creator, etc. are indispensable to identify and exchange competency information amongst ITLET systems.

For these requirements, some industrial standard organizations were developed specifications for express competency information such like HR-XML competencies, RDCEO, RDC and so on. These packaged information are called sharable competency core information in this standard.

Some stakeholders and organizations require access to more detailed competency semantics, especially the individuals who want to use and produce further development of competency semantics, such as teachers, learners, instructional designers, HRD staff, learning content developers, and so on. More detailed information about competency semantics is useful to refer to and to understand what a competency is, not only to support and develop human understanding but also for intelligent information systems. Competency related objects as semantic entities can provide meaning and contextual information. These entities were indicated in ISO/IEC TR 24763.
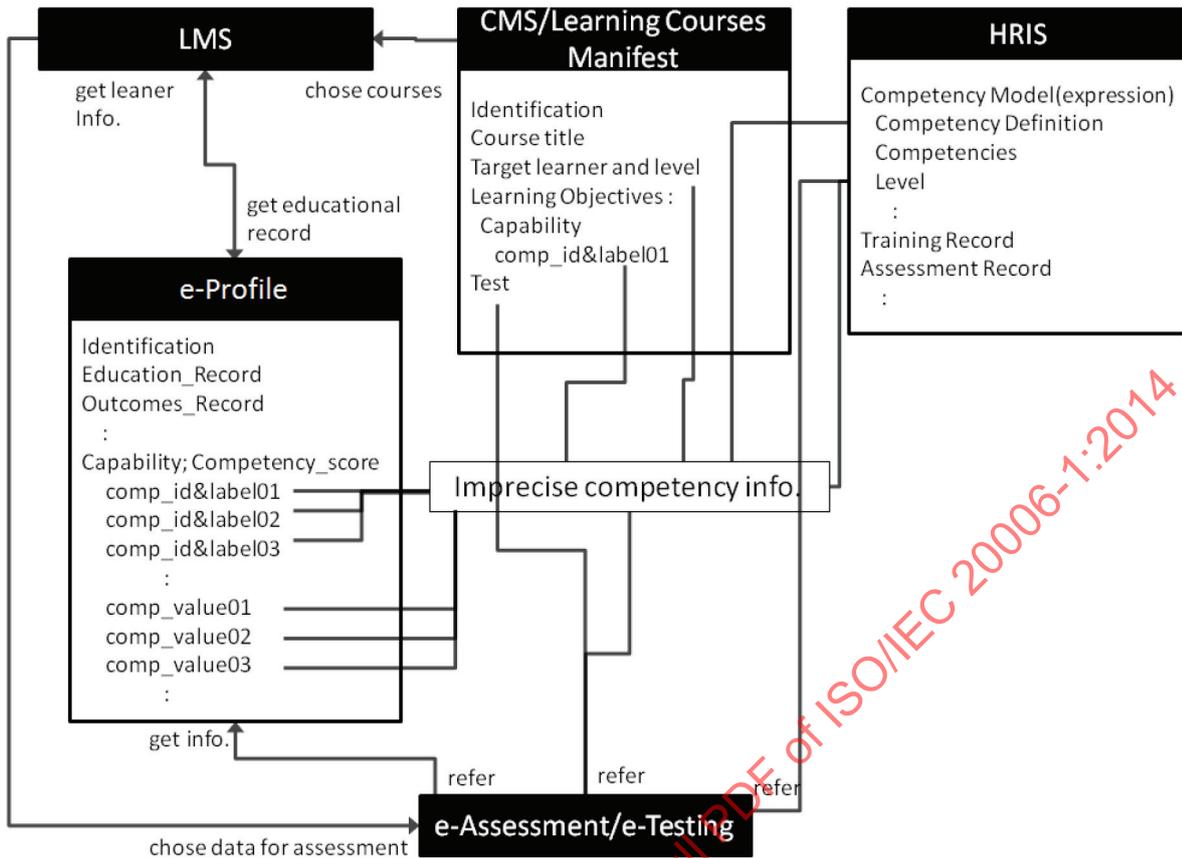
Figure 1 — Competency information amongst different systems

However these specifications did not guide the ways of expressing more detailed or more specific information with exchangeable and interoperability. Two more information entities for competency are needed, semantic information as extensions and competency proficiency level information as different conceptions (Figure 2).
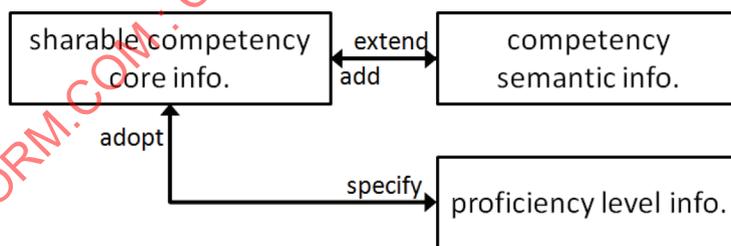
Figure 2 — Extensible expressions for competency information

Information architecture view includes a basic outline and data flows that need to be adaptable and flexible to accommodate connections to various IT systems in ways that make sense for the particular context. information architectures includes a basic outline and data flows. These are adaptable and flexible and can be changed in various IT systems for particular contexts. For example, in some systems connecting relationships designated by arrows may be present and in others some may be absent. Specific instances of the architecture including data flows may differ to accommodate specific requirements and contexts. The system architecture including data flows can be flexibly adapted to enable data transfer or integration of data flows into other systems, such as those used for job markets, resumes, learner assessment, etc."

This part of ISO/IEC 20006 mainly addresses and provides guidance regarding competency information and how it is organized (Clause 6.3), and the entity of "competency semantic information" (see Clause 6.5). In addition, an introduction to the relationships between this standard and the competency CRM (ISO/IEC TR 24763) is provided in sub Clause 6.4. It should be noted that ISO/IEC 20006-2 addresses the entity of "proficiency level information".

Additionally, in Clause 7 the difference between sharable competency core information and competency semantic information is clarified. Although the representation of competency concepts can be ambiguous in human communications, due to the way people view and construct competencies within ITLET systems, a certain competency information may exist in real systems as a particular type of data and may be labelled as something else. For example, a certain company set "communication skill" as one critical assessment dimension (factor) or as complex or composite learning objectives, then the term of "communication skill" may be used as a label that exists within the ITLET system and can be exchanged with other ITLET systems in the real world.

Annex A below presents examples for these cases that can be differentiated to describe how competency semantics might be implemented in and used by ITLET systems.

6.3 Competency organization

A set of competency, such as competency dictionaries, skills standards, or assessment dimensions can have different competency organization forms, such as a hierarchal structure (taxonomy), a natural language statement, and others. A structural complex or an organized competency can include multiple child or sub-competencies. For example, in the case of 21st Century skills (The partnership for 21st century skills; US National organization)", the root competency title is "21st. Century skills" itself. Competencies on the second layer are "life and career skills", "learning and innovation skills" and so on. Then these second layers consist of the third levelled competencies at the lowest layer levels.

Lower level competencies in a hierarchy are sometimes defined by sub-competencies or other organized competencies. These parent-children relations and other relations among competencies are indicated within the semantics of each competency. These relationships provide rich context and meaning that is far more descriptive than a single competency label.

Parent-Children relationship may be organized several patterns, General-Specific relation, Whole-Parts relation, Universal-Particular relation. Abstract-Concrete relation, Level relation and others. Explanations for these patterns are indicated in Annex C, so this standard focuses on expressing competency information, not expressing competency organization directly. This standard is useful for building and using a competency information database or exchanging and managing competency information. This standard can be used to support a shared vocabulary regarding the types of relations that exist in the way that competency information is organized and to assist in efforts to exchange and manage this type of information.

6.4 Elements of competency

The main classes of this standard (based on the classes of the ITLET Conceptual Reference Model for Competency Information and Related Objects from the technical report ISO/IEC TR 24763) are provided below. Examples of subclasses for each class are given in the form of {a list}.

E1: [Action] {action related to learning, action related to teaching/training, action related to HR management, action related to HR administration, action related to LET administration…}

E2: [Actor] {person, group, automated agent…}

E3: [Competency] {simple competency, complex competency…}

E4: [Criteria and method] {performance criteria, method of measurement…}

E5: [Environment] {location description, duration, date and time, equipment…}

E6: [Evaluation, assessment process] {jury, exam, test…}

E7: [LET institution] {school, university, training department…}

E8: [Outcome] {observable result, measurable result…}

E9: [Role] {learner, tutor, teacher, trainer, support, administrator, staff…}

The following three cases have to be differentiated that describe how competency semantics might be implemented in and used by ITLET systems.

Case 1: Directly used by other systems:

Competency information provided in a competency system or database is identified and extracted to be used by another ITLET system, such as an LMS (learning objective attained), an e-Profile system (such as a grade residing in a student information system), metadata for learning resources (which indicates competencies for which a learning resource is intended). For example, ITLET systems are harvesting and using information contained in learning course descriptions, job profiles, personal learning records, and so on. In these cases, competency information as it resides in a system is used through a variety of methods (e.g. database query) by another ITLET system is used for a different purpose than what was originally intended.

Case 2: Referring to competency database or competency information from other systems:

Competency information is referred to through specific competency system or database. In this case, other systems refer to competency information in a competency database or competency object file to support analysis and action. For example, learning objectives in an LMS could refer to an already established competency ontology developed by a professional organization; an HRIS could refer to a national occupational classification system. For these cases competency information is referred to from within another ITLET system.

Case 3: Building a competency system or database:

National, industrial and also company common competency are informed and their meaning is described, in order to promote correct understanding among users. In this case, competency database or specific system should be developed, then competency information is implemented with its meaning and detailed information.

6.5   Semantic elements in competency expressions

For example using an approach such as the one suggested in ISO/IEC TR 24763, competency meaning information can be composed as a set of elements with attributes and properties for representation of competency semantics, especially having direct relationship with the ITLET Conceptual Reference Model "competency [E3] class. In this example, activity and outcome are also elements that are essential in expressing the meaning of competency. Competency situation information is composed of a set of elements with attribution and properties for representation of competency semantics, especially having indirect relationships amongst the "competency [E3]" class and other classes such as "environment [E5]", "criteria and method [E4", "LET institution [E7]". Typically competency organization information may be structured or organized as a taxonomy or it may be expressed in another manner."

As mentioned above, competency information objects should be divided into two objects: the competency information (as the sharable competency core information) and the competency semantics information. The two objects will be developed and are managed according to different purposes and usages in practice. Additionally, elements in competency expressions for semantics should follow the standardization rule of simplicity.

The figure below shows the relationship that exists between competency information, which is typically core competency information that is shared and competency semantic information. Competency information is extended using semantic information that includes competency meaning information and competency situation information. Reviewing competency expressions as descriptions or definitions of competency content, competency semantic information might consist of two types of elements in general, and are composed of the aspects of meaning expression (the "competency meaning information") and

situation information expression (the "competency situation information") (Figure 3). Competency meaning information is composed of a set of elements with attributes and properties for representation of competency semantics, especially having direct relationship with the "competency [E3]" class. For example, activity and outcome are also elements that are essential in expressing the meaning of competency.

Competency situation information is composed of a set of elements with attribution and properties for representation of competency semantics, especially having indirect relationship between "competency [E3]" class and other classes such as "environment [E5]", "criteria and method [E4]", "LET institution [E7]". Typically competency organization information may be structured or organized as a taxonomy or in another manner.
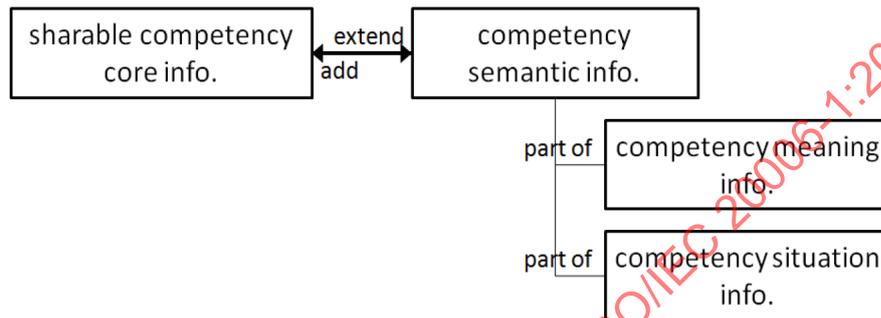

Figure 3 — Conceptual diagram for competency semantic information

7   Competency Semantic Information

7.1   Architecture of competency information

There are currently many different ways to compose competency information using various models and approaches. A model may be used to describe, reference and exchange information regarding competency. The model provides a structure that assists with the formal expression of competency representations and thus assists with the automated exchange of this type of information. A model may take many forms, and include text, graphical expressions, specified relationships, and identification of mandatory and optional elements and the relationships that exist between these elements. For example, the composition of competency information as shareable core information at the information model stage is shown by specifications, such as IMS Reusable Definition of Competency or Educational Objective (RDCEO), and expressed and supported through the implementation of competency data models, such as IEEE standard Reusable Competency Definitions (RCD) or the data schema of HR-XML competencies specification. To support the implementation of an information model, more detailed information, such as competency definition or other semantic information used to describe competency, is needed. In addition, with the support of a semantic composition, an information model can be further extended so that it not only expresses a competency in existence, but also supports the sharing, exchange, and management of these competency representations.

Clause 6 explains that sharable competency core compositions may be used to identify the existence of basic information. For example, main elements may include "identifier", "name", "description" and so on, which attributions and elements are formed using RDCEO or HR-XML competencies. These are simple and essential for the exchange of competency information; however, the sharable core compositions in and of themselves may not provide the necessary detailed information to support semantic interoperability, additional semantic information can be extended freely in the "definition" element by RDCEO or the "competency" element in HR-XML competencies.

This composition includes two types, the meaning element type and the situation element type. These different types of elements include several sub-elements. The meaning element type is focused on the content of competency information itself, in other words, it is something that an individual can do. In the example provided below in Figure 7, these elements are linked to some of the classes that are provided in

ISO/IEC TR 24763 including the "competency [E3]" class, "action [E1]", "evaluation/assessment process [E6]", "role [E9]", etc. (see Figure 1 of ISO/IEC TR 24763 for more information about the relationships amongst these different classes).

Moreover, supplemental composition may be used to modify or arrange a certain competency in order to adapt or customize for individual institutional or organization usages. General or well-known competencies tend to be introduced into individual institutional or organization usage. In spite of customization, there need to be the capability to allow for referencing and having relationships that link to an original competency. The supplemental information may be used if the original competency information needs to be retained and used for exchange, such as national skill standards or well-known competency models. This information type is explained in greater detail in ISO/IEC 20006-3.

The proficiency level composition is accompanying information that provides necessary detail to assist with understanding the competency information being shared, exchanged, or managed. It provides measurement categories for identifying the degree or level of competency (e.g. knowledge, skills, attitude, performance, etc.). Although this International standard, ISO/IEC 20006-1, provides an overview of the different types of compositions, and defines the semantic composition, more information about proficiency level is provided in ISO/IEC 20006-2.

Below in Figure 4 relationships are outlined regarding the system side, the content side, and the customization side (how competency information may be customized and extended). As well, Figure 4 presents an example that illustrates how systems and content can be customized and extended.
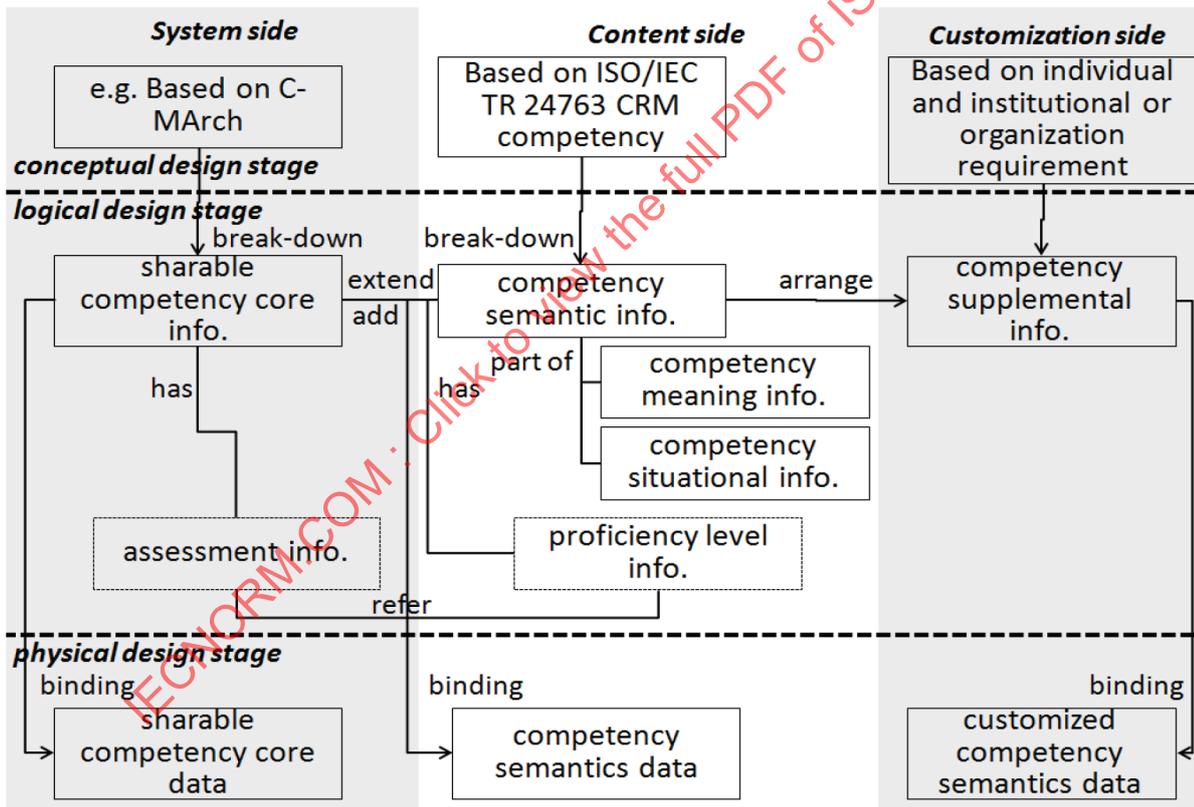

Figure 4 — System design and development model for competency

7.2 Competency semantic information model

As mentioned above, semantic information elements are divided into 2 units: competency meaning information and competency situational information. Competency meaning information is also divided into 2 sub-units: essential unit and scenario unit.

The essential unit consists of two elements: the actionVerb element and object element, which are core substances of the "action [E1]" class. The scenario unit consists of many elements.

This standard provides and defines nine classes and 17 properties to identify "action [E1]" and other classes that have a direct connection to "competency [E3]". These nine classes and 17 properties are based on the classes and properties outlined in the technical report ISO/IEC TR 24763.

The combination of scenario elements can express any kind of "given contexts" of competency.

The situation element consists of several properties, relevant to placement, competency organization, assessment and level. These elements are linked to some directly related classes such as the "competency [E3]" class, "action [E1]", "evaluation/assessment process [E6]", "role [E9]", etc. (see Figure 1 of ISO/IEC TR 24763 for an example). The "action" object in Figure 5 below is equivalent to actionVerb, object (of actionVerb), object modifiers and some contextual expressions.

Figure 5 shows the hierarchies: All elements in Figure 5 below are useful to understand and manage competency information, but there are no direct relationships with the definition of competency content itself.

Competency meaning information elements

— Essential unit

— actionVerb

— object

— Scenario unit

— relevantKnowledge

— tool

— resources

— task

— performanceProcess

— purpose

— prerequisite

— condition

— outcome

— role

— assessmentProcess

— performanceState

— Competency Situational information elements

— placement

— taxonomy

— siteInTaxonomy

— relatedCompetency

— level

— criteria
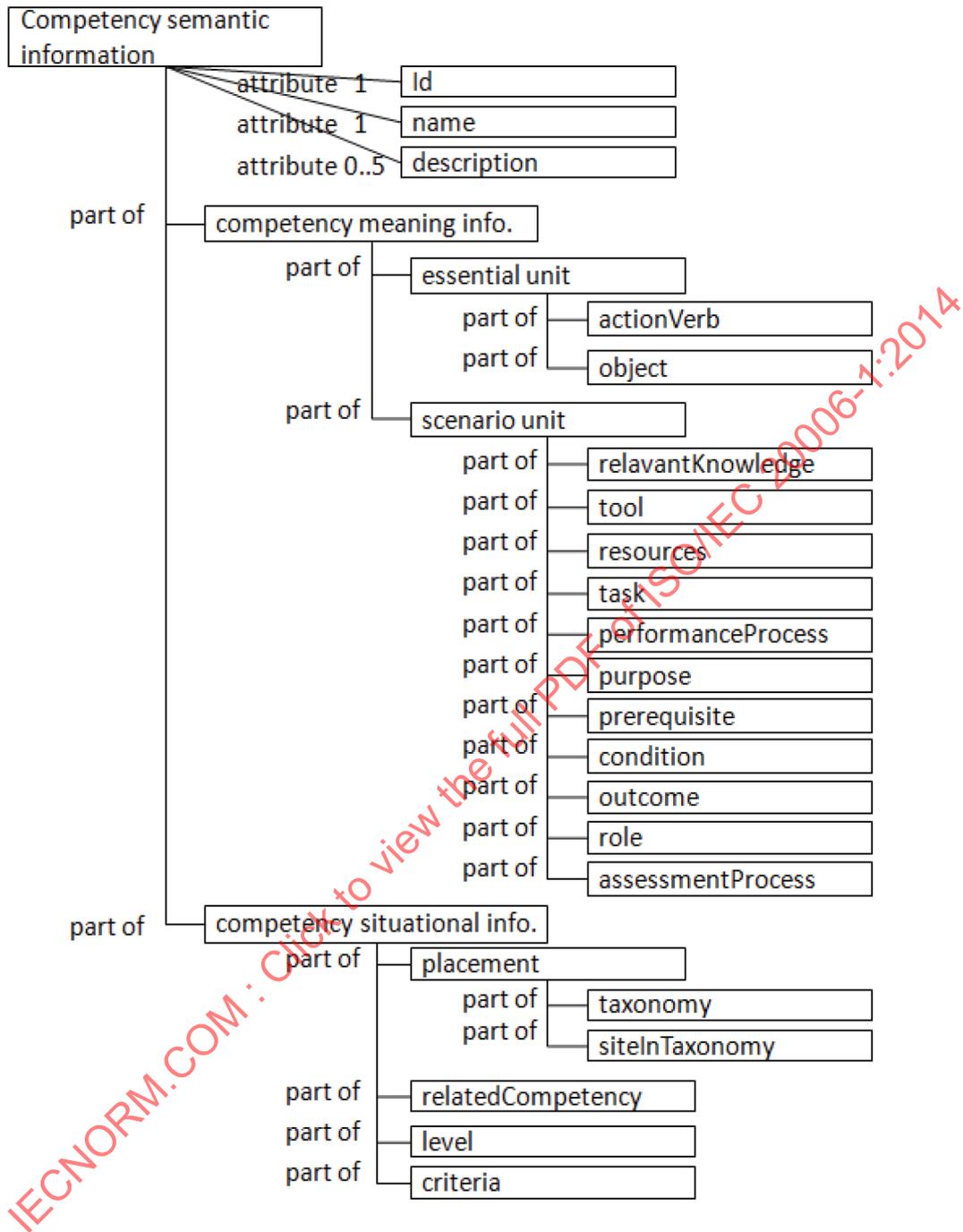
Figure 5 — Competency semantic information model

More details regarding each of the competency semantic information items is provided in the subsequent clauses. The item identifiers, names, explanations, examples and notes are outlined. In addition, this structured competency semantic information can be mapped to the ITLET Conceptual Reference Model so that a common reference point is created for concepts related to competency that are expressed within ITLET systems. For example, the actionVerb and object sub-units could be considered part of the "action [E1]" class. In all, ISO/IEC TR 24763 provides and defines 9 classes and 17 properties. The relation to ISO/IEC TR 24763 classes is provided for each competency semantic information item in the subsequent clauses.

7.3 Types of Competency Semantic information - Competency Meaning Information

7.3.1 Introduction

As noted in Figure 3, competency semantic information includes competency meaning information (Clause 7.3), which is divided into two sub-units, essential unit (Clause 7.3.2) and scenario unit (Clause 7.3.3).

7.3.2 Essential unit

Essential unit can be used to express and action that needs to be executed or provide information about how an input is transformed to an output. It may include different types of verbs that could be categorized as behavioural, affective, cognitive, etc. Essential units include an actionVerb and an object.

7.3.2.1 actionVerb

Element Specification	
Identifier	ISO_20006_1_2012_av
Name	*actionVerb*
Explanation	To express the action that needs to be executed or how input is to be transformed to output. It includes not only behavioural verbs, but also may include affective and cognitive verbs. This element can have sub-elements (e.g. child verbs). This element is indispensable to define competency. It can be used to indicate knowledge, belief, and other characteristics
Relation to ISO/IEC TR 24763 class	action [E1]
Example	From title; statistical skill → analyse
	From definition; ability to analyse statistical data → analyse
	The verb has child verbs based on the construct and process that could include items such as **design** survey, **set** data, **analyse** statistical data, **write** report. All of the verbs can be children.
Note	— Verb expressions may be still ambiguous, so sophisticated or structured verb taxonomies are recommended.
	— For expressing statistical skill, "statistical data" is the object, and "analyse" is the actionVerb. Factor analysis skill is a statistical skill, object and verb are the same as abstract level, but additional specific elements may be needed to express something like a "factor analysis skill" in object expression or scenario elements.

7.3.2.2 object

Element Specification	
Identifier	ISO_20006_1_2012_ob
Name	*Object*
Explanation	The target of an action or verb as grammatical object or objective case. Action and verb can be qualified with object. The combination of verb and object is a typical pattern of expression of skill and competency.
Relation to ISO/IEC TR 24763 class	action [E1]

Example	From title; analysis skill → none
	From title; statistical skill → statistical data
	From definition: ability to analyse statistical data → statistical data
Note	For expressing statistical skill, "statistical data" is the object, and "analyse" is the actionVerb. For a more specific statistical analysis skill, such as "factor analysis skill", the object and verb are the same, but additional information elements may be needed.

7.3.3   Scenario unit

Scenario unit are used to describe the scenario where the competency is being executed or provides additional details that provide context for how an input is transformed into an output. Scenario units include items such as relevantKnowledge, tool, resources, task, performanceProcess, purpose, prerequisite, condition, outcome, role, and assessmentProcess.

7.3.3.1   relevantKnowledge

Information Element Specification	
Identifier	ISO_20006_1_2012_rk
Name	*relevantKnowledge*
Description	Knowledge that is needed before execution or during execution to attain the learning objectives or outcomes. This could be provided in the form of a list or an explanation of the knowledge relevant to the competency. For example, "counselling knowledge" is closely related to social skill. Some related information could include educational knowledge title. Some types of knowledge could be stated as an element and some may be stated as being critical or required.
Relation to ISO/IEC TR 24763 class	action [E1]
Example	Relevant knowledge can be set in various ways. In the case of statistical skill, the most abstract level is mathematics or statistical theory, another layer would be different approaches such as the application of factor analysis theory or procedural knowledge (for example, at a specific level this knowledge could include items such as knowledge of identification of outliers, sample size, and how normality of distribution is set).
Note	— In the above example, relevant knowledge can be measured to compare the attainment level of competency in pre-test with summative test results.
	— It is suggested that relevant knowledge can refer to knowledge structure, subject structure, or domain knowledge ontology to help clarify complex references.

7.3.3.2   tool

Information Element Specification	
Identifier	ISO_20006_1_2012_to
Name	*Tool*
Description	These are modifiers for actionVerb. These can include equipment, software or other devices that an individual uses in execution of the competency. For example, programming skill requires not only knowledge of computers and software, but also to the use computers and software as tools. An action is executed using some instrument(s), materials, equipment, software or other devices that an individual uses in execution of a competency.
Relation to ISO/IEC TR 24763 class	action [E1]

Example	From title; statistical skill → a) none, b) statistical software or factor analysis program can be used effectively to accomplish a task
	From definition; ability to analyse statistical data with specific statistical software → statistical software
Note	The tool may be digital or non-digital or a combination of both (e.g. software and hardware).

7.3.3.3 resources

Information Element Specification	
Identifier	ISO_20006_1_2012_re
Name	*resources*
Description	Items used to support execution or performance of a target competency. Information resources or reference material are used in execution of a competency. Some competencies should be executed in conformity to legislation or defined rules. Instantiated competencies in certain industries or organization need to be specified and delineated (e.g. in standards, guidelines, manuals, etc.).
Relation to ISO/IEC TR 24763 class	action [E1]
Example	In the case of statistical skill; statistics textbook, statistical software guidebook or analysis procedure manual
Note	Resources may be in digital or non-digital format.

7.3.3.4 task

Information Element Specification	
Identifier	ISO_20006_1_2012_ta
Name	*Task*
Description	Tasks are designed with some knowledge, skills and competencies in mind. Tasks are set not only in work settings but also in academic activities. Some competencies or skills have named titles that are based on specific task(s) in industry (or other) domains.
Relation to ISO/IEC TR 24763 class	action [E1]
Example	In case of statistical skill, market analysis task, customer service task, or need definition task are typical ones.
Note	Resources may be in digital or non-digital format

7.3.3.5 performanceProcess

Information Element Specification	
Identifier	ISO_20006-1_2012_po
Name	*performanceProcess*
Description	Process or activities that consist of a competency and its performance. Executing competency requires performance of some sub-activities or processes. Refinements are used to inform child relationships. This element is used to elaborate child relationships by providing a breakdown of the process involved.
Relation to ISO/IEC TR 24763 class	action [E1]

Example	In the case of factor analysis skill, some child competencies could be set to support the performance process.
	For example, factor analysis skill: definition → to perform factor analysis procedure at a graduate student level
	— Child 1 – to provide written rationale that accompanies the data analysis (i.e. to indicate if variables are truly continuous, variables are multivariate normally distributed);
	— Child 2 – to identify whether exploratory or confirmatory factor analysis has been performed;
	— Child 3 – to complete all three factor analysis steps in correct sequence (i.e. factor extraction, factor rotation, and identification of the factors); and,
	— Child 4 – to submit data output file using software package X
Note	Note that typically the development of these types of structures requires the involvement of many different experts. For example, in a higher education institution, the development of these types of structures may involve subject matter experts, pedagogical or academic faculty developers, instructional technology designers, librarians, and others.

7.3.3.6 purpose

Information Element Specification	
Identifier	ISO_20006_1_2012_pu
Name	*purpose*
Description	Goal, aim, or orientation to perform or to acquire. It means the reason why the competency is needed. This element gives context for the competency.
Relation to ISO/IEC TR 24763 class	evaluation, assessment process [E6]
Example	In the case of statistical skill
	→ To find a new fact through data = adequate / to specify customer needs – adequate.
	→ To build a new theory = too ambiguous.
	For example, "to forge a trusting relationship with others" is a purpose of "social skill" execution. The outcome element is sometimes confused with purpose element. The former is a final state expression of object, the latter is an orientation of execution.
Note	A competency is executed to attain a certain purpose. The purpose of competency execution will be changed by context and role, so it is not fixed. The purpose can be used to support assessment and evaluation.

7.3.3.7 prerequisite

Information Element Specification	
Identifier	ISO_20006_1_2012_pm
Name	*prerequisite*
Description	prerequisite or matter in order to execute a competency
Relation to ISO/IEC TR 24763 class	role [E9]

Example	In case of statistical skill: received graduate level statistics course or training.
	For example, if he/she does not have graduate level statistics course or training, then this can impact on performance. If a person does not "give one's mind to customers (attention)", then social skill will be non-functional or not executed.
Note	

7.3.3.8 condition

Information Element Specification	
Identifier	ISO_20006_1_2012_cd
Name	*condition*
Description	Environmental condition or performance state, which is useful to assess competency execution and to express degree of difficulty, frequency, strength and so on.
Relation to ISO/IEC TR 24763 class	action [E1] or evaluation, assessment process [E6]
Example	In case of statistical skill: using biometrics data / ability to work with more than 1 million data points.
	Another example would be when "social skill" is described simply as a state of skill execution, "persuading others". It is useful to describe in more detail the state of skill execution, for example "persuading others who have xenophobia".
Note	Individuals are sometimes required to demonstrate their competency under specific conditions or within certain restrictions. For example, competency could be demonstrated in complex or difficult conditions. The relevant condition for performance should be defined in the level class of competency.

7.3.3.9 outcome

Information Element Specification	
Identifier	ISO_20006_1_2012_ot
Name	*Outcome*
Description	Description of outcome, after competency demonstration. Including output, sequence and result through action(s) along with competency execution.
Relation to ISO/IEC TR 24763 class	outcome [E8]
Example	In the case of statistical skill, completion of an academic report using statistical analysis or completion of a market analysis strategy based on statistical analysis.
Note	Another example would be "social skill" executed to achieve an intended object or outcome, then "fulfilment of customer requirements" can be traced as a state element.

7.3.3.10 role

Information Element Specification	
Identifier	ISO_20006_1_2012_ro
Name	*role*
Description	Perspectives of job role, position or specific functions that individuals have. A perspective might influence or direct orientation to competency execution.

Relation to ISO/IEC TR 24763 class	role [E9]
Example	In case of statistical skill: an individual may perform statistical analysis skills as a market researcher or from the perspective of a consultant for example.
Note	

7.3.3.11 assessmentProcess

Information Element Specification	
Identifier	ISO_20006_1_2012_ap
Name	*assessmentProcess*
Description	In order to keep competency measureable, assessment is important. Assessment record information is used as evidence and supports accountability. It consists of items such as assessment, execution date, place, actors, and records with methods and metrics.
Relation to ISO/IEC TR 24763 class	evaluation and assessment process [E6]
Example	Output in the form of a written report, or a data file, or a test or exam usually is evaluated based on predetermined criteria. In this case, the assessment methods could be expressed in an IT system in a variety of ways such as, — [Assignment] Data analysis report — [Mid-term test] date, score — [Final exam] date, score
Note	Note that the result of the evaluation in the case of a higher education institution could be expressed in an academic record, such as a report card or transcript.

7.4 Types of Competency Semantic Information - Competency Situation Information

7.4.1 Introduction

Competency semantic information also includes competency situation information (as noted in Figure 3). These types of information are used to express the origin of competency information, how it is organized and related, different levels and criteria that are used for measurement. Competency situation information includes items such as taxonomy, placement, relatedCompetency, level, and criteria.

7.4.2 Situation element unit

Situation element units provide additional contextual information that is used to record detailed competency information. These types of competency information units include placement, relatedCompetency, level, and criteria.

7.4.2.1 placement

Information Element Specification	
Identifier	ISO_20006_1_2012_pl
Name	*placement*
Description	To express the specific position of a competency in a whole competency structure or a model. Usually the placement refers to sub elements of "taxonomy" sub "site in taxonomy.
Relation to ISO/IEC TR 24763 class	competency [E3]

Example	taxonomy -> InfraSS_ver.2011_layer02_TokyoMetropolitanGovernment
	siteInTaxonomy -> Layer 02/04
Note	

7.4.2.2 relatedCompetency

Information Element Specification	
Identifier	ISO_20006_1_2012_rc
Name	*relatedCompetency*
Description	To express the relationship to other competencies. There are several types of relationships. A basic relationship is a parent-children relation in a taxonomy. Other relationships can be associated with performance. Sometimes there are other competencies that are needed for execution of this competency. Some competencies can require that an individual has a specific competency prior to the execution of an activity. Other competencies require that an individual execute a competency in combination with other competencies.
Relation to ISO/IEC TR 24763 class	competency [E3]
Example	In the case of statistical skill:
	— [parent] Social research competency
	— [children] Factor analysis skill/ Regression analysis skill
Note	

7.4.2.3 level

Information Element Specification	
Identifier	ISO_20006_1_2012_lv
Name	*Level*
Description	Competency usually is accompanied with proficiency level class as noted in ISO/IEC 20006-2. If there is not specific data for level in a system, level information should be defined by the elements. Sometimes, a competency has not only several levels, but also has several types of levels.
Relation to ISO/IEC TR 24763 class	criteria and method [E4]
Example	In this case, level information can refer. For example, a reference could be made to an external IT system such as InfraSS_Skill_level_2.
	Some examples are provided below in Case 1 and Case 2 where the level information is provided as there is no reference to an external IT system.
	Case 1: Social research competency
	— total grade:1
	— target grade:1
	— criterion: to pass the examination
	Case 2: Marketing statistical skill
	— total grade: 5
	— target grade: 2
	— criterion: to perform basic skill performance procedure individually without help
Note	

7.4.2.4 criteria

Information Element Specification	
Identifier	ISO_20006_1_2012_cr
Name	*Criteria*
Description	Providing information regarding competency measurement. Method, metrics, or criteria are used for measuring and assessing a competency.
Relation to ISO/IEC TR 24763 class	criteria and method [E4]
Example	[Method] certification examination [criteria] Score of over 70 out of 100
Note	For specifying assessment criteria and method, please refer to ISO/IEC 19796-3. Assessment execution information can refer to assessmentProcess elements, which are associated with the evaluation and assessment process [E6] class of ISO/IEC TR 24763. Measurement metrics: Competency is defined by metrics for its measurement whether an individual has or executes a certain competency or not. For example, "more than 5 on a 7-point customer satisfaction scale". This is an example of the use of metrics to judge demonstration of a social skill or competency. Measurement method: Skill and competency is defined also by method for its measurement whether an individual has or executes a certain competency or not. For example, "paper based test", which is an assessment method that may be used to measure knowledge. A "360 evaluation" may be used to measure an attitude or a competency.

Annex A
(informative)

Cases and relationships between ISO/IEC 20006 and ISO/IEC TR 24763

This standard provides a general framework and information model based on the Conceptual Reference Model (CRM) from the technical report ISO/IEC TR 24763, using common vocabulary and a toolkit to identify competency information and related objects within IT systems. The conceptual reference model includes nine classes. These classes can be considered as informational elements that support competency semantics. As explained in Clause 6.2. above, three cases can be differentiated to describe how competency semantics might be implemented in and used by ITLET systems:

Case 1: Directly used by other systems;

Case 2: Referring to competency database or competency information from other systems;

Case 3: Building a competency system or database.

For case 1 (Table A.1), it is hard to implement detailed information. Normally only a competency title and some categories, or level information are available. These categories can be referred into the elements described by ISO/IEC TR 24763. Level information is described more fully in ISO/IEC 20006-2. Information such as learning time, result, and course title in Table A.1 are outside the scope for this standard.

Table A.1 — Example of interface using competency information; personal learning record 1

course title	level	category	learning and access time	result
communication skill	basic	Human	5:32:20	Completed
business strategy	middle	business	6:11:35	Open

Case 2, which is shown below (Table A.2) deals with the implementation of referring to competency databases or competency information from other systems. Some of this information can be defined using semantic classes provided in ISO/IEC TR 24763. Although the information items provided below are considered as "action [E1]" and "outcome [E8]" classes, more specific elements and expressions are needed. More detailed competency information that indicates composition and constituent elements provides a more explicit expression to support competency semantics and the exchange of competency information.
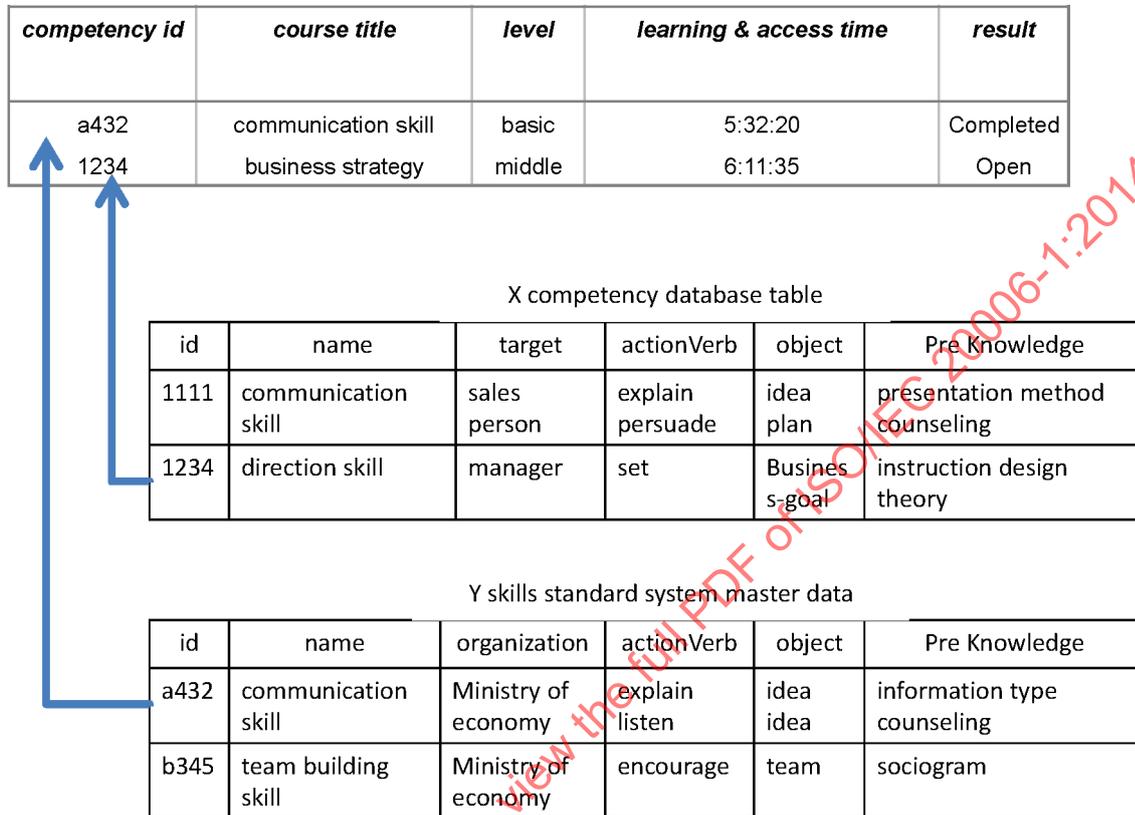
Table A.2 — Example of interface referring competency information: personal learning record 2

competency id	course title	level	learning and access time	result
a432	communication skill	basic	5:32:20	Completed
1234	business strategy	middle	6:11:35	Open

The case 3 (Figure A.1) below provides more details regarding the implementation of referring to competency databases or competency information from other systems. In this case an IT system is referring to "X competency database table", which could have been developed by another company or a professional association. The IT system also is referring to "Y skills standard system master data", which may have been developed as a national or industry standard. The information contained within "X competency database table" and "Y skills standard system master data" can be identified with the semantic classes provided in ISO/IEC TR 24763. In Figure A.1, "target" in the middle of the figure is to

set as "role [E9]" class, and "organization" in the bottom of the figure is to set as "LET Institute [E7]" class. Although the information provided includes "action [E1] and "outcome [E8]" classes in Table A.2, Figure A.1 indicates how more specific elements and expressions can be used to support interoperability. Information composition and elements focused on expressing competency semantics are needed to provide a more detailed picture of how a system can refer to competency information that resides in other systems.

competency id	course title	level	learning & access time	result
a432	communication skill	basic	5:32:20	Completed
1234	business strategy	middle	6:11:35	Open

X competency database table

id	name	target	actionVerb	object	Pre Knowledge
1111	communication skill	sales person	explain persuade	idea plan	presentation method counseling
1234	direction skill	manager	set	Business-goal	instruction design theory

Y skills standard system master data

id	name	organization	actionVerb	object	Pre Knowledge
a432	communication skill	Ministry of economy	explain listen	idea idea	information type counseling
b345	team building skill	Ministry of economy	encourage	team	sociogram

Figure A.1 — Semantic information elements in ITLET corresponding to the classes

ISO/IEC TR 24763 provides a Conceptual Reference Model that includes classes and relationships that may be found in IT systems used for LET to manage and exchange competency information and related objects. In order for the conceptual framework of ISO/IEC TR 24763 to be implemented in practice, it should be transformed into a broader general framework as well as into a more concrete model such as an information model. This multipart International Standard focuses on a general framework that is used to adapt, arrange and recompose entities from ISO/IEC TR 24763 to support the management and exchange of competency information present in information technology (IT) systems used to support learning, education, and training (LET). This multipart international standard focuses on the information model, and provides mappings between ISO/IEC TR 24763 and this standard.

In order to develop information models (and not to develop physical or psychical models) a platform-independent approach is followed. Guidance is provided regarding an informative framework, which will include an architecture that describes how information is exchanged within and among information technology systems that are used to support the management and exchange of competency information. In addition, this standard will assist with understanding a framework that can be used by those designing, developing, and working with IT systems that are used to support the management and exchange of competency information for learning, education, and training.

This International Standard also provides preliminary information regarding proficiency levels of competency information such as knowledge, skill, ability, and attitude. Although ISO/IEC TR 24763 provides a common language and approach for competencies and related objects, it does not define detailed information. This International Standard describes how ISO/IEC TR 24763 entities may be

adapted, arranged and recomposed to support the management and exchange of competency information present in information technology (IT) systems used to support learning, education, and training (LET).

During previous study periods, many NBLOs provided information. Based on the information provided and pertinent submissions provided during this standards development process, use cases of this information model are described in the remaining annexes.
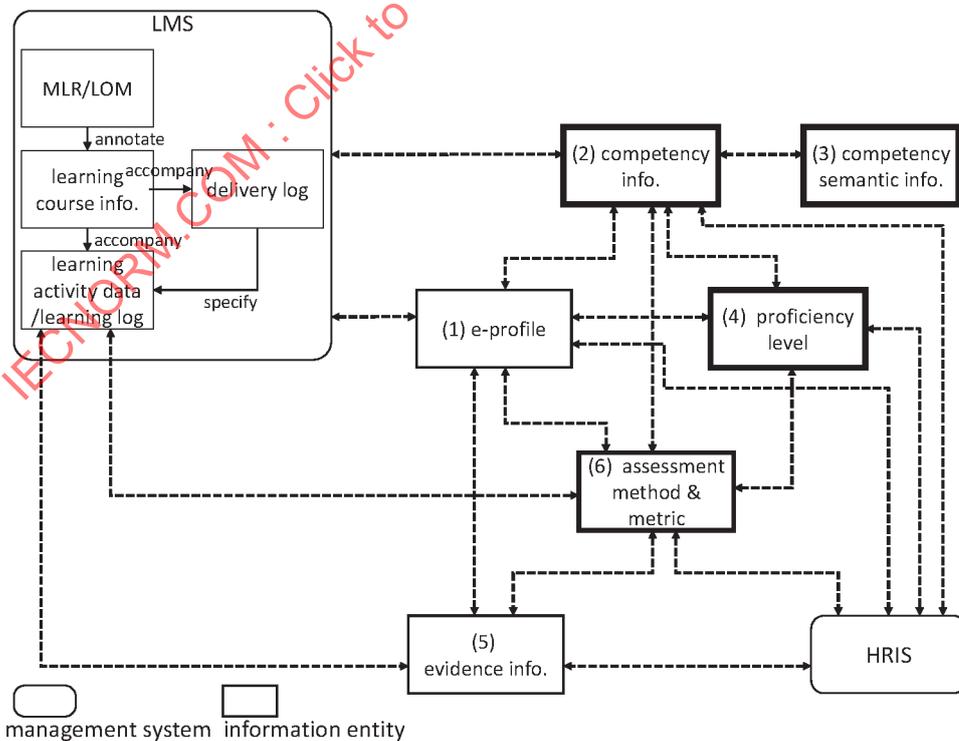
Annex B
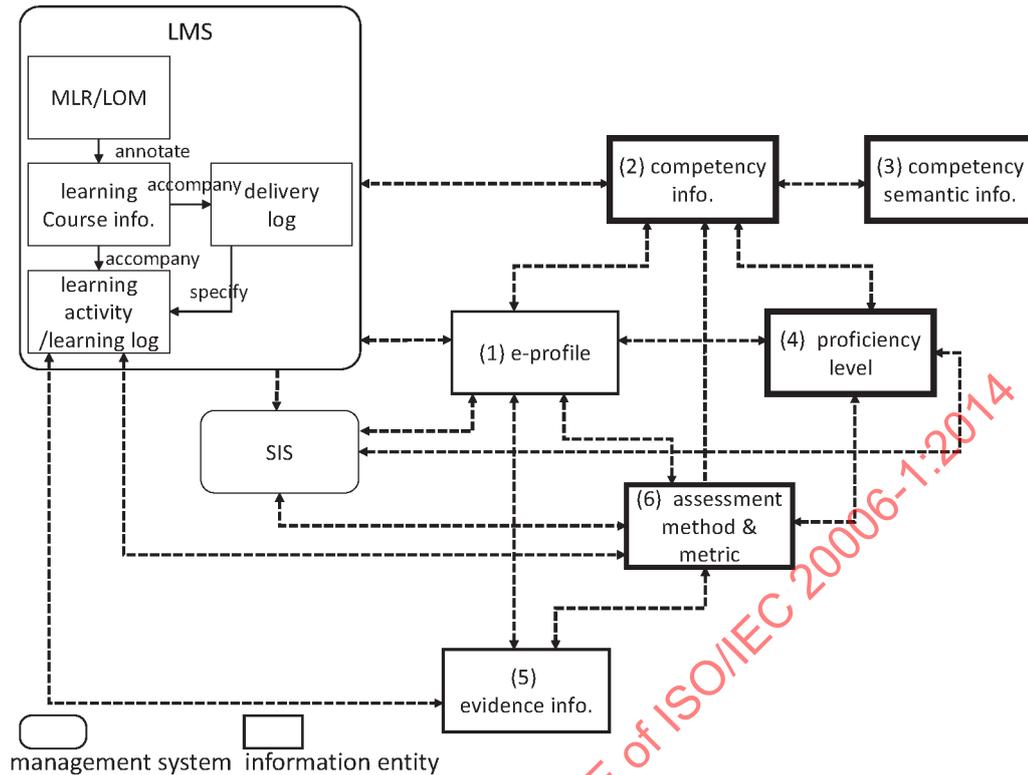## (informative)

Examples for competency information architectures

Below in Figure B.1, a data-entity based Competency Information Architecture is provided that demonstrates the relationships between each of these six information entities.
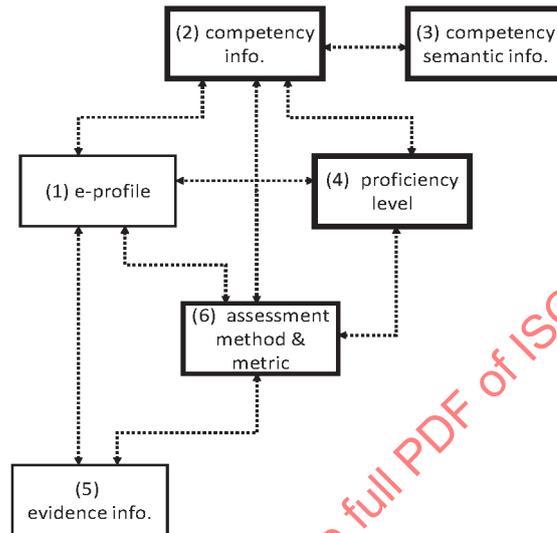
Figure B.1 — Competency Information Architecture

Figure B.2 — Competency information architecture with system architecture detail for HRM

Figure B.3 — Competency Information Architecture with system architecture detail for Higher Education

This standard ISO/IEC 20006-1 mainly addresses and provides guidance regarding the second entity "competency information" and how it is organized (Clause 6.3), and the third entity "competency semantic information" (see Clause 6.5). In addition, an introduction to the relationships between this standard and the competency CRM (ISO/IEC TR 24763) is provided in sub-Clause 6.4. It should be noted that ISO/IEC 20006-2 addresses the fourth entity "proficiency level" of the competency information architecture, also called "level information". The first entity "e-profile", the fifth entity "evidence information" and the sixth entity "assessment method and metric" are not addressed by the standard series ISO/IEC 20006.

Additionally, in Clause 7 the difference between the second entity ("competency information") and the third entity ("competency semantic information") is clarified. Although the representation of competency concepts can be ambiguous in human communications, due to the way people view and construct competencies within ITLET systems, certain competency information may exist in real systems as a certain type of data and may be labelled as something else. For example, a certain company set "communication skill" as one critical assessment dimension (factor) or as complex or composite learning objectives, then the term of "communication skill" may be used as a label that exists within the ITLET system and can be exchanged with other ITLET systems in the real world.

ITLET systems (such as LMSs and HRM systems) have to deal with competency label data. Whether the definition of a skill is clear or not, and also whether the definition exists or not, the data may need to be exchanged among many stakeholders, organizations and other ITLET systems and applications. This competency related information should be consistent and well formed in implementations being used for managing and exchanging data. For the purpose of managing and exchanging, identifiable information elements, such as identifier, name, creator, etc. are indispensable to manage and exchange competency information amongst ITLET systems.

Some stakeholders and organizations require access to more detailed competency semantics, especially the individuals who want to use and produce further development of competency semantics, such as teachers, learners, instructional designers, HRD staff, learning content developers, and so on. More detailed information about competency semantics is useful to refer to and to understand what a

competency is, not only to support and develop human understanding but also for intelligent information systems. Competency related objects as semantic entities can provide meaning and contextual information. These entities were indicated in ISO/IEC TR 24763.

This means that two aspects are needed to build information models for competency; one consists of identifiable elements for indicating the existence of a competency and for exchanging and managing a competency, and the second includes semantic elements used to specify meaning and characteristics of competency.

Annex C
(informative)

Patterns of competency organization by HRMLs

Each competency is usually set under a unit of competency. A unit of competency is organized as a tree structure, a network structure or a hierarchal structure (taxonomy). This means there are different competency organization forms. A structural complex or an organized competency can include multiple child or sub-competencies. Parent-Children relationships may be organized into several patterns.

Competency information semantics requires ITLET systems to be able to understand and handle the relationships (or structures). Children might become elements or factors of a parent. In other words, children are expressing meaning of a parent, while a parent also provides context for the children. These structures or relationships promote meaningful understanding for people. In order to support the need for enriched competency semantic information, HRMLs proposed the characteristics of competency structure patterns using ontology engineering techniques (Figure C.1). Then as noted in Figure C.1, five different types of structural and relational patterns were derived. More details regarding each of the five patterns are provided below.

The 1st pattern, General-Specific relation, is the most typical in the competency relations. The parent competency is the categorical name or the over-arching concept of sub-competencies. Child competencies are bundled together under the parent competency and are based on the essential character of the parent competency identity. However, each has a specific function in expressing a specific aspect of the parent competency. In case of "automobile", the parent is "automobile", and children are "bus", "track", and "family car", and so on. All "automobiles" have a common ability and purpose "to transport humans or others". The pattern is shown as "member of" relation in Figure C.1. In the case of "social skill", the primary characteristic is the "ability to interact with other people successfully for desired outcome". Figure C.1 illustrates that parent competency "social skill" can group together "communication skill", "negotiation skill", and "leadership skill". Each child competency (or sub-competency) expresses a more specific aspect of the parent competency.

The 2nd pattern is the Whole-Parts relation, which is a typical pattern. Children are parts or elements of a parent. The pattern is shown as the "is-part-of" relation in Figure C.1. For this pattern, the child (or sub-elements) in a Whole-Parts relation are grouped together to contribute to the overall parent competency. Figure C.1 below represents various manifestations of "social skill", both "social awareness skill" and "social understanding skill" are related to each other and are part of the parent competency. In the case of an "automobile", parent is automobile, and children are "tire", "engine", "handle" and so on. If one part is missing, the parent can be non-functional. In Figure C.1, the parent competency of "social skill" includes the parts such as "social awareness skill" and "social understanding skill". In this case both of the child competencies are requisite parts of the parent competency.

The 3rd pattern is Universal-Particular relation. Parent and children have the same meaning or the same character, but they are being applied in different contexts. The pattern is shown as "is-contained in" relation in Figure C.1, where the parent competency "social skill" is applied in the children competencies in the contexts of "school" and "family". In case of "automobile", parent is automobile, and children are "sporty car", "sedan", "wagon", and so on. As noted in Figure C.1, the parent competency of "social skill" is viewed as universal, and the two child competencies are particular manifestations or types of the parent competency social skill, in this case one is "social skill in school" and the other is "social skill in family".

The 4th pattern, Abstract-Concrete relation, is instantiation. Children are objective entities of a parent, such as instance. Children have the same essential properties of parents such as attributes or factors. The pattern is shown as "is-instance-of" relation in Figure C.1. In case of "automobile", parent is automobile, and children are cars from specific car builders ("xxx" car with "xxx" as the car builder company). In

Figure C.1 the parent competency "social skill" has two child competencies. One is "social skill" as it has been defined in an institute, and the other is a "social skill" as it has been defined in a company.

The 5th pattern, Level relation, is to figure out the degree of competency. The parent can be further described using the child relations that are used to express the degree or grade for example, to which a competency is attained as level. Children of level do not reflect the meaning of a parent; however, children of level can express different states of execution. So children of level are not essential for the concept of a parent, these are recognized through the concept of role to a parent. The pattern is shown as "role" in Figure C.1 below.

This standard focuses on expressing competency information, not expressing competency organization directly. This standard is useful for building and using a competency information database or exchanging and managing competency information. This standard can be used to support a shared vocabulary regarding the types of relations that exist in the way that competency information is organized and to assist in efforts to exchange and manage this type of information.
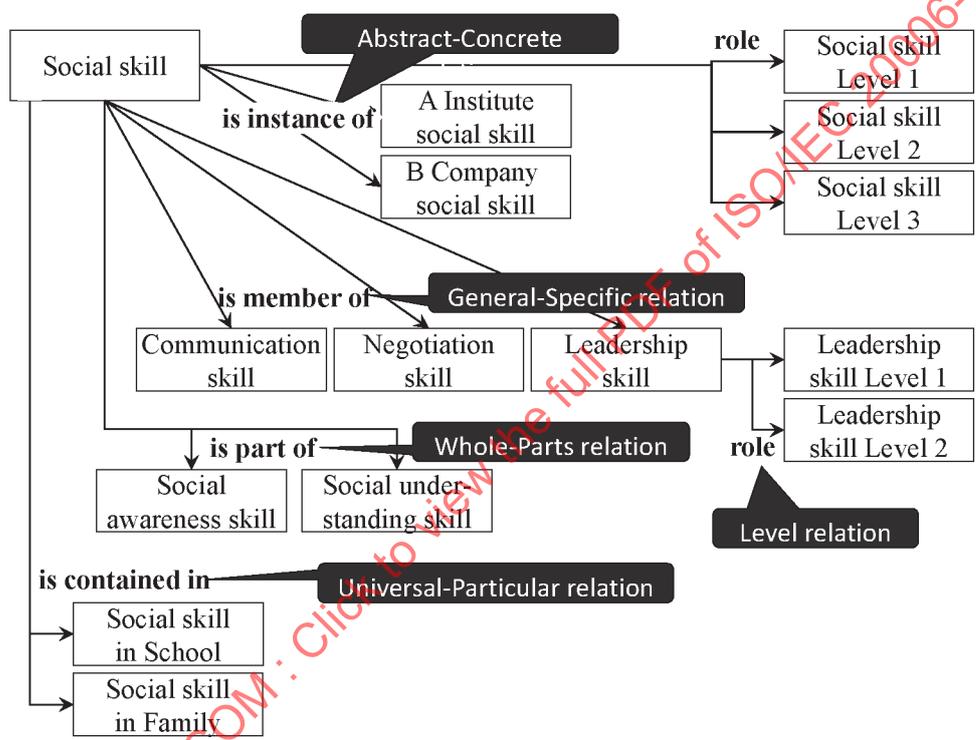

Figure C.1 — Relations in competency organization

Annex D
(informative)

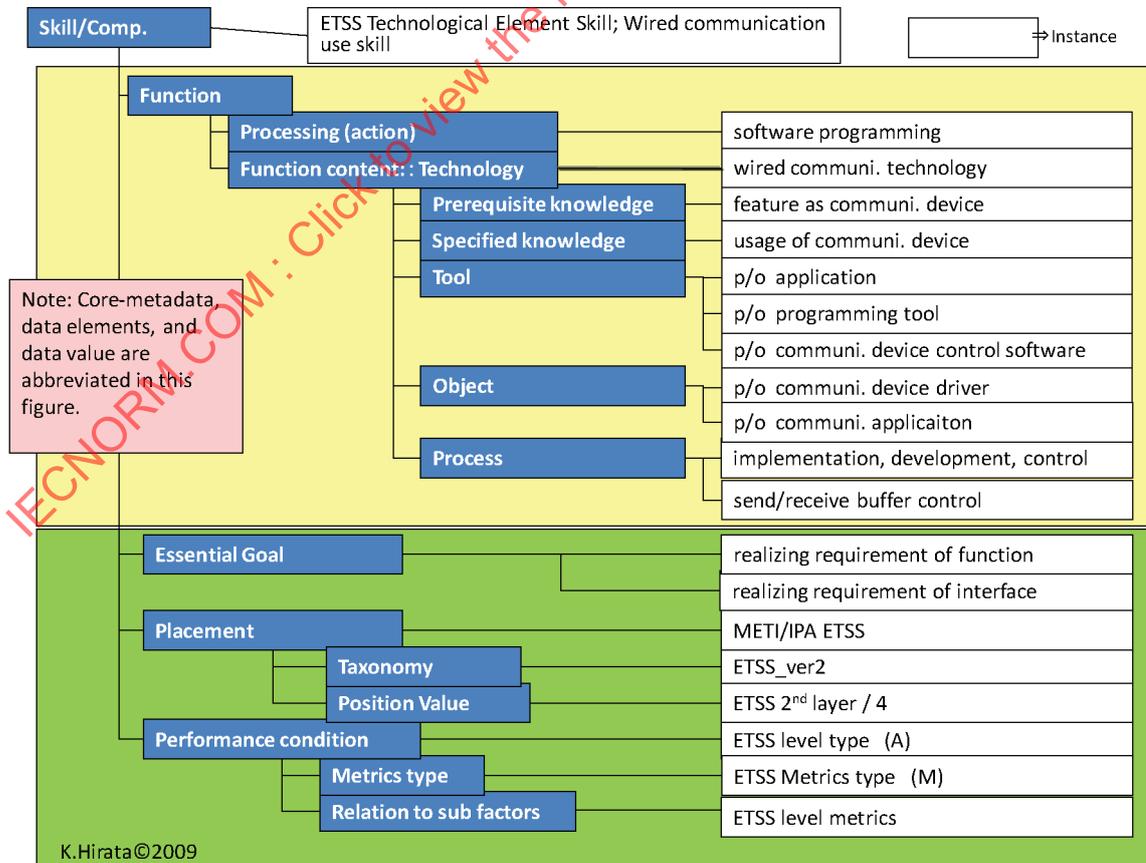# Previous use case on Japanese National Skills Standard (ETSS)

D.1 General

To develop world-class IT human resources, IPA (Information technology Promotion Agency) and METI (Ministry of Economy, Trade and Industry) have established the Common Career/Skill Framework to serve as a reference model for ITEE (IT Engineer Examination) and three skill standards (ITSS, ETSS and UISS). This framework serves as the foundation for developing highly skilled IT human resources.

In working to strengthen development capabilities for embedded software, IPA is formulating and promoting the Embedded Technology Skill Standards (ETSS) as guidelines for the effective development and deployment of human resources. ETSS consists of the three elements of "skill standards," "career standards" and "training standards."

D.2 Development of semantic information model on ETSS as previous case

IPA developed a meta model for skill expression for ETSS skill semantics, and then it also conducted its data set for common usage of ETSS skill data among industries. Figure D.1 below provides one example of an expression of a certain skill in ETSS, "Wired communication use skill"[3].

Figure D.1 — Example Implementation for a certain skill in ETSS

Annex E
(informative)

Application to Japanese National Skills Standard (ITSS)

E.1   General

To develop world-class IT human resources, IPA (Information technology Promotion Agency) and METI (Ministry of Economy, Trade and Industry) have established the Common Career/Skill Framework to serve as a reference model for ITEE (IT Engineer Examination) and three skill standards (ITSS, ETSS and UISS). This framework serves as the foundation for developing highly skilled IT human resources.

Intensifying competition in the IT industry has prompted companies to shift their development bases overseas to avoid high personnel expenses in Japan, and in turn is causing a so-called hollowing-out of the industry. To prevent this shift, there have been calls for urgent action to develop essential IT human resources. In response, METI established ITSS as an industry skill standard in 2002. METI subsequently transferred the control of ITSS to IPA and entrusted IPA with the administration of these standards.

Specifically, ITSS is a set of systematic indices that clarify and systemize the skills needed for people working in the IT services industry. ITSS is utilized as a tool for developing professional human resources to implement corporate strategies. Organized into a career framework, ITSS classifies the information services industry into 11 job categories and 35 speciality fields. In each field, there are several skills, skill definition for each level, and knowledge. One appealing feature of ITSS is that this standard allows engineers to draw roadmaps for their own futures and career advancement.

Approximately 90 % of large enterprises and over 60 % of SMEs have introduced or are considering using ITSS. As reflected by these figures, ITSS is being effectively utilized as an indicator for business managers and engineers to systematically consider both their own professional development and the future development of their respective companies.

E.2   Application of semantic information model to project quality management skill in ITSS

ITSS defines job specification and skills for 13 types of IT engineers, consultants, IT architects, project manager, application specialist, and so on. Skills are defined under each job. There is one example of project quality management skill in a skill set for IT project managers. Figure E.1 below provides details regarding the representation of the semantic information model within an IT system that is used to express a specific skill.
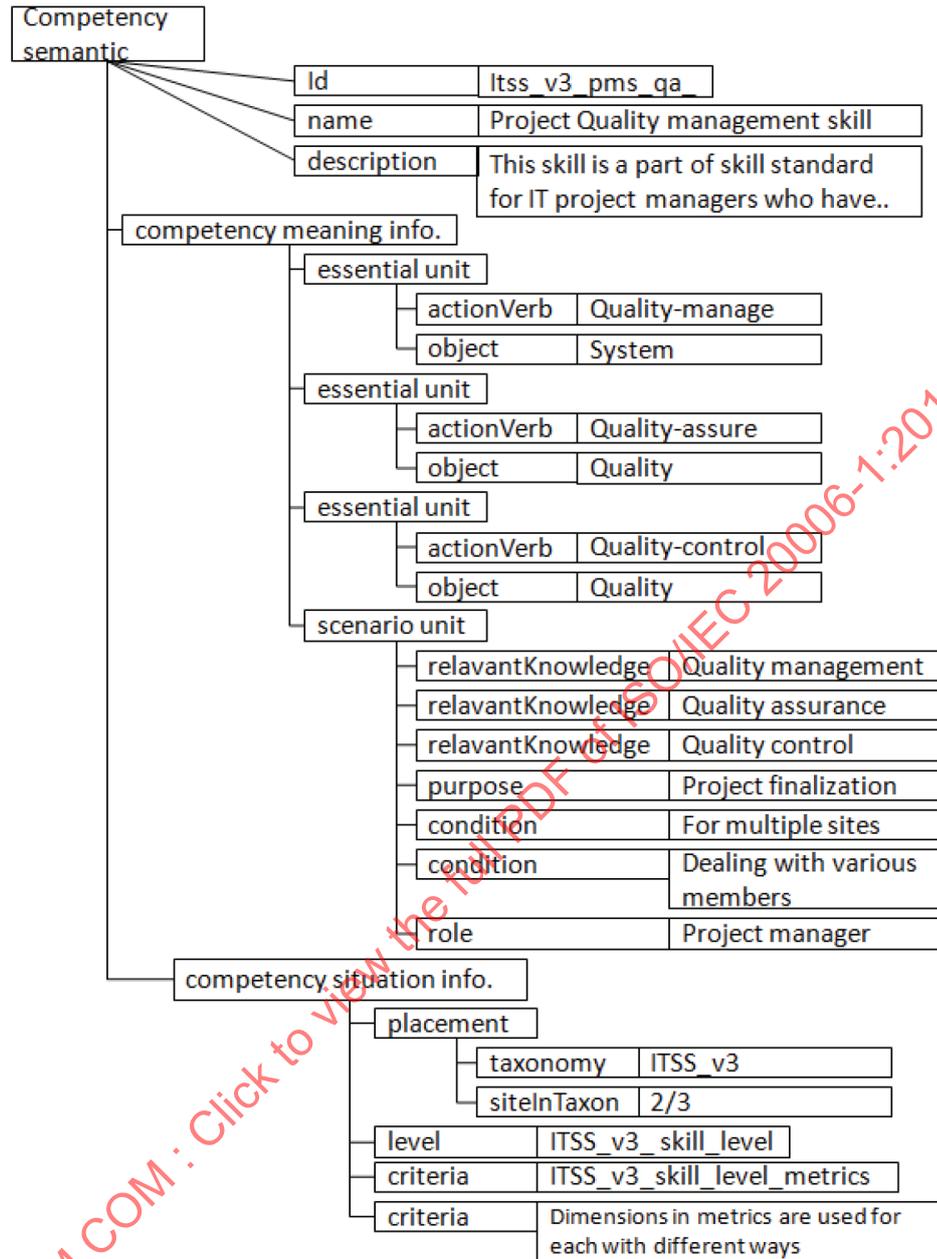
Figure E.1 — Competency semantic information model for project quality management skill

Annex F
(informative)

Application to Canadian Learning Management System Desire2Learn

F.1   General

Founded in 1999, Desire2Learn is a Canadian company that provides platforms and services that support learning, education, and training in K-12 Schools, Higher Education, Corporate, Health Care, and Government.

As a learning management system that is mainly used in Canada and the USA, there are many functionalities that Desire2Learn provides to learners, instructors, and administrations such as:

— Desire2Learn Competency Model that underpins the IT structure to support the linkages made between competency elements, learning objectives, and activities;

— IT structure that is flexible and adaptable to the competency definition requirements of each discipline, subject area;

— Processes to support instructor and administration monitoring, exchange, and re-purposing of competency information structures within a course, across different courses, within a department, across an institution, with other institutions;

— Methods to determine specific competencies using measurable action statements;

— Ability to pinpoint where specific competencies are being measured and to determine and compare the respective assessment methods that are being used;

— Ways to determine the learning objectives, activities, and the specific achievement levels for each competency;

— Ability to measure the achievement thresholds attained (determined by institution, department, major or course goals) when a competency is being assessed;

— Ability to develop, use and evaluate simple and complex competency structures;

— Methods to capture and express learner competency requirements within an IT system and to record individual student competency attainments; and,

— Other.

Furthermore, potential future uses of this type of competency information and data include:

— Support for personal human development (e.g. assessment feedback, comparison with personal learning goals, etc.) to allow individuals to develop target competencies and to monitor and document progress;

— Potential to better integrate different competency information and data structures (e.g. national occupational databases, competency frameworks developed by professional associations, educational institutions, and other classification systems such as ontologies, thesauri, etc.) to inform competency development in formal and non-formal learning, educational, and training settings;

— Support for third-party tools that can be used to measure, analyse, evaluate, and communicate competency information and data that may be used by private, non-profit and voluntary sectors;