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Geographic information — Ubiquitous public access — Reference model

Information géographique — Ubiquitaire l'accès du public — Modèle de référence

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Contents

Page

Foreword ... **iv**

Introduction ... **v**

1 Scope ... **1**

2 Conformance ... **1**

3 Normative references ... **1**

4 Terms and definitions ... **1**

5 Symbols (and abbreviated terms) ... **5**
5.1 Abbreviated terms ... 5
5.2 UML notation ... 6

6 Reference model requirements ... **6**
6.1 Background ... 6
6.2 Design principles of ubiquitous public access ... 7
6.3 Semantics of UPA ... 7
6.4 Conceptual framework ... 8
6.5 Relationship with other ISO geographic information standards ... 9
6.6 Other areas of standardization ... 11

7 RM-ODP viewpoints ... **12**
7.1 Enterprise viewpoint ... 12
7.2 Information viewpoint ... 14
7.3 Computational viewpoint ... 19

Annex A (normative) **Abstract test suite** ... **22**

Annex B (informative) **Additional background information on UPA-to-GI** ... **24**

Annex C (informative) **Open Distributed Processing (RM-ODP) for UPA-to-GI reference model** ... **26**

Annex D (informative) **Service architecture for UPA-to-GI** ... **27**

Annex E (informative) **Existing standardization efforts** ... **30**

Annex F (informative) **UPA-to-GI service scenarios** ... **37**

Bibliography ... **43**

Foreword

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

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 ISO documents 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/TC 211, *Geographic information/Geomatics*.

Introduction

Recent advances of web-based and mobile computing technologies have ushered in an era where the general public are not only consumers of content, but also act as creators or providers of new, enriched content.

One sector in particular that is experiencing rapid change and growth is that of geographic information.

“Location” in a general sense is one of the basic requirements of all mobile users. In early development, users were only “consuming” location-based content, but with ever increasingly sophisticated mobile hardware devices and the ever expanding extent of telecommunications networking and sensor web enabled infrastructure, mobile users are now able to create many types of geographic data. Creation of content can be on an individual level, using a coordinate location to enable navigation to a new café described in a blog entry, or as a collaborative effort, such as collecting GPS tracks and incorporating them into the Open Street Map project.

Smaller devices, embedded systems, wireless communication, and sensor networks (ubiquitous computing technologies) require methods of handling geographic information in terms of both production and consumption. Beyond the previously limited public consumption of geographic information, ubiquitous computing technologies provide the infrastructure for the general public to produce, distribute, and consume geographic information. These concepts are manifested as “seamless access from anywhere and at any time to easy-to-use geographic information and services”. We refer to these concepts as Ubiquitous Public Access to geographic information.

The goal of ubiquitous public access to geographic information (UPA-to-GI) is to make the user experience of any “smart” device intuitive to understand, along with being easy to use. To achieve this goal, contextual information that is gathered from varied sources is managed efficiently within the UPA architecture. Therefore, systems or services for UPA to geographic information need to support a delivery mechanism of contextual information.

This International Standard defines the requirements of standardization for systems and services supporting ubiquitous public access to geographic information, and describes a comprehensive set of fundamental facets that specify an abstract description of the elements for UPA to geographic information.

This International Standard further establishes a series of models comprised as a conceptual framework that, when implemented, will support the development of a set of systems and services for enabling ubiquitous public access to geographic information. In a UPA environment, general users are no longer only passive consumers of geographic information, but rather active participants in several steps of the data and information management lifecycle such as collection, creation and capture, and/or use and dissemination.

Ubiquitous public access to geographic information might be thought of as a type of geographic information service. However, the currently available standards used in mobile environments are based on web technologies which are not efficient enough to handle the requirements of UPA. In order to provide relevant geographic information to users, the context of the users is described.

The reference model specified here defines a group of models which form a framework that supports methods of extracting geographically explicit context information from varied information sources, such as a lexicon, photos, videos, and others sources. Additional models in the framework specify how geographic data produced and distributed by the general public can be semantically linked to meet the user’s contextual requests, and how heterogeneous geographic content can be seamlessly accessed, integrated, and provided to a user regardless of the kind of device the user operates.

Geographic information — Ubiquitous public access — Reference model

1 Scope

This International Standard defines a reference model for ubiquitous public access (UPA) to geographic information. This reference model uses standard concepts from both the Open distributed processing — Reference model (RM-ODP) in ISO/IEC 10746-1 and ISO 19101.

The reference model specified in this International Standard defines the following:

— conceptual models for ubiquitous public access (UPA) to geographic information;

— a reference model and framework to support current and future specification development in this area;

— the semantics of information and processing within systems and services for the UPA of geographic information;

— the architectural relationship between this International Standard and other ISO geographic information standards.

This International Standard is applicable to location-based services (LBS), ubiquitous computing environments, linked open data, and other domains that require a seamless public access to geographic information.

Although structured in the context of information technology and information technology standards, this International Standard is independent of any application development method or technology implementation approach.

2 Conformance

General conformance and testing requirements are defined in ISO 19105. Conformance requirements are specified in Annex A.

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 19101-1:2014, *Geographic information — Reference model — Part 1: Fundamentals*

ISO/TS 19101-2:2008, *Geographic information — Reference model — Part 2: Imagery*

ISO 19103:—[1)], *Geographic information — Conceptual schema language*

ISO 19109:—[2)], *Geographic information — Rules for application schema*

4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1) To be published.

2) To be published.

4.1
ambient intelligence
convergence of ubiquitous computing, ubiquitous communication, and interfaces adapting to the user

4.2
application
manipulation and processing of data in support of user requirements

[SOURCE: ISO 19101-1:2014, 4.1.1]

4.3
computational viewpoint
viewpoint (4.29) on an ODP system and its environment which enables distribution through functional decomposition of the system into objects which interact at *interfaces* (4.13)

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.3]

4.4
context
aspects or properties of an entity that affect the behaviour or expectations of that entity in any given situation

4.5
context-awareness
integrated operations to collect and deliver *context* (4.4) specific information, and convert it to tailored data for each user

EXAMPLE getContext(staticFeature) = FD_Feature

Note 1 to entry: In the example, the getContext operation would extract geographically explicit context information FD_Feature from varied information sources, such as photos, videos, etc.

4.6
enterprise viewpoint
viewpoint (4.29) on an ODP system and its environment that focuses on the purpose, scope, and policies for that system

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.1]

4.7
geographic context awareness
application (4.2) or *service* (4.23) behaviour based on the recognition of user's geographic *context* (4.4)

4.8
geographic information
information concerning phenomena implicitly or explicitly associated with a location relative to the Earth

[SOURCE: ISO 19101-1:2014, 4.1.18]

4.9
geographic information service
service (4.23) that transforms, manages, or presents geographic information to users

[SOURCE: ISO 19101-1:2014, 4.1.19]

4.10
geographic information system
information system dealing with information concerning phenomena associated with location relative to the Earth

[SOURCE: ISO 19101-1:2014, 4.1.20]

4.11
information system
information processing system, together with associated organizational resources such as human, technical, and financial resources, that provides and distributes information

[SOURCE: ISO/IEC 2382-1:1993]

4.12
information viewpoint
viewpoint (4.29) on an ODP system and its environment that focuses on the semantics of information and information processing

[SOURCE: ISO/IEC 10746-3:2009, 4.1.1.2]

4.13
interface
named set of *operations* (4.17) that characterize the behaviour of an entity

[SOURCE: ISO 19119:2005, 4.2]

4.14
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

[SOURCE: ISO/IEC 2382-1:1993, 01.01.47]

4.15
linked geodata
geographic data and information sources published on the *Semantic Web* (4.22)

Note 1 to entry: These publicly available geographic data and information sources are published in a standardized formal model.

4.16
ontology
formal representation of phenomena of a *universe of discourse* (4.28) with an underlying vocabulary including definitions and axioms that make the intended meaning explicit and describe phenomena and their interrelationships

[SOURCE: ISO 19101-1:2014, 4.1.26]

4.17
operation
specification of a transformation or query that an object may be called to execute

[SOURCE: ISO 19119:2005, 4.3]

4.18
public access
open access to information sources and/or *services* (4.23) by general public users and professional users alike

4.19
reference model
framework for understanding significant relationships among the entities of some environment, and for the development of consistent standards or specifications supporting that environment

Note 1 to entry: A reference model is based on a small number of unifying concepts and can be used as a basis for education and explaining standards to a non-specialist.

[SOURCE: ISO 14721:2003, 1.7.2.63, modified — the second sentence in definition has been made a note to entry.]

4.20
schema
formal description of a model

[SOURCE: ISO 19101-1:2014, 4.1.34]

4.21
seamless mobility
continuous and intuitive access to various information sources and *services* (4.23) regardless of protocols, networks, frequency bands, and physical environments

4.22
Semantic Web
Web (4.30) of data with meaning

Note 1 to entry: The association of meaning allows data and information to be understood and processed by automated tools as well as by people.

[SOURCE: ISO 19101-1:2014, 4.1.35]

4.23
service
distinct part of the functionality that is provided by an entity through *interfaces* (4.13)

[SOURCE: ISO 19119:2005, 4.1]

4.24
service broker
application (4.2) that combines or offers lower-level *services* (4.23) for specific user needs

[SOURCE: ISO 19132:2007, 4.46]

4.25
ubiquitous public access
UPA
service (4.23) that enables end-users to have easy and interoperable access to specific types of data, irrespective of their location or access device, and that match their interest criteria

EXAMPLE Linked Geodata Service

Note 1 to entry: In the example, the Linked GeoData Service is responsible for openly inter-connecting geographic information to external repositories or web resources using a transform to either Resource Description Framework (RDF) or Web Ontology Language (OWL) format.

4.26
ubiquitous geographic information
geographic information (4.8) provided to users following the concepts of *ubiquitous public access* (4.25)

4.27
universal representation
universal feature model to be specified without knowing users' structures or abstraction models

4.28
universe of discourse
view of the real or hypothetical world that includes everything of interest

[SOURCE: ISO 19101-1:2014, 4.1.38]

4.29
viewpoint (on a system)
form of abstraction achieved using a selected set of architectural concepts and structuring rules, in order to focus on particular concerns within a system

[SOURCE: ISO/IEC 10746-2:2009, 3.2.7]

4.30
World Wide Web
Web
universe of network-accessible information and *services* (4.23)

[SOURCE: ISO 19101-1:2014, 4.1.40]

4.31
Web service
service (4.23) that is made available through the *Web* (4.30)

Note 1 to entry: A Web service usually includes some combination of programming and data. It can also include human resources.

[SOURCE: ISO 19101-1:2014, 4.1.41]

5 Symbols (and abbreviated terms)

5.1 Abbreviated terms

API	Application Programming Interface
CRS	Coordinate Reference System
FOAF	Friend of a Friend
GeoRSS	Geographic Rich Site Summary
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technology
IETF	Internet Engineering Task Force
LBS	Location-based Service
LGD	Linked GeoData
OGC	Open Geospatial Consortium
OMG	Object Management Group
OWL	Web Ontology Language
RDF	Resource Description Framework
RM-ODP	Reference Model of Open Distributed Processing (ISO/IEC 10746)
SRS	Spatial Reference System
UML	Unified Modeling Language
UPA-to-GI	Ubiquitous Public Access to Geographic Information

URI Uniform Resource Identifier

XML eXtensible Markup Language

5.2 UML notation

The notation used in this International Standard as conceptual models of information systems and services are presented using the Unified Modeling Language as specified in ISO 19103.

6 Reference model requirements

6.1 Background

Today, with the rapid spread of small and powerful mobile devices, the general public is not only consuming various types of content embedded with geographic information, but they are also creating similar content.

Computing advances in seamless mobility, context awareness, sensor networks, and cloud computing have led to the emergence of applications and services many of which are based on, or related to, geographic information.

The widespread availability of telecommunication and networking infrastructure, coupled with the ever increasingly degree of "smart" mobile hardware devices and accompanying software and services, is enabling the general public to access and use geographic information services frequently, and without actually realizing it.

Within the field of geographic information systems and services, ubiquitous public access to geographic information (UPA-to-GI) consists of the following two concepts:

— ubiquity;

— public access.

In order to address the needs of users and providers requiring access to geographic information under ubiquitous computing infrastructure, this International Standard defines a reference model for UPA-to-GI using the viewpoints based on the model specified in ISO 19101-1:2014 and RM-ODP system architecture approach as specified by ISO/IEC 10746.

Clause 7 defines the RM-ODP viewpoints of this reference model. Further details are specified in

— enterprise viewpoint with UPA-to-GI related services (7.1),

— information viewpoint for three types of geographic context (7.2), and

— computational viewpoint for UPA-to-GI services (7.3).

To aid developers implementing systems based on the reference model defined in this International Standard, additional background and related standards activities, example conceptual service architecture design, and use case scenarios are presented in the following annexes.

— Annex A defines the abstract test suite for conforming to the reference model specified in this International Standard.

— Annex B provides additional background on the concepts of UPA-to-GI.

— Annex C describes the RM-ODP viewpoints for UPA-to-GI Reference Model.

— Annex D presents the conceptual service architecture for UPA-to-GI.

— Annex E examines a number of existing and in-progress standardization efforts by ISO, OGC, and other standards bodies.

— Annex F presents three UPA-to-GI service scenarios to help developers visualize the merits of UPA-to-GI.

6.2 Design principles of ubiquitous public access

When considering the design of ubiquitous public access systems, this International Standard presents two motivating factors that comprise the fundamental principal of UPA-to-GI.

a) The standardization of geographic information systems/services will enable end-users to have access to geographic information meeting their needs in a convenient and interoperable manner.

b) The use of ubiquitous computing technologies will enable an augmented and intelligent information infrastructure.

Figure 1 visually presents these two motivating factors of the design of a service environment for UPA-to-GI. These systems and services function as an effective interface between emerging ubiquitous computing technology and traditional geographic information services within a new information and communication technology (ICT) ecosystem.

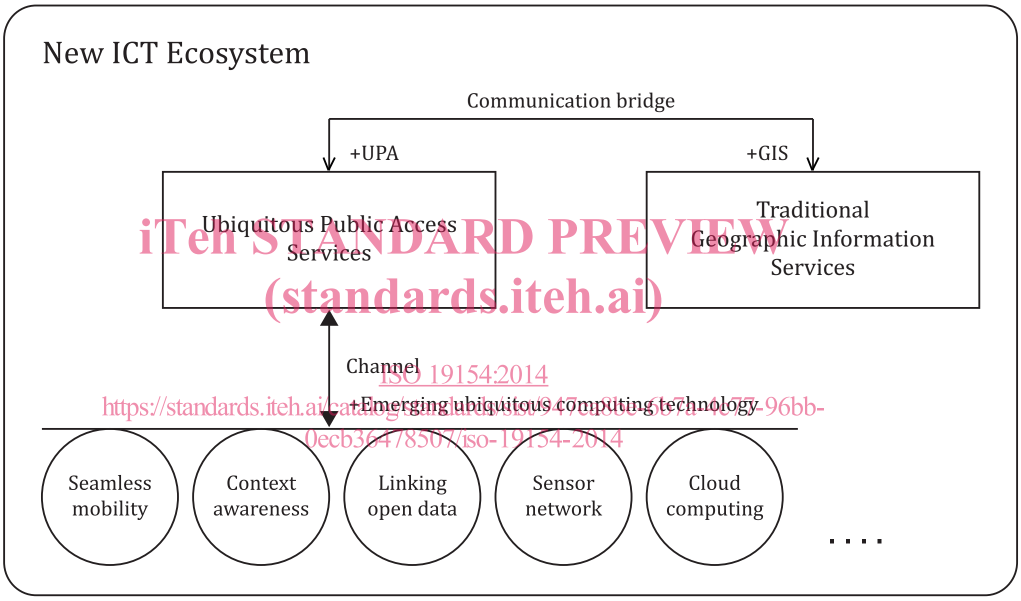

Figure 1 — Two motivating factors of ubiquitous public access

6.3 Semantics of UPA

6.3.1 Overview

Three semantic properties can be used to more clearly describe the requirements of the UPA-to-GI reference model defined in this International Standard. The three required semantic properties are the following:

— ubiquity of geographic information (6.3.2);

— degree of public access (6.3.3);

— ubiquitous public access (6.3.4).

6.3.2 Ubiquity of geographic information

Within a ubiquitous computing environment, end-users make use of varied geographic information services based on “ambient intelligence”.

To enable the understanding of ambient intelligence for geographic information, this International Standard specifies the context information model for supporting UPA-to-GI as defined in 7.2.2.

This context model is based on seamless mobility and geographic context.

Seamless mobility provides mobile users with continuous and intuitive access to various information sources and services including geographic information services regardless of protocols, networks, frequency bands, and physical environments.

Geographic context awareness uses ambient intelligence to gather specific context of the user which may include identity, time, activity, and the location of the user. Once the geographic context of a user is extracted, information services are able to provide rich and high quality ambient intelligence to the user.

The geographic context can include one's individual context (e.g. location, speed, and orientation), static context (geographic information), and dynamic context (e.g. weather, traffic conditions, data from sensor, and more).

6.3.3 Degree of public access

Public access to geographic information implies easy or open access to geographic information sources and/or services by general public users and professional users alike. Greater emphasis is placed on the ease-of-use of geographic information services for the general public.

This International Standard presents the following two concepts to clarify the degree of public access required for UPA-to-GI systems.

a) Universal representation refers to any request from a user for any type of geographic information service (an LBS request, map display, etc.) and implies that the request shall be unambiguously specified, without requiring the details of the underlying structures or abstraction models, using the universal feature model defined in ISO 19109.

b) Linked open geodata refers to publicly available open geographic data and information sources. The reference model defined in this International Standard identifies areas in which there are further standards for public access to geographic information sources through the Linking Open GeoData framework.

6.3.4 Ubiquitous Public Access

As specified in this reference model, UPA-to-GI services infer and extract the geographical context of various types of non-geographic information embedded with geospatial semantics.

This reference model also provides a framework for an open access environment to enable the linking of geographic data, including data from other sources, along with those produced by the users. The result of this linking will facilitate easy and seamless access to geographic information services regardless of a user's computing environment.

6.4 Conceptual framework

The reference model defined in this International Standard specifies a conceptual framework clarifying how the domain of ubiquitous computing and geographic information are interconnected through a logical environment for a set of applications and processed within each domain.

Figure 2 illustrates a conceptual framework where varied implicit geographic information of a user retrieved from a ubiquitous computing infrastructure can be effectively processed by different geographic information services defined within a UPA-to-GI system.

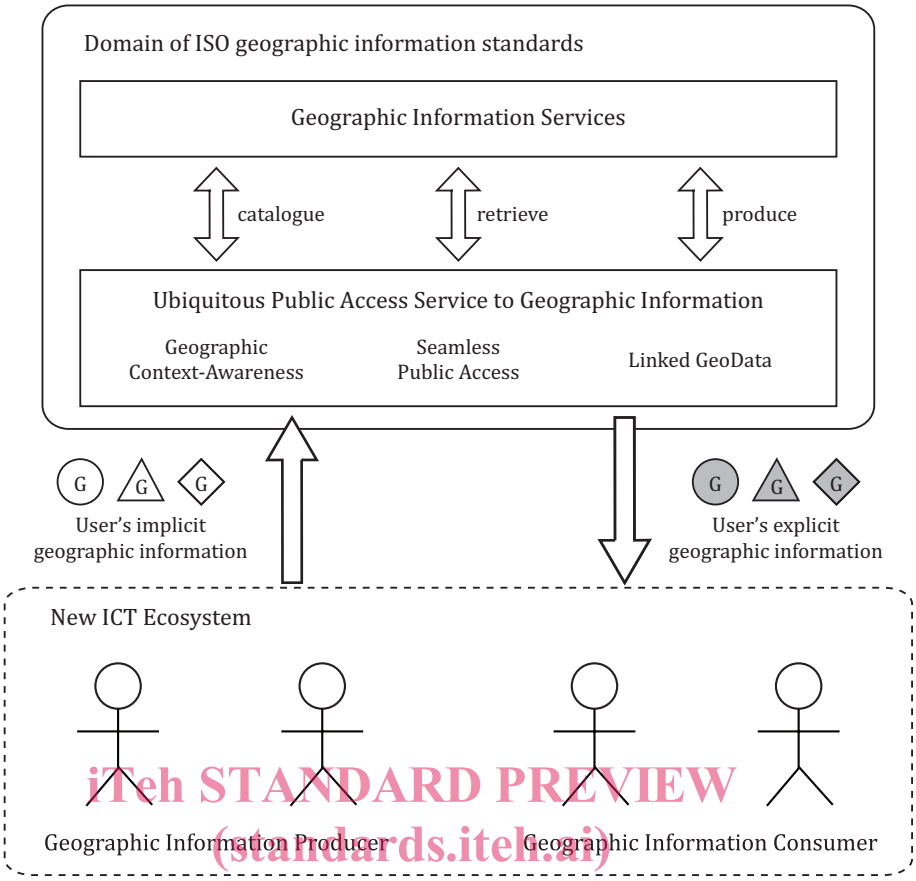

Figure 2 — Conceptual framework of ubiquitous public access to geographic information

As shown in Figure 2, a user, either a human or machine, can receive requested information from an application service, which is relevant to the current context of the user. The current contextual information of the user is retrieved through various mechanisms, such as positioning devices or sensor networks that are available within a ubiquitous computing infrastructure.

The application service to which the user is currently subscribed will then send, using a network infrastructure, the contextual information to the ubiquitous public access interface.

Relevant UPA services will transform implicit geographic information, which is tacit in nature and not documented nor clearly expressed, into explicit geographic information which is well documented and clearly expressed.

This explicit geographic information can be accessed from a repository, using the contextual information of the user by interoperating with other relevant geographic information services. The application service can further interoperate with other general information services to meet any additional, non-geographic requests of the user.

6.5 Relationship with other ISO geographic information standards

6.5.1 Overview

The reference model defined in this International Standard occupies a close and important relationship with other ISO geographic information standards. This reference model builds on the existing ISO 19101-1:2014 reference model fundamentals and also ISO/TS 19101-2:2008 reference model for imagery and gridded data.