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OWS 1.2 image handling requirements

Warning

This document is not an OGC Standard or Specification. This document presents a discussion of technology issues considered in an Interoperability Initiative of the OGC Interoperability Program. The content of this document is presented to create discussion in the geospatial information industry on this topic; the content of this document is not to be considered an adopted specification of any kind. This document does not represent the official position of the OGC nor of the OGC Technical Committee. It is subject to change without notice and may not be referred to as an OGC Standard or Specification. However, the discussions in this document could very well lead to the definition of an OGC Implementation Specification.

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i. Preface

This document was developed as part of the Image Handling Thread of the OGC Web Services Initiative Phase 1 Thread Set 2 (OWS 1.2). This document specified the requirements for the image handling functions to be supported by draft specifications prepared under that thread. Not all of the requirements stated herein were supported by the draft specifications prepared. These draft specifications were largely, but not completely, implemented and tested in that testbed.

This is now an OGC Discussion Paper made publicly available for review by OGC members and other interested parties. Comments and suggestions on this Discussion Paper are welcome and encouraged. Such comments and suggestions may be submitted by email message.

This document specifies the requirements for both the image archive and catalog services, although those services will be specified largely separately, because the requirements have many overlaps. This document also specifies the requirements for the image metadata to be used in the OWS 1.2 testbed. Finally, Annex C (informative) specifies tentative requirements for an expected future image distribution service.

NOTE This document currently uses the terms "archive" and "archiving" service; one alternative synonymous term is "repository" service. This document also uses the terms "catalog" and "cataloging" service; one alternative synonymous term is "registry" service.

ii. Submitting organizations

This Interoperability Program Report was submitted to the OGC Interoperability Program by the following organizations:

BAE SYSTEMS Mission Solutions

iii. Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Contact	Company	Address	Phone	Email
Arliss Whiteside	BAE SYSTEMS Mission Solutions	10920 Technology Place, San Diego, CA 92127-1874	858-592-1608	Arliss.whiteside@baesystems.com
Vitaliy Zavesov	BAE SYSTEMS Mission Solutions	10920 Technology Place, San Diego, CA 92127-1874	858-385-3221	Vitaliy.zavesov@baesystems.com
Stephane Fellah	PCI Geomatics Inc.	490 rue St. Joseph, Suite 400, Hull, Quebec J8Y 3Y7 CANADA	819-770-0022 x223	Fellah@pcigeomatics.com
Tony Cook	University of Alabama at Huntsville	[To be supplied]	256-961-7767	tcook@nsstc.uah.edu
George Percivall	Geospatial Interoperability Office NASA/GST, Inc.	NASA Goddard Space Flight Center, Greenbelt, MD 20770 USA	301-286 4073	percivall@gsfc.nasa.gov
Barry Schlesinger	George Mason University	9801 Greenbelt Road, Suite 316-317, Lanham, MD 20706	301-552-8957, 301-552-9671	bschlesi@rattler.gsfc.nasa.gov
Simon Cox	CSIRO Australia	ARRC, PO Box 1130 Bentley WA 6102 Australia	+61 (8) 6436 8639	mailto:Simon.Cox@csiro.au
John Vincent	Intergraph Mapping and GIS Solutions	[To be supplied]	256-730-7767	jtvincen@intergraph.com

iv. Revision history

Date	Release	Editor	Primary clauses modified	Description
22 July 2002	0.0.1	Whiteside / Zavesov	—	Initial version of this document
24 July 2002	0.0.2	Whiteside / Zavesov	5, 6	Interchanged Clauses 5 and 6, and then edited parts of the new Clause 5 (formerly Clause 6) trying to make it clearer, based on discussions in the July 23 Image Handling teleconference
26 July 2002	0.0.3	Whiteside / Zavesov	5, B	Edited document parts trying to make it clearer, including resolve the issues raised by Barry Schlesinger. Largely copied text into 5.2 and Annex B.
2 August 2002	0.0.4	Whiteside / Zavesov	5, A	Edited document parts trying to make it clearer, partially based on discussion in interim meeting. Moved and reformatted third level use cases from Image handling architecture DIPR.
10 August 2002	0.1.0	Whiteside	5, A	Moved rest of use cases from Image handling architecture DIPR. Edited document parts trying to make it clearer, partially based on suggestions from George Percivall and Barry Schlesinger and on discussions in the August 8 Image Handling teleconference.
16 August 2002	0.1.1	Whiteside	5.2, 6.2, A	Edited document parts to correct error and trying to make it clearer, based on suggestions from Simon Cox and on discussions in Image Handling teleconferences.
29 August 2002	0.1.2	Whiteside	5.3, 5.4, A, C	Edited document parts trying to make it more complete, based on forum discussions, including distribution service requirements, use cases, and update requirements.
19 November 2002	0.1.3	Whiteside	5.5	Updated reference to Topic 11 and related image metadata requirements.
6 August 2004	0.1.4	Whiteside	I, Foreword	Updated for use as Discussion Paper

v. Future work

Improvements in this document are desirable to add additional terms and definitions to Clause 8. Other improvements will probably also be found to be desirable, but none are known at this time

vi. Relationship to other activities

This topic is related to several other OWS 1.2 testbed activities, including:

a) Web Registry Service

b) Repository Service (or Web Object Service)

c) Integrated Multi-Source Client

d) Sensor Markup Language (SensorML)

Foreword

This document was developed under the image handling thread of the OGC Web Services Phase 1 Thread Set 2 (OWS 1.2) testbed Interoperability Program initiative. The editor and contributors to this document are image handling thread members.

This report often uses the terminology defined in the OGC Abstract Specification, including in:

a) Topic 12 “Service Architecture", especially the terms service, interface, and operation.

b) Topic 2 "Spatial Referencing by Coordinates", especially the terms coordinate reference system and coordinate operation.

Introduction

This report specifies the image handling functionality required to be provided by the relevant set of OGC Web Services Initiative Phase 1 Thread Set 2 (OWS 1.2) draft engineering specifications. This report also specifies the image metadata requirements for the OWS 1.2 testbed, to support demonstration of this image handling functionality.

An image is defined as a special type of gridded coverage, with the coverage function relating locations on the ground to their representation in an image. The images discussed in this document could be collected by video, radar, or some other type of a sensor. These images could be processed and analyzed by photogrammetric software.

The required image handling functionality supports both discovery and evaluation of images for possible exploitation, and retrieving discovered images for exploitation (or use). In an implementation of the OWS architecture, a set of archives stores the set of images currently accessible for exploitation, and allows a set of clients to retrieve selected images and subsets of images for exploitation. A set of catalogs store metadata for the set of images currently archived, and allows a set of clients to query this metadata to discover and evaluate images that might be exploited.

This report specifies abilities for handling a wide variety of images, including original, derived, orthorectified, and mosaicked images. In an original or derived image, the pixels are evenly spaced in an image coordinate reference system. This image coordinate reference system is usually considered to be Cartesian, with a rectangular extent and the origin in the center or corner of the image. Orthorectified and mosaicked images have image pixels resampled into a grid coordinate reference system (usually not into a ground coordinate reference system). This grid coordinate reference system is usually Cartesian with a rectangular extent.

This report specifies abilities for handling a very large set of images currently accessible for exploitation within a large enterprise, with heavy usage and frequent additions to this set of images. For example, ~10^7 images might be archived, with ~10^4 additional images per day, ~10^6 image retrievals per day, and ~10^6 image queries per day.

OWS 1.2 image handling requirements

1 Scope

This report specifies the image handling functionality required for the OGC Web Services Initiative Phase 1 Thread Set 2 (OWS 1.2). The ability to support these functions is required in the relevant set of draft engineering specifications produced in OWS 1.2. The scope of this report includes summarizing the image:

a) Archive service interface requirements

b) Catalog service interface requirements

c) Metadata to be used in the OWS 1.2 testbed requirements

d) Distribution service interface tentative requirements

NOTE An image distribution service is expected to be required in the future, to reduce client requirements for inputting images and metadata into archives and catalogs. Since this future service impacts some of the thinking for the image archive and catalog services, the image distribution service tentative requirements are discussed in Annex C (informative).

The scope of the required image handling functionality can be summarized:

a) Support both query to discover images (for exploitation) and exploitation (or use) of (discovered) images. In an implementation of the OWS architecture, a set of archives (or repositories) stores the set of images currently accessible for exploitation, and allows a set of clients to access selected images or subsets of images for exploitation. A set of catalogs (or registries) store metadata for the set of images currently archived, and allows a set of clients to query this metadata to discover and evaluate images that might be exploited.

b) Handle original, derived, orthorectified, and mosaicked images. In an original or derived image, the pixels are evenly spaced in an image coordinate reference system. This image coordinate reference system is usually considered to be Cartesian with a rectangular extent and the origin in the center or corner of the image. Orthorectified or mosaicked images have image pixels resampled into a grid coordinate reference system (usually not into a ground coordinate reference system). This grid coordinate reference system is usually Cartesian with a rectangular extent.

c) Handle both georeferenced and ungeoreferenced images. A georeferenced image has at least one known coordinate transformation between the image coordinate reference system and a ground coordinate reference system. An ungeoreferenced image has no known coordinate transformation between the image coordinate reference system and any ground coordinate reference system.

d) Handle a wide variety of digital image types, sizes, and formats, including compressed and tiled image data. An image can be collected instantaneously (e.g., by a frame camera) or by a camera that moves during image exposure (e.g., pushbroom, panoramic, and whiskbroom cameras). Images collected by both optical and radar image sensors should be handled. Images can be single-band (greyscale) and multi-band (color, multispectral, or hyperspectral). Both single (still) images and video (time sequence of) images should be handled.

e) Handle a very large set of images currently accessible for exploitation within a large enterprise, with heavy usage and frequent additions to this set of images. For example, ~10^7 images might be archived, with ~10^4 additional images per day, ~10^6 image retrievals per day, and ~10^6 image queries per day.

This report summarizes the OWS 1.2 requirements for handling images, sometimes ignoring the requirements and abilities for handling other forms of geospatial data, including digital feature data and more general coverages.

2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata, FGDC draft standard, available at: http://www.fgdc.gov/standards/status/csdgm_rs_ex.html

Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation 6 October 2000, available at: http://www.w3.org/TR/REC-xml

OGC 00-115, OGC Abstract Specification Topic 15: Image Exploitation Services, available at: http://www.opengis.org/techno/abstract/00-115.pdf

OGC 00-116, OGC Abstract Specification Topic 16: Image Coordinate Transformation Services, available at: http://member.opengis.org/tc/archive/arch00/00-116.doc

OGC 01-011, OGC Abstract Specification Topic 6: Coverages, available at: http://member.opengis.org/tc/archive/arch01/01-011.doc (contains ISO/DIS 19123)

OGC 01-065, Web Feature Server Implementation Specification, available at: http://member.opengis.org/tc/archive/arch01/01-065.doc

OGC 01-067, Filter Encoding Implementation Specification, available at: http://member.opengis.org/tc/archive/arch01/01-067.doc

OGC 01-068r3, Web Map Server Implementation Specification, available at: http://www.opengis.org/techno/specs/01-068r3.pdf

OGC 01-111, OGC Abstract Specification Topic 11: Metadata, available at: http://member.opengis.org/tc/archive/arch01/01-053r1.doc (contains ISO/DIS 19115: Geographic information – Metadata)

NOTE The "Future Work" clause of the following document 01-053r1 was accepted as an addition to document 01-111 above, but has not yet been included in that document.

OGC 01-053r1, Addition to Abstract Specification Topic 11, available at: http://member.opengis.org/tc/archive/arch01/01-053r1.pdf

OGC 02-009, Geography Markup Language version 2.1.1, available at: http://www.opengis.net/gml/02-009/GML2-11.pdf

OGC 02-013, Styled Layer Description Implementation Specification, available at: http://member.opengis.org/tc/archive/arch02/02-013.doc

OGC 02-017r1, Web Map Service Implementation Specification Part 2: XML for Requests using HTTP POST http://www.opengis.org/techno/discussions/02-017r1.pdf

OGC 02-024, Web Coverage Server Implementation Specification draft, available at: http://www.opengis.org/techno/discussions/02-024.pdf

OGC 02-026r1, Sensor Markup Language Specification draft, available at: http://member.opengis.org/tc/archive/arch02/02-026r1.doc

OGC 02-034, Geography Markup Language version 3 schemas draft, available at: http://member.opengis.org/tc/archive/arch02/02-034.zip

OGC 02-049, Web Object Service Implementation Specification (draft, DIPR), file posted on the OWS 1.2 portal under Common Architecture

OGC 02-050, OWS 1 Registry Service (draft Implementation Specification, DIPR), file posted on the OWS 1.2 portal under Registry Files under Common Architecture

OGC 02-102, OGC Abstract Specification Topic 2: Spatial Referencing by Coordinates, available at: http://www.opengis.org/techno/abstract/02-102.pdf (supersedes ISO/DIS 19111). A modified and expanded UML model for Topic 2 is contained in attachments to OGC Document 02-036r21, available at: http://member.opengis.org/tc/archive/arch02/02-036r1.pdf

OGC 02-112r2, OGC Abstract Specification Topic 12: Service Architecture, available at: http://www.opengis.org/techno/abstract/02-112.pdf (contains ISO/DIS 19119: Geographic information – Services)

XML Schema Part 1: Structures, W3C Recommendation 2 May 2001, available at: http://www.w3.org/TR/xmlschema-1/

XML Schema Part 2: Datatypes, W3C Recommendation 02 May 2001, available at: http://www.w3.org/TR/xmlschema-2/

3 Conventions

3.1 Symbols (and abbreviated terms)

The following symbols and abbreviated terms are used in this document.

~	Order of magnitude
DIPR	Draft Interoperability Program Report
EU	European Union
FGDC	Federal Geographic Data Committee
GML	Geography Markup Language
HTTP	Hyper-Text Transfer Protocol
IPR	Interoperability Program Report
ISO	International Organization for Standardization
OGC	Open GIS Consortium
OWS	OGC Web Services (initiative)
SLD	Styled Layer Descriptor
TC	Technical Committee
UML	Unified Modeling Language
WCS	Web Coverage Server
WFS	Web Feature Server
WMS	Web Map Server
WRS	Web Registry Server
WOS	Web Object Server
XML	Extensible Markup Language

4 Usage scenarios

Images are a common source of geospatial information, and image exploitation is used both to make decisions and to produce other geospatial information. The images used by an enterprise are often numerous, making highly desirable the use of image cataloging and archiving services. A catalog service will store metadata about a set of images, and support query to discover images suitable for exploitation. An archive service will store and manage a set of images, and support retrieval of discovered images for exploitation.

An archive service may also store image metadata, especially metadata needed for image exploitation but not for discovery.

A large enterprise will often require the use of multiple image catalog and archive services. That is, a set of archives stores the set of images currently accessible for exploitation, and allows a set of clients to retrieve selected images and subsets of images for exploitation. A set of catalogs store metadata for the set of images currently archived, and allows a set of clients to query this metadata to discover and evaluate images that might be exploited.

More detailed image handling use cases are summarized and referenced in Annex A (informative). Also, more usage scenario information is included in Clause 3 of the OWS Image handling architecture DIPR.

5 Requirements

5.1 Introduction

This clause specifies the requirements for the image archive service interface(s), image catalog service interface(s), and image metadata for OWS 1.2. The requirements common to the archive function, catalog function, and metadata are specified first, followed by the specific requirements for each.

5.2 Common requirements

5.2.1 Introduction

This subclause specifies the OWS 1.2 requirements that are common to all image handling, including the image archive service interface(s), image catalog service interface(s), and image metadata. These common requirements are specified in the groups:

a) Image categories

b) Image types

c) Image sizes and formats

d) Image metadata structure

e) Multiple servers

f) Enterprise scalability

g) Web service interfaces

5.2.2 Image categories

The image metadata, image archive interface(s), and image catalog interface(s) shall all meet the following image category requirements:

a) Original, derived, orthorectified, and mosaicked images shall all be able to be handled, by the same server instances.

NOTE This ability shall be specified in the image archiving and cataloging interface specification(s) prepared under OWS 1.2. The image archive and catalog server components implemented in the OWS 1.2 testbed may not fully implement this ability. However, the image archive and catalog server components implemented in the OWS 1.2 testbed shall at least handle original and orthorectified images.

b) Georeferenced and non-georeferenced images shall both be able to be handled, by the same server instances.

c) Image geometry model coordinate transformations shall be used for georeferenced original images, to relate any position in the image coordinate reference system with the corresponding position in a ground coordinate reference system.

d) Coordinate transformations shall be able to be used for georeferenced derived images, to relate any position in the image coordinate reference system with the corresponding position in the original image coordinate reference system. Also, an image geometry model shall be able to be used for georeferenced derived images, to relate any position in the image coordinate reference system with the corresponding position in a ground coordinate reference system.

e) Coordinate transformations shall be used for georeferenced orthorectified and mosaicked images, to relate any position in the grid coordinate reference system with the corresponding position in a ground coordinate reference system.

f) All the coordinate transformations used to meet requirements c), d), and e) shall be specified by image metadata that is input into and stored by archive and/or catalog services.

g) All the coordinate transformations used to meet requirements c), d), and e) shall be XML encoded based on the Coordinate Operation package of the UML model in OGC Abstract Specification Topic 2. More specifically, this XML encoding shall be based on the modified and expanded UML model for Topic 2 that is contained in the attachments to OGC Document 02-036r2, and the XML Schemas encoding that UML model also contained in those attachments.

Some of the terms used in the above requirements statements are discussed in Annex B (informative). For example, a "coordinate transformation" need not be in analytic form; it may be a table.

5.2.3 Image types

The image metadata, image archive interface(s), and image catalog interface(s) shall all be able to handle a wide variety of image types, including:

a) Images collected by optical, radar, lidar, sonar, and other image sensors.

b) Both single-band (grey scale) and multi-band (color, multispectral, or hyperspectral) images. The metadata and interfaces should not limit the maximum number of image bands (although implementations can limit the number of bands).

c) Images both collected instantaneously (e.g., by a frame camera) and by a camera that moves during image exposure (e.g., pushbroom, panoramic, and whiskbroom cameras).

d) Both single (still) images and video (time sequence of) images.

5.2.4 Image sizes and formats

The image metadata, image archive interface(s), and image catalog interface(s) shall all be able to handle a wide variety of image sizes and formats, including:

a) Image sizes from less than 1,000,000 pixels (1 Megapixel) to at least 10,000,000,000 pixels (10 Terapixels) in one image.

b) Pixel bits per band from one bit to 16 bits (uncompressed).

c) Both uncompressed and compressed image data, where data compression reduces the average number of bits per pixel or band to a few bits or a fraction of one bit, including non-integer average numbers of bits.

d) Both pixels sequenced by row and column within the entire image and within each rectangular tile of a tiled large image, where the tiles are then sequenced by tile row and column. Tile sizes may or may not be powers of two pixels in each image direction.

5.2.5 Image metadata structure

The image metadata, image archive interface(s), and image catalog interface(s) shall together meet the following metadata structure requirements:

a) Image metadata shall be divided into multiple groups that are “logically” separated for retrieval and input.

NOTE 1 The primary reason for multiple groups is metadata reuse. Some metadata groups will be common for many different images. One example of such metadata is basic sensor data, including the camera interior orientation. Other metadata groups will have multiple contents for one image. An example is the estimated transformation from ground to image coordinates (exterior orientation). In most uses,

metadata values are not updated and the old values lost; instead, new metadata values are added while the previous values are retained.

NOTE 2 Another reason for implementing multiple metadata groups is that the contents of different groups become available at significantly different times. It is important to be able to input each group into the catalog and/or archive when the data becomes available, thus avoiding update of the larger set of metadata and data. For example, the data that is common to many images is often available months before most of the corresponding images are collected. Moreover, multiple versions of the same metadata are recorded for a single image largely because it becomes available at significantly different times (e.g., separated by days).

b) These multiple metadata groups shall be linked, and the links shall be automatically traversed, to provide the “virtual” appearance of a complete structure that is queried and retrieved as if they were one structure.

c) The metadata for multiple images shall be able to be aggregated into image collections.

NOTE 3 Such image collections can be used to aid user comprehension and data management. For example, all the images collected over a single "target" for the purposes of some analysis could be referenced as one logical "collection" of images. Such an image collection may be formed based on the location of the target, date range of collection, and analysis theme, etc. Such a collection may be formed "manually" and maintained by a particular user. Indeed, a hierarchy or net of collections could be formed, with some images included in multiple collections.

d) The metadata for multiple images shall not be required to be aggregated into image collections, for any purpose.

NOTE 4 Useful and defined image collections do not exist for many images.

5.2.6 Multiple servers

The image archive interface(s), image catalog interface(s), and image metadata shall together meet the following multiple server instance requirements:

a) The archiving and cataloging functions shall use interfaces and metadata that, when implemented by different web server instances, shall allow multiple catalog services to easily work with multiple archive services.

b) One catalog server instance shall be able to handle metadata for data handled by multiple archive server instances.

c) Multiple catalog server instances shall be able to handle metadata for different data handled by one archive server instance. In addition, multiple catalog server instances shall be able to handle metadata for the same data handled by one archive server instance.

d) The transition from image discovery, using an image catalog service, to image exploitation, using an image archive service, should be as smooth and easy as practical.

EXAMPLE A catalog server shall store metadata that includes the data identifier by which that complete data item can be easily retrieved from an archive server which stores that data item.

5.2.7 Enterprise scalability

The components implemented in OWS 1.2 will be exercised with only limited quantities of data during this initiative. However, the service interfaces and metadata specified shall be scalable for use in a large enterprise, which archives, queries, and retrieves large quantities of data that change rapidly. Specifically, such a large enterprise may need to handle the magnitudes specified in Table 1. This table shows order-of-magnitude numbers; these numbers are probably within a factor of ten larger or smaller than the actual numbers for some large enterprises.

Table 1 — Large enterprise order-of-magnitudes

Quantity	Order-of-magnitude
Number of datasets archived	10,000,000
Number of new datasets per day	10,000
Number of queries per day from clients	1,000,000
Number of entire datasets retrieved per day	100,000
Number of dataset sections retrieved per day	1,000,000
Average number of pixels in one image	1,000,000,000
Average number of pixels in one image section	10,000,000
Number of archive servers	1,000
Number of catalog servers	100

NOTE 1 Each archive server instance will normally have a required maximum time from when an archive receives an image until that image is fully available to clients. That maximum time requirement is typically several minutes, and is considered very important. However, the ability to meet such a time requirement heavily depends on the speed of the computer system used to implement the archive. Therefore, this maximum time is not listed in the table above.

Digital images can be the vast majority of the listed order-of-magnitude numbers in some enterprises, although these magnitude numbers include all types of geospatial data. The images to be exploited, or currently being exploited, by a large organization or geospatial community are often numerous, with many new images being received each day.

NOTE 2 These enterprise scalability requirements are explicitly stated because some existing OWS interfaces do not appear to support such large numbers. For example, the Web Map Service (WMS) version 1.1.1 interface specifies a GetCapabilities operation that returns a list of all the data layers available from a server implementation. No other direct means is specified for a client to find out what layers are available from a WMS server instance. That interface version does not appear suitable for serving perhaps 10,000 data layers with perhaps 100 new layers per day.

5.2.8 Web service interfaces

The service interfaces specified to support the image archive and image catalog functions shall meet the following web service interface requirements:

a) The image archiving and cataloging functions shall each use specified interfaces that can also handle many types of non-image geospatial data and metadata, including features and other coverage data, which can be stored in the same web server instances. (Of course, different types of data and metadata will require use of different data schemas, but the interface differences should be limited to different data schemas. Also, some interface abilities may be limited to certain types of data.) All the following requirements shall apply to archiving and cataloging service interfaces that can handle multiple types of geospatial data.

NOTE 1 This ability shall be specified in the image archiving and cataloging interface specification(s) prepared under OWS 1.2 . However, the image archive and catalog server components implemented in the OWS 1.2 testbed are not expected to fully implement this ability.

b) The archiving and cataloging functions shall each use OGC Web Service (OWS) styled interfaces and operations, and shall each adapt existing OWS interfaces (such as WFS, WCS, WMS, and WRS).

c) The archiving and cataloging functions shall use interfaces that are as nearly identical as is deemed practical.

d) The archiving and cataloging functions shall use interfaces that are separately specified so they can be separately implemented.

e) The archiving and cataloging functions shall use interfaces that can be implemented by the same web server instance, when desired.

NOTE 2 The more-specific requirements stated in Subclauses 5.3 and 5.4 are partially based on requirements a) through e) listed above, and provide more specifics.

f) The image archiving and cataloging functions shall each use service interfaces that are specified and implemented to allow more than one client to simultaneously request the same and different operations from one image archive or catalog server instance.

5.3 Image archive requirements

5.3.1 Introduction

This subclause specifies the more-specific requirements for the image archive function interface(s) that are specified in OWS 1.2, in addition to the common requirements specified in Subclause 5.2. This subclause specifies that a set of web services operations be provided by one or more interfaces which can be implemented by one server providing the required image archive functionality. However, this subclause does not specify the:

a) Number of those operations, or their names

b) Number of those interfaces, or their names

One or more interfaces shall be specified that, when all are implemented by one archive server instance, provide operations that support the functionality specified in the following subclauses, namely providing operations allowing:

a) Get service metadata

b) Get schema

c) Input and delete object

d) Get object

e) Get coverage (optional)

f) Get map (optional)

5.3.2 Get service metadata

The archive function interface(s) shall provide one or more operations that together meet the following service metadata retrieval requirements:

a) This operation(s) shall allow clients to retrieve service metadata for the archive server instance.

b) This operation(s) shall allow retrieving service metadata that describes all the operations implemented by the archive server instance, providing information needed for a client to request those operations and use the operation responses.

c) This operation(s) shall allow retrieving a list of all the data and metadata types that can (currently) be retrieved from or input into the archive server instance. This operation(s) shall not require retrieving some metadata from all of the data and/or metadata groups currently stored by the archive server instance. Also, this operation(s) should not require retrieving the complete data schema for all of the data and metadata types that can be stored.

d) The service metadata output(s) shall be encoded in XML.

e) The output contents and format(s) shall be specified using XML Schema, and those schema(s) should be based on GML wherever applicable.

f) This operation(s) shall be required implementation by all compliant archive server instances.

NOTE That is, an archive server instance which does not (fully) implement this operation(s) shall not be considered compliant with the specification. All the image archiving server components implemented in the OWS 1.2 testbed shall implement this operation(s).

This get service metadata operation(s) should be as similar as practical to both the

a) GetCapabilities operation of the WFS, WRS, or WOS.

b) Get service metadata operation(s) of the catalog services described in Subclause 5.4.2.

5.3.3 Get schema

The archive function interface(s) shall provide one or more operations that together meet the following data schemas retrieval requirements:

a) This operation(s) shall allow clients to retrieve the data schema(s) (or data schemas) used for selected types of data and/or metadata that can (currently) be stored by the archive server instance. This operation(s) should not always retrieve the data schema(s) for all types of data and/or metadata that can (currently) be stored by the archive server instance. Also, this operation(s) shall not always retrieve some data or metadata for all instances of the type(s).

b) This operation(s) shall allow retrieving data schemas for image metadata and also for other types of geospatial data and metadata that are stored in the same archive server instance.

c) The type(s) of data or metadata for which schema(s) are retrieved shall be able to be selected by specifying the data type identifier(s) which can be retrieved from the same archive service using the get service metadata operation(s) discussed in Subclause 5.3.2.

d) The output format shall be XML Schema for all XML encoded data and metadata, and those schema(s) shall be GML application schemas wherever applicable.

e) This operation(s) shall be required implementation by all compliant archive server instances.

This get schema operation(s) should be as similar as practical to both the

a) DescribeFeatureType operation of the WFS or DescribeRecord operation of the WRS.

b) Get schema operation(s) of the catalog services described in Subclause 5.4.3.

5.3.4 Input and delete object

The archive function interface(s) shall provide one or more operations that together meet the following data input and management requirements:

a) This operation(s) shall allow clients to input new data and metadata groups that will be stored by the archive server instance.

b) This operation(s) shall allow input of entire new data and/or metadata groups that are provided as operation input parameters.

c) This operation(s) shall allow input of modified versions of previously input data and/or metadata groups, where entire groups are provided as operation input parameters. When a modified version is input, both the new modified version and the previously input version(s) shall be stored and shall be retrievable. If two or more modified versions are input "simultaneously", all these modified versions shall be stored and shall be retrievable.

NOTE 1 Both the modified version and the previously input version(s) are expected to be required to be stored indefinitely by most archive applications. However, indefinitely storing previous version(s) will not always be required by an application. There is no requirement to allow input of a modified version of a data and/or metadata group that automatically replaces a previously input version (or that also deletes the previous version). However, providing that ability might be cost-effective and is allowed. Without that ability, any client not wishing to retain the previously input version can later delete the previous version.

NOTE 2 Although possible, "simultaneous" input of two or more new modified versions is expected to be rare. However, when "simultaneous" or sequential input of multiple modified versions occurs, each modified version will normally be useful to the client that inputs it.

d) This operation(s) can also allow input of updated or corrected versions of previously input data and/or metadata groups. When an updated version is input, the updated version shall be stored and shall be retrievable, and the previously input version(s) shall be automatically deleted. If two or more updated versions are input "simultaneously", conflicts between these updates shall be avoided as appropriate.

e) This operation(s) shall allow input of images and image metadata plus other types of geospatial data and metadata that are stored in the same archive server instance.

f) The allowed input format(s) shall include XML encoded data and metadata, and that XML encoding shall be based on GML wherever applicable.

g) The XML encoded input formats allowed shall be specified using XML Schema that can be retrieved using the get schema operation discussed in Subclause 5.3.3.

h) When a new data or metadata group is input, this operation(s) shall assign a unique data identifier that can later be used to retrieve that object, by the get object operation(s) discussed in Subclause 5.3.5, and to delete that object.

i) The data identifiers used for requirement f) shall be unique identifiers across all (relevant) archive server instances.

j) The unique data identifiers assigned to meet requirement f) shall be compatible with web services. For example, each identifier can be a URN or URL.

k) This operation(s) shall allow input of needed links between new data and metadata groups and previously entered data and metadata groups.

NOTE 3 The ability to update data and metadata previously archived is not required, except for adding new metadata groups which are associated with previous data and metadata. In most uses, metadata group contents are not updated and the old values lost; instead, new metadata group values are added while the previous group values are retained. When modification is required, the new group values can be added and then the old group values can be deleted or deprecated.

l) This operation(s) shall allow clients to request deletion (or discarding) of data and metadata groups currently stored by the archive server instance.

m) The data or metadata group deleted shall be able to be selected by specifying the same unique data identifier as used by the get object operation(s), and which can be retrieved from the catalog service discussed in Subclause 5.4. This data identifier should also be included in the metadata stored in the image archive service.

n) This operation(s) should be required implementation by all compliant archive server instances.

NOTE 4 This operation(s) should be required implementation in the image archiving interface specification(s) prepared under OWS 1.2. That is, an archive server instance which does not (fully) implement this operation(s) can be considered compliant with the specification, but at a compliance level less that a server which implements this operation(s). However, all the image archiving server components implemented in the OWS 1.2 testbed shall implement this operation(s).

This input and delete data operation(s) should be as similar as practical to both the

a) Transaction operation of the WFS, WRS, or WOS.

b) Input and delete metadata operation(s) of the catalog services described in Subclause 5.4.4.

5.3.5 Get object

The archive function interface(s) shall provide one or more operations that together meet the following data and metadata retrieval requirements:

a) This operation(s) shall allow clients to retrieve selected data and/or metadata groups currently stored by the archive server instance.

b) This operation(s) shall allow retrieving images and image metadata plus other types of geospatial data and metadata that are stored in the same archive server instance.

c) This operation(s) shall allow retrieval of the entire unaltered image, with all its metadata that is stored in that archive. The metadata stored in that archive can include all or any of the metadata that is not useful for searching (and is thus not required to

be stored in the catalog), especially the detailed metadata needed to support image exploitation. This metadata can also include all or any of the metadata that is useful for searching, and is thus also stored in the catalog service(s).

d) This operation(s) shall allow retrieval of a selected subset of the metadata groups that are stored in that archive for an image. This operation(s) should also allow retrieval of the entire image with the selected metadata.

e) The data or metadata group retrieved shall be able to be selected by specifying the data identifier which can be retrieved (with other metadata) from the catalog service discussed in Subclause 5.4. This data identifier can also be included in the metadata stored in the image archive service.

f) The data or metadata group retrieved should also be able to be selected by specifying a filter expression based on the Filter Encoding Implementation Specification, modified as needed. If provided, this query ability should support searches of an archive containing up to about 10**6 entries. Furthermore, this operation(s) shall support the iterative refinement of a filter expression, and should do so without requiring the client to cache the query.

g) This operation(s) shall automatically follow the stored links that connect all the metadata groups for one cataloged object, for retrieved data and metadata selection as specified in items c) through f).

h) When multiple versions of a data or metadata group are currently stored, this operation(s) shall allow either the latest or all versions to be selected and/or retrieved as specified in items c) through g). This operation(s) should also allow a specified previous version to be selected and/or retrieved.

i) The data identifiers used for requirement e) shall be unique identifiers across all (relevant) archive and catalog server instances.

j) The allowed output format(s) shall at least include XML encoded data and metadata, and that XML encoding shall be based on GML wherever applicable.

k) The XML encoded output formats allowed shall be specified using XML Schema, that can be retrieved using the get schema operation discussed in Subclause 5.3.3. Those XML Schema shall be GML application schema wherever applicable.

l) This operation(s) shall be required implementation by all compliant archive server instances.

This get object operation(s) should be as similar as practical to both the

a) GetFeature operation of the WFS or the GetObject operation of the WOS.

b) Query metadata operation(s) of the catalog services described in Subclause 5.4.5.

5.3.6 Get coverage (optional)

The image archive function interface(s) shall provide one or more operations that together meet the coverage data retrieval following requirements:

a) This operation(s) shall allow clients to retrieve a selected subset of the stored image or other coverage. This operation(s) should allow resampling of the selected grid coverage subset, as needed to obtain an output grid spacing different from the stored grid spacing. This operation(s) should also allow clients to retrieve the entire unaltered stored image or other coverage. In all cases, this retrieval can be without most of the image metadata that is stored in that archive server instance.

b) The coverage subsets allowed in requirement a) shall include both domain (usually spatial-temporal) and range subsets, including domain and range combinations.

c) The coverage from which a subset is retrieved shall be able to be selected by specifying the data identifier which can be retrieved from the catalog service discussed in Subclause 5.4. This data identifier can also be included in the metadata stored in the image archive service. In addition, the coverage may be able to be selected by specifying a filter expression based on the Filter Encoding Implementation Specification, modified as needed. That filter expression should be applied to the coverage metadata stored by the archive server instance.

d) The data identifiers used for requirement c) shall be unique identifiers across all (relevant) archive and catalog server instances.

e) The client specification of the coverage subset to be retrieved shall be based on coverage metadata that is stored with the coverage in the same archive server instance, and can be retrieved using the get object operation(s) discussed in Subclause 5.3.5. This coverage metadata can also be included in the metadata stored in catalog server instance(s).

f) This operation(s) shall also be able to output metadata describing the coverage subset that is actually output.

g) The allowed metadata output format(s) shall include XML encoded metadata, and that XML encoding shall be based on GML wherever applicable.

h) The XML encoded output formats allowed shall be specified using XML Schema, including GML application schema where applicable.

i) This operation(s) shall be optional implementation by a compliant archive server instance.

NOTE This operation(s) shall be optional implementation in the image archiving interface specification(s) prepared under OWS 1.2. That is, an archive server instance which does not (fully) implement this operation(s) should be considered compliant with the specification, but at a compliance level less that a server which implements this operation(s). However, all the image archiving server components implemented in the OWS 1.2 testbed are expected to implement this operation(s).

This get coverage operation(s) should be as similar as practical to either the

a) GetCoverage operation of the (draft) WCS or the GetFeature operation of the WFS.

b) Get object operation(s) of the archive service, discussed in Subclause 5.3.5.

5.3.7 Get map (optional)

The image archive function interface(s) can provide one or more operations that together meet the following coverage data portrayal requirements, if such operation(s) are specified:

NOTE If not included in OWS 1.2, this get map functionality is expected to be required in a later OWS testbed. Therefore, decisions should not be made in OWS 1.2 that would make it more difficult to include this get map functionality.

a) This operation(s) shall allow clients to retrieve an image map portraying a selected subset of the stored image or other coverage. This operation(s) shall allow resampling of the selected image subset, as needed to obtain an image map pixel spacing different from the stored grid spacing.

b) The portrayal used in a retrieved image map shall be specified using SLD, modified as needed.

c) The coverage from which a subset is retrieved shall be able to be selected by specifying the data identifier which can be retrieved from the catalog service discussed in Subclause 5.4. This data identifier can also be included in the metadata stored in the image archive server instance.

d) The data identifiers used for requirement c) shall be unique identifiers across all (relevant) archive and catalog server instances.

e) The client specification of the coverage subset to be retrieved shall be based on coverage metadata that is stored with the coverage in the same archive service, and can be retrieved using the get object operation(s) discussed in Subclause 5.3.5.

f) This operation(s) shall be optional implementation by a compliant archive server instance.

NOTE This operation(s) shall be optional implementation in the image archiving interface specification(s) prepared under OWS 1.2. That is, an archive server instance which does not (fully) implement this operation(s) should be considered compliant with the specification, but at a compliance level less that a server which implements this operation(s). However, some of the image archiving server components implemented in the OWS 1.2 testbed are expected to implement this operation(s).

If such operation(s) are specified, this get map operation(s) should be as similar as practical to both the:

a) GetMap operation of the WMS.

b) Get coverage operation(s) of the archive service, discussed in Subclause 5.3.6.

5.4 Image catalog requirements

5.4.1 Introduction

This subclause specifies the more-specific requirements for the image catalog function interface(s) that are specified in OWS 1.2, in addition to the common requirements specified in Subclause 5.2. This subclause specifies that a set of web service operations be provided by one or more interfaces which can be implemented by one server providing the required image catalog functionality. However, this subclause does not specify the:

a) Number of those operations, or their names

b) Number of those interfaces, or their names

One or more interfaces shall be specified that, when all implemented by one catalog server instance, provide operations that support the functionality specified in the following subclauses, namely providing operations allowing:

a) Get service metadata

b) Get schema

c) Input and delete metadata

d) Query metadata

5.4.2 Get service metadata

The catalog function interface(s) shall provide one or more operations that together meet the following service metadata retrieval requirements:

a) This operation(s) shall allow clients to retrieve service metadata for the catalog server instance.

b) This operation(s) shall allow retrieving service metadata that describes all the operations implemented by the catalog server instance, providing information needed for a client to request those operations and use the operation responses.

c) This operation(s) shall allow retrieving a list of all the metadata group types that can (currently) be retrieved from or input into the catalog server instance. This operation(s) shall not require retrieving some metadata from all of the metadata groups currently stored by the catalog server instance. Also, this operation(s) should not require retrieving the complete data schema for all of the metadata types that can be stored.

d) The service metadata output(s) shall be encoded in XML.

e) The output contents and format(s) shall be specified using XML Schema, and those schema(s) shall be based on GML wherever applicable.

f) This operation(s) shall be required implementation by all compliant catalog server instances.

NOTE That is, a catalog server instance which does not (fully) implement this operation(s) shall not be considered compliant with the specification. All the image cataloging server components implemented in the OWS 1.2 testbed shall implement this operation(s).

This get service metadata operation(s) should be as similar as practical to both the

a) GetCapabilities operation of the WFS or WRS.

b) Get service metadata operation(s) of the catalog services described in Subclause 5.3.2.

5.4.3 Get schema

The catalog function interface(s) shall provide one or more operations that together meet the following metadata schemas retrieval requirements:

a) This operation(s) shall allow clients to retrieve the data schema(s) used for selected types of metadata groups that can (currently) be stored by the catalog server instance. This operation(s) should not always retrieve the data schema(s) for all types of metadata that can (currently) be stored by the catalog server instance. Also, this operation(s) shall not always retrieve some metadata for all instances of the type(s).

b) This operation(s) shall allow retrieving data schemas for metadata for images and also for other types of geospatial data and metadata that are stored in the same archive server instance.

c) The type(s) of metadata groups for which schema(s) are retrieved shall be able to be selected by specifying the data type identifier(s) which can be retrieved from the same catalog service using the get service metadata operation(s) discussed in Subclause 5.4.2.

d) The schema output format shall be XML Schema, and those schema(s) shall be based on GML wherever applicable.

e) This operation(s) shall be required implementation by all compliant catalog server instances.

This get schema operation(s) should be as similar as practical to both the

a) DescribeFeatureType operation of the WFS or DescribeRecord operation of the WRS.

b) Get schema operation(s) of the archive services described in Subclause 5.3.3.

5.4.4 Input and delete metadata

The catalog function interface(s) shall provide one or more operations that together meet the following metadata input and management requirements:

a) This operation(s) shall allow clients to input new metadata groups that will be stored by the archive server instance.

b) This operation(s) shall allow input of entire new metadata groups that are provided as operation input parameters.

c) This operation(s) shall allow input of modified versions of previously input metadata groups, where entire groups are provided as operation input parameters. When a new modified version is input, both the modified version and the previously input version(s) of that metadata group shall be stored and shall be queryable and retrievable. If two or more modified versions are input "simultaneously", all the new versions shall be stored and shall be retrievable.

NOTE 1 Both the new version and the previously input version(s) are expected to be required to be stored indefinitely by many catalog applications. However, indefinitely storing previous version(s) will not always be required by an application. There is no requirement to allow input of a modified version of a metadata group that automatically replaces a previously input version (or that also deletes the previous version). However, providing that ability might be cost-effective and is allowed. Without that ability, any client not wishing to retain the previously input version can later delete the previous version.

NOTE 2 Although possible, "simultaneous" input of two or more modified versions is expected to be rare. However, when "simultaneous" or sequential input of multiple modified versions occurs, each modified version will normally be useful to the client that inputs it.

d) This operation(s) can also allow input of updated or corrected versions of previously input metadata groups. When an updated version is input, the updated version shall be stored and shall be retrievable, and the previously input version shall be automatically deleted. If two or more updated versions are input "simultaneously", conflicts between these updates shall be avoided as appropriate.

e) This operation(s) shall allow input of image metadata and also metadata for other types of geospatial data that are stored in the same catalog server instance.

f) The input metadata shall be encoded in XML, and that XML encoding shall be based on GML wherever applicable.

g) The XML encoded input formats allowed shall be specified using XML Schema that can be retrieved using the get schema operation discussed in Subclause 5.4.3.

h) When a new metadata group is input, this operation(s) shall assign a unique metadata identifier that can later be used to retrieve that object, by the query metadata operation(s) discussed in Subclause 5.4.5, and to delete that object.

i) The metadata identifiers used for requirement f) shall be unique identifiers across all (relevant) catalog server instances.

j) The unique metadata identifiers assigned to meet requirement f) shall be compatible with web services. For example, each identifier can be a URN or URL.

k) This operation(s) shall allow input of needed links between new metadata groups and previously entered metadata groups.

NOTE 3 The ability to update metadata previously cataloged is not required, except for adding new metadata groups which are associated with previous metadata. In many uses, metadata group contents are not updated and the old values lost; instead, new metadata group values are added while the previous group values are retained. When modification is required, the new group values can be added and then the old group values can be deleted or deprecated.

l) This operation(s) shall allow clients to request deletion (or discarding) of metadata groups currently stored by the archive server instance.

m) The metadata group deleted shall be able to be selected by specifying the same unique metadata identifier as used by the query metadata operation(s) discussed in Subclause 5.4.5, and which can be previously retrieved from the same catalog server instance.

n) This operation(s) should be required implementation by all compliant catalog server instances.

NOTE 4 This operation(s) should be required implementation in the image cataloging interface specification(s) prepared under OWS 1.2. That is, a catalog server instance which does not (fully) implement this operation(s) can be considered compliant with the specification, but at a compliance level less that a server which implements this operation(s). However, all the image cataloging server components implemented in the OWS 1.2 testbed shall implement this operation(s).

This input and delete metadata operation(s) should be as similar as practical to both the

a) Transaction operation of the WFS or WRS.

b) Input and delete object operation(s) of the archive services described in Subclause 5.3.4.

5.4.5 Query metadata

The catalog function interface(s) shall provide one or more operations that together meet the following metadata query and retrieval requirements:

a) This operation(s) shall allow clients to retrieve selected metadata groups currently stored by the catalog server instance.

b) The metadata retrieved for cataloged objects shall be able to be selected by a query expression based on the Filter Encoding Implementation Specification, modified as needed.

c) The metadata query ability of requirement b) shall support searches of a catalog containing up to about 10**6 entries.

d) This operation(s) shall support the iterative refinement of a query, and should do so without requiring the client to cache the query.

e) A retrieved metadata group shall also be able to be selected by specifying a metadata group identifier which can be previously retrieved from the same catalog service.

f) The metadata identifiers used for requirement e) shall be unique identifiers across all (relevant) catalog server instances.

g) This operation(s) shall allow retrieval of all the metadata that is stored in the catalog for each selected cataloged object.

h) This operation(s) shall also allow retrieval of a selected portions of the complete metadata that is stored in the catalog for each selected cataloged object.

i) This operation(s) shall automatically follow the stored links that relate all the metadata groups for one cataloged object, for object selection as specified in item b) and for retrieved metadata selection as specified in item g).

j) When multiple versions of a metadata group are currently stored, this operation(s) shall allow either the latest or all versions to be selected and/or retrieved as specified in items b) and g) through i). This operation(s) should also allow a specified previous version to be selected and/or retrieved.

k) This operation(s) shall allow retrieving image metadata and also metadata for other types of geospatial data that are stored in the same archive server instance. This operation(s) should also allow retrieving metadata for services and other information objects, when stored in the same catalog server instance.

l) The metadata output(s) shall be encoded in XML, and that XML encoding shall be based on GML wherever applicable.

m) The XML encoded output formats allowed shall be specified using XML Schema, that can be retrieved using the get schema operation discussed in Subclause 5.4.3. Those XML Schema shall be GML application schema wherever applicable.

n) This operation(s) shall be required implementation by all compliant catalog server instances.

This query metadata operation(s) should be as similar as practical to both the

a) GetFeature operation of the WFS or the GetRecord and GetRecordByID operations of the WRS.

b) Get object operation(s) of the archive services described in Subclause 5.3.4.

5.5 Image metadata requirements

5.5.1 Introduction

This subclause specifies the more-specific requirements for the image metadata specified for use in OWS 1.2, in addition to the common requirements specified in Subclause 5.2. These requirements are separately listed for image metadata used by catalog and archive servers, although many of these requirements are the same for both.

5.5.2 Catalog metadata

In addition to the common requirements specified in Subclause 5.2, the image metadata specified for use by OWS 1.2 catalog servers shall meet all the following requirements:

a) The catalog metadata shall be transferred between clients and servers using XML encoding, with the correct encoding and contents specified using XML Schema.

b) The catalog metadata should adapt OGC Abstract Specification new Topic 11 (which contains ISO/DIS 19115) to adequately describe all the categories and types of images handled in OWS 1.2. Such adaptation means selecting a suitable subset of this metadata, and extending that metadata as needed for effective query and retrieval.

NOTE The "Future Work" clause of OGC document 01-053r1 was accepted as an addition to the Abstract Specification new Topic 11, but has not yet been physically included in Topic 11. Among other things, that clause states that the “Reference system information” parts of ISO 19115 need to be modified to be more consistent with the new Abstract Specification Topic 2.

c) The catalog metadata should use GML and XML encoding of OGC Abstract Specification Topic 2, wherever applicable, especially for coordinate reference systems and coordinate operations.

d) The catalog metadata should adapt the FGDC Remote Sensing Extensions as needed to adequately describe all the categories and types of images handled in OWS 1.2.

The catalog metadata should also use SensorML where applicable and not contradictory.

e) The catalog metadata that can be queried shall be distinguished from the catalog metadata that can only be retrieved. All the catalog metadata that can be queried should also be able to be retrieved.

f) The catalog metadata shall be divided into two or more metadata groups suitable for input at different times. Also, separate metadata groups shall be defined for metadata that is applicable to many images and for metadata that is applicable to single images.

5.5.3 Archive metadata

In addition to the common requirements specified in Subclause 5.2, the image metadata specified for use by OWS 1.2 archive servers shall meet all the following requirements:

a) The catalog metadata shall be transferred between clients and servers using XML encoding, with the correct encoding and contents specified using XML Schema.

b) The archive metadata should adapt OGC Abstract Specification new Topic 11 (which contains ISO/DIS 19115) to adequately describe all the categories and types of images handled in OWS 1.2. Such adaptation means selecting a suitable subset of this metadata, and extending that metadata as needed for effective query and retrieval.

NOTE The "Future Work" clause of OGC document 01-053r1 was accepted as an addition to the Abstract Specification new Topic 11, but has not yet been physically included in Topic 11. Among other things, that clause states that the “Reference system information” parts of ISO 19115 need to be modified to be more consistent with the new Abstract Specification Topic 2.

c) The catalog metadata should use GML and XML encoding of OGC Abstract Specification Topic 2, wherever applicable, especially for coordinate reference systems and coordinate operations.

d) The archive metadata should adapt the FGDC Remote Sensing Extensions as needed to adequately describe all the categories and types of images handled in OWS 1.2. The catalog metadata should also use SensorML where applicable and not contradictory.

e) The archive metadata shall be divided into two or more metadata groups suitable for input at different times. Also, separate metadata groups shall be defined for metadata that is applicable to many images and for metadata that is applicable to single images.

6 Design principles

6.1.1 Introduction

The following design principles should be considered in specifying the image archive interface(s), image catalog interface(s), and image metadata for the OWS 1.2 testbed.

6.2 General

The general design principles that should be considered include:

a) Specified services should be as easy-as-practical for a client to use, including by the programmers of client software, and including clients that use a wide variety of types of geospatial data.

b) Specified services should be as easy-as-practical to implement, including by the programmers of the server software.

c) Specified services, interfaces, and data structures should be as easy-as-practical to understand, by potential specification users, client users and programmers, data providers, OGC members, and server programmers.

d) Specified services should be targeted as a frequently-included part of a set of OGC web services.

e) Specifications shall be testable in this testbed. A requirement of the OGC Interoperability Program is demonstration that all elements in a potential specification can be implemented. Therefore, implementation testing in the form of technology integration experiments must play a large part in any potential specification's design.

f) When a potential OGC Implementation Specification is developed, that specification shall be accompanied by a comprehensive, completed test suite.

6.3 Compatible, consistent and extensible

The compatibility, consistency, and extensibility design principles that should be considered include:

a) Revised and new services should have client interfaces that are similar to the already-approved OGC web services and associated data format specifications, including WMS, WFS, GML, SLD, and Filter Encoding.

b) Revisions of already-approved OGC web services and associated data formats specifications should be maximally compatible with the previous versions.

c) All aspects of a specification should be maximally compatible with other aspects of that specification.

d) Specifications should be as easy-as-practical to extend, especially for expected future additions and improvements.

e) Specifications should be as compliant-as-practical with the current OGC Abstract Specification, including Topics 2, 6, 7, 11, 12, 15, and 16.

6.4 Relationships to other standards

The relationships to other standards that should be considered include:

a) Specifications should be compatible with and/or leverage W3C standards efforts such as HTTP, XML, XML Schema, XPointer, and Xquery.

b) Specifications should be compatible with and/or leverage ISO/TC 211 standards and drafts, including ISO 19118 (Encoding), 19115 (Metadata), and 19119 (Services).

c) Metadata should be compatible with and/or leverage FGDC metadata standards, including the draft extensions for remote sensing images.

d) Clients and service implementations should be able to conform to Web accessibility standards (such as those of the W3C Web Accessibility Initiative Content Guidelines).

7 Document terms and definitions

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

7.1
informative
a part of a document that is provided for explanation, but is not required

7.2
normative
a part of a standards document that is required

7.3
annex
an auxiliary part of a document, called an “appendix” in United States English

7.4
clause
a major part of a document, called a “section” or “paragraph” in United States English

7.5
subclause
a secondary part of a clause or annex, called a “subsection” in United States English

7.6
shall
verb form used to indicate a requirement to be strictly followed to conform to this specification, and from which no deviation is permitted

7.7
should
verb form used to indicate desirable ability, without mentioning or excluding other possibilities

7.8
may
verb form used to indicate an action permissible within the limits of this specification

7.9
can
verb form used for statements of possibility

8 Technical terms and definitions

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

8.1
Cartesian coordinate system
coordinate system which gives the position of points relative to *N* mutually perpendicular straight axes

NOTE In the context of geospatial coordinates the maximum value of N is three.

8.2
coordinate
one of a sequence of *N* numbers designating the position of a point in *N*-dimensional space

NOTE In a coordinate reference system, the coordinate numbers must be qualified by units.

8.3
coordinate reference system
coordinate system which is related to the real world by a datum

NOTE For geodetic and vertical datums, it will be related to the Earth.

8.4
coordinate system
set of coordinate axes, with defined or implied metric, used to record point coordinates in a coordinate reference system

NOTE One coordinate system may be used in many coordinate reference systems.

8.5
coordinate transformation
computational process of converting a position given in one coordinate reference system into the corresponding position in another coordinate reference system

NOTE 1 A coordinate transformation can require and use the parameters of the ellipsoids associated with the source and target coordinate reference systems, in addition to the parameters explicitly associated with the transformation.

NOTE 2 The term 'transformation' is used only when the parameter values associated with the transformation have been determined empirically from a measurement / calculation process. This is typically the case when a change of datum is involved.

8.6
coverage
object that uses a coverage function to return one or more attribute values for any direct position within its spatiotemporal range

8.7
data schema
definition of data (or metadata) contents, meanings, structure, and encoding

NOTE In this document, a model of data encoded in XML is defined by one or more XML Schemas for that data. Data item and group meanings are normally defined by text, in Documentation elements in the XML Schemas and in explicitly referenced documents.

8.8

derived image
new image produced by subsetting and/or resampling the pixels in an original image

8.9
elevation
distance of a point from a chosen reference surface along the direction of the gravity vector from the point to that surface.

NOTE 1 See ellipsoidal height and gravity-related height. It should be noted that ellipsoidal height is defined w.r.t. an ellipsoidal model of the shape of the earth. Ellipsoidal height is measured from the point along the line perpendicular to the ellipsoid's surface.

NOTE 2 Height of a point outside the surface treated as positive; negative height is also named as depth.

8.10
feature (in GML)
abstraction of real world phenomena

8.11
frame camera
camera in which an entire frame or format is exposed through a lens that is fixed relative to the focal plane

8.12
geographic coordinate reference system
coordinate reference system using an ellipsoidal coordinate system and based on an ellipsoid that approximates the shape of the Earth

NOTE A geographic coordinate system can be 2D or 3D. In a 3D geographic coordinate system, the third dimension is height above the ellipsoid surface.

8.13

georeferenced image
image where the image position that corresponds to any ground position covered by that image can be computed using an image geometry model or other coordinate transformation

NOTE Most images being exploited are georeferenced, at least approximately. Georeferenced implies that the sensor position and pointing directions at the time of image collection are known, with some degree of accuracy. For a two-dimensional image (the normal type), the image coordinate reference system is 2D. However, the ground coordinates are always 3D. The 3D ground coordinates are "projected" into 2D image coordinates using an image projection.

8.14
ground coordinates
coordinates of points measured in a non-image coordinate reference system

NOTE The term ground coordinates is used herein to distinguish such coordinates from image coordinates. Even when an image is collected by a near vertical camera, image coordinates are different from ground coordinates!

8.15
image
record of the likeness of any features, objects, and activities

NOTE An image can be acquired through the sensing of visual or any other segment of the electromagnetic spectrum by sensors, such as thermal infrared, and high resolution radar. An image can also be acquired outside the electromagnetic spectrum, e.g., sonar and seismic images.

8.16
image archive
repository of image data and some associated metadata

8.17
image catalog
registry of metadata about images

8.18
image compression
operation that, through various techniques, reduces the quantity of stored data needed to represent a digital image

8.19
image coordinates
definition of position within an image, expressed in image row and column coordinates

8.20
image exploitation
evaluation of an image or multiple images to extract the information contained within the image(s) as it pertains to a specific list of questions or general categories of questions

NOTE Exploitation may result in the creation of a report or product to disseminate the information, whether disseminated to a requester or to a database.

8.21
image footprint
polygon outline of ground area covered by an image, often stored as image metadata

8.22
image geometry model
mathematical model that specifies the mapping (or projection) from 3D ground position coordinates to the corresponding 2D image position coordinates

NOTE 1 An image geometry model is alternately called an image sensor model, sensor model, imaging model, or image mathematical model. The term "sensor" is often used when the image is generated by a digital camera and is thus originally digital. The word "camera" is usually used when the image is recorded in analog form, normally on film. Of course, film images can be later scanned or digitized and are then "digital".

NOTE 2 An image geometry model can also be used to determine the correct ground position for an image position, if used with additional data. When a single (or monoscopic) image is used, this additional data normally defines the shape and position of the visible ground (or object) surface. For example, this additional data is often a single elevation or is grid elevation data, sometimes called a Digital Terrain Model (DTM). Alternately, two stereoscopic images or multiple overlapping images can be used, that show the same ground point viewed from different directions. In this case, the two (or more) image geometry mathematical models can also be used, with the point coordinates in each individual image, to determine the corresponding 3D ground position.

8.23

image resolution
degree of detail visible in an image

8.24
image tile
part of an image based on rectangular or square image areas

8.25
imagery client
computer software that retrieves images and image metadata from image archives and catalogs, to process or use those images

8.26
interface
named set of operations that characterise the behaviour of an element

8.27

metadata
data about the content, quality, condition, and other characteristics of data

8.28
metadata group
group of metadata that is input as one group at one time

NOTE Metadata items are placed in different groups when they are expected to be input, or be updated by inputting a new version, at different times. For example, metadata that is common to multiple images, including a collection of images, is separated from metadata that differs for each image. Catalog-stored metadata is also separated from archive-stored metadata.

8.29
monoscopic image
a single image taken of a target

8.30
mosaicked image
image mosaic
an image that combines two or more previously separate images

8.31
order of magnitude
approximation of a number that is probably within a factor of ten of being correct

8.32
original image
collected image without any modifications

8.33
orthorectified image
copy of an image in which image displacements due to camera tilt and terrain relief have been removed

NOTE A digital orthophotograph.

8.34
panoramic camera
camera which takes a partial or complete panorama of the terrain

NOTE Some designs utilize a lens which revolves about an axis perpendicular to the optical axis; in other designs, the camera itself is revolved by clockwork to obtain a panoramic field of view. See also frame camera.

8.35
pixel
2-dimensional picture element that is the smallest nondivisible element of a digital image. In image processing, the smallest element of a digital image that can be assigned a grey level.

NOTE This term originated as a contraction for “picture element”.

8.36
photogrammetry
use of aerial photographs to produce planimetric and topographic maps of the earth's surface and of features of the built environment

NOTE Effective photogrammetry makes use of ground control by which aerial photographs are carefully compared and registered to the locations and characteristics of features identified in ground-level surveys.

8.37
position
spatial reference of a point or an object

8.38
query language
computer language in which server requests are defined

NOTE Query languages are often server-specific.

8.39
server request
set of instructions passed to the server to initiate desired operations, such as to retrieve needed information

8.40
stereoscopic images
two images of a single target allowing three-dimensional viewing of a target.

NOTE 1 The two images (or photographs) must have sufficient overlap of detail to make possible stereoscopic examination of an object or an area common to both images.

NOTE 2 The two (or more) images of the same object (or target) must be taken from different imaging positions in space, and thus different object viewing directions. These multiple images can be used to determine object position or dimensions in three-dimensions. Two stereoscopic images are often taken from different points along one flight path, but there are also stereoscopic images from different flight paths.

8.41
transformation
change of coordinates from one coordinate reference system to another coordinate reference system based on a different datum through a one-to-one relationship

NOTE A transformation uses parameter values which may have to be derived empirically by a set of points common to both coordinate reference systems. See coordinate conversion and coordinate transformation.

8.42
unit
defined quantity in which dimensioned parameters are expressed

NOTE In this document, the subtypes of units are length units, angular units, time units, and pixel spacing units.

Annex A
(informative)

Image handling use cases

A.1 Overview

This annex provides a set of use cases that illustrate potential applications of products implementing the OWS 1.2 image handling and other specifications. These use cases are modularized into three levels of detail:

a) The top level use cases describe image handling applications at a high level. This annex includes four such use cases; and references additional top level use cases described in other documents. In addition, some steps in the listed second level use cases could be described in more detail as additional top level use cases.

b) The second level use cases describe image handling applications at a more detailed level. These three use cases are used by all or most top level use cases.

c) The third level use cases provide still more detail about the service calls and data transfers by which clients use the image handling software components. These three third level use cases are used by the second level use cases.

The third level use cases are described first, since they are more directly relevant to the requirements for the image archive and catalog service interfaces. The second level use cases are then described, followed by the top level use cases.

A.2 Third level use cases

A.2.1 Introduction

These third level use cases provide a detailed description of the software component requests and data transfers needed to support second-level use cases. In these third level use cases, the use case steps describing direct interaction between a client and the OWS interfaces are marked "(Note 1)". Multiple archives and catalogs could be used in a single use case step. Notice that all of these third level use cases are applied to multiple types of data, and are essentially independent of the types of data being handled.

These three third level use cases would normally be used in the sequence in which they are described below. These use cases are described separately because they would usually be interleaved with activities not directly involving data catalogs and archives, as indicated in the second level use cases. Also, these use cases would sometimes be repeated in higher level use cases. Note that these three use cases might be performed by

different clients, users, and/or actors. Indeed, different steps in one use case could be performed by different clients, users, and/or actors.

Much of the information needed by a client to perform each of these third level use cases is provided by the top level or second level use case which is currently using this third level use case. That is, much of the needed information is provided by the context provided by that higher level use case.

A.2.2 Put data into archives and catalogs

The "Put data into archives and catalogs" use case is described in Table A.1.

Table A.1 — Put data into archives and catalogs use case

Use case description	
Name	Put data into archives and catalogs
Priority	High (third level use case that directly interacts with image archive and catalog services)
Description	Client inputs image or other data and associated metadata into archive(s) and catalog(s).
Precondition	The data and associated metadata to be stored are already known by the client, from the higher level use case that uses this use case. All the relevant data and metadata types are also already known by the client (or can be determined from data and metadata item names). The needed data archive and catalog servers are available and already known by the client, and they support data schemas for all needed types of data and metadata. These archive and catalog servers may already store some of the needed metadata.
Flow of events – basic path	
1)	Client gets the data schema(s) for data and archive metadata to be stored (Note 1)
2)	If needed, client gets the data schema(s) for catalog metadata to be stored (Note 1)
3)	Client checks that new data complies with the data schema(s)
4)	Client formats new data and/or metadata as needed for entry
5)	If needed, client puts data and/or metadata into archive(s) (Note 1)
6)	Client links newly archived data and/or metadata to previous data (Notes 1 and 2)
7)	Client verifies that new data is recorded in archive(s) (Note 1)
8)	If needed, client puts new metadata into catalog(s) (Note 1)
9)	Client links newly cataloged metadata to previous metadata (Notes 1 and 2)
10)	Client verifies that new metadata is recorded in catalog(s) (Note 1)
Flow of events – alternative paths	
	(none)
Postcondition	The client data and/or metadata are stored in needed data archive(s) and catalog(s).
NOTE 1 Client directly interacts with server(s) through OWS interfaces in this use case step. NOTE 2 This use case step assumes that the client must initiate and supply information for linking new metadata to previous metadata.	

A.2.3 Perform queries of data catalogs

The "Perform queries of data catalogs " use case is described in Table A.2.

Table A.2 — Perform queries of data catalogs use case

Use case description	
Name	Perform queries of data catalogs
Priority	High (third level use case that directly interacts with image archive and catalog services)
Description	Client queries one or more catalogs to find needed image(s) and/or other data.
Precondition	The desired values of useful metadata items are already known by the client, from the higher level use case that uses this use case. All the corresponding metadata types are also already known by the client (or can be determined from the metadata item names). The needed data catalog server(s) are available and already known by the client, and they support data schemas for all needed types of metadata. These catalog servers already store metadata for all of the needed data.
Flow of events – basic path	
1)	Client gets data schema(s) for metadata types to be queried (Note 1)
2)	Client gets list of standard queries for metadata schema(s) (Notes 1 and 2)
3)	Client selects standard query to be adapted
4)	Client adapts selected query for specific metadata needs
5)	Client queries catalog(s) (Note 1)
6)	Client reviews query results
7)	If results are not good enough, client returns to step 4) or 2)
Flow of events – alternative paths	
	(none)
Postcondition	The client has identified (suitable) needed image(s) and/or other data, has their identifiers, and knows the archive(s) which store that data.
NOTE 1 Client directly interacts with server(s) through OWS interfaces in this use case step. NOTE 2 This step assumes that standard queries are stored in an archive.	

A.2.4 Retrieve data and metadata from archives and catalogs

The "Retrieve data and metadata from archives and catalogs" use case is described in Table A.3.

Table A.3 — Retrieve data and metadata from archives and catalogs use case

Use case description	
Name	Retrieve data and metadata from archives and catalogs
Priority	High (third level use case that directly interacts with image archive and catalog services)
Description	Client retrieves image or other data and/or metadata from archive(s) and catalog(s).
Precondition	The data and metadata to be retrieved are already known by the client, from the higher level use case that uses this use case. All the corresponding data and metadata types are also already known by the client (or can be determined from the data and metadata item names). The needed data archive and catalog servers are available and already known by the client, and they support data schemas for all needed types of data and metadata. These archive and catalog servers already store all of the needed data and metadata, and the client already has the identifiers and knows the archive(s) or catalog(s) which store that data and/or metadata.
Flow of events – basic path	
1)	Client gets data schema(s) for data and/or archive metadata types to be retrieved (Note 1)
2)	If needed, client gets data schema(s) for catalog metadata types to be retrieved (Note 1)
3)	Client gets list of standard retrieval requests for data schema(s) (Notes 1 and 2)
4)	Client selects standard retrieval request to be adapted
5)	Client adapts standard retrieval request for specific needs
6)	Client retrieves data and/or metadata from archive(s) (Note 1)
7)	If needed, client retrieves metadata from catalog(s) (Note 1)
Flow of events – alternative paths	
	(none)
Postcondition	The client has retrieved the needed data and/or metadata.
NOTE 1 Client directly interacts with server(s) through OWS interfaces in this use case step. NOTE 2 This step assumes that standard retrieval requests are stored in an archive.	

A.3 Second level use cases

A.3.1 Introduction

These second level use cases provide a more-detailed description of key steps needed to perform the tasks outlined in the top level use cases. The OWS 1.2 testbed is defining application interfaces for image archives and catalogs. In these second level use cases, the use case steps describing direct interaction using OWS interfaces are marked "(Note 1)", while the steps that indirectly use image archive and catalog functions are marked "(Note 2)". For each of these direct interaction steps, the more-detailed interface requests

and data transfers needed for utilizing image archives and catalogs are described in a third-level use case included in Subclause A.2. Each of these indirect interaction steps is much like another top level use case, that uses one or more of these second level use cases.

Much of the information needed by a client to perform each of these second level use cases is provided by the top level use case which is currently using this second level use case. That is, much of the needed information is provided by the context provided by that higher level use case. Similarly, much of the information needed by a client to perform a third level use case which is used is provided by this second level use case.

The OWS 1.2 testbed must support a high level of interoperability between software and hardware components used in image handling. As a result, multiple data archives and catalogs could be used in a single use case step. That is, the image data collected with a sensor could be placed into multiple image archives, and the metadata collected could be placed into multiple catalogs and archives. Image query and retrieval would then involve using multiple archives and catalogs, connected by a network such as the Internet.

A.3.2 Provide images to archives

The "Provide images to archives" use case is described in Table A.4.

Table A.4 — Provide images to archives use case

Use case description	
Name	Provide images to archives
Priority	Medium (second level use case that uses third level use cases to directly interact with image archive and catalog services)
Description	Client uses a sensor to collect image(s), and client inputs image(s) and metadata into data archive(s) and catalog(s).
Precondition	Client has access to an image sensor. All the relevant image data and metadata types are already known by the client (from the higher level use case that uses this use case). The needed data archive and catalog servers are available and already known by the client, and they support data schemas for all needed types of data and metadata. These archive and catalog servers may already store some of the needed metadata.
Flow of events – basic path	
1)	Client calibrates image sensor (Note 2)
2)	Client puts image sensor metadata into archive(s) and catalog(s) (Note 1)
3)	Client plans collection of group of images (Note 2)
4)	Client puts collection plan metadata into archive(s) and catalog(s) (Note 1)
5)	Client collects images, probably using other services
6)	Client processes collected images as needed, probably using other services. These processes can include developing, digitizing, and interior orienting film images, generating reduced resolution and histogram equalized digital images, etc. (Note 3)
7)	Client checks and evaluates processed images (Note 2)
8)	Client puts processing metadata into archive(s) and catalog(s) (Note 1)
9)	Client determines and collects other metadata for images (Note 2)
10)	Client puts images with metadata into archive(s) and catalog(s) (Note 1)
11)	Client updates image georeferencing metadata by triangulation and/or other methods, when needed images and/or other data are available. (Notes 2 and 4)
12)	Client puts updated image metadata into archive(s) and catalog(s) (Note 1)
13)	For more images from the sensor, client returns to step 3)
Flow of events – alternative paths	
	(none)
Postcondition	The collected images and metadata are stored in needed data archive(s) and catalog(s).

NOTE 1 Client interacts with server(s) through OWS interfaces in this step using one of the third level use cases described herein.

NOTE 2 This step indirectly uses image archive and catalog functions, and is much like another top level use case that uses the same second level use cases.

NOTE 3 This image processing does NOT include georectifying, mosaicking, or georeferencing, which are treated separately in these use cases.

NOTE 4 This step is described in more detail in the Register Images use case in Section 2.1.2.5 of OGC Abstract Specification Topic 15: Image Exploitation Services.

A.3.3 Find source images and other data

The "Find source images and other data" use case is described in Table A.5.

NOTE Notice that this use case applies to multiple types of data, and is essentially independent of the types of data being found. This use case is described in more detail in the Prepare Feature Source Package use case, in Section 2.1.2.4 of OGC Abstract Specification Topic 15: Image Exploitation Services.

Table A.5 — Find source images and other data use case

Use case description	
Name	Find source images and other data
Priority	Medium (second level use case that uses third level use cases to directly interact with image archive and catalog services)
Description	Client searches network accessible data catalogs for needed source data, including images and other types of data.
Precondition	The exploitation tasks to be performed are already known by the client, from the higher level use case that uses this use case. All the relevant data and metadata types are already known by the client, from the higher level use case that uses this use case. The needed data catalog servers are available and already known by the client, and they support data schemas for all needed types of metadata. These catalog servers already store all of the needed metadata for all relevant available data.
Flow of events – basic path	
1)	Client determines exploitation needs for source data
2)	Client performs general query of enterprise data catalog(s) (Note 1)
3)	Client selects data groups and types for further selection
4)	Client performs detailed queries of appropriate data catalogs (Note 1)
5)	If needed, client retrieves and evaluates candidate source data (Note 2)
6)	Client evaluates and selects images and other data source to be exploited
7)	Client produces a list of selected sources for later exploitation
8)	If appropriate, client put sources list into archive(s) and/or catalog(s) (Note 1)
Flow of events – alternative paths	
	(none)
Postcondition	The client has identified (suitable) needed image(s) and/or other data, has their identifiers, and knows the archive(s) which store that data.
NOTE 1 Client interacts with server(s) through OWS interfaces in this step using one of the third level use cases described herein. NOTE 2 This step indirectly uses image archive and catalog functions, and is much like another top level use case that uses the same second level use cases.	

A.3.4 Exploit images and other data

The "Exploit images and other data" use case is described in Table A.6.

Table A.6 — Exploit images and other data use case

Use case description	
Name	Exploit images and other data
Priority	Medium (second level use case that uses third level use cases to directly interact with image archive and catalog services)
Description	Client retrieves image(s) and other source data from data archive(s) and exploits that data, including feature extraction.
Precondition	The image exploitation tasks to be performed are already known by the client, from the higher level use case that uses this use case. The needed data and metadata types are also already known by the client (or can be determined from data and metadata item names). The needed data archive and catalog servers are available and already known by the client, and they support data schemas for all needed types of data and metadata. These archive and catalog servers already store all needed data and metadata. The client has already identified (suitable) needed image(s) and other data, has their identifiers, and knows the archive(s) which store that data.
Flow of events – basic path	
1)	Client retrieves part of image(s) covering area of interest, with all the image metadata needed for exploitation (Note 1)
2)	Client retrieves parts of other data covering area of interest (Note 1)
3)	Client computes image positions of feature points and vertices, using image georeferencing metadata
4)	Client displays images with other data overlaid
5)	Client user manually views display(s) and interprets the information needed
6)	If needed, client extracts new and edits existing features. (Notes 2 and 3)
7)	Client computes ground positions of feature points and vertices, using image georeferencing metadata
8)	If needed, client performs other image exploitation. (Note 4)
9)	As appropriate, client puts exploitation results in a data archive(s) (Note 1)
Flow of events – alternative paths	
	(none)
Postcondition	Client has performed needed image exploitation, including needed feature extraction and editing.
NOTE 1 Client interacts with server(s) through OWS interfaces in this step using one of the third level use cases described herein. NOTE 2 This step indirectly uses image archive and catalog functions, and is much like another top level use case that uses the same second level use cases. NOTE 3 This step is described in more detail in the Extract Feature From Image use case in Section 2.1.2.2 of OGC Abstract Specification Topic 15: Image Exploitation Services. NOTE 4 Many other possible image exploitation activities are listed in Section 2.2 of Abstract Specification Topic 15: Image Exploitation Services.	

A.4 Top level use cases

A.4.1 Introduction

These top level use cases provide a high-level description of several image exploitation scenarios, and imply the use of image handling components supporting these scenarios. As previously indicated, these top level use cases use the three second level use cases described above. Much of the information needed by a client to perform a second level use case which is used is provided by this top level use case.

A.4.2 Agricultural irrigation use case

The "Agricultural irrigation" use case is described in Table A.7.

NOTE This use case is similar to the Farmer use case in Section 2.1.2.2 of OGC Abstract Specification Topic 15: Image Exploitation Services.

Table A.7 — Agricultural irrigation use case

Use case description	
Name	Agricultural irrigation
Priority	Low (top level use case that uses second and third level use cases to interact with image archive and catalog services)
Description	Agricultural company buys and exploits images to determine irrigation needs of crop fields in central California.
Precondition	Suitable data archive and catalog servers are available to the companies involved, and they support data schemas for all needed types of data and metadata. The needed data and metadata types are also already known by these companies. The available archive and catalog servers may already store some of the needed metadata and data.
Flow of events – basic path	
1)	An agricultural company hires a mapping company to collect images of their crop fields in central California.
2)	The mapping company collects digital images of specified crop fields.
3)	The mapping company inputs the collected images into a data archive connected to the Internet
4)	The mapping company places metadata for collected images in a data catalog, and perhaps an archive, connected to the Internet. That metadata includes the relevant image collection conditions, such as time of the day, cloud cover, sun direction. etc.
5)	The agricultural company accesses the data catalog through the Internet, and searches it for images taken in areas on dates needed to estimate field irrigation patterns. For example, the catalog search might produce five image IDs that the agricultural company later uses to retrieve these images from the archive.
6)	The agricultural company retrieves the needed images from the data archive.
7)	If needed for following step(s), the agricultural company georectifies and perhaps mosaics the retrieved images, using image georeferencing metadata.
8)	The agricultural company evaluates the images to determine irrigation needs. This information allows the agricultural company to improve field irrigation and to increase productivity. (Note 1)
Flow of events – alternative paths	
	(none)
Postcondition	Agricultural company has determined irrigation needs for selected crop fields.
NOTE 1 Georectified images are likely to be needed in this step if two or more images must be directly compared. Whether georectified or georeferenced images are used, image georeferencing metadata is likely to be used in this step, to convert image coordinates to ground coordinates and/or to convert ground coordinates to image coordinates.	

A.4.3 Vehicle traffic use case

The "Vehicle traffic" use case is described in Table A.8.

Table A.8 — Vehicle traffic use case

Use case description	
Name	Vehicle traffic
Priority	Low (top level use case that uses second and third level use cases to interact with image archive and catalog services)
Description	A civil engineering company obtains and uses aerial images to evaluate traffic conditions on the I 5 freeway in the city of Portland, OR.
Precondition	Suitable data archive and catalog servers are available to the companies involved, and they support data schemas for all needed types of data and metadata. The needed data and metadata types are also already known by these companies. The available archive and catalog servers already store all of the needed data and metadata.
Flow of events – basic path	
1)	A civil engineering company contracts with an aerial photography company to gain access to their image archive(s) covering Portland.
2)	The engineering company searches the aerial photography company's online catalog for existing digital images taken in the desired area of Portland on a certain date at different times of the day.
3)	The engineering company uses image IDs retrieved from the catalog to retrieve images from an online archive.
4)	The images retrieved are enhanced for easier viewing by defining portrayal criteria with a Styled Layer Descriptor definition. (Note 1)
5)	The enhanced images are searched for car features on the freeway under evaluation.
6)	The numbers of car features are used to evaluate traffic conditions on the freeway during a particular time of the day. This extracted traffic information can be used to improve driving conditions.
Flow of events – alternative paths	
	(none)
Postcondition	The civil engineering company has evaluated traffic conditions on the I 5 freeway in the city of Portland, OR.
NOTE 1 We assume that image georectification and mosaicking are not needed in this use case.	

A.4.4 Natural resources use case

The "Natural resources" use case is described in Table A.9.

Table A.9 — Natural resources use case

Use case description	
Name	Natural resources
Priority	Low (top level use case that uses second and third level use cases to interact with image archive and catalog services)
Description	A natural resources company performs a broad search on a single-access image catalog to find information on a particular aerial photography image that they have received from one of their field analysts.
Precondition	Suitable data catalog servers are available to and already known by the natural resources company, and they support data schemas for all needed types of metadata. The needed data and metadata types are also already known by the natural resources company. The available catalog servers already store all of the needed metadata.
Flow of events – basic path	
1)	A natural resources company receives an image from one of their field analysts.
2)	The natural resources company formulates a catalog query for needed information about the received image.
3)	The natural resources company sends a query to a single-access catalog that searches a number of network-accessible catalogs for the required information.
4)	The single-access catalog searches other catalogs for the desired information.
5)	The single-access catalog consolidates the metadata returned by other catalogs, and sends the result back to the natural resources company.
6)	The natural resources company used the metadata returned to evaluate and identify the image received.
Flow of events – alternative paths	
	(none)
Postcondition	The natural resources company has found and retrieved the needed metadata about the received image.

A.4.5 Hurricane evacuation use case

The "Hurricane evacuation" use case is described in Table A.10.

NOTE This use case was submitted by Tony Cook of the University of Alabama at Huntsville.

Table A.10 — Hurricane evacuation use case

Use case description	
Name	Hurricane evacuation
Priority	Low (top level use case that uses second and third level use cases to interact with image handling services)
Description	Command center gets immediate, continuous input on approaching tropical storm, assesses the potential danger, and determines the best routes for escape if necessary.
Precondition	The available data of relevance to an image archive service is: a) Goes Satellite data - visible, IR b) Doppler Radar data c) Aerial photography/Video d) Dropsondes, Balloons, Station Data for various meteorological parameters (Features?) e) Flood stage data
Flow of events – basic path	
1)	Prior to event, image archive is continually populated with Goes Satellite data and Doppler Radar data in real-time. (Note 1)
2)	Prior to event, aerial photography/video is obtained for region of interest (ROI), to be used as a baseline. (Note 1)
3)	Command Center is placed on alert due to incoming tropical system.
4)	During period of alert, aerial photography/video is captured every *N* hours and added to the Image Archive. (Note 1)
5)	During period of alert, image archive is continually populated with Goes Satellite data and Doppler Radar data in real-time. (Note 1)
6)	Command center constantly monitors progress of tropical system as it approaches ROI, by accessing georeferenced Goes Satellite data. (Note 2)
7)	If available, dropsonde and profiler data from aircraft overflights and ground profiler systems are accessed to monitor strength of tropical storm.
8)	Command Center accesses Map/Feature data for all outgoing traffic routes from ROI. Near-real time Aerial Photography/Video of ROI is also obtained and orthorectified, so that Command Center can plan optimal escape routes. (Note 2)
9)	If the decision is made to evacuate, command center continues to monitor near-real time status of outgoing routes and traffic flow. Escape routes are modified as needed. (Note 2)
Flow of events – alternative paths	
	This use case could be extended to include monitoring of flood stages, damage assessment, recovery efforts, etc. Of course, aerial photography will grow increasingly difficult to obtain as weather conditions degenerate. Also, other satellite platforms, such as NOAA's AMSU may be available to monitor the tropical system. The availability of this data is more limited, however, as these platforms are polar arbiters, and will only cross the ROI twice daily.
Postcondition	Command center monitors approaching tropical storm, assesses the potential danger, and determines the best routes for escape if necessary.
NOTE 1 Image exploitation services used: Put data and metadata into archive NOTE 2 Image exploitation services used: Display images with overlaid graphics	

A.4.6 Abstract Specification Topic 15 use cases

Eight relevant top level use cases are described in OGC Abstract Specification Topic 15: Image Exploitation Services. To minimize redundancy, these eight use cases are not copied or reformatted here. Section 2.1.1 of the Topic 15 describes three use cases in which information consumers could perform activities that use image exploitation services. Section 2.1.2 of the Topic 15 describes a set of five use cases from the geospatial information producer perspective. These five use cases show parts of a workflow used by information producers to extract features and other geospatial data from images.

These eight use cases generally do not explicitly indicate where an image archive or catalog is used. However, many of the listed steps must use an image archive or catalog, or use metadata previously retrieved from an image catalog or archive. Section 2.1.3 of Topic 15 describes in more detail some of the image exploitation services used by steps in these eight use cases.

A.4.7 European Union crop monitoring usage scenario

Stephane Fellah of PCI Geomatics has posted on the OWS 1.2 portal a document file labeled "EU Crop monitoring Usage Scenario (full)". That document includes useful information for the image handling thread, common architecture thread, and common source thread. Because of that breadth and the document length, that document is not copied or paraphrased in this document.

That usage scenario document contains information which could be included in many separate use cases. Many of those potential use cases would be top level use case for the image handling services discussed in this document. That is, these top level use cases would use the second and third level use cases that are discussed herein. All of the direct interactions with the image archiving and cataloging services discussed in this document would be through the same three third level use cases discussed in this document.

Annex B
(informative)

Image categories and georeferencing

B.1 Introduction

This annex describes and discusses some of the image categories and georeferencing terms used in Subclause 5.2.2.

B.2 Original images

The pixels in an original digital image are evenly spaced in an image coordinate reference system. This image coordinate reference system is usually Cartesian with a rectangular extent and the origin in the center or corner of the image. This image coordinate reference system is never a well-known ground coordinate reference system. That is, the origin of each image has a different position in ground space, and the axes of each image usually have different directions in ground space. (A coordinate transformation between an image coordinate reference system and a ground coordinate reference systems is usually known as described below, but that coordinate transformation is not part of the specification of the image coordinate reference system.)

In many cases, image exploitation uses original images, not previously orthorectified images. Orthorectification is done by image pixel resampling, which usually reduces the quality of the image, by reducing the effective image resolution or reducing the ability to perform automated classification of multispectral images. In addition, image orthorectification requires elevation coverage plus significant computation resources, which are not always available.

B.3 Derived images

The simplest forms of derived images are image sections (or partial images) and reduced image resolutions. Other useful forms of derived images include affine warped image sections or entire images. Images can be derived directly from an original image or from a previously derived image.

In a derived image, the pixels are evenly spaced in a different image coordinate reference system. This image coordinate reference system is usually Cartesian with a rectangular extent and the origin in the center or corner of the image. (This image coordinate reference system is never a well-known ground coordinate reference system. That is, the origin of each image has a different position in ground space, and the axes of each image usually have different directions in ground space.)

In general, a set of derived images can form an acyclic directed graph rooted in a set of original images. That is, multiple images can be derived from one original image. A derived image can have multiple base images, from the same or different original images, although having only one base image will be most common. Similarly, the set of coordinate transformations for one image can be linked to form an acyclic directed graph. Also, a set of coordinate transformations revisions can be linked to form an acyclic directed graph rooted in a set of original coordinate transformations.

B.4 Orthorectified images

An orthorectified image is not considered to be a derived image in this document. Orthorectified images have image pixels resampled into a grid coordinate reference system (usually not into a well-known ground coordinate reference system). A grid coordinate reference system is usually a derived coordinate reference system of type "engineering", which has a specified coordinate transformation from a well-known ground coordinate reference system. Alternately, a grid coordinate reference system can be a specialized engineering coordinate reference system used for a grid of points. This grid coordinate reference system is usually Cartesian with a rectangular extent.

NOTE This document includes the term "orthorectified image" because that term is often used in photogrammetry, and is currently used in the OGC Abstract Specification. Subclause 7.3.2 of the current working draft for ISO 19129 (OGC document 02-002) uses the term "georectified" image to mean almost the same thing. However, a georectified image can be a mosaicked combination of multiple original images, while an orthorectified image is produced from a single original image.

Orthorectification uses some form of image geometry model plus an elevation coverage. For a suitably flat portion of the earth's surface, rectification (using a fixed elevation instead of an elevation coverage) can be substituted for orthorectification. An orthorectified image is usually georeferenced, but exceptions are possible.

B.5 Image mosaics

In some applications, the number of images can be reduced by creating an image mosaic combining many discrete images. The multiple images are usually each orthorectified before they are combined. An image mosaic is usually georeferenced, but exceptions are possible.

From a users point of view, dealing with multiple images can make it difficult to use the data. A seamless image mosaic over some geographic extent often can be produced and will reduce the number of images, but some image quality is sacrificed. That is, the image quality is degraded by the resampling and combining performed in mosaicking. There is thus a tradeoff between ease of use and high image quality. If the quality of the seamless mosaic exceeds that needed for a task, then the mosaic would usually be preferred over the multiple images. In other cases, the higher quality is required, and mosaicking is not an option.

B.6 Elevation coverages

An elevation coverage is often used with one (monoscopic) image position to determine the corresponding 3D ground position, using the image geometry model. Alternately, a constant-elevation surface is sometimes used. That is, the image position and image geometry model can be used to find the imaging ray in 3D ground space. This imaging ray is then (virtually) intersected with the ground surface defined by the elevation coverage.

The simplest form of elevation coverage is grid elevation data, and only grid elevations are required to be used in this thread set. In the longer term, Triangulated Irregular Network (TIN) and other types of elevation coverages should be allowed. For some purposes, grid or TIN elevation data can be usefully supplemented by 3D digital feature data. Such digital feature data can be used to describe objects that sit on top the basic ground surface represented by the elevation coverage, or to define surface break lines and points (i.e., geomorphic features).

B.7 Georeferenced images

An original, derived, orthorectified, or mosaicked image can be georeferenced or ungeoreferenced. A georeferenced image has at least one known coordinate transformation between the image or grid coordinate reference system and an identified ground coordinate reference system. Such a coordinate transformation (or coordinate operation) uses parameters with values specific to that image. (That coordinate transformation is usually not part of the specification of the image coordinate reference system. However, that coordinate transformation is likely to be part of the specification of the grid coordinate reference system for an orthorectified or mosaicked image.)

In most cases, each original image coordinate reference system is georeferenced to a ground coordinate reference system using an image geometry model. This georeferencing is often fairly accurate (e.g., errors of a few pixel spacings), but an image may be only poorly georeferenced (e.g., errors of hundreds of pixel spacings). Image geometry models are described in Subsections 2.3 and 2.4 of OGC Abstract Specification Topic 16. (Some approximate image geometry models are described in Section 6 of Abstract Specification Topic 7.) One image will often be associated with a sequence of slightly different image geometry models, with improving position accuracy.

Similarly, each derived image is referenced to the original or base image coordinate reference system using a parameterized coordinate transformation. The coordinate transformation from the base image is often used to specify the derived system, and is then included in the specification of the derived image coordinate reference system. Alternately or in addition, a derived image can be directly referenced to a ground coordinate reference system using an image geometry model.

B.8 Image geometry models

In most cases, each original image coordinate reference system is georeferenced to a ground coordinate reference system using an image geometry model. Each image geometry model specifies one or more parameterized coordinate transformations, each using a transformation (or operation) method. The mathematics of a basic image geometry model defines a transformation method that is applicable to many images. Each image then uses a specific set of transformation parameter values; these values capture the camera position and direction at the time of image exposure, plus various non-idealities.

B.9 Coordinate reference systems

Position coordinates are unambiguous only when the coordinate reference system used by those coordinates is fully defined. A coordinate reference system is a coordinate system (a set of coordinate axes) that is related to the real world by a datum (which defines the position of the origin and the directions of the axes). Coordinate reference systems are defined in OGC Abstract Specification Topic 2.

This document uses the standard term "coordinate reference system" for all coordinate reference systems, as defined in ISO/DIS 19111 and Topic 2 of the OGC Abstract Specification. Some OWS interface specifications now improperly use the less precise ISO term "spatial reference system". That term also includes spatial referencing by identifier (without coordinates). Notice that a "coordinate system" is less complete and is just one part of a coordinate reference system. This document uses the term image coordinates for positions in a 2D image (coordinate reference system), and sometimes uses the term ground coordinates for positions in a 3D ground coordinate reference system.

B.10 Coordinate transformations

Interfaces specified and components implemented in OWS 1.2 shall support performing all the coordinate transformations needed to handle original and derived images. That is, this thread set must handle positions in original images, not already orthorectified into ground coordinates. This thread set can be limited to handling only one (monoscopic) image at a time, although handling two or more (stereoscopic) images together would be desirable and will ultimately be required. In addition, these components should support performing coordinate transformations needed to provide flexibility in the ground coordinate reference systems available to users of client components.

This document currently uses the widely-used term "coordinate transformation" for all changing of position values from one coordinate reference system to another. The newly revised Topic 2 of the OGC Abstract Specification uses the ISO/DIS 19111 specified term "operation" for all such coordinate reference system changes. Both of those documents recognize two different subtypes of "operations", namely "conversions" and "transformations". By definition, conversions are specified with no errors, while transformations are specified with errors.

A "coordinate transformation" or "operation" need not be in analytic form; it may be specified by a table of corresponding data values. That table may include information other than the location of the data points.

Annex C
(informative)

Image distribution service

C.1 Introduction

An image distribution service interface is also expected to be needed in the longer term. This distribution interface could be implemented by a separate server instance, or by a server that also implements the image archive, catalog, and/or other OGC interfaces.

This image distribution service is needed to simplify clients that input image data, by avoiding the need for client software to input data and metadata into both image archives and catalogs, while keeping their contents consistent. This image distribution service is also needed to simplify clients that delete image data, by avoiding the need for client software to delete data and metadata from both image archives and catalogs, keeping their contents consistent.

Specifying and implementing this image distribution service is not required in OWS 1.2. It is acceptable for OWS 1.2 implementations to leave all inputting of search metadata into appropriate catalogs up to the clients which input data into archives. It is also acceptable in OWS 1.2 to include a small incomplete extension of having clients input metadata into catalogs. Specifically, when a catalog and an archive are implemented together, the archive could automatically input the appropriate metadata into the (one) associated catalog, when data is input into that archive. In this case, the client would remain responsible for inputting metadata into all other appropriate catalogs.

Having an archive automatically input appropriate metadata into the one directly associated catalog would be a good implementation for a small enterprise, which uses just this one combined catalog and archive. However, this is not sufficient in a large enterprise which needs multiple catalogs and archives without one-to-one associations between catalogs and archives. In that case, data input into an archive may need to go to multiple catalogs, and that set of catalogs might not include the catalog associated with that archive.

It is also acceptable in OWS 1.2 to specify and implement a simplified version of a distribution service interface, provided that the simplified interface can be later migrated to a fully-capable interface. The tentative requirements for a highly-capable distribution service are thus discussed below.

C.2 Image distribution requirements

A highly-capable distribution service interface would fully support the requirements stated in Subclause 5.2.6 of this document. From those requirements, we can derive

tentative requirements for a distribution service. These derived requirements tentatively include:

a) A Distribution service shall automatically input data and associated metadata into a set of one or more Archives whenever new, modified, or updated data is received by that Distribution service. A Distribution service may also allow a client to initiate automatic input of data and associated metadata into a set of one or more additional Archives, for data previously received by that Distribution service.

b) A Distribution service shall also automatically input search metadata into a set of one or more Catalogs whenever new, modified, or updated is received by that Distribution service, and that data has been successfully input into one or more Archives. A Distribution service should also be able to automatically input search metadata into a set containing zero Catalogs. A Distribution service may also allow a client to initiate automatic input of search metadata into a set of one or more additional Catalogs, for data previously received by that Distribution service.

c) The distribution of new images among multiple catalogs and archives shall be flexible to meet dynamically changing enterprise needs and constraints. The distribution criteria or policies used by the Distribution service shall thus be readily changeable to meet dynamically changing distribution needs and constraints.

NOTE The users and clients of images in a large enterprise will usually be geographically distributed. The multiple archives and catalogs used by a large enterprise will thus often be geographically distributed, partially due to communications capabilities and costs. The work responsibilities of these users, clients, and servers are likely to be geographically and/or organizationally correlated with their physical locations.

d) A Distribution service shall use information input from clients specifying the set of Archives into which to automatically input data and associated metadata. This set of Archives shall be allowed to be different for each new data set that is received by that Distribution service.

e) A Distribution service shall use information input from clients specifying the set of Catalogs into which to automatically input search metadata. This set of Catalogs shall be allowed to be different for each new data set that is received by that Distribution service.

f) The client information specifying the sets of Archives and Catalogs into which to input data shall be able to be input separate from the input data and metadata, by the same or different clients. This client information can also be able to be provided combined with the input data and metadata (from the same client).

g) The client-controllable information specifying the sets of Archives and Catalogs into which to input data and associated metadata shall use distribution criteria that are based on the values of selected image metadata. That distribution criteria shall also be able to use the values of other information, including the identities of archive and catalog servers and of clients providing the input data and metadata.

h) A Distribution service shall automatically remove or deprecate data and associated metadata from all the Archives into which it put that data whenever a client requests that that data be removed from Archives.

i) A Distribution service shall automatically remove or deprecate search metadata from all the Catalogs into which it put search metadata whenever a client requests the previously input data is removed from Catalogs.

j) The requirements listed above shall all apply even when one server instance implements both Distribution and Archive or Catalog services.

k) The Distribution service interface shall be specified independently of the Archive and Catalog interfaces, so that this service could be implemented independently of any archive and catalog server implementation. However, the same server instance could implement multiple interfaces, and this is expected to be common.

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