Open Geospatial Consortium, Inc.

OGC® NSG Plugweek Engineering Report

Warning

Preface

The Open Geospatial Consortium (OGC®) conducted a series of tests that examined the interoperability, suitability and performance of National System for Geospatial-Intelligence (NSG) Profiles provided by the National Geospatial-Intelligence Agency (NGA) of four OGC Standards, Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), and Catalog Service (CAT). In the study, vendors, users, and other interested parties conducted Technology Integration Experiments (TIEs) and mutually refined clients, services, interfaces and protocols in the context of a hands-on engineering experience expected to shape the future NGA, NSG and Geospatial Intelligence (GEOINT) web based distribution.

Contents Page

Figures

Tables

OGC® NSG Plugweek Engineering Report

1   Introduction

1.1   Scope

This OGC Engineering Report (ER) documents findings of the NSG Plugweek which was conducted via the unclassified OGC Network to address requirements stated in the OGC Request for Quotation and Call for Participation in the NSG Profiles Plugweek Pilot (NPP) [1] sponsored by the National Geospatial-intelligence Agency (NGA). This ER addresses issues that arose, and provides recommendations for the refinement of NSG Profiles of OWS WMS, WFS, WCS and CSW specifications, OGC Specifications, CITE Tests, and the IE/Plugweek process. Recommendations in this ER will be considered in the planning of future activities.

1.2   The Open Geospatial Consortium

The Open Geospatial Consortium (OGC) is an international not for profit voluntary industry consensus standards organization that provides a forum and proven processes for the collaborative development of free and publicly available interface specifications (open standards). These open standards enable easier access to and use of geospatial information and improved interoperability of geospatial technologies (across any device, platform, system, network or enterprise) to meet the needs of the global community. OGC open standards have been implemented broadly in the marketplace and are helping to foster distributed and component technology solutions that geo-enable web, wireless, and location based services as well as broader government and business IT enterprises worldwide.

To accomplish the mission of the Consortium, OGC conducts three programs:

- OGC's Specification Program facilitates formal consensus-based committees, working groups and special interest groups that establish a forum for OGC's industry, academic/research and user community members to collaboratively identify, prioritize and advance solutions to meet standards needs of the global community.

- OGC's Interoperability Program promotes rapid prototyping, testing and validation of emerging standards through fast paced testbeds, experiments, pilot initiatives and related feasibility studies.

- OGC's Outreach and Community Adoption Program conducts programs (training, articles in publications, workshops, conferences, etc) to promote awareness and implementation of OGC standards across the global community.

This NSG Plugweek initiative was an element of the OGC Interoperability Program. The initiative was based upon interest and contributions from several OGC Member organizations, including the NGA, Northrop Grumman, Intergraph, ERDAS, Cubewerx, Compusult, Snowflake, and The Carbon Project.

1.3   Document contributor contact points

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

Name	Organization
George Percivall	Open Geospatial Consortium (OGC)
Sam Bacharach	OGC
Paul Daisey	OGC IPTeam and Image Matters
John Davidson	OGC IPTeam and Image Matters
Panagiotis (Peter) A. Vretanos	CubeWerx Inc.
Stanley P. Tillman	Intergraph Corporation
David S. Rosinger	Intergraph Corporation
Jim Ressler	Northrop Grumman Information Systems
Ian Painter	Snowflake Software Ltd

1.4   Revision history

Date	Release	Editor	Primary clauses modified	Description
2009-10-09	0.0	John Davidson	Entire document	Initial Outline
2009-10-16	0.1	Paul Daisey	Entire document	First Draft
2009-10-26	0.2	John Davidson	Entire document	Second Draft
2009-10-31	1.0	Paul Daisey	Entire Document	Public Version 1.0
2009-11-02	1.0.1	Paul Daisey	6.3.1.2.1	One Vendor passed basic WFS CITE tests
2009-11-12	1.0.2	Paul Daisey	Entire Document	Clarifications and section reording in response to Geogre Percivall's comments.

1.5   Forward

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

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

2 References

[1] Request for Quotation and Call for Participation in the NSG Profiles Plugweek Pilot (NPP) 20090712_NPW_RFQ_CFP.doc

[2] Request for Quotation and Call for Participation in the NSG Profiles Plugweek Pilot (NPP) Annex A – NPW Work Breakdown Structure
 20090712_NPW_Plug _Week_Annex_A.doc

[3] Request for Quotation and Call for Participation in the NSG Profiles Plugweek Pilot (NPP) Annex B – NSG Plugweek Pilot Concept Architecture
 20070712_NPW_Plugweek_Annex_B.doc

[4] Request for Quotation and Call for Participation in the NSG Profiles Plugweek Pilot (NPP) Annex C – NSG Plugweek Pilot Concept of Operations
 20090712_NPW_Plugweek_Annex_C.doc

[5] NSG Web Map Service Implementation Profile WMS_1.1.1_Profile_NSG_v3.0.doc

[6] NSG Web Map Service Implementation Profile WMS_1.1.1_Profile_NSG_v3.0.xls

[7] NSG Web Feature Service Implementation Profile
WFS_1.1.0_Profile_NSG_v3.0.doc

[8] NSG Web Feature Service Implementation Profile
WFS_1.1.0_Profile_NSG_v3.0.xls

[9] NSG Web Coverage Service Implementation Profile
WCS_1.0.0_Profile_NSG_v3_0.doc

[10] NSG Web Coverage Service Implementation Profile
WCS_1.0.0_Profile_NSG_v3_0.xls

[11] Topographic Data Store Entity Catalog (TDS EC) Version 2.0
 TDS DCS EC (v2.0).xls

[12] TECHNICAL STATUS REPORT: Northrop Grumman IT Support to OGC NGA Plugweek, Sept-Oct, 2009   NGA_Plugweek_Tech_Status_Oct_2009.doc

[13] ClientResultsTemplate.xls

[14] TDS_v2.0_SF-0_GML_311.zip

[15] TDS_v2.0_SF-0_GML_321.zip

[16] OGC Document 03-041_Mapping_WMS_and_WFS_Capabilities_Documents
_into_the_OGC_Registry_Information_Model.zip

[17]   ISO 19142 DIS - Final text of ISO/CD 19142, Geographic information — Web feature service, as sent to the ISO Central Secretariat for issuing as Draft International Standard   211n2632_Text_for_DIS_19142.pdf

[18]   GWG_Pocket_Guide_09-2.xls

3   Terms and definitions

CITE: Compliance & Interoperability Testing & Evaluation initiative (http://cite.opengeospatial.org).

Plugfest: Event authorized by the Open Geospatial Consortium (OGC) to test and validate products to interoperate with other offerings implementing the same standards. Plugfests are both facilitated and led by an OGC staff person and operated by participating organizations.

Plugweek: A multi-day plugfest.

Test Suite: a combination of data and software that is used to determine compliance by implementing a test for all Compliance Items within a particular Compliance Alternative.

Profile: specification or standard consisting of a set of references to one or more base standards and/or other profiles, and the identification of any chosen **conformance test classes**, conforming subsets, options and parameters of those base standards, or profiles necessary to accomplish a particular function.

Reference Implementation: a fully functional implementation of a specification in reference to which other implementations can be evaluated. The OGC provides open source reference implementations to ensure maximum transparency of its specifications for both vendors and customers. OGC reference implementations are provided as-is, with no implied or explicit warranty from the OGC or implementation creators. The OGC does certify that these implementations are compliant with their respective specifications.

Exemplar Implementation: An active, online and publically accessible Reference Implementation of a particular version of an OGC Standard

4   Conventions

4.1   Abbreviated terms

BNF   Backus–Naur Form

CITE   Compliance & Interoperability Test & Evaluation

CAT   Catalog Service

CONOPS   Concept of Operations

CSW   Catalog Services for the Web

CRS   Coordinate Reference System

DCS	Data Content Specifications
DDMS	DoD Discovery Metadata Specification
DISR	DoD Information Technology Standards and Profile Registry
DoD	Department of Defense
EC	Entity Catalog
EPSG	European Petroleum Survey Group
ER	Engineering Report
GEOINT	Geospatial Intelligence
GML	Geography Markup Language
GWG	Geospatial Intelligence Standards Working Group
HTTP	HyperText Transfer Protocol
IE	OGC Interoperability Experiment
IP	OGC Interoperability Program
KML	(was Keyhole Markup Language, now just KML)
NEC	NSG Entity Catalog
NFDD	NSG Feature Data Dictionary
NGA	National Geospatial-intelligence Agency
NSG	National System for Geospatial-Intelligence
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geospatial Consortium
OWS	OGC Web Services
REGEX	Regular Expression (for matching text strings)
REST	Representational State Transfer
RFI	Request for Information
SE	Symbol Encoding
SF-0	GML Simple Features Level 0 Profile
SLD	Style Layer Descriptor
SOAP	(was Simple Object Access Protocol, now just SOAP)
SRS	Spatial Reference System
TBD	To Be Determined
TDS	Topographic Data Store
TFDM	Topographic Features Data Management

TIE	Technology Integration Experiment
URI	Universal Resource Identifier
URL	Universal Resource Locator
URN	Universal Resource Name
WBS	Work Breakdown Structure
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
XML	Extensible Markup Language
XSLT	Extensible Stylesheet Language: Transformations

5   Overview

5.1   Objectives of the Study

The primary objective of the NSG Plugweek was to "examine the suitability and performance of NGA provided Profiles of four OGC Standards, Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), and Catalog Service (CAT)." A secondary objective was to exercise the TFDM model through server and client demonstrations. It was not an objective of this study to "report on relative capabilities and performance of any of the services that companies provide." [1]

Table 1 – Participating Organizations and Individuals

Aziz, Faheem	Northrop Grumman Corporation
Bacharach, Sam	Open Geospatial Consortium, Inc.
Birkel, Paul	MITRE Corporation
Bouzane, Larry	Compusult Limited
Buehler, Greg	Open Geospatial Consortium, Inc.
Daisey, Paul	Image Matters LLC
Davidson, John	Image Matters LLC
Guempel, Glenn	US National Geospatial-Intelligence Agency (NGA)
Hardwick, Daniel	Snowflake Software Ltd
Harrison, Jeff	The Carbon Project/CubeWerx
Harvie, John	US National Geospatial-Intelligence Agency (NGA)
Joglekar, Ballal	Snowflake Software Ltd
Keighan, Edric	CubeWerx
Luxeder, Rob	ERDAS, Inc.
Marcus, Jen	Northrop Grumman Corporation
Morris, Chuck	Northrop Grumman Corporation
O'Rourke, Barry	Compusult Limited
Painter, Ian	Snowflake Software Ltd
Pearsall, Richard	US National Geospatial-Intelligence Agency (NGA)
Percivall, George	Open Geospatial Consortium, Inc.
Ressler, Jim	Northrop Grumman Corporation
Rosinger, David	Intergraph Corporation
Singh, Raj R.	Open Geospatial Consortium, Inc.
Thomas, Robert	Compusult Limited
Tillman, Stan	Intergraph Corporation
VanDermark, Sherman	ERDAS, Inc.

Vretanos, Panagiotis (Peter) A.	CubeWerx
Wesloh, David	US National Geospatial-Intelligence Agency (NGA)
Younge, Dean	Compusult Limited
Yutzler, Jeff	ERDAS, Inc.

5.2 Plugweek Process, Activities, Procedures, and Artifacts

The NSG Plugweek was run as an OGC Pilot Project with a WBS [2] and CONOPS [4] that were modified to focus on services and schemas instead of use cases [3]. Figure 1 below shows the target architecture for this effort. [3]
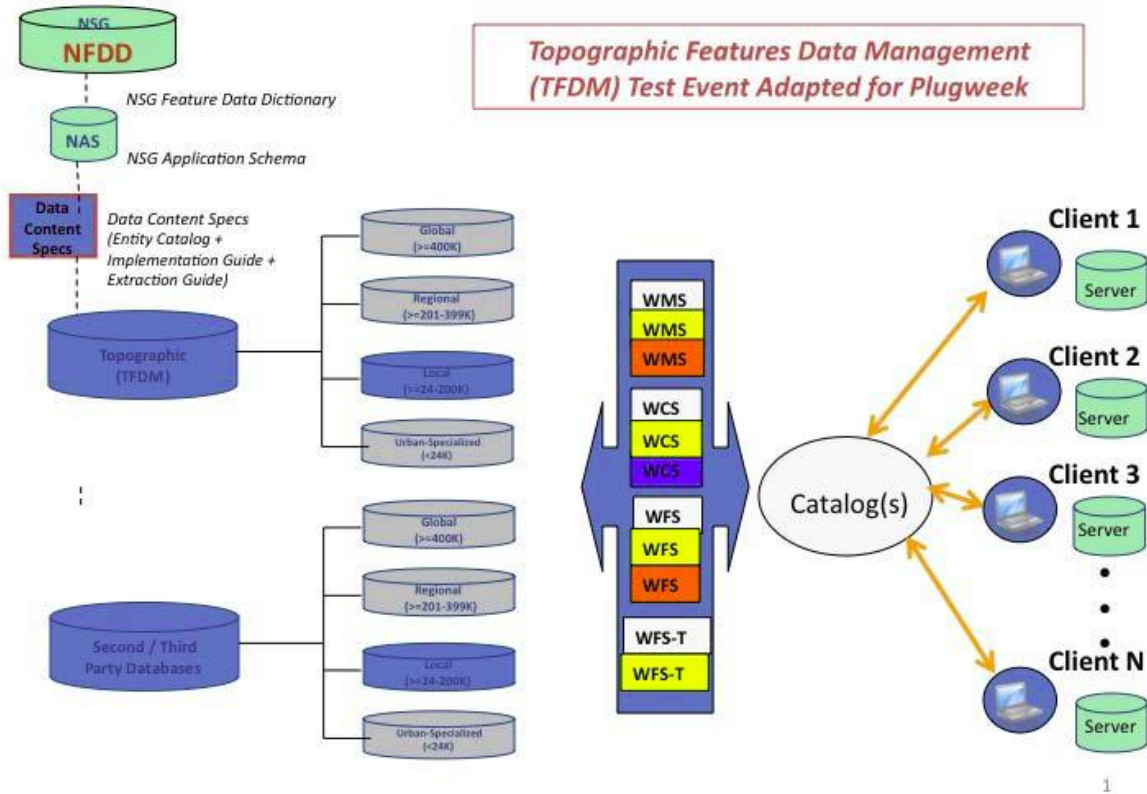

Figure 1 NPP Target Architecture

The Plugweek itself was preceded by many months of preparation by NGA, and two months of WBS activities by NGA, CITE test developers, and Plugweek participants. These activities and the artifacts produced therein are described in the following sub-sections.

5.2.1   NGA Developed Profiles of OGC Standards for the NSG

The NGA developed Class 2 performance profiles that both restrict and extend the WMS version 1.1.1, WFS version 1.1.0, and WCS version 1.0.0 OGC standards in conformance with the provisions of ISO 19106 to assure that the services specified by those standards "fulfill their intended purpose and are fit for use" [5], [7], [9].   Each profile consisted of a descriptive document [5], [7], [9] and a prescriptive compliance spreadsheet [6], [8], [10]. The compliance spreadsheets provide conformance test details and document the status (Informative, Recommended, Optional, or Mandatory) of all clauses in both the referenced standard, and the NGA profile. Note that these NSG profiles were not of the latest versions of the OGC standards. Rather, they were of the latest versions of the OGC standards that had been approved and included in the DISR [18].

- CAT 2.0.1
- GML 3.1.1
- Filter 1.1
- SLD 1.0
- WFS 1.1
- WMC 1.1
- WMS 1.1.1

5.2.2   NGA Funded Development of NSG Profile Compliance Tests

The NGA funded development of automated tests of the NSG Profiles described in the preceding section [12]. These tests were extensions and adaptations of OGC CITE compliance tests "based on the same software used for OGC's CITE test engines". [5],[7],[9]. See the NSG Plugweek CITE Tests Table below for links to descriptive web pages for these tests.

5.2.3   NGA Provided EC for TFDM exerpt of NAS

The NGA provided a spreadsheet [11] containing the Topographic Data Store Entity Catalog (TDS EC) Version 2.0 for topographic features from the NSG EC.   "The TDS EC specifies the complete set of allowable feature types, geometries, attributes, and enumerants, as well as their individual specifications (e.g., definition, datatype, value range) for this suite of four Topographic Data Stores." [11]

5.2.4   NGA Developed GML schemas for TFDM from TDS EC

The NGA developed GML schemas for version 3.1.1 (OGC 03-105r1) that also conformed to SF-0 (OGC 06-049r1) [14]. These schemas included 17 ".xsd" schema documents, defined 500 feature classes, and were in subsequent Plugweek activities. NGA also developed GML schemas for version 3.2.1 (OGC 07-036) that followed the SF-0 design pattern to support future work [15]. These schemas were not used in Plugweek activities because the versions of OGC services selected for use in the Plugweek did not support GML version 3.2.1.

5.2.5   NGA Provided TDS data

The NGA provided two sets of TDS vector data for different regions that conformed to the TFDM and implemented the NFDD.

5.2.6   Participant transformed TDS data to GML

A Plugweek WFS participant transformed the TDS data to GML SF-0 following the guidance provided in the TDS EC {11], and validated it using the NGA GML schemas. One data set included data for 50 feature types; the other for 25 feature types. The feature types in the two data sets overlapped, so that in total 65 feature types of the 500 included in the GML schemas were used in Plugweek activities [14].

5.2.7   Project Kickoff 2009-09-10 via Teleconference and Online Document Sharing

NGA Sponsor and OGC IP Staff lead a project kickoff via teleconference and online document sharing. They reiterated that the project goal was to vet profiles for NSG use, and make online distribution of HSG data via OGC services and encodings a reality. They informed Plugweek participants that the TFDM team participation that had been expected during the project to address NSG profile refinement would not happen until after the Plugweek was concluded. They also clarified two items of project scope. First, the CSW v2.0.1 core queryables were required, but others were optional for testing. Second, the Plugweek would not test PKI level security.

5.2.8   Collaborative Planning and Work via Teleconferences and Email

NGA Sponsors, OGC Staff, and Plugweek participants met online for weekly teleconferences and exchanged email daily to refine the plans for Plugweek activites, resolve data errors, announce server status, coordinate TIEs, and to identify and resolve other issues.

5.2.9   CITE Testing

CITE testing before and during the NSG Plugweek was based on both standard OGC CITE Tests, and more stringent NSG Profile tests. Details of the tests are available from the web pages accessible via the links in the following table. Issues with CITE tests were recorded in the on-line CITE issue tracker, and most were resolved before or during the Plugweek [11]. Results of the tests were recorded in an on-line spreadsheet and are reported in the Plugweek Outcomes section below.

Table 2 NSG Plugweek CITE Tests

CITE Test Authority	OGC Service and Version	Test Web Page Link
OGC	All	http://cite.opengeospatial.org/teamengine/
OGC	WFS 1.1.0	http://cite.opengeospatial.org/teamengine/docs/wfs/1.1.0/

		Contact information shall be provided in the capabilities document	149
		An abstract and keyword list shall be included for each layer in the capabilities document	162
		Each named layer shall contain one or more MetadataURL elements	187
		Each feature data layer shall be marked queryable and be subsettable	196
		A layer shall not have fixed size	195
GetMap			3
		Select data layer and add to display. The server shall render the requested layers.	214
		Select data layer from a second server and add to display. The order shall be that the leftmost in the list is drawn first, the next one over that, and so on.	214
		Select data layer from a third server and add to display. The order shall be that the leftmost in the list is drawn first, the next one over that, and so on.	214
		Select data layer from a fourth server and add to display. The order shall be that the leftmost in the list is drawn first, the next one over that, and so on.	214
		Request a data layer with a Bounding Box within the Bounding Box advertised in the Capabilities Response. Any elements that are partly or entirely contained in the Bounding Box should be returned in the appropriate format	88
		Request a data layer with a Bounding Box that overlaps the Bounding Box advertised in the Capabilities Response. Any elements that are partly or entirely contained in the Bounding Box should be returned in the appropriate format	88
		Request a data layer with a Bounding Box that does not overlap the Bounding Box advertised in the Capabilities Response. The server should return empty content	89
		Request a data layer with an invalid BoundingBox. The server should return an exception	86
		Select a data layer that requires re-projecting some but not all layers (Monterrey data set for this query)	
		Select a data layer using the STYLES parameter	215
		Select a data layer using the TRANSPARENT parameter	233
		Select a data layer using the BGCOLOR parameter	238-1
		Select a data layer using the EXCEPTIONS parameter	242-1
		Select a data layer using the TIME parameter	255
		Select a data layer using the ELEVATION parameter	256
		Change the style of roads (using SLD or alternate WMS layer style)	
GetFeatureInfo			4
		Issue GetFeatureInfo request with INFO_FORMAT parameter	272

		Issue GetFeatureInfo request with FEATURE_COUNT parameter	274-1
WFS			
GetCapabilities			
DescribeFeatureType			
		Issue DescribeFeatureType request with no specific output format. Receive MIME type "text/xml; subtype=gml/3.1.1"	133
		Issue DescribeFeatureType request with outputFormat = XMLSCHEMA Receive MIME type "text/xml; subtype=gml/2.1.2"	132
GetFeature			
		Select a feature type, request and receive feature data	
		Select a feature type, request specific properties, receive them	183
		Select a feature type and Filter based on attribute values	188
		Select a feature type and Filter based on spatial extent	188
		Select a feature type and Filter based on attribute values and spatial extent	188
		Select a feature type and resultType=results	194
		Request GML3.1.1 features	
		Request a non-existent feature type. Receive XML Exception report that validates against exception response schema	112, 113
GetGMLObject			
		Execute a GetGmlObject request with traverseXlinkDepth = *	223
LockFeature			
		Issue LockFeature request. The response to a LockFeature request includes the identifiers of features that were locked.	243
		Issue LockFeature request with expiry attribute. Issue subsequent LockFeature request after expiry; should succeed	236
		Issue LockFeature request with lockAction=SOME The response is a <WFS_LockFeatureResponse> element that lists the previously unlocked feature ids in the <FeaturesLocked> element and the previously locked feature ids in the <FeaturesNotLocked> element.	241, 247, 248
		Issue LockFeature request that locks no features; issue another LockFeature request that reuses the same lock ID; receive expected error.	250, 251
Transaction			
		Execute WFS transaction with XlinkPropertyName and test for exception.	191
		Execute WFS transaction to Insert features	
		Execute WFS tranaction to update features	
		Execute WFS transaction to delete features	
WCS			
GetCapabilities			
		Access GetCapabilities document. The version and updateSequence attributes must be omitted	81
		Access GetCapabilities document with section = /WCS_Capabilities/Service The version attribute shall be returned.	69
		Access GetCapabilities document with section = /WCS_Capabilities/Capability The version attribute shall be	75

	returned.	
	Access GetCapabilities document with section = /WCS_Capabilities/ContentMetadata The version attribute shall be returned.	80
	Access GetCapabilites with updateSequence paramter	57
DescribeCoverage		
	Access DescribeCoverage response	107
GetCoverage		
	Specify area of interest and access imagery.	
	Request parameters conform to specification	29
	Requests are valid URIs	30
	Response format is at least one of these: GeoTIFF, HDF-EOS, DTED, NITF, or GML	166
	Specify area of interest with a BBOX inside the defined BoundingBox and access imagery with server's native CRS	117, 153
	Specify area of interest with a BBOX partially contained in the defined BoundingBox and access imagery with the server's native CRS	117, 153
	Specify area of interest with a BBOX inside the defined BoundingBox and access imagery with request CRS different than server's native CRS	117, 153
	Specify area of interest with a BBOX partially contained in the defined BoundingBox and access imagery with request CRS different than the server's native CRS	117, 153
	Specify area of interest with a BBOX inside the defined BoundingBox and access imagery with response CRS different than server's native CRS	117, 153
	Specify area of interest with a BBOX partially contained in the defined BoundingBox and access imagery with response CRS different than the server's native CRS	117, 153
	Specify area of interest and interpolation method and access imagery	170
	Specify area of interest out of valid range. Receive expected error.	44
	Specify area of interest out of valid range. Service exception XML validates according to the Service Exception XML Schema	44
	Specify time instant of interest and access imagery from coverage with temporal domain of time instants	124
	Specify time period of interest and access imagery from coverage with temporal domain of time period	124
	Specify Axis for coverage that does not have default Axis description and access imagery	139
	Specify coverage name containing embedded commas and spaces. The server handles encoded commas and spaces in list values correctly	137
	Select number of bands to show and display the image	
	Access services via HTTPS	24

CS-W		
GetCapabilities		
DescribeRecord		
GetDomain		
GetRecordById		
GetRecords		
	Discover data and images	
	View and evaluate metadata of data and images discovered	
	Transfer service GetCapabilities end point to WMS, WFS, or WCS client (cut and paste, drag, hand copy and enter, however your software does it)	
Transaction		
Harvest		
AD-HOC		
	Mix and match individual operations from above as a client is capable.	
	Select and display data from non-Plugweek servers on the Internet	

6   Plugweek Outcomes

Outcomes of the NSG Plugweek are discussed in the following sub-sections. The first sub-section contains a summary of recommendations. Crosscutting issues that arose during Plugweek are documented in the second sub-section. The subsequent sub-sections provide an overview of results including details of findings and recommendations in four categories: NSG Profiles, OGC Specifications, CITE Tests, and the IE/Plugweek process.

6.1   Summary of Recommendations

The recommendations listed here in bullet form are discussed in detail at the end of their respective sections below.

6.1.1   Summary of NSG Recommendations

- Transition from WMS 1.1.1 to WMS 1.3.0 as soon as WMS 1.3.0 is in the DISR
- Transition from SLD 1.0 to SLD 1.1.0 and SE 1.1.0 as soon as they are in the DISR
- Transition from WCS 1.0.0 to WCS 1.1.0 as soon as 1.1.0 is in the DISR
- Add explanatory note to TDS DCS EC [11] in section 5.3.3 as line "c"
- Use gml:identifier in GML version 3.2.1 TDS Application schemas
- NSG Profile should be prepared for OWS Common
- Transition from WFS 1.1.0 to ISO 19142 (WFS 2.0) as soon as 19142 is in the DISR
- Prepare NSG Requirements for OWS Clients
- Prepare NSG Requirements for OWS Test Data
- Prepare NSG requirements for CSW

6.1.2   Summary of OGC Recommendations

- Adopt documented best practices for CRS definitions (URN CRS per 07-092r3)
- WMS 1.3.0 Change Request (URN CRS per 07-092r3)
- SF-0 Change Request (correct informative example)
- GML Change Request (profile schema import)
- SF-0 Version Upgrade Request (GML 3.2 support; profile schema import)
- Catalog Harvest Specification Recommendation
- OWS Client Capabilities Recommendation
- OWS Reference Implementation Recommendation
- OWS Common Change Request on Exception Handling

6.1.3   Summary of CITE Recommendations

- Change the WFS test dataset
- Implement Request Parameter Multiplicity Tests
- Improve Test Failure Messages
- Improving OWS Specifications will improve CITE tests

6.1.4   Summary of IE / Plugweek Process Recommendations

- Revise Plugfest Policies and Procedures

Find Sponsors for OWS Testing Tools

6.2 Plugweek Crosscutting Issues

Crosscutting issues that arose during Plugweek are documented in this sub-section. These issues spanned multiple NSG Profiles and OGC Specifications, or resulted in findings and recommendations in more than one category covered in the sections that follow, which refer back to the sub-sections in which the issues are described. Issues that affect only one NSG Profile and/or OGC Specification are discussed in the sections to which they apply.

6.2.1 CRS Specification Issue

Different OGC specifications for WMS, WFS, WCS, CAT, GML, OWS_Common, and different versions of those specifications require different forms of CRS specification. Those differences carried over automatically into the NSG profiles. It is a significant hindrance to interoperability long recognized in the OGC community to have to use different CRS specifications for different OGC Specifications.

The TDS EC 2.0 CRS Specification was not supported by several of the service versions in the NSG profiles. See the CRS Specification Requirements for TDS EC 2.0 in Table 4 below. Consequently, a "private" agreement had to be reached among the sponsor and participants on which CRS specifications to use for the NSG Plugweek tests, and to clarify that in the URN form of a CRS specification, two colons must appear in a row if the version is missing. Widespread adoption of future versions of OWS that follow the guidance of OGC Document 07-092r3 should eventually eliminate this issue.

Table 4 below summarizes the results of the specification review in the following subsections.

Table 4 CRS SpecificationRequirements

TDS EC or OWS Specification	CRS Specification Requirement	Syntax Form	Allows use of TDS EC 2.0
TDS EC 2.0	http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E_2D	URL	yes
TDS EC 2.0	http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E_3D	URL	yes
WMS 1.1.1	EPSG:<EPSG code>	REGEX	no
WMS 1.1.1	AUTO	REGEX	no
WMS 1.3.0	Label CRS	REGEX	no
WMS 1.3.0	Label EPSG	REGEX	no

WMS 1.3.0	Label AUTO2	REGEX	no
WMS 1.3.0	URL	URL	yes
WFS 1.1.0	EPSG:<EPSG code>	REGEX	no
WFS 1.1.0	http://www.opengis.net/gml/srs/epsg.xml#<*EPSG code*>	REGEX	no
WFS 1.1.0	urn:EPSG:geographicCRC:<*epsg code*>	URN	no
WFS 1.1.0	DEFAULT_SRS	URL	yes
WFS 1.1.0	BoundingBox	URL	yes
WCS 1.0.0	EPSG:<EPSG code>	REGEX	no
WCS 1.0.0	AUTO:xyz	REGEX	no
WCS 1.0.0	OGC:xyz	REGEX	no
WCS 1.0.0	Engineering	REGEX	no
WCS 1.0.0	Image	REGEX	no
WCS 1.1.0	EPSG:<EPSG code>	REGEX	no
WCS 1.1.0	AUTO:xyz	REGEX	no
WCS 1.1.0	OGC:xyz	REGEX	no
WCS 1.1.0	Engineering	REGEX	no
WCS 1.1.0	Image	REGEX	no
WCS 1.1.0	URL	URL	yes
CAT 1.0.1	URN	URN	no
CAT 1.0.1	URL	URL	yes
CAT 1.0.2	URN	URN	no
CAT 1.0.2	URL	URL	yes
GML 3.1.1	srsName	URI	yes

GML 3.2.1	srsName	URI	yes
OWS 0.3.0	URN	URN	no
OWS 0.3.0	URL	URL	yes
OWS 1.0.0	URN	URN	no
OWS 1.0.0	URL	URL	yes
OGC URN	URN	URN	no
OGC URN	URL	URL	yes

6.2.1.1 TDS EC CRS Specification

The TDS EC [11] provides the following CRS specification in section 5.3.9.2 on the Overview sheet:

This GML-based SF-0 conformant encoding for the TDS EC adopts the practices established by the DoD Discovery Metadata Specification (DDMS: http://metadata.dod.mil/mdr/irs/DDMS/).
The allowed values of the XML srsName attribute shall be exactly one of the following:

(a) World Geodetic System 1984 – Geographic, 2-Dimensional, identified by the URI: http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E_2D

(b) World Geodetic System 1984 – Geographic, 3-Dimensional, identified by the URI: http://metadata.dod.mil/mdr/ns/GSIP/crs/WGS84E_3D

The axis order for these CRSs is geodeticLatitude, geodeticLongitude [, ellipsoidalHeight].

6.2.1.2 WMS 1.1.1 CRS Specification

Section 6.5.5.1 EPSG Namespace for CRS of the WMS 1.1.1 specification (OGC 01-068r3) describes the use of EPSG numeric identifiers, e.g. "EPSG:4326" for WGS84. It also describes a convention for WMS whereby "the returned image is implicitly projected using a pseudo-Plate Carrée projection that plots Longitude along the X-axis and Latitude along the Y-axis." Unfortunately, that convention is at odds with the EPSG:4326 CRS axis order definition of latitude as the first axis and longitude as the second axis. This is the only way to specify a geographic CRS (not projected) in WMS 1.1.1. The alternative AUTO Namespace for CRS described in section 6.5.5.2 is for projected CRSs. The only other option in WMS 1.1.1 is an undefined CRS. Unfortunately, there is no way to specify a CRS in accordance with both the TDS EC CRS Specification and the WMS 1.1.1 CRS Specification.

6.2.1.3 WMS 1.3.0 CRS Specification

Section 6.7.3 Layer CRS of the WMS 1.3.0 specification (OGC 06-042) provides for two types of CRS namespace identifiers, "Label" and "URL". It also describes a convention for WMS whereby "Coordinates shall be listed in the order defined by the CRS and shall be mapped appropriately". It specifies three "Label" identifiers, "CRS", "EPSG", and "AUTO2". In Annex B, it defines three geographic CRS identifiers for the WGS84, NAD27, and NAD83 datums. The definition in Section B.3 Layer CRS using WGS84 longitude-latitude (CRS:84) allows for the (continued from WMS 1.1.1) use of WGS84 with axes reversed from the order specified by EPSG 4326.

As in WMS 1.1.1, the CRS namespace (e.g., EPSG) label is followed by a colon and a coordinate system identifier. Unlike WMS 1.1.1, the axis order is correctly specified to be latitude then longitude in WMS 1.3.0.

The AUTO2 Label is for projected CRSs that specify a center of projection.

The "URL" identifier is *"a fully-qualified URL that references a publicly-accessible file containing a definition of the CRS that is compliant with ISO 19111"*. The TDS EC CRS Specification meets that requirement. Unfortunately, WMS 1.3.0 is not yet in the DISR and so was not used for the NGA Plugweek.

6.2.1.4 WFS 1.1.0 CRS Specification

Section 9.2 Request of the WFS 1.1.0 specification (OGC 04-094) allows the following CRS options:

Any valid URI value can be assigned to the **srsName** attribute. However, in order to enhance interoperability, a web feature service must be able to process **srsName** attribute values with the following "format models":

- EPSG:*<EPSG code>*
- http://www.opengis.net/gml/srs/epsg.xml#*<EPSG code>*
- urn:EPSG:geographicCRC:*<epsg code>*

In these format models, the values <EPSG code> are placeholders for actual EPSG code values. Here is an example of the **srsName** where the assigned value follows one of the required format models: srsName="urn:EPSG:geographicCRS:63266405".

No further guidance is provided on whether the format models apply only to CRSs specified by the EPSG, or whether the second format model allows any URLs, and the third format allows any URNs. Note that EPSG:63266405 was a special specification for WGS84 created for OGC with axis order longitude then latitude.

Section 13.3.3 FeatureTypeList section Table 6 – Elements to Describe Feature Types, the entry for DefaultSRS states:

The SRS may be indicated using either the European Petroleum Survey Group form 'EPSG:<POSC Code>' or the URL format defined in subclause 4.3.2 of reference [2].

Reference 2 is to the GML 3.1.1 specification. As described below, theTDS EC CRS Specification meets its requrements.

Section 14.3.3 Bounding Box states that "The KVP encoding for a bounding box is defined in subclause 10.2.3 of normative reference [15]. " Reference 15 is to the OGC 04-016r3 draft of OWS Common. As described below, the TDS EC CRS Specification meets these requirements.

6.2.1.5   WCS 1.0.0 CRS Specification

Section 8.3.4 Supported CRSs and coordinate reference systems of the WCS 1.0.0 specification (OGC 05-076) states:

CRS identifiers may be any of the **EPSG:xyz**, **AUTO:xyz, or OGC:xyz** coordinate systems defined in the Web Map Service Implementation Specification (OGC Doc. 01-0685r3); or the strings "**Engineering**" or "**Image**" to denote an "engineering" or "image" CRS, whose relationship to earth co-ordinates may not be well defined.

The OGC document referent is interpreted here as a typographic error; it should be 01-068r3 (WMS 1.1.1). Unfortunately, there are no OGC:xyz coordinate systems defined in OGC 01-068r3.

TDS EC CRS Specification does not meet these requirements.

6.2.1.6   WCS 1.1.0 CRS Specification

Section v. Revision History of the WCS 1.1.0 specification (OGC 06-083r8) states:

WCS 1.1 introduces (only) the following functional changes:
a) Use of GridCRS in coverage descriptions and requests

(See 9.3.1.2, 10.2.1.1, 10.2.2, 10.3.4, 10.3.6, and Annexes G and H)

Section 7.6.3 CRS references states:

Clause 10.3 of OWS Common [OGC 05-008] specifies how CRSs shall be referenced.

The TDS EC CRS Specification meets those requirements.

6.2.1.7   CAT 1.0.1 CRS Specification

Section 6.3.2 Core Queryable Properties of the CAT 1.0.1 specification (OGC 04-021r3) Table 1 – Common Queryable Elements definition for CRS is "Coordinate Reference System (Authority and ID) for the BoundingBox" specified as type Identifier, with a footnote that "If not supplied, the BoundingBox CRS is a Geographic CRS with the Greenwich prime meridian". Section 6.2.2 OGC_Common Catalog Query Language section provides BNF for identifier as follows:

```
<identifier> ::=
<identifier start [ { <colon> | <identifier part> }... ]
<identifier start> ::= <simple Latin letter>
<identifier part> ::= <simple Latin letter> | <digit>
```

So this Identifier could be either a URL or a URN. The TDS EC CRS Specification meets this requirement.

6.2.1.8 CAT 1.0.2 CRS Specification

The CAT 1.0.2 specification (07-006r1) CRS Specification is the same as that for CAT version 1.0.1. The TDS EC CRS Specification meets its requirements.

6.2.1.9 GML 3.1.1 CRS Specification

The GML 3.1.1 specification (03-105r1) section 9.1.2.2 SRSReferenceGroup states:

In general the attribute "srsName" points to a CRS instance of gml:CoordinateReferenceSystemType (see coordinateReferenceSystems.xsd). For well-known references it is not required that the CRS description exists at the location the URI points to.

No further normative guidance is provided, but all informative examples include srsName URN values like the following, which are not URLs that point to anything:

srsName="urn:EPSG:geographicCRS:62836405" or

srsName="urn:EPSG:geographicCRS:4326"

The TDS EC CRS Specification refers to a GML coordinate reference system definition (gml:GeodeticCRS) on the web, so it meets these requirements.

6.2.1.10 GML 3.2.1 CRS Specification

The GML 3.2.1 specification (07-036) section 10.1.3.2 SRSReferenceGroup states:

In general the attribute srsName points to a CRS instance of gml:AbstractCoordinateReferenceSystem (see 12.2.3). For well-known references it is not required that the CRS description exists at the location the URI points to.

No further normative guidance is provided, but all informative examples include URN srsName values like the following, which are not URLs that point to anything:

srsName="urn:x-ogc:def:crs:EPSG::4326" or

srsName="urn:x-ogc:def:crs:EPSG:6.6:4326"

The TDS EC CRS Specification refers to a GML coordinate reference system definition (gml:GeodeticCRS) on the web, so it meets these requirements.

6.2.1.11 OWS Common 0.3.0 CRS Specification

The draft OWS Common specification (04-016r3) section 10.3.2 URL References stated that URL references were to be to definitions that "shall be encoded in XML, using one or more Application Schemas based on the CRS Schemas in Clause 12 of [GML 3.1]. " (Coordinate Reference Systems). This requirements of this specification are described here because it is nomratively referenced by the WFS 1.1.0 specification (OGC 04-094).

The TDS EC CRS Specification refers to a GML coordinate reference system definition (gml:GeodeticCRS) on the web, so it meets these requirements.

6.2.1.12 OWS Common 1.0.0 CRS Specification

The OWS Common 1.0.0 specification (05-008) states that URL references are to be to definitions that "shall be encoded in XML, using one or more Application Schemas based on the CRS Schemas in Clause 12 of [GML 3.1]. " (Coordinate Reference Systems).

The TDS EC CRS Specification refers to a GML coordinate reference system definition (gml:GeodeticCRS) on the web, so it meets these requirements.

In section 10.3.3 URN References, 05-008 states that "For all XML attributes and elements with the anyURI data type, a URN value in the "ogc" URN namespace can be used".

6.2.1.13 Definition Identifier URNs in OGC Namespace Best Practice

The Definition Identifier URNs in OGC Namespace OGC Best Practice (07-092r3) document clause 6.2 states:

When using a XML attribute or element with the type anyURI to reference a CRS, CRS-related, or other object, that URI shall have a value which uses one of two alternative URI formats:

a)   Universal Resource Locator (URL), with standard form. The URL format should be used whenever the referenced definition is known to be electronically available using this standard URL

.
b)   Universal Resource Name (URN), with a specified form. The URN format shall be used whenever the referenced definition is not, or might not be, available using a URL. This URN shall reference data that is specified by some "authority" and is "well-known" to both client and server software, including multiple clients and multiple servers.

Document clause 7.2 provides an example:

EXAMPLE The URN value urn:ogc:def:crs:EPSG:6.6:4326 shall mean the Coordinate Reference System (CRS) with code 4326 specified in version 6.6 of the EPSG database available at http://www.epsg.org/. That CRS specifies the axis order as Latitude followed by Longitude.

The TDS EC CRS Specification refers to a GML coordinate reference system definition (gml:GeodeticCRS) on the web, so it meets the URL requirement, and should be supported by all future versions of OWS specifications.

6.2.2   CRS Axis Order Issue

Different OWS specifications and different versions of those specifications are silent on or contain different provisions for specifying the order of axes in a CRS as documented in the preceding section. Unfortunately, some of those specifications mandated past common practices which ignored the axis order specified by the CRS definition, and reversed it, e.g. using EPSG:4326 with a longitude (X) then latitude (Y) axis order per computer graphics conventions despite the definition of EPSG:4326 axis order of latitude then longitude.

GML version 3.2.1 (07-036) added attributes to allow data providers to be explicit about the axis order specified by the CRS definition:

The attributes uomLabels and axisLabels, defined in the gml:SRSInformationGroup attribute group, are optional additional and redundant information for a CRS to simplify the processing of the coordinate values when a more complete definition of the CRS is not needed. This information shall be the same as included in the complete definition of the CRS, referenced by the srsName attribute. When the srsName attribute is included, either both or neither of the axisLabels and uomLabels attributes shall be included. When the srsName attribute is omitted, both of these attributes shall be omitted.

Unfortunately, those attributes are sometimes used incorrectly to indicate a different axis order than that specified by the CRS definition.

Widespread adoption of future versions of OWS that follow the guidance of the OGC Axis Order Policy (08-038r5) should eventually eliminate this issue.

6.2.3   Get Capabilities Service Identification Abstract and Keywords Issue

The OWS Common specification defines a CapabilitiesBaseType in owsGetCapabilities.xsd that is the base for all OWS capabilities types. It contains a <ows:ServiceIdentification> element containing <ows:Abstract> and <ows:Keywords> elements. The existence and contents of these elements varied widely in GetCapabilitiesResponse documents returned from OWS servers supporting the NGA Plugweek.   Once harvested by a CSW, this inconsistency would hinder efforts to discover multiple OWS servers for the same data sets and themes.

6.2.4   Styled Layer Issue

Both WMS 1.1.1 and WMS 1.3.0 support portrayal of "styled layers" using the LAYER and STYLES parameters to define pair-wise combinations of "named layers" and "named styles". A given WMS implementation must "know" (be configured with) its layers and styles and these are advertised in the WMS capabilities document for clients to discover and use in subsequent GetMap requests.

The Styled Layer Descriptor (SLD) 1.1.0 specification (05-078r4) defines extensions to WMS 1.3.0 to enable support for "user-defined layers" and "user-defined styles", allowing map styling to be defined externally from a WMS implementation and shared from client-to-client and WMS-to-WMS in an interoperable format.

The Symbology Encoding (SE) 1.1.0 specification (05-077r4) defines an XML language for styling information that can be applied to Feature and Coverage data and is designed for reuse in multiple specifications beyond WMS.

Together, SLD 1.1.0 and SE 1.1.0 replace the SLD 1.0.0 (02-070) specification.

6.2.5   FeatureMember Property Namespace Issue

One vendor's WFS returned features inside featureMember property elements ("tds:featureMember") in the application schema namespace instead of using "gml:featureMember" elements as children of the wfs:FeatureCollection element as specified for WFS 1.1.0 by OGC 04-094.

A note in the SF-0 specification OGC 06-049r1 on page 13 says

The only feature member container supported by this profile, for compliance level SF-0, shall be [prefix:]featureMember. Use of a feature container corresponding to gml:featureMembers in GML 3.1.1 is not allowed by this specification for compliance level SF-0.

This is followed by an informative example on page 22 that includes a <wfs:FeatureCollection> with a <gml:featureMember> property. That example conforms to the WFS 1.1 specification OGC 04-094, which defines a wfs:FeatureCollectionType based on a gml:AbstractFeatureCollectionType; the latter may have gml:featureMember child elements. But the normative text of the SF-0 specification makes no exception for inclusion of GML Features conforming to SF-0 in a wfs:FeatureCollection.

On the CITE page for WFS: http://cite.opengeospatial.org/teamengine/docs/wfs/1.1.0/ there is a note:"GMLSF Levels 0 and 1 **DO NOT** support the use of feature collections through WFS interfaces."

Section vii of the SF-0 specification OGC 06-049r1 lists changes to WFS specification that are required to support SF-0. For the GetFeatureOperation, the change is to the allowed values for the outputFormat subType: "The WFS should respond by generating an instance document that validates against a schema document that complies with this profile." e.g.

<ows:Value>text/xml; subType=gml/3.1.1/profiles/gmlsf/1.0.0/0</Value>
<ows:Value>text/xml; subType=gml/3.1.1/profiles/gmlsf/1.0.0/1</Value>

Section 8.4.2 defining feature collections "shows how to define a feature collection in a GML application schema that complies with level SF-0 of this profile".

The next revision of the WFS specification [17] has changed the definition of a wfs:FeatureCollection in Section 11.3.2 XMLEncoding to comply with SF-0.

6.2.6   Client Specifications vs. Server Specifications Issue

CITE tests exercise servers. Some of the NSG Plugweek TIEs also tested client capabilities. The user experience is heavily dependent on client capabilities. One participant noted that there is much emphasis on server-side compliance and not enough emphasis on enabling a stack of essential client capabilities: view, discover, filter, analyze, etc.

6.2.7   Reference Implementation Issue

Several participants noted that the lack of online reference implementations for all OGC Web Service standards is a hindrance to commercial development of standard-conformant clients and servers.

6.2.8   Test Data Must Support Required Tests Issue

The NSG Plugweek test data did not support a number of required tests. All test data was WGS84, and requests were to be for WGS84, so WFS coordinate conversion capabilites could not be tested. Test data attribute values were dummy values that did not vary among feature instances for any feature type, so WFS attribute queries could not be tested. Test data was for one time instance, so temporal queries could not be tested.

6.2.9   Character Case of HTTP Parameters and Values Issue

There are character case inconsistencies in specifications across service types (WMS, WFS, WCS, CSW) and inconsistencies in implementation. Several participants raised this issue

In section 11.5.2 Capitalization the OGC Web Services Common Specification (06-121r3) states:

The capitalization of parameter names when KVP encoded shall be case insensitive, meaning that parameter names may have mixed case or not.

EXAMPLES The "request" parameter name could be REQUEST, request, Request, or ReQuEsT.

NOTE The XML capitalization is uniformly used in Clauses 7 through 10 plus Annex C of this document.

The capitalization of parameter values when encoded using Keyword Value Pairs shall be as used in Clause 7 through 10 of this document. More generally, all value strings shall have the first word and any subsequent words in the name capitalized. All other letters will be lower case.

EXAMPLE One possible "request" parameter value is "GetCapabilities".

6.2.10   Server Behavior for Multiple Values for an HTTP Parameter Issue

Some clients sent multiple values for a given request parameter, e.g. version. Some servers use the first value, some use the last value and others concatenate the values and return an exception message because the value is invalid. The OGC Web Services Common Specification (06-121r3) lists the multiplicity of parameters for requests, states that mandatory parameters must be implemented, that optional parameters should be implemented, and that implementation specifications may change the multiplicity of parameters, as needed. But it does not explicitly state that variance from the specified multiplicity is an exception.

6.2.11   Server Behavior for Invalid Parameter Values Issue

The OGC Web Services Common Specification (06-121r3) lists missingParameterValue and invalidParamterValue as exception codes in Table 25 on p44. Unfortunately, some service implementations try to "do the right thing", assume a default parameter value and return a "good" response instead of returning an exception message in the face of a missing or invalid paramter value. For example one WFS returned results when the value of the results parameter was "foo".

6.2.12 Informative OWS Exception Messages Issue

Many servers do not include text in <ows:Exception> elements in exception reports. It can be hard to figure out what is wrong based solely on the exception code and locator value in an <ows:Exception>. In Table 23 Parameters in Exception Element of the OGC Web Services Common Specification (06-121r3), the Multiplicity And Use value for ExceptionText is optional, and "Omitted only when no more useful information available ". But it is often omitted when more useful information is available.

This may be because in the same table, the value for Data Type and Value is "Character String type, not empty. Value is exception description as defined by individual servers." This clause may be interpreted to mean that an OWS implementation with no exception descriptions does not have to provide any exception text.

6.2.13 Informative CITE Exception Messages Issue

It can be hard to figure out what is wrong. For example, the CITE readiness test does not say why the test fails when it fails.

6.3   NSG Profiles

6.3.1   Findings

6.3.1.1   WMS 1.1.1

6.3.1.1.1 NSG Profile CITE Tests

Two out of three server vendors passed the WMS 1.1.1 NSG CITE Tests. The third server vendor only failed to provide styling for point features.

6.3.1.1.2 TIE Results

Table 5 WMS 1.1.1 TIE Results

Service / Operation	Sub-Operation / Scenario	NSG Item #	Results
WMS			One client tested against 1 server, 1 data set. A second client tested against 3 servers, 2 data sets.
GetCapabilities		133	
	A service level keyword list shall be included in the capabilities document	148	One client tied with one server. Second client tied with two servers. Second client received no keywords from one server.
	Contact information shall be provided in the capabilities document	149	All ties succeeded.
	An abstract and keyword list shall be included for each layer in the capabilities document	162	Two servers did not return an abstract or keyword list. Both clients tied with third server.

27

	Each named layer shall contain one or more MetadataURL elements	187	Two servers did not return a MetadataURL element. One client tied with third server.
	Each feature data layer shall be marked queryable and be subsettable	196	All ties succeeded.
	A layer shall not have fixed size	195	All ties succeeded.
GetMap		3	
	Select data layer and add to display. The server shall render the requested layers.	214	One server data set was not observable. Otherwise, all ties succeeded.
	Select data layer from a second server and add to display. The order shall be that the leftmost in the list is drawn first, the next one over that, and so on.	214	One client reported not observable. Second client reported one server data set was not observable, otherwise all ties succeeded.
	Select data layer from a third server and add to display. The order shall be that the leftmost in the list is drawn first, the next one over that, and so on.	214	One client reported not observable. Second client reported one server data set was not observable, otherwise all ties succeeded.
	Select data layer from a fourth server and add to display. The order shall be that the leftmost in the list is drawn first, the next one over that, and so on.	214	Not Applicable as no 4th server was available to test.
	Request a data layer with a Bounding Box within the Bounding Box advertised in the Capabilities Response. Any elements that are partly or entirely contained in the Bounding Box should be returned in the appropriate format	88	One server data set was not observable. Otherwise, all ties succeeded.
	Request a data layer with a Bounding Box that overlaps the Bounding Box advertised in the Capabilities Response. Any elements that are partly or entirely contained in the Bounding Box should be returned in the appropriate format	88	One server data set was not observable. Otherwise, all ties succeeded.
	Request a data layer with a Bounding Box that does not overlap the Bounding Box advertised in the Capabilities Response. The server should return empty content	89	One server data set was not observable. Otherwise, all ties succeeded.
	Request a data layer with an invalid BoundingBox. The server should return an exception	86	All ties succeeded.
	Select a data layer that requires re-projecting some but not all layers (Monterrey data set for this query)		One client succeeded with one server. Other client reported not observable.
	Select a data layer using the STYLES parameter	215	One client succeeded with one server. Other client succeeded with two servers, reporte not observable for other server.
	Select a data layer using the TRANSPARENT parameter	233	One client reported not observable with one server. Other client tied to all three servers.
	Select a data layer using the BGCOLOR parameter	238-1	One client reported not observable with one server. Other client tied to all three servers.

	Select a data layer using the EXCEPTIONS parameter	242-1	One client reported not observable with one server. Other client tied to all three servers.
	Select a data layer using the TIME parameter	255	Both clients reported not observable.
	Select a data layer using the ELEVATION parameter	256	Both clients reported not observable.
	Change the style of roads (using SLD or alternate WMS layer style)		One client succeeded with one server. Other client reported not observable for all three servers.
GetFeatureInfo		4	
	Issue GetFeatureInfo request with INFO_FORMAT parameter	272	One client reported partial success with one server; GetFeatureInfo only works for GML output format. Second client reported success with two servers, partial success with one server; client was unable to ingest the GML format returned in the GetFeatureInfo response
	Issue GetFeatureInfo request with FEATURE_COUNT parameter	274-1	One client reported success with one server. Second client reported not observable for 3 servers.

6.3.1.2 WFS 1.1.0

6.3.1.2.1 NSG Profile CITE Tests

No server vendors passed all the WFS 1.1.0 NSG CITE Tests due to three problems, #347, #372, and #396 with the tests themselves.

6.3.1.2.2 TIE Results

Table 6 WFS 1.1.0 TIE Results

Service / Operation	Sub-Operation / Scenario	NSG Item #	Results
WFS			One client tested against 1 server, 1 data set. Second client tested against 4 servers, 1 data set. Third client tested against 4 servers, 2 data sets. Three of 4 servers were transactional.
GetCapabilities			One client did not test against one server. Two clients tied to 4 servers. See additional notes below table.
DescribeFeatureType			
	Issue DescribeFeatureType request with no specific output format. Receive MIME type "text/xml; subtype=gml/3.1.1"	133	One client reported not observable against one server. Second client reported not observable against 4 servers. Third client tied to 4 servers.
	Issue DescribeFeatureType request with outputFormat = XMLSCHEMA Receive MIME type "text/xml; subtype=gml/2.1.2"	132	One client reported not observable against one server. Second client reported not observable against 4 servers. Third client reported success against 2 servers and failure against 2 servers; the response was still gml 3.1.1 instead of gml 2.1.2.
GetFeature			
	Select a feature type, request and receive feature data		All ties succeeded.
	Select a feature type, request	183	One client reported not observable against one

	specific properties, receive them		server. Second client client tied to all 4 servers. Third client reported not observable against all 4 servers.
	Select a feature type and Filter based on attribute values	188	One client tied with one server. Second client tied to all 4 servers. Third client tied to all 4 servers.
	Select a feature type and Filter based on spatial extent	188	One client tied with one server. Second client tied to one server, reported not observable against 3 servers. Third client tied with one server, reported failure against others; client not generating valid spatial query.
	Select a feature type and Filter based on attribute values and spatial extent	188	One client tied with one server. Second client tied to all 4 servers. Third client tied with one server, reported partial success with others; client not generating valid spatial query.
	Select a feature type and resultType=results	194	One client reported not observable against one server. Second client reported not observable against 4 servers. Third client reported partial success against 4 servers. For 3 servers, no exception is returned if an invalid resultType is sent such as resultType = foo. For 1 server, the service did not include timestamp on the hits request.
	Request GML3.1.1 features		All ties succeeded.
	Request a non-existent feature type. Receive XML Exception report that validates against exception response schema	112, 113	One client reported not observable against one server. Second client reported not observable against 4 servers; client does not allow this to occur. Third client tied with all 4 servers.
GetGMLObject			
	Execute a GetGmlObject request with traverseXlinkDepth = *	223	All clients reported not observable.
LockFeature			See additional notes below table.
	Issue LockFeature request. The response to a LockFeature request includes the identifiers of features that were locked.	243	One client reported not observable against one server. Second client reported not observable against 3 servers, not applicable against fourth server. Third client reported not observable against 4 servers.
	Issue LockFeature request with expiry attribute. Issue subsequent LockFeature request after expiry; should succeed	236	One client reported not observable against one server. Second client reported not observable against 3 servers, not applicable against fourth server. Third client reported not observable against 4 servers.
	Issue LockFeature request with lockAction=SOME The response is a <WFS_LockFeatureResponse> element that lists the previously unlocked feature ids in the <FeaturesLocked> element and the previously locked feature ids in the <FeaturesNotLocked> element.	241, 247, 248	One client reported not observable against one server. Second client reported not observable against 3 servers, not applicable against fourth server. Third client reported not observable against 4 servers.
	Issue LockFeature request that locks no features; issue another LockFeature request that reuses the same lock ID; receive expected error.	250, 251	One client reported not observable against one server. Second client reported not observable against 3 servers, not applicable against fourth server. Third client reported not observable against 4 servers.
Transaction			

	Execute WFS transaction with XlinkPropertyName and test for exception.	191	One client reported not observable against one server. Second client reported not observable against 3 servers, not applicable against fourth server. Third client reported not observable against 4 servers.
	Execute WFS transaction to Insert features		One client tied to one server. Second client tied to three servers, reported not applicable against fourth server. Third client tied to one server, reported not applicable for 1 server and failure against 2 servers. This was due to a problem in the client that does not recognize Insert, Update, and Delete operations located in the root level of the FeatureTypeList
	Execute WFS tranaction to update features		One client tied to one server. Second client tied to three servers, reported not applicable against fourth server. Third client tied to one server, reported not applicable for 1 server and failure against 2 servers. This was due to a problem in the client that does not recognize Insert, Update, and Delete operations located in the root level of the FeatureTypeList
	Execute WFS transaction to delete features		One client tied to one server. Second client tied to three servers, reported not applicable against fourth server. Third client tied to one server, reported not applicable for 1 server and failure against 2 servers. This was due to a problem in the client that does not recognize Insert, Update, and Delete operations located in the root level of the FeatureTypeList

Several participants said it was unclear why some test cases exist or what they're specifically intended to test. Providing rationale for these cases would help developers and testers understand what and how to implement. This may have been a side-effect of the decision to focus on services and schemas instead of use cases [3].

- LockFeature
  - o optional in OGC spec, NSG says mandatory
  - o There was considerable skepticism among participants that this is a required operation, as the need for it depends on the capabilities of the underlying implementation. Some vendors need it, others don't. Why make it mandatory? Is there a NSG use-case or CONOP that requires feature locking?
- Listing supported/allowed operations is inconsistently implemented/supported
  - o Ability to list allowed operations per feature type in the capabilities document may not be uniformly supported by clients.

6.3.1.3   GML and SF0

The NGA TDS_v2.0_SF0_GML311 schemas were provided in a directory tree that included the full GML version 3.1.1 schema set. They referenced gml.xsd in that directory tree [14]. The following schema exerpt shows this reference via an <xsd:import> element:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
```

```
<schema xmlns="http://www.w3.org/2001/XMLSchema" xmlns:gml="http://www.opengis.net/gml"
xmlns:gmlsf="http://www.opengis.net/gmlsf"
xmlns:tds="http://metadata.dod.mil/mdr/ns/GSIP/2.0/tds/2.0" elementFormDefault="qualified"
targetNamespace="http://metadata.dod.mil/mdr/ns/GSIP/2.0/tds/2.0" version="v2.0">
  <annotation>
    <appinfo source="../3.1.1/profiles/gmlsfProfile/1.0.0/gmlsfLevels.xsd">
      <gmlsf:ComplianceLevel>0</gmlsf:ComplianceLevel>
       <gmlsf:GMLProfileSchema>http://schemas.opengis.net/gml/3.1.1/profiles/gmlsfProfile/1.0.0/gm
lsf.xsd</gmlsf:GMLProfileSchema>
    </appinfo>
  </annotation>
  <import namespace=http://www.opengis.net/gml schemaLocation="../3.1.1/base/gml.xsd"/>
  <import namespace="http://www.opengis.net/gmlsf"
schemaLocation="../3.1.1/profiles/gmlsfProfile/1.0.0/gmlsfLevels.xsd"/>
```

This is in accordance with the SF-0 specification (OGC 06-049r1) section 8.3.1, but it led to some controversy as to whether the GML data for plugweek was valid, as it allowed instance documents to be approved by validating XML/Schema parsers, when they would have failed validation had the gmlsf.xsd schema been imported instead. The instance document that passed validation and caused controversey had a <tds:geometry> element that included a <gml:CompositeCurve> element. This is valid in full GML version 3.1.1, but not in SF-0. The tds:geometry elemet is defined in the NGA schemas as a gml:CurvePropertyType, which contains a <gml:_Curve> element, or any element in its substitution group. In SF-0 and the gmlsf.xsd schema, the only allowed elements in the gml:_Curve substitution group are gml:Curve and gml:LineString, whereas the full GML version 3.1.1 geometry schemas also include gml:Composite curve in the gml:_Curve substitution group.

6.3.1.4   WCS 1.1.1

6.3.1.4.1 NSG Profile CITE Tests

One server vendor passed the WCS 1.1.1 NSG CITE Tests; the second server vendor failed.

6.3.1.4.2 TIE Results

Table 7 WCS 1.1.1 TIE Results

Service / Operation	Sub-Operation / Scenario	NSG Item #	Results
WCS			One client tested against two servers.
GetCapabilities			
	Access GetCapabilities document. The version and updateSequence attributes must be omitted	81	Tie to one server succeeded, the other failed; version provided where prohibited.
	Access GetCapabilities document with section = /WCS_Capabilities/Service The version attribute shall be returned.	69	All ties succeeded.

	Access GetCapabilities document with section = /WCS_Capabilities/Capability The version attribute shall be returned.	75	All ties succeeded.
	Access GetCapabilities document with section = /WCS_Capabilities/ContentMetadata The version attribute shall be returned.	80	All ties succeeded.
	Access GetCapabilites with updateSequence paramter	57	All ties succeeded.
DescribeCoverage			
	Access DescribeCoverage response	107	
GetCoverage			
	Specify area of interest and access imagery.		All ties succeeded.
	Request parameters conform to specification	29	Client reported not observable.
	Requests are valid URIs	30	All ties succeeded.
	Response format is at least one of these: GeoTIFF, HDF-EOS, DTED, NITF, or GML	166	All ties succeeded.
	Specify area of interest with a BBOX inside the defined BoundingBox and access imagery with server's native CRS	117, 153	All ties succeeded.
	Specify area of interest with a BBOX partially contained in the defined BoundingBox and access imagery with the server's native CRS	117, 153	All ties succeeded.
	Specify area of interest with a BBOX inside the defined BoundingBox and access imagery with request CRS different than server's native CRS	117, 153	All ties succeeded.
	Specify area of interest with a BBOX partially contained in the defined BoundingBox and access imagery with request CRS different than the server's native CRS	117, 153	All ties succeeded.
	Specify area of interest with a BBOX inside the defined BoundingBox and access imagery with response CRS different than server's native CRS	117, 153	All ties succeeded.
	Specify area of interest with a BBOX partially contained in the defined BoundingBox and access imagery with response CRS different than the server's native	117, 153	All ties succeeded.

	CRS		
	Specify area of interest and interpolation method and access imagery	170	Client reported not observable.
	Specify area of interest out of valid range. Receive expected error.	44	Client reported not observable.
	Specify area of interest out of valid range. Service exception XML validates according to the Service Exception XML Schema	44	Client reported not observable.
	Specify time instant of interest and access imagery from coverage with temporal domain of time instants	124	Client reported not observable.
	Specify time period of interest and access imagery from coverage with temporal domain of time period	124	Client reported not observable.
	Specify Axis for coverage that does not have default Axis description and access imagery	139	Client reported not observable.
	Specify coverage name containing embedded commas and spaces. The server handles encoded commas and spaces in list values correctly	137	Client reported not observable.
	Select number of bands to show and display the image		Client reported not observable.
	Access services via HTTPS	24	Client reported not observable.

6.3.1.5 CSW 2.0.1

There was no NSG Profile for CSW 2.0.1. See OGC Specification results in section 6.3.1.5 below.

6.3.2   Recommendations

6.3.2.1 Transition from WMS 1.1.1 to WMS 1.3.0 as soon as WMS 1.3.0 is in the DISR

WMS 1.3.0 supports the use of the TDS EC CRS Specification, whereas WMS 1.1.1 does not. This transition will also help to resolve the CRS Axis Order issue discussed above. It will also avoid the GetFeatureInfo assumed INFO_FORMAT value issue discussed below.

6.3.2.2 Transition from SLD 1.0 to SLD 1.1.0 and SE 1.1.0 as soon as they are in the DISR

Transitioning to WMS 1.3.0 and SLD 1.1.0 (and SE 1.1.0) will provide a more capable and interoperable means to dynamically style layers according to the user's preferences, role, and mission. The SLD 1.1.0 specification depends on (extends) WMS 1.3.0 and references SE 1.1.0.

The recommendation here is to transition to the WMS 1.3.0, SLD 1.1.0, and SE 1.1.0 specifications at the same time.

6.3.2.3 Transition from WCS 1.0.0 to WCS 1.1.0 as soon as 1.1.0 is in the DISR

WCS 1.1.0 supports the use of the TDS EC SRS Specification, whereas WCS 1.0.0 does not.

6.3.2.4 Add explanatory note to TDS DCS EC [11] in section 5.3.3 as line "c"

"Note: Per SF-O specification, the TDS GML application schemas import gml.xsd. Validation of instance documents against these schemas with a validating XML parser checks conformance to full GML, not SF-0. Validation of instance documents to check conformance with SF-0 can be accomplished by replacing the import of gml.xsd with gmlsf.xsd in TDS GML application schemas."

6.3.2.5 Use gml:identifier in GML version 3.2.1 TDS Application schemas

TDS Application schemas for GML versions 3.1.1 and 3.2.1 define tds:uniqueEntityIdentifier. There is no unique identifier type in GML 3.1.1, but GML 3.2.1 specifies use of gml:identifier for this purpose. It should be used if possible in GML version 3.2.1 application schemas, e.g. if backwards compatibility with version 3.1.1 data sets is not required.

6.3.2.6 NSG Profile should be prepared for OWS Common

The Get Capabilities Service Identification Abstract and Keywords Issue is an indicator that NGA should consider profiling OWS Common in addition to various OWS specifications. If this is done, the NSG Common profile should add some mandatory service level keywords, and make the service level abstract mandatory.

6.3.2.7 Transition from WFS 1.1.0 to ISO 19142 (WFS 2.0) as soon as 19142 is in the DISR

WFS 2.0 (ISO 19142) will correctly support SF-0 whereas WFS 1.1.0 does not.

6.3.2.8 Prepare NSG Requirements for OWS Clients

The NGA should prepare a document listing requirements for OWS clients.

Previous OWS Testbeds have investigated requirements for OWS Clients.   These results are documented in two OGC Engineering Reports

- *OWS Integrated Client (GeoDSS Client), OGC Document 05-116*
- *Integrated Client for Multiple OGC-compliant Services, OGC Document 03-021*

6.3.2.9 Prepare NSG Requirements for OWS Test Data

The NGA should prepare a document listing requirements for test data structure and content for each future OWS activities and create test data that meets the stated requirements so that the test data supports all of the tests planned for the activity.

6.3.2.10 Prepare NSG requirements for CSW

The NGA should prepare a document listing the NSG requirements for CSW. It should address capabilities like the following:

- Core queries for resource discovery using the CSW Dublin Core properties or DDMS
- Query/resolve associations between resources (e.g., find services associated with a layer or dataset)
- Association management (create, maintain, resolve, validate/fix)
- Semantic/taxonomic searches and mappings

6.4   OGC Specifications

6.4.1   Findings

6.4.1.1   WMS 1.1.1

6.4.1.1.1   OGC Specification CITE Tests

Two out of three server vendors passed the WMS 1.1.1 OGC CITE Tests. The third server vendor only failed to provide styling for point features.

6.4.1.1.2   TIE Results

See the NSG Profile TIE Results above.

6.4.1.1.3   GetFeatureInfo response

During the Plugweek, one WMS client issued a GetFeatureInfo request for the same feature to three WMS servers. One responded in XML, the second responded in HTML, and the third responded in GML.

The WMS 1.1.1 Specification is ambiguous regarding what a WMS server should do if no optional INFO_FORMAT parameter is included with a GetFeatureInfo request. No mechanism for specifying a default value for the INFO_FORMAT parameter is provided. And clause 7.3.4 GetFeatureInfo Response says "The WMS shall return a response according to the requested INFO_FORMAT if the request is valid, or issue an exception otherwise." This could be interpreted to mean that the WFS server should not assume a default value for INFO_FORMAT, but issue an exception if it is not included in a request.

The INFO_FORMAT parameter was made mandatory in WMS 1.3.0.

6.4.1.2   WFS-1.1.0

6.4.1.2.1   OGC Specification CITE Tests

One vendor passed the WFS 1.1.0 OGC CITE Tests; others encountered problem #347 with the test itself.

6.4.1.2.2 TIE Results

See the NSG Profile TIE Results above.

- Filter operations are inconsistently advertised

6.4.1.3 GML and SF-0

6.4.1.3.1 GML Simple Features Specification Outdated

The SF-0 specification is based on GML 3.1.1. SF-0 has not been normatively brought forward to profile GML 3.2.1.

6.4.1.3.2 GML Simple Features Schema Imports Full GML Schema

As discussed above in section 6.2.1.3, the SF-0 specification notes the compliance level and references the SF-0 schema gmlsf.xsd, but imports the full GML 3.1.1 schema gml.xsd instead. The SF-0 editor recalls that this was done to avoid a general XML parser caching issue that can affect any XML schema and profiles thereof that share the same namespace. Here is the scenario:

1. Both gml.xsd and any profile of gml (like gmlsf.xsd) use the same gml namespace (i.e. http://www.opengis.net/gml).

2. XML parsers typically cache schemas based on their namespace. (e.g. Oracle XML parser does this, so does XML-Spy)

3. A user validates an application schema uthat imports gmlsf.xsd. The xml parser caches gmlsf.xsd using the gml namespace as the key.

4. The user then validates an application schema that imports gml.xsd, the schema for full GML.

5. However, since the namespace is the same, the xml parser assumes that its cached copy of the schema is OK and uses that. The second validation fails because the application schema that imported gml.xsd includes elements from full GML that gmlsf.xsd does not.

Because this is a general parser problem, for the gml namespace it affects all profiles of GML, not just GML Simple Features.

6.4.1.3.3 Enumeration Implementation in Schema or Dictionary Issue

Section E.2.4.8 UML Classes (code lists) in the GML 3.1.1 specification (03-105r1) documents the use of XML Schema enumerations in GML, and states "Alternatively, gml:Dictionaries can be used to represent code lists." Using a gml:Dictionary document to hold enumeration values instead of an XML Schema enumeration in a GML Application Schema has several potential advantages. It makes the schema smaller, so it can be parsed faster. It can be changed without requiring a version number change in the schema. But a dictionary of enumerations would need to be versioned just like a schema, so this just moves the problem rather than solving it. Although internationalization was cited by several participants as an advantage or an external dictionary, an XML Schema is also an

XML document, so the xml:lang attribute may be use in it as well. The XML recommendation states: "A special attribute named `xml:lang` may be inserted in documents to specify the language used in the contents and attribute values of any element in an XML document."   A disadvantage of using a gml:Dictionary instead of an XML Schema enumeration is that it prevents a validating XML parser from checking the values in an instance document against the enumerated values.

6.4.1.4   WCS 1.1.1

6.4.1.4.1 OGC Specification CITE Tests

One server vendor passed the WCS 1.1.1 OGC CITE Tests; the second server vendor failed.

6.4.1.4.2 TIE Results

See the NSG Profile TIE Results above.

6.4.1.5   CSW 2.0.1

6.4.1.5.1 OGC Specification CITE Tests

Two server vendors passed the CSW 2.0.1 CITE Tests.

6.4.1.5.2 TIE Results

Table 8 CSW 2.0.1 TIE Results

Service / Operation	Sub-Operation / Scenario	NSG Item #	Results
CS-W			One client tested against three servers.
GetCapabilities			Client tied to one server, failed against other two servers. Many differences were found between the catalog vendors that prevented a single client from completing successful TIEs with all of them
DescribeRecord			Client reported not applicable.
GetDomain			Client reported not applicable.
GetRecordById			Client reported not applicable.
GetRecords			
	Discover data and images		Client tied to one server, failed against other two servers. Many differences were found between the catalog vendors that prevented a single client from completing successful TIEs with all of them
	View and evaluate metadata of data and images discovered		Client tied to one server, failed against other two servers. Many differences were found between the catalog vendors that prevented a single client from completing successful TIEs with all of them
	Transfer service GetCapabilities end point to WMS, WFS, or WCS client (cut and paste, drag, hand copy and enter, however your software does it)		Client tied to one server, failed against other two servers. Many differences were found between the catalog vendors that prevented a single client from completing successful TIEs with all of them

Transaction			Client reported not applicable.
Harvest			Client reported not applicable. All servers harvested WMS, WFS, WCS services. One server harvested the other servers. But the catalog records from the harvested servers in the harvesting server did not match the catalog records from the harvested servers.

Issues with CONOPS, use-cases, and test cases: What functionality is mandatory? Knowing this would help drive whether ebRIM is required.

6.4.1.5.3 Catalog Harvest Specification Issue

A service gets registered differently in different catalogs. The result is that clients can never reliably query any given catalogue. This is the case whether the catalogs harvest WMS, WFS and WCS services directly, or harvest other CSW servers to obtain information about the WMS, WFS and WCS services they have harvested. See the NSG Profile TIE Results above. An OGC ER addressed this issue 6 years ago [16]. One problem appears to be the lack of common mappings between the CAT specifications' core queryables and returnables and the GetCapabilitiesResponses of services being harvested, which was addressed for a much earlier version of the CAT specification in OGC 03-041 [16]. Another problem appers to be the lack of common mappings between the CAT specifications' core queryables and returnables and elements of the metadata models used in catalog profiles. The CAT ISO Metadata Application Profile (OGC 07-045) provides a mapping to ISO 19115 metadata model elements that is lacking for other metadata models.

6.4.1.6 Catalog Query Parameter Value Namespace Qualification

When the types of queried object are part of an inheritence hierarchy and the query element specification is not namespace qualified, the desired object is ambiguous. For example, wrs:ExtrinsicObject is in the XML Schema substitution group for rim:ExtrinsicObject. Which should be retured to a query for "ExtrinsicObject"?

6.4.2 Recommendations

6.4.2.1 Adopt documented best practices for CRS definitions

All subsequent versions of OGC specifications must support use of URN CRS definitions according to the guidance of 07-092r3.

6.4.2.2 WMS 1.3.0 Change Request

Submit a ChangeRequest for WMS 1.3.0 to support use of URN CRS definitions according to the guidance of 07-092r3.

6.4.2.3 SF-0 Change Request

Submit a ChangeRequest for the SF-0 specification (OGC 06-049r1) to change the informative example on page 22 that includes a <wfs:FeatureCollection> with a

<gml:featureMember> property to an example that conforms with SF-0 normative requirements.

6.4.2.4 GML Change Request

Ask the GML SWG to reconsider the mechanism whereby profile schemas such as gmlsf.xsd are referenced but not imported, as this practice avoids situational XML Schema parser caching problems at the expense of universal inability to correctly validate SF-0 instance documents or those using other GML profiles.

6.4.2.5 SF-0 Version Upgrade Request

Request the formation of a Working Group to revise the GML Simple Features specification to profile GML version 3.2.1. Ask the working group to reconsider the mechanism whereby gmlsf.xsd is referenced but not imported, as this practice avoids situational XML Schema parser caching problems at the expense of universal inability to correctly validate SF-0 instance documents.

6.4.2.6 Catalog Harvest Specification Recommendation

Further work needs to be done on mapping of CAT core queryables and returnables to both OWS GetCapabilitesResponse documents, and to CAT profile metadata models, particularly those for ebRIM. There are currently two in play; the CSW-ebRIM profile of CAT and the ebRIM/ebRIM v4.0 catalog from OASIS which is being extended for spatial within OGC.

6.4.2.7 OWS Client Capabilities Recommendation

Prepare an OGC Recommendation Paper listing desirable OWS client capabilities.

- Include capabilities to handle data where the axis order has been switched from that defined in the specified CRS.

For WFS,

- Include capabilities to display all supported operations for each feature type.

Previous OWS Testbeds have investigated requirements for OWS Clients. These results are documented in two OGC Engineering Reports

- OWS Integrated Client (GeoDSS Client), OGC Document 05-116
- Integrated Client for Multiple OGC-compliant Services, OGC Document 03-021

6.4.2.8 OWS Common Change Request on Exception Handling

Submit a ChangeRequest for the OGC Web Services Common Specification (06-121r3) to address the following exception handling issues. These changes will help standardize error reporting and the error message text returned by service implementations.

- Explicitly specify that variance from the specified multiplicity of any request parameter is an invalid operation request to which the service should return an exception report. A new "InvalidParameterMultiplicity" exception code should be added to Table 25 Standard Exception Codes and Meanings for such exceptions, for all variances other

than that coverd by the existing missingParameterValue exception code. The locator value for this exception code is the name of the parameter. The ExceptionText for this exception is "X paramter values expected, Y values found: Z" where X is a string value containing the expected multiplicity range, Y is the number of parameters in the request, and Z is a comma separated list of the parameter values in the request.

- Change the Data Type and Value value for ExceptionText in Table 23 Parameters in Exception Element from "Character String type, not empty. Value is exception description as defined by individual servers." to "Character String type, not empty. Value is ExceptionText from Table 25 for common exception codes, or ExceptionText defined by OWS specification for OWS service-specific exception codes 'c'." Add a footnote 'c': "The contents and meaning of this parameter shall be defined for each allowed exceptionCode value. For some exceptionCode values, the meaning may be different for different operations. This exception text should be included whenever meaningful information can be provided by the server." Change the Multiplicity and Use value for ExceptionText in Table 23 Parameters in Exception Element from "Zero or more (optional)'a' Omitted only when no more useful information available." to "Zero or more (optional)'a' Omitted only when no ExceptionText is specified for the ExceptionCode."

- Add an ExceptionText column to to Table 25 Standard Exception Codes and Meanings with values for exception codes as shown in the following table.

Table 9 Exception Text Values for Common Exception Codes

Exception Code Value	Exception Text
OperationNotSupported	"Supported Operations are: " + comma separated list of supported operations
MissingParameterValue	"Valid values are: " + comma separated list of legal values if there are less than 8 of them, or + " valid values specified in " + document name or URL
InvalidParameterMultiplicity	"X paramter values expected, Y values found: Z" where X is a string value containing the expected multiplicity range, Y is the number of parameters in the request, and Z is a comma separated list of the parameter values in the request.
InvalidParameterValue	"Invalid value was X. Valid values are: Y" where X is the iinvalid parameter value, and Y is a comma separated list of legal values if there are less than 8 of them, or "specified in" + document name or URL if there are more.
VersionNegotiationFailed	"Client specified version X; Server supports versions Y" where X is the version or versions specified by the client, and Y is a comma separated list of the versions supported by the server.

InvalidUpdateSequence	"Request Sequence was X; Service Metadata Update Sequence Number was Y"
OptionNotSupported	"Valid options are: " + comma separated list of supported options
NoApplicableCode	"Request was X; Problem is Y" where X is the request or "null" if missing and Y is text that describes the server exception.

6.5 CITE Tests

The CITE home page is http://cite.opengeospatial.org/forum

Complete documentation of the test issues listed below is available from the CITE Issue Tracker at http://portal.opengeospatial.org/?m=projects&a=view&project_id=85&tab=5

Complete details on the changes made to implement test fixes listed below are provided in [12].

6.5.1 Findings

- CITE tests still use the 'x-' URN notation i.e. urn:x-ogc:def:crs:EPSG:4326

6.5.1.1 WMS 1.1.1

- Issue #309 OGC CITE Test for WMS 1.1.1 does not include Version Parameter
    - fixed in the latest release of the WMS 1.1.1 test
- Issue #316 EXCEPTIONS=BLANK is treated as mandatory for implementations
    - implementation problem; no change to test logic

6.5.1.2 WFS 1.1.0

- Issue #302 GMLSF L0 Schema is NOT GMLSF L0 compliant
    - not a test problem; issue noted on CITE web site
- Issue #303 Use of xsd:NCName is GMLSFL0 schemas is not valid
    - not a test problem
- Issue #308 WFS 1.1.0 Features are not sorted by sf:str4Property in ascending order
    - fixed in latest release of WFS 1.1.0 test
- Issue #317 PropertyisBetween is treated as mandatory
    - issue remains outstanding
- Issue #318 SortBy is treated as mandatory
    - not a test problem
- Issue #319 KVP over Post is treated as a mandatory encoding
    - fixed in latest release of WFS 1.1.0 test

- Issue #321 Test wfs:wfs-1.1.0-Basic-GetFeature-tc11.1 is expecting a response but should be expecting an exception.
  - o fixed in latest release of WFS 1.1.0 test
- Issue #322 A number of tests fail if the gml:boundedBy is not generated
  - o fixed in latest release of WFS 1.1.0 test
- Issue #323 Test wfs:wfs-1.1.0-Basic-GetFeature-tc34.1 is not valid.
  - o issue remains outstanding
- Issue #324 CITE tests do not respect the idgen parameter in the capabilities document.
  - o issue remains outstanding
- Issue #347 Test wfs:wfs-1.1.0-Basic-GetFeature-tc102.1 is not detecting sorted features correctly
  - o fixed in latest release of WFS 1.1.0 test, but not yet re-tested
- Issue #372 Assertion for NGA profile test wfs:wfs-1.1.0-Basic-GetFeature-tc209.3 is not valid.
  - o issue remains outstanding
- Issue #380 Test wfs:wfs-1.1.0-Basic-GetFeature-tc49.1 uses invalid CRS.
- Issue #396 WFS NSG Profile Transaction test runs even when transactions are not being tested
  - o Issue (posted after plugweek) remains outstanding
- The test dataset uses special characters in field (feature class and property) names that aren't uniformly supported across implementations. Also field name lengths cause similar problems.

6.5.1.3 WCS 1.0.0

- Issue #306 WCS GetCoverage with invalid TIME not caught
  - o fixed in latest release of WCS 1.0.0 test.
- Issue #307 WCS 1.0.0 timePosition param not retrieved correctly
  - o fixed in latest release of WCS 1.0.0 test.
- Issue #330 WCS 1.0.0 GetCoverage with invalid time; missing "crs"
  - o Duplicate of issues 306, 307; fixed in latest release of WCS 1.0.0 test

6.5.1.4 CSW 2.0.1

- Issue #374 Test csw:csw-2.0.2-GetRecordById-tc5.1 should use a different test value

6.5.2 Recommendations

6.5.2.1 Change the WFS test dataset

- Remove special characters
- Use shorter field names (max 30 characters).

6.5.2.2 Implement Request Parameter Multiplicity Tests

Test the multiplicity of all OWS request parameters against the multiplicity stated in the specifications. Services pass this test if they provide a meaningful exception report when the multiplicity of the provided parameters is at variance with the specifications.

6.5.2.3 Improve Test Failure Messages

- Add "show failure details" option that specifies detailed error messages are to be returned for test failures
- Add "show request response" option that specifies HTTP request and response text are to be included in test failure error messages to support debugging

6.5.2.4 Improving OWS Specifications will improve CITE tests

The Specification Model — A Standard for Modular specifications (OGC 08-131r3) specifies desirable characteristics of a standards specification that will encourage implementations by minimizing difficulty determining requirements, mimicking implementation structure and maximizing usability and interoperability. Future versions of OGC Standards are moving to implement the policy defined in this document. OGC Standards written to adhere to O8-131r3 will have clearer definition of requirements. Clearer definition of the requirements will result in better compliance tests.

6.5.2.5 OWS Exemplar Implementation Recommendation

The OGC should establish exemplar implementations for all OWS standards to facilitate commercial development of OWS-conformant servers and clients. Exemplar implementations are active, online and publically accessible Reference Implementations that provide authoritative TIE partners for OWS clients under development, and a means for developers to see what an authoritative service does as apposed to what the standard says it should do, in cases where the wording of the standard is ambiguous and subject to different interpretations.

The current approach for CITE Reference Implementations is for them to be open source to allow developers to understand how the implementation meets the specification. Development of open source Reference Implementations is done as a part of OWS TEstbeds based upon sponsorship. As the development of Reference Implementations for all OWS standards is a resource issue for the OGC, it could establish a new policy of holding competitions for designation of commercial products as exemplar implementations, whereby the winner gets an "exemplar implementation" gold star in the online listing of conformant products in exchange for the expense of establishing the exemplar implementation and keeping it online.

6.6 IE/Plugweek Process

6.6.1 Findings

- Test datasets didn't support testing the specifications and NSG profiles.
  - Many test conditions were not observable because of the test data

- o The lack of realistic values for feature properties prevented testing queries and generating views, etc.
- Many test conditions were not observable because of client shortcomings.
- Detailed CITE results were not logged.
- Some CITE tests that failed due to errors in the tests were not repeated after the tests were fixed at the end of the plugweek.
- TIE coverage was incomplete; some clients did not test against all available servers.
- TIE results reporting was incomplete; no details were provided for tests that were not observable via client interfaces; few request and response values were provided for failed tests.
- Regarding WFS tests, several participants said it was unclear why some test cases exist or what they're specifically intended to test. Providing rationale for these cases would help developers and testers understand what and how to implement. This may have been a side-effect of the decision to focus on services and schemas instead of use cases [3].
- Considerable time and effort were expended discovering the issues that are documented in this ER which became interoperability hurdles, establishing private conventions to work around specification version incompatabilities, and modifying server and client code and configuration settings.
- Once interoperability hurdles were surmounted, an OWS client could "plug-and-play" with the OWS services, and exercise most of their capabilities.

6.6.2   Recommendations

6.6.2.1   Revise Plugfest Policies and Procedures

The OGC Plugfest Policies and Procedures should be revised to address the following issues.

- Thorough planning and preparation is key to IE / Plugweek activity success
- If CITE testing is part of the activity
    - o Arrange for CITE test issue resolution support.
    - o Specify which CITE tests, conformance levels, and options to use
- Tests and TIEs to be performed must be completely specified
    - o OWS and/or profiles thereof
    - o Capabilities, operations, sub-operations, and options
    - o Expected results and exceptions
- Test request and response values and any other data to be gathered to document results must be completely specified
- Results reporting mechanisms must be established
- The test environment configuration must be specified and publicized
- Test datasets must be prepared to support all intended tests. Document the requirements for test data structure and content based on test and TIE specifications and create test data that meets the stated requirements so that the test data supports all of the tests planned for the activity.

- Test workflows must be established for all participants to assure complete test coverage including repeating tests that failed due to interoperability hurdles once the problems have been resolved.
- General HTTP GET and POST clients must be available to perform tests that commercial OWS clients cannot perform.

6.6.2.2   Find Sponsors for OWS Testing Tools

The labor expense of conducting OGC testing activities for OWS could be significantly reduced and the quality of the ER documentation created could be significantly improved by the use of appropriate HTTP test infrastructure tools.   Two tools are suggested for sponsor support via funding, in-kind contribution, or open source development. The log output of both tools should be XML documents that conform to the same XML Schema, to facilitate conversion of test results to report document fragments via XSLT stylesheets.

- General HTTP GET and POST client that logs request and response values and HTTP headers and times service delivery
- HTTP TestWall Servlet intermediary that serves as a 2-way proxy for commercial OWS clients and servers and that logs request and response values and HTTP headers and times service delivery

Bibliography

The following documents are referenced in this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

OGC 01-068r3, *OpenGIS® Web Map Service (WMS) Implementation Specification, version 1.1.1*

OGC 02-070, *Styled Layer Descriptor Implementation Specification (SLD), version 1.0.0*

OGC 03-105r1, *OpenGIS® Geography Markup Language (GML) Encoding Specification, version 3.1.1*

OGC 04-016r3, *OWS Common Implementation Specification, version 0.3.0*

OGC 04-021r3, *OpenGIS® Catalog Service Implementation Specification, version 2.0.1*

OGC 04-094 *OpenGIS® Web Feature Server (WFS) Implementation Specification, version 1.1.0*

OGC 04-095, *OpenGIS® Filter Encoding Implementation Specification, version 1.1.0*

OGC 05-008, *OpenGIS® Web Services Common Specification, version 1.0.0*

OGC 05-076, *Web Coverage Service (WCS), Version 1.0.0 (Corrigendum), version 1.0.0*

OGC 05-077r4, *Symbology Encoding (SE) Implementation Specification, version 1.1.0 (revision 4)*

OGC 05-078r4, *Styled Layer Descriptor (SLD) profile of the WMS Implementation Specification, version 1.1.0 (revision 4)*

OGC 06-023r1, *Definition Identifier URNs in OGC namespace, Best Practices Paper*

OGC 06-042, OpenGIS® Web Map Server Implementation Specification, version 1.3.0

OGC 06-049r1, *Geography Markup Language Simple Features Profile*

OGC 06-083r8 OpenGIS® Web Coverage Service Implementation Specification, version 1.1.0

OGC 06-121r3, *OpenGIS® Web Services Common Standard*

NOTE   This OWS Common Specification contains a list of normative references that are also applicable to this Implementation Specification.

OGC 07-006r1, *OpenGIS® Catalog Services Specification, Version 2.0.2, Corrigendum 2*

OGC 07-036, OpenGIS® Geography Markup Language (GML) Encoding Standard, version 3.2.1

OGC 07-045, OpenGIS® Catalogue Services Specification 2.0.2 - ISO Metadata Application Profile

OGC 07-092r3 Definition Identifier URNs in OGC Namespace

OGC 07-107r3 (IETF) A Uniform Resource Name (URN) namespace for the
    Open Geospatial Consortium (OGC)

OGC 08-038r5 Axis Order Policy and Recommendations

ISO 19106, Geographic Information – Profiles

ISO 19115, Geographic Information – Metadata

Department of Defense Discovery Metadata Specification
    http://metadata.dod.mil/mdr/ns/DDMS/2.0/

Extensible Markup Language (XML) 1.0 (Fifth Edition)

    http://www.w3.org/TR/xml/

Table 10 Relevant Discussion Papers

Title	Version
GEOINT Structure Implementation Profile (GSIP) Schema Processing	0.5.0
Imagery Metadata	1.0.0
OGC Web Services Architectural Profile for the NSG	1.3.0
OWS-3 Integrated Client (GeoDSS Client) (05-116)	-
OWS-3 UML to GML Application Schema (UGAS) Tool (05-118)	-
OWS-4 CSW Modeling Guidelines IPR (06-155)	-
OWS-5 Data View Architecture ER (07-163r1)	-
OWS-5 OGC Web Services Architectural Profile for the NSG (07-009r3)	-
Schema Maintenance and Tailoring (05-117)	-

Table 11 Relevant Recently Approved OGC Discussion Papers

Title	Version or Doc#
OWS-6 GML Profile Validation Tool Guidelines ER	09-038r1
OWS-6 Symbology-Encoding Harmonization ER	09-012
OWS-6 Symbology Encoding (SE) CR	09-014
OWS-6 Symbology Encoding (SE) Changes ER	09-016
OWS-6 Styled Layer Descriptor (SLD) CR	09-013
OWS-6 Styled Layer Descriptor (SLD) Changes ER	09-015