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Geographic information — Web map server interface

Information géographique — Interface de carte du serveur web

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Foreword

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

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

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

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

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Introduction

A Web Map Service (WMS) produces maps of spatially referenced data dynamically from geographic information. This International Standard defines a “map” to be a portrayal of geographic information as a digital image file suitable for display on a computer screen. A map is not the data itself. WMS-produced maps are generally rendered in a pictorial format such as PNG, GIF or JPEG, or occasionally as vector-based graphical elements in Scalable Vector Graphics (SVG) or Web Computer Graphics Metafile (WebCGM) formats.

This International Standard defines three operations: one returns service-level metadata; another returns a map whose geographic and dimensional parameters are well-defined; and an optional third operation returns information about particular features shown on a map. Web Map Service operations can be invoked using a standard web browser by submitting requests in the form of Uniform Resource Locators (URLs). The content of such URLs depends on which operation is requested. In particular, when requesting a map the URL indicates what information is to be shown on the map, what portion of the Earth is to be mapped, the desired coordinate reference system, and the output image width and height. When two or more maps are produced with the same geographic parameters and output size, the results can be accurately overlaid to produce a composite map. The use of image formats that support transparent backgrounds (e.g. GIF or PNG) allows underlying maps to be visible. Furthermore, individual maps can be requested from different servers. The Web Map Service thus enables the creation of a network of distributed map servers from which clients can build customized maps. Illustrative examples of map request URLs and their resulting maps are shown in Annex G.

This International Standard applies to a Web Map Service instance that publishes its ability to produce maps rather than its ability to access specific data holdings. A basic WMS classifies its geographic information holdings into “Layers” and offers a finite number of predefined “Styles” in which to display those layers. This International Standard supports only named Layers and Styles, and does not include a mechanism for user-defined symbolization of feature data.

NOTE The Open Geospatial Consortium (OGC) Styled Layer Descriptor (SLD) specification [6] defines a mechanism for user-defined symbolization of feature data instead of named Layers and Styles. In brief, an SLD-enabled WMS retrieves feature data from a Web Feature Service [7] and applies explicit styling information provided by the user in order to render a map.

Geographic information — Web map server interface

1 Scope

This International Standard specifies the behaviour of a service that produces spatially referenced maps dynamically from geographic information. It specifies operations to retrieve a description of the maps offered by a server to retrieve a map, and to query a server about features displayed on a map. This International Standard is applicable to pictorial renderings of maps in a graphical format; it is not applicable to retrieval of actual feature data or coverage data values.

2 Conformance

2.1 Conformance classes and requirements

This International Standard defines two conformance classes, one for a basic WMS, and the other for a queryable WMS. Each has two subclasses, one for clients and the other for servers.

2.2 Basic WMS

A basic WMS shall support the basic service elements (see Clause 6), the GetCapabilities operation (see 7.2), and the GetMap operation (see 7.3). To conform to this International Standard, a basic WMS shall satisfy the requirements of A.1 of the Abstract Test Suite in Annex A.

2.3 Queryable WMS

A queryable WMS shall satisfy all the requirements for a basic WMS, and shall also support the GetFeatureInfo operation (see 7.4). To conform to this International Standard, a queryable WMS shall satisfy all requirements of the Abstract Test Suite in Annex A.

3 Normative references

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

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO 19111, *Geographic information — Spatial referencing by coordinates*

ISO 19115:2003, *Geographic information — Metadata*

EPSG (February 2003), *European Petroleum Survey Group Geodesy Parameters*, Lott, R., Ravanas, B., Cain, J., Simonson, G, and Nicolai, R., eds., available at <*http://www.epsg.org/*>

IETF RFC 2045 (November 1996), *Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies*, Freed, N. and Borenstein, N., eds., available at <*http://www.ietf.org/rfc/rfc2045.txt*>

IETF RFC 2396 (August 1998), *Uniform Resource Identifiers (URI): Generic Syntax*, Berners-Lee, T., Fielding, N., and Masinter, L., eds., available at <*http://www.ietf.org/rfc/rfc2396.txt*>

IETF RFC 2616 (June 1999), *Hypertext Transfer Protocol – HTTP/1.1*, Gettys, J., Mogul, J., Frystyk, H., Masinter, L., Leach, P., and Berners-Lee, T., eds., available at <*http://www.ietf.org/rfc/rfc2616.txt*>

UCUM, *Unified Code for Units of Measure*, Schadow, G. and McDonald, C.J. (eds.), version 1.5 <*http://aurora.regenstrief.org/UCUM/ucum.html*>

XML 1.0, *Extensible Markup Language (XML) 1.0*, World Wide Web Consortium Recommendation, Bray, T., Paoli, J., Sperberg-McQueen, C.M., and Maler, E., eds., available at <*http://www.w3.org/TR/*>

XML Schema, *XML Schema Part 1: Structures*, World Wide Web Consortium Recommendation, Thompson, H.S., Beech, D., Maloney, M., and Mendelsohn, N., eds., available at <*http://www.w3.org/TR/*>

4 Terms and definitions

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

4.1
client
software component that can invoke an **operation** from a **server**

4.2
coordinate reference system
coordinate system that is related to the real world by a datum

[ISO 19111]

4.3
coordinate system
set of mathematical rules for specifying how coordinates are to be assigned to points

[ISO 19111]

4.4
geographic information
information concerning phenomena implicitly or explicitly associated with a location relative to the Earth

[ISO 19101]

4.5
interface
named set of **operations** that characterize the behaviour of an entity

[ISO 19119]

4.6
layer
basic unit of **geographic information** that may be requested as a **map** from a **server**

4.7
map
portrayal of **geographic information** as a digital image file suitable for display on a computer screen

4.8
operation
specification of a transformation or query that an object may be called to execute

[ISO 19119]

4.9
portrayal
presentation of information to humans

[ISO 19117]

4.10
request
invocation of an **operation** by a **client**

4.11
response
result of an **operation** returned from a **server** to a **client**

4.12
server
a particular instance of a service

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

[ISO 14252]

4.14
service metadata
metadata describing the **operations** and **geographic information** available at a **server**

5 Abbreviated terms

CDATA	XML Character Data
CRS	Coordinate Reference System
CS	Coordinate System
DCP	Distributed Computing Platform
DTD	Document Type Definition
EPSG	European Petroleum Survey Group
GIF	Graphics Interchange Format
GIS	Geographic Information System
HTTP	Hypertext Transfer Protocol
IANA	Internet Assigned Numbers Authority
IERS	International Earth Rotation Service
IETF	Internet Engineering Task Force
ITRF	International Terrestrial Reference Frame
ITRS	IERS Terrestrial Reference System

JPEG	Joint Photographic Experts Group
MIME	Multipurpose Internet Mail Extensions
NAD	North American Datum
OGC	Open GIS Consortium
PNG	Portable Network Graphics
RFC	Request for Comments
SVG	Scalable Vector Graphics
UCUM	Unified Code for Units of Measure
URL	Uniform Resource Locator
WebCGM	Web Computer Graphics Metafile
WCS	Web Coverage Service
WFS	Web Feature Service
WGS	World Geodetic System
WMS	Web Map Service
XML	Extensible Markup Language

6 Basic service elements

6.1 Introduction

This clause specifies aspects of Web Map Server behaviour that are independent of particular operations or are common to several operations.

6.2 Version numbering and negotiation

6.2.1 Version number form and value

The Web Map Service (WMS) defines a protocol version number. The version number applies to the XML schema and the request encodings defined in this International Standard. The version number contains three non-negative integers, separated by decimal points, in the form "*x*.*y*.z". The numbers "*y*" and "z" shall not exceed 99.

Implementations of this International Standard shall use the value "1.3.0" as the protocol version number.

6.2.2 Version number changes

The protocol version number shall be changed with each revision of this International Standard. The number shall increase monotonically and shall comprise no more than three integers separated by decimal points, with the first integer being the most significant. There may be gaps in the numerical sequence. Some numbers may denote draft versions. Servers and their clients need not support all defined versions, but shall obey the negotiation rules below.

6.2.3 Appearance in requests and in service metadata

The version number shall appear in at least two places: in the service metadata and in the parameter list of client requests to a server. The version number used in a client's request of a particular server shall be equal to a version number which that server has declared it supports (except during negotiation, as described below). A server may support several versions, whose values clients may discover according to the negotiation rules.

6.2.4 Version number negotiation

A WMS client may negotiate with a server to determine a mutually agreeable protocol version. Negotiation is performed using the GetCapabilities operation (described in 7.2) according to the following rules.

All service metadata shall include a protocol version number and shall comply with the XML DTD or Schema defined for that version. In response to a GetCapabilities request (for which the VERSION parameter is optional) that does not specify a version number, the server shall respond with the highest version it supports. In response to a GetCapabilities request containing a version number that the server implements, the server shall send that version. If the server does not support the requested version, the server shall respond with output that conforms to a version it does support, as determined by the following rules:

— If a version unknown to the server and higher than the lowest supported version is requested, the server shall send the highest version it supports that is less than the requested version.

— If a version lower than any of those known to the server is requested, then the server shall send the lowest version it supports.

— If the client does not support the version sent by the server, it may either cease communicating with the server or send a new request with a different version number that the client does support.

The process may be repeated until a mutually understood version is reached, or until the client determines that it will not or cannot communicate with that particular server.

EXAMPLE 1 Server understands versions 1, 2, 4, 5 and 8. Client understands versions 1, 3, 4, 6, and 7. Client requests version 7. Server responds with version 5. Client requests version 4. Server responds with version 4, which the client understands, and the negotiation ends successfully.

EXAMPLE 2 Server understands versions 4, 5 and 8. Client understands version 3. Client requests version 3. Server responds with version 4. Client does not understand that version or any higher version, so negotiation fails and client ceases communication with that server.

The VERSION parameter is mandatory in requests other than GetCapabilities.

6.3 General HTTP request rules

6.3.1 Introduction

This International Standard defines the implementation of the WMS on a distributed computing platform (DCP) comprising Internet hosts that support the Hypertext Transfer Protocol (HTTP) (see IETF RFC 2616). Thus, the Online Resource of each operation supported by a server is an HTTP Uniform Resource Locator (URL). The URL may be different for each operation, or the same, at the discretion of the service provider. Each URL shall conform to the description in IETF RFC 2616 (section 3.2.2 "HTTP URL") but is otherwise implementation-dependent; only the query portion comprising the service request itself is defined by this International Standard.

HTTP supports two request methods: GET and POST. One or both of these methods may be offered by a server, and the use of the Online Resource URL differs in each case. Support for the GET method is mandatory; support for the POST method is optional.

6.3.2 Reserved characters in HTTP GET URLs

The URL specification (IETF RFC 2396) reserves particular characters as significant and requires that these be escaped when they might conflict with their defined usage. This International Standard explicitly reserves several of those characters for use in the query portion of WMS requests. When the characters “?”, “&”, “=”, “,” and “+” appear in one of the roles defined in Table 1, they shall appear literally in the URL. When those characters appear elsewhere (for example, in the value of a parameter), they shall be encoded as defined in IETF RFC 2396.

The server shall be prepared to decode any character escaped in this manner, and to decode the “+” character as a space.

Table 1 — Reserved characters in WMS query string

Character	Reserved usage
?	Separator indicating start of query string.
&	Separator between parameters in query string.
=	Separator between name and value of parameter.
,	Separator between individual values in list-oriented parameters (such as BBOX, LAYERS and STYLES in the GetMap request).
+	Shorthand representation for a space character.

6.3.3 HTTP GET

A WMS shall support the “GET” method of the HTTP protocol (IETF RFC 2616).

An Online Resource URL intended for HTTP GET requests is in fact only a URL prefix to which additional parameters are appended in order to construct a valid Operation request. A URL prefix is defined in accordance with IETF RFC 2396 as a string including, in order, the scheme (“http” or “https”), Internet Protocol hostname or numeric address, optional port number, path, mandatory question mark “?”, and optional string comprising one or more server-specific parameters ending in an ampersand “&”. The prefix defines the network address to which request messages are to be sent for a particular operation on a particular server. Each operation may have a different prefix. Each prefix is entirely at the discretion of the service provider.

This International Standard defines how to construct a query part that is appended to the URL prefix in order to form a complete request message. Every WMS operation has several mandatory or optional request parameters. Each parameter has a defined name. Each parameter may have one or more legal values, which are either defined by this International Standard or are selected by the client based on service metadata. To formulate the query part of the URL, a client shall append the mandatory request parameters, and any desired optional parameters, as name/value pairs in the form “name=value&” (parameter name, equals sign, parameter value, ampersand). The “&” is a separator between name/value pairs, and is therefore optional after the last pair in the request string.

When the HTTP GET method is used, the client-constructed query part is appended to the URL prefix defined by the server, and the resulting complete URL is invoked as defined by HTTP (IETF RFC 2616).

Table 2 summarizes the components of an operation request URL when HTTP GET is used.

Table 2 — Structure of WMS request using HTTP GET

URL component	Description
http://host[:port]/path[?{name[=value]&}]	URL prefix of service operation. [ ] denotes 0 or 1 occurrence of an optional part; {} denotes 0 or more occurrences.
name=value&	One or more standard request parameter name/value pairs as defined for each operation by this International Standard.

6.3.4 HTTP POST

A WMS may support the “POST” method of the HTTP protocol (IETF RFC 2616).

An Online Resource URL intended for HTTP POST requests is a complete URL (not merely a prefix as in the HTTP GET case) that is valid according to IETF RFC 2396 to which clients transmit request parameters in the body of the POST message. A WMS shall not require additional parameters to be appended to the URL in order to construct a valid target for the operation request. When POST is used, the request message is formulated as an XML document.

6.4 General HTTP response rules

Upon receiving a valid request, the server shall send a response corresponding exactly to the request as detailed in Clause 7 of this International Standard, or send a service exception if unable to respond correctly. Only in the case of Version Negotiation (see 6.2.4) may the server offer a differing result. Upon receiving an invalid request, the server shall issue a service exception as described in 6.11.

A server may send an HTTP Redirect message (using HTTP response codes as defined in IETF RFC 2616) to an absolute URL that is different from the valid request URL that was sent by the client. HTTP Redirect causes the client to issue a new HTTP request for the new URL. Several redirects could in theory occur. Practically speaking, the redirect sequence ends when the server responds with a WMS response. The final response shall be a WMS response that corresponds exactly to the original request (or a service exception).

Response objects shall be accompanied by the appropriate Multipurpose Internet Mail Extensions (MIME) type (IETF RFC 2045) for that object. A list of MIME types in common use on the internet is maintained by the Internet Assigned Numbers Authority (IANA) [2]. Allowable types for operation responses and service exceptions are discussed below. The basic structure of a MIME type is a string of the form “type/subtype”. MIME allows additional parameters in a string of the form “type/subtype; param1=value1; param2=value2”. A server may include parameterized MIME types in its list of supported output formats. In addition to any parameterized variants, the server should offer the basic unparameterized version of the format.

Response objects should be accompanied by other HTTP entity headers as appropriate and to the extent possible. In particular, the Expires and Last-Modified headers provide important information for caching; Content-Length may be used by clients to know when data transmission is complete and to efficiently allocate space for results, and Content-Encoding or Content-Transfer-Encoding may be necessary for proper interpretation of the results.

6.5 Numeric and Boolean values

Integer numbers shall be represented in a manner consistent with the specification for integers in XML Schema Datatypes ([8], section 3.3.13). This International Standard shall explicitly indicate where an integer value is mandatory.

Real numbers shall be represented in a manner consistent with the specification for double-precision numbers in XML Schema Datatypes ([8], section 3.2.5). This representation allows for integer, decimal and exponential notations. A real value is allowed in all numeric fields defined by this International Standard unless the value is explicitly restricted to integer.

Positive, negative and zero values are allowed unless explicitly restricted.

Boolean values shall be represented in a manner consistent with the specification for Boolean in XML Schema Datatypes ([8], section 3.2.2). The values “0” and “false” are equivalent. The values “1” and “true” are equivalent. Absence of an optional value is equivalent to logical false. This International Standard shall explicitly indicate where a Boolean value is mandatory.

6.6 Output formats

The response to a Web Map Service request is always a computer file that is transferred over the Internet from the server to the client. The file may contain text, or the file may represent a map image. As stated in 6.4, the type of the returned file shall be indicated by a MIME type string.

Text output formats are usually formatted as Extensible Markup Language (XML; MIME type text/xml). Text formats are used to convey service metadata, descriptions of error conditions, or responses to queries for information about features shown on a map.

Allowed map formats are either “picture” formats or “graphic element” formats. Picture formats constitute a rectangular pixel array of fixed size. Picture formats include file types such as Graphics Interchange Format (GIF; MIME type “image/gif”), Portable Network Graphics (PNG; MIME type “image/png”), Joint Photographics Expert Group (JPEG; MIME type “image/jpeg”), all of which can be displayed by common Web browsers, and file types such as Tagged Image File Format (TIFF: MIME type “image/tiff”) that may require additional software (beyond a basic Web browser) for display. Graphic element formats constitute a scale-independent description of the graphic elements to be displayed (including points, lines, curves, text and images), such that the size of the display may be modified while preserving the relative arrangement of the graphic elements. Graphic element formats include Scalable Vector Graphics (SVG; MIME type “image/svg+xml”) or Web Computer Graphics Metafile (WebCGM; MIME type “image/cgm;Version=4;ProfileId=WebCGM”) formats.

NOTE 1 SVG is expressed using XML, and could therefore be considered to be a text output format, but for the purposes of this International Standard SVG is considered to be a map format.

NOTE 2 WebCGM is a profile of ISO/IEC 8632.

A server may offer multiple map formats. The formats it offers are enumerated in <Format> elements in its service metadata. Use of a specific format is not required by this International Standard. However, for maps that portray vector features the server should offer at least one format that supports transparency in order that maps may be overlaid without obscuring other maps below (see the discussion about transparency in 7.3.3.9). Also, for ease of use, the server should offer at least one format that can be displayed by common Web browsers without additional software. Based on these considerations, the server should offer at least the PNG format.

6.7 Coordinate systems

6.7.1 Introduction

This International Standard uses two principal classes of Coordinate Systems: a Map CS applicable to the map portrayal generated by the WMS, and a Layer CRS for a Bounding Box applied to the source data. During a portrayal operation, a WMS converts or transforms geographic information from a Layer CRS into a Map CS. In addition, a Layer may have an associated vertical, temporal or other coordinate system.

6.7.2 Map CS

A Map CS is a coordinate reference system for a map produced by a WMS. A WMS map is a rectangular grid of pixels displayed on a computer screen (or a digital file that could be so displayed). The Map CS has a horizontal axis denoted i, and a vertical axis denoted j. i and j shall have only nonnegative integer values. The origin (i,j) = (0,0) is the pixel in the upper left corner of the map; i increases to the right and j increases downward. The Map CS is defined using ISO 19111 terminology in B.2. The Map CS is identified by the label “CRS:1”.

The usual orientation of the Map CS shall be such that the i axis is parallel to the East-to-West axis of the Layer CRS and increases Eastward, and the j axis is parallel to the North-to-South axis of the Layer CRS and increases Southward. This orientation will not be possible in some cases, as (for example) in an orthographic projection over the South Pole. The convention to be followed is that, wherever possible, East shall be to the right edge and North shall be toward the upper edge of the Map CS.

The WIDTH and HEIGHT parameters used in the GetMap request (see 7.3.3.8) and by inclusion in the GetFeatureInfo request (7.4.3.3) correspond to i and j as follows:

— WIDTH denotes the size of the map image in pixels along the i axis (that is, WIDTH-1 is the maximum value of i).

— HEIGHT denotes the size of the map image in pixels along the j axis (that is, HEIGHT-1 is the maximum value of j).

The *I* and *J* parameters used in the GetFeatureInfo request (see 7.4.3.7) denote integer values along the i and j axes, respectively, of the Map CS.

6.7.3 Layer CRS

6.7.3.1 Introduction

A Layer CRS is a horizontal coordinate reference system for the geographic information that serves as the source for a map. As discussed below, many Layer CRSs are possible. A Layer CRS appears in the following entities relevant to the WMS:

— the <BoundingBox> element in the service metadata (7.2.4.6.8);

— the CRS parameter in the GetMap request (7.3.3.5);

— the CRS parameter in the map request part of the GetFeatureInfo request (7.4.3.3).

A WMS must support at least one CRS, and maps from multiple servers may be overlaid only if all the selected servers have at least one CRS in common. This International Standard does not mandate support for any particular Layer CRS(s). Instead, it only defines how CRSs are identified and discusses several optional Layer CRSs, in this clause and in Annex B. Map providers may support the CRSs that are most useful and appropriate to their geographic locale or information community. To maximize interoperability among servers, providers should also support geographic coordinates by geocentric coordinate systems such as “CRS:84” (see 6.7.3.2), “EPSG:4326” (see 6.7.3.3) or other ITRF-based systems.

Every Layer CRS has an identifier that is a character string. Two types of Layer CRS identifiers are permitted: “label” and “URL” identifiers:

— **Label**: The identifier includes a namespace prefix, a colon, a numeric or string code, and in some instances a comma followed by additional parameters. This International Standard defines three namespaces: CRS, EPSG and AUTO2, as discussed below.

— **URL**: The identifier is a fully-qualified URL that references a publicly-accessible file containing a definition of the CRS that is compliant with ISO 19111.

The Layer CRS has two axes, denoted x and y. The x axis is the first axis in the CRS definition, the y axis is the second axis. Depending on the particular CRS, the x axis may or may not be oriented West-to-East, and the y axis may or may not be oriented South-to-North. The WMS portrayal operation shall account for axis order, origin and direction in the Layer CRS when projecting geographic information from a Layer CRS to the Map CS.

Coordinates shall be listed in the order defined by the CRS and shall be mapped appropriately to the Map CS i and j axes, swapping axis order as needed during the projection operation. Many projected coordinate