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Editor(s): James Ressler

OGC[®] OWS-6 TEAM Engine Engineering Report

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Preface

This document summarizes the work done on the TEAM compliance test engine and DGIWG Profile compliance test by Northrop Grumman for the CITE thread of OWS-6 in 2008-2009.

Forward

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OWS-6 Testbed

OWS testbeds are part of OGC's Interoperability Program, a global, hands-on and collaborative prototyping program designed to rapidly develop, test and deliver Engineering Reports and Change Requests into the OGC Specification Program, where they are formalized for public release. In OGC's Interoperability Initiatives, international teams of technology providers work together to solve specific geoprocessing interoperability problems posed by the Initiative's sponsoring organizations. OGC Interoperability Initiatives include test beds, pilot projects, interoperability experiments and interoperability support services - all designed to encourage rapid development, testing, validation and adoption of OGC standards.

In April 2008, the OGC issued a call for sponsors for an OGC Web Services, Phase 6 (OWS-6) Testbed activity. The activity completed in June 2009. There is a series of on-line demonstrations available here: <http://www.opengeospatial.org/pub/www/ows6/index.html> The OWS-6 sponsors are organizations seeking open standards for their interoperability requirements. After analyzing their requirements, the OGC Interoperability Team recommended to the sponsors that the content of the OWS-6 initiative be organized around the following threads:

1. Sensor Web Enablement (SWE)
2. Geo Processing Workflow (GPW)
3. Aeronautical Information Management (AIM)
4. Decision Support Services (DSS)
5. Compliance Testing (CITE)

The OWS-6 sponsoring organizations were:

- U.S. National Geospatial-Intelligence Agency (NGA)
- Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD)
- GeoConnections - Natural Resources Canada
- U.S. Federal Aviation Agency (FAA)
- EUROCONTROL
- EADS Defence and Communications Systems
- US Geological Survey
- Lockheed Martin

- BAE Systems
- ERDAS, Inc.

The OWS-6 participating organizations were:

52North, AM Consult, Carbon Project, Charles Roswell, Compusult, con terra, CubeWerx, ESRI, FedEx, Galdos, Geomatys, GIS.FCU, Taiwan, GMU CSISS, Hitachi Ltd., Hitachi Advanced Systems Corp, Hitachi Software Engineering Co., Ltd., iGSI, GmbH, interactive instruments, lat/lon, GmbH, LISAsoft, Luciad, Lufthansa, NOAA MDL, Northrop Grumman TASC, OSS Nokalva, PCAvionics, Snowflake, Spot Image/ESA/Spacebel, STFC, UK, UAB CREAM, Univ Bonn Karto, Univ Bonn IGG, Univ Bunderswehr, Univ Muenster IfGI, Vightel, Yumetech.

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OGC® OWS-6 TEAM Engine Engineering Report

1 Introduction

1.1 Scope

This OGC™ document summarizes work delivered in version 2.0 of the TEAM Compliance Test Engine used in the OWS-6 Compliance & Interoperability Test & Evaluation thread. This OGC™ document is applicable to the OGC Compliance Test Program.

1.2 Document contributor contact points

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

Name	Organization
James Ressler	Northrop Grumman Information Systems, TASC
Chuck Morris	Northrop Grumman Information Systems, TASC

1.3 Revision history

Date	Release	Editor	Primary clauses modified	Description
5/22/2009	0.1	James Ressler	All new	Publish Draft document for review and use in CITE Engineering Report
6/05/2009	1.0	James Ressler	Section 8.2	Final Version
8/03/09	0.3.0	Carl Reed	Various	Prepare for Publication

1.4 Future work

Improvements to the TEAM Engine and future compliance test work are contained in section 10 of this document.

2 References

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 06-126r2, Compliance Test Language (CTL) version 0.6 Best Practice Change Request

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

STD-08-054-ED1.3, DGIWG WMS 1.3 Profile and systems requirements for interoperability for use within a military environment, edition 1.3

ISO 19105 Geographic information — Conformance and testing

3 Terms and definitions

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

3.1 Compliance Test Engine

OGC currently uses the Open Source Test Evaluation And Measurement (TEAM) engine which runs executable test suites to verify compliance to OGC web services specifications.

3.2 Abstract Test Suite

Testable assertions extracted from specification document; defined as mandatory or optional; test cases are specified independently of any particular test procedure (ISO 19105, 4.4); may be used to create an Executable Test Suite for a particular test harness

3.3 Executable Test Suite

Set of executable test assertions written in CTL and executed by the TEAM Engine to validate compliance to an implementation specification.

3.4 Compliance Test Language

Compliance Test Language is an XML grammar for documenting and scripting suites of compliance tests for verifying that an implementation of a specification complies with the specification. A suite of CTL files is installed in the compliance test engine, which executes the scripts and determines whether the implementation being tested passes or fails.

3.5 Reference Implementation

Open source implementation of an OGC Web Service which is 100% compliant with the associated compliance tests.

3.6 Test Data

Static dataset provided along with executable test suites; loaded into service implementation to be tested; this data is necessary for the ETS to test the service implementation

4 Conventions

4.1 Abbreviated terms

ATS	Abstract Test Suite
ATC	Abstract Test Case
CITE	Compliance and Interoperability Test and Evaluation
CTL	Compliance Test Language
DGWIG	Defence Geospatial Information Working Group
ETS	Executable Test Suite
OWS	Open Web Services
RI	Reference Implementation
TEAM	Test Evaluation and Measurement
WMS	Web Map Service
XSLT	eXtensible Stylesheet Language Transformation

5 OWS-6 TEAM Engine Engineering Report Overview

As a principle participant in the CITE Thread of OWS-6, Northrop Grumman developed new compliance tests for the WMS 1.3 DGIWG profile and delivered a new version of the TEAM compliance Engine to the OGC. This report summarizes the development and release of TEAM 2.0. The following subjects regarding this release are included in this report.

- Achievements
- TEAM Enhancements
- Maintenance of the TEAM Engine
 - Bug Fixes
 - Regression Test Results

6 Achievements

Northrop Grumman was responsible for the development of compliance test for the DGIWG Profile of WMS 1.3. A new version of the OGC's standards compliance test tool, the TEAM Engine, was delivered in support of the CITE thread of OWS-6.

Northrop Grumman collaborated with the other participants in the CITE thread: lat-lon, who provided the reference implementation of WMS 1.3 (Christian Kiehle and Andreas Schmitz); the sponsors, NGA (Dave Wesloh) and DGIWG (Cyril Minoux); and the CITE thread lead architect, Jen Marcus (Northrop Grumman TASC).

A timeline of accomplishments throughout the OWS-6 period is summarized below.

Month, Year	Accomplishment
Oct. 2008	Chuck Morris attended the OWS-6 kickoff meeting Oct 14-15, 2008 at George Mason University. Chuck met with other participants agreed on a tentative schedule for the project. A draft of abstract test suite cases was prepared. A set of questions on the profile were sent to Cyril Minoux.
Nov. 2008	The abstract test suite (ATS) for the WMS DGIWG profile was completed and distributed, pending review and resolution to remaining questions. Test data was published and implementation of the test cases began development. Answers to questions and revisions to the profile from DGIWG were reviewed.
Dec. 2008	The first phase of WMS 1.3 executable tests containing time and vector elevation tests for WMS 1.3.0 were delivered and were tested by lat-lon. A draft change request for the WMS 1.3 specification (07-013r1) abstract test suite (ATS) and WMS DGIWG profile ATS (08-207) were published for review.
Jan. 2009	A package of the DGIWG profile tests were delivered for testing. After testing, some fixes were made to the test scripts and image parser application. Initial feedback was received from lat-lon. Northrop Grumman released TEAM 2.0 and assisted the OGC in installation on a beta test site. We received changes to the DGIWG profile abstract test suite from review and adapted the tests accordingly.
Feb. 2009	We received feedback on the WMS DGIWG profile abstract test suite from two people and made revisions to the implementation of the second phase of tests.

Month, Year	Accomplishment
Mar. 2009	Chuck Morris and Faheem Aziz completed the DGIWG web interface, executable tests, and test data in order to publish the updated WMS 1.3 test suite. The TEAM Engine and DGIWG Profile test was delivered to OGC for on-line testing. The DGIWG profile test and reference implementation began a beta test period on 9 Mar. Chuck Morris submitted a change request for WMS 1.3 to clarify how intervals in dimension values are handled (CR 1, 09-070). Jim Ressler submitted a change request to CTL (06-126r2) to reflect changes in TEAM 2.0 and progress the document from a discussion paper to a best practice. The DGIWG Profile, CTL and TEAM 2.0 were presented to the CITE TC meetings on 30-31 Mar in Athens.
Apr. 2009	The beta test period for the WMS DGIWG profile was completed and we prepared a final installed version of the TEAM engine, DGIWG profile compliance tests, test overview and ATS. We delivered ATS change requests for WMS 1.3 (# 07-013r1) and a pending document for the DGIWG Profile of WMS 1.3 (# 08-207). The video recordings demonstrating the DGIWG profile were completed and given to the OWS-6 thread architects. We prepared to participate in the OWS-6 webinar on 29 April, but it was canceled by the OGC.
May 2009	Delivered this report.

Deliverable Status

We completed the following deliverables for the CITE thread.

Work Item	Type	Milestone	Note
WMS 1.3 Change Request	Report	Final: April 17, 2009	Completed March 2009
WMS 1.3 DGIWG Profile ATS Change Request	Report	Final: April 17, 2009	Completed Apr 17

Work Item	Type	Milestone	Note
WMS 1.3 DGIWG Profile ATS & ETS	Test Script	Draft: January 16, 2009 Phase 2 ETS: Mar 6, 2009 (revised)	Phase 1 ETS provided, Phase 2 completed Completed Apr 17
Enhance GUI and Engine to allow for profile testing	Software	Draft: January 13, 2009	Complete, profile enhancement available in TEAM 2.0
Maintenance	Software	Draft: January 16, 2009	TEAM 2.0 with DGIWG profile completed, documented in this report

7 TEAM Enhancements

The OGC Compliance Test for OWS-6 delivered the enhancements in Table 1 to the TEAM engine in version 2.0.

Table 1: TEAM 2.0 Enhancement Summary

USER INTERFACE ENHANCEMENTS	<ul style="list-style-type: none"> Redesigned welcome page Changed create test sessions page to allow selecting test suites (including revisions) from drop-down boxes. Redesigned results page Modified form behavior so following a link on a form brings up a popup window.
TEST PERFORMANCE	<ul style="list-style-type: none"> Allocate memory dynamically for faster test execution
TEST DESIGN	<ul style="list-style-type: none"> Pass parameters to start test case for modularity
PROFILE MANAGEMENT	<ul style="list-style-type: none"> Develop capability to test web service profiles/subset of full specification Develop capability to manage profiles
IMAGE PARSER ENHANCEMENTS	<ul style="list-style-type: none"> Allow configuration on initialization Added support for reading image metadata Added support for reading images that contain multiple frames (animated) images and return image metadata
IMPROVE XINCLUDE SUPPORT	<ul style="list-style-type: none"> Fixed view source link of test code to work with CTL with xinclude Internally use Saxon xinclude
IMPROVE SESSION HANDLING	<ul style="list-style-type: none"> Create an integrated "email session results" option
SCRIPTING ENHANCEMENTS	<ul style="list-style-type: none"> Support uploading files in forms Allow setting custom headers on HTTP requests Improved the XMLValidatingParser to support validating against DTDs as well as XML Schemas Add MixParamCase and MixParamOrder attributes to request instruction

The performance improvement to TEAM was a major enhancement, and required rewriting large portions of the core TEAM Engine code. The new version is more responsive to the needs of test developers and test execution. The design of a major

performance enhancement of TEAM Engine implemented in TEAM 2.0 is shown in Figure 1.

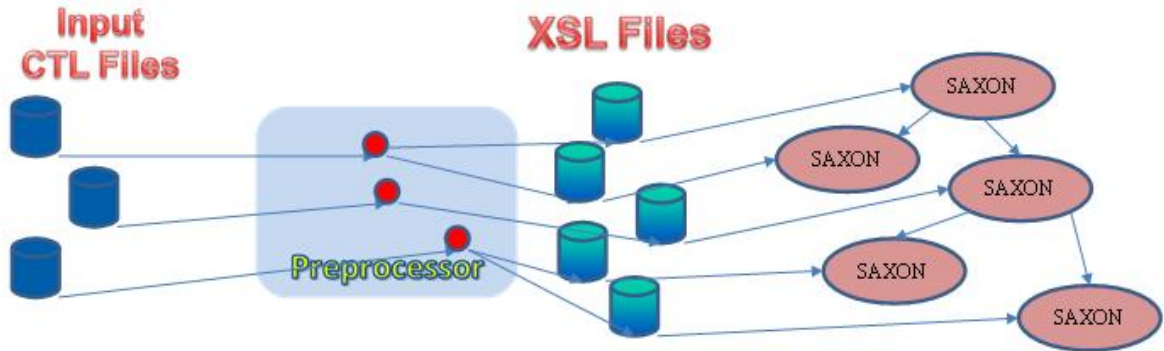


Figure 1: TEAM Engine Processing

TEAM Engine processes test scripts that are divided for optimum performance. Test scripts are written in CTL and each input CTL file is converted into a series of XSL files that can be interpreted by the Saxon XSL interpreter. The XSL generated for the starting test is executed in an instance of Saxon. Each test may call subtests, at which point a new instance of Saxon is created and the XSL for generated for the subtest is executed. This approach conserves memory and increases parallelization of test execution.

Figure 2 shows a sequence diagram showing the execution process in greater detail.

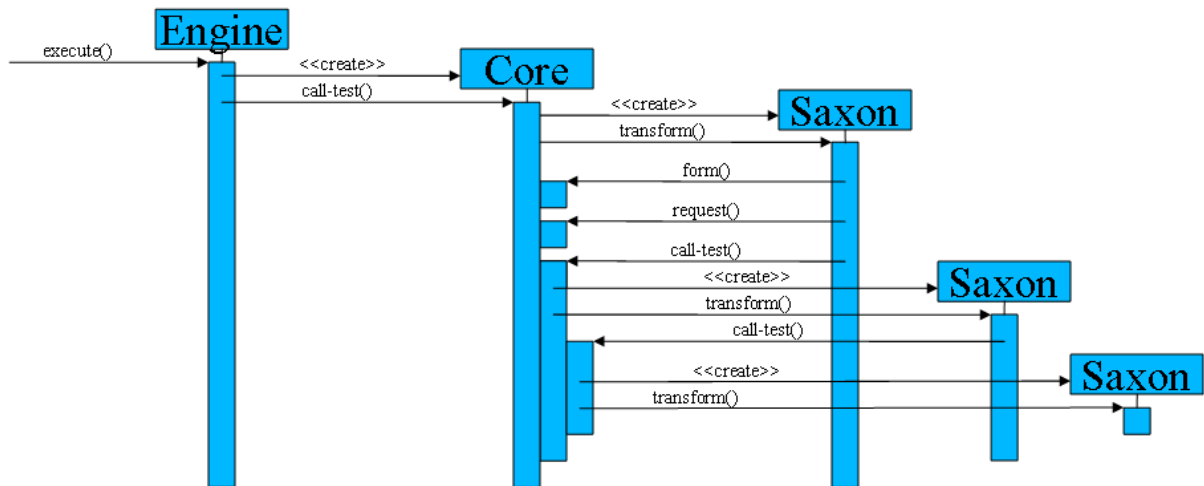


Figure 2: TEAM Engine Sequence Diagram

The execution process starts with the execute method in the Engine class. It creates an instance of the Core class, and starts the root test with its call-test method. The call-test method in Core creates an instance of the Saxon interpreter and starts the session by executing the XSL for the root test with the transform method. The XSL that is executed may contain calls to other methods in the Core class. The methods shown here are form (displays a form and retrieves input from the user), request (submits a web service

request and returns the results), and call-test. The call-test method creates a new instance of Saxon and uses it to execute the XSL for a subtest.

The other major enhancement to TEAM 2.0 supported testing Implementation Profiles that are an extension of a baseline compliance test. The structure of the Compliance Test Language (CTL) was enhanced to include the ability to test standards profiles. As shown in Figure 3, a profile is an encapsulation of tests that are part of an overall test suite. The use of profiles enables standards to be tailored to a particular user community to extend a base test suite to meet specific requirements. A new version of CTL including profiles was written for submittal in March, 2009. OGC document 06-126r2, CTL v. 0.6, was adopted as an OGC Best Practice. CTL section 8.2 contains more information and a code example of profiles.

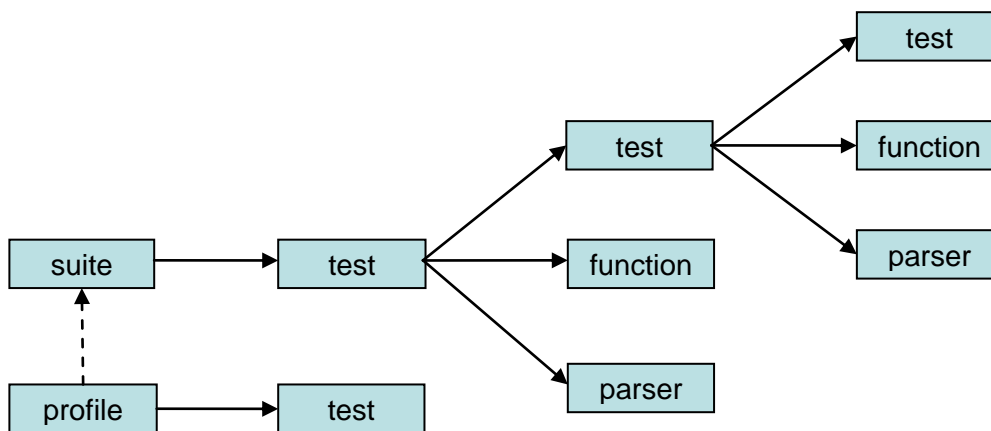


Figure 3: CTL Structure

In TEAM, the User Controls what baseline test and profile is used in a session and the Test Results are reported from base and profile separately. An example of profile selection and profile test results in the TEAM 2.0 web interface is depicted in Figure 4.

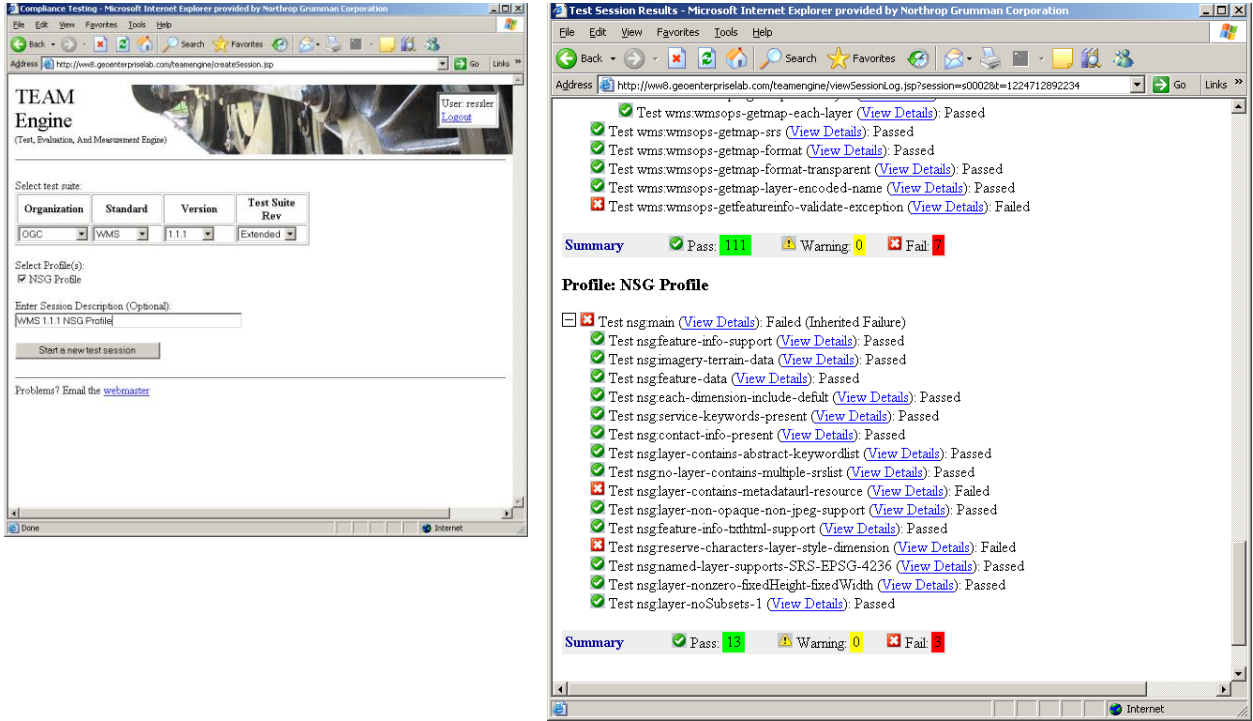


Figure 4: Profile Test in TEAM 2.0

8 Maintenance of the TEAM Engine

8.1 TEAM Fixes

The discrepancy (bug) fixes to TEAM Engine implemented in OWS-6 and prior were delivered in TEAM Version 2.0. The most significant and documented fixes are summarized in Table 2.

Table 2: TEAM Engine Maintenance Fixes in release 2.0

Email / Issue Tracker # / Date	Title	Tests / Services Affected	Originator	Resolution
Email / 2009-04-29	WFS-T test error	WFS 1.0.0	ERDAS	Modified OpenGroup to CTL translator and generated new WFS 1.0.0 test scripts
Email / 2008-02-26	HTTP zero length status	WMS 1.3	Fitzgerald, J.	Bug fix in HTTPParser.java
Email / 2009-04	Time function	WFS 1.1.0 NSG Profile	Aziz, F.	Fixed bug in call-function instruction

Email / Issue Tracker # / Date	Title	Tests / Services Affected	Originator	Resolution
Email / 2009-05-04	Java long data type	All	Aziz, F.	Fixed bug in TECore.java
Self discovered / 2008	Conflicting schemas for WFS	WSF 1.1.0 and any other service	Morris, C.	TEAM allows multiple scripts to be installed even if they reference conflicting schema resources
Self discovered / 2008	WFS Xinclude error	WFS 1.1.0	Morris, C.	Change test script build process for WFS
OWS-6 / 2009-01-27	Fixed a bug in the TEAM Engine code for viewing script listings	All	Morris, C.	Rewrote script listing code

8.2 Regression Test Results

As part of the release process for TEAM Engine, Northrop Grumman conducted regression tests of the major release of TEAM against the baseline compliance tests. The goal of the regression testing is to insure the new release of TEAM is backwards compatible and it doesn't introduce problems to the OGC's compliance testing and certification program. The regression testing is performed with the OGC's official reference implementation for each standard.

TEAM 1.0 is the previous version of the TEAM engine, which is the version used in OGC's production compliance tests¹ and was used in OWS-5 beta tests. The results of testing the reference implementations of TEAM 1.0 compared with TEAM 2.0 engine are in **Table 3**. The test result is the number of assertions passed over the total number of assertions in the baseline compliance test. The goal of TEAM regression test is to meet or exceed the previous level of successful assertions. The test scripts used in the regression test were the latest baseline tests available, some of which are still considered Beta because they have not been officially released by OGC. The (Beta) version of compliance test are from the OGC's TEAM 2.0 beta test site², which either await three implementations to pass the test (such as SOS, SPS) or a fix to the test suite was made and await the beta test period to be completed before moving to production.

¹ <http://cite.openegeospatial.org/teamengine/>

² <http://cite.openegeospatial.org/te2/>

Table 3: Regression Test Results

Spec	Version	Test Script Version	Reference Implementation	TEAM 1.0 Result	TEAM 2.0 Result
WMS	1.1.1	A (Beta)	deegree-wms_v2_1	98 / 98	98 / 98
WMS	1.3	A	deegree-wms_v2_1	220 / 220	220 / 220
WFS	1.0.0	B	N/A (unique test data)	not tested	lat/lon reported success
WFS	1.1	B	geoserver-1.7.0-beta1	500 / 604	500 / 605
WFS	1.1	D (Beta)	geoserver-1.7.0-beta1	521 / 632	517 / 632
WFS	1.2	not in OGC baseline	Not Available	-	-
WCS	1.0	A (Beta)	deegree 2.1	79 / 83	79 / 83
WCS	1.1.1	A (Beta)	geoserver-1.7.0-beta1	157 / 157	157 / 157
WMC	1.1.0	A	http://schemas.opengis.net/context/1.1.0/context.xml	12/27	12/27
CS/W	2.0.1	A	Not Available	-	-
CS/W	2.0.2	A (Beta)	geonetwork-csw-2.0.2	69 / 103	69 / 103
SOS	1.0	A (Beta)	52N-SOS-3.0.1	54 / 54	54 / 54
SPS	1.0	A (Beta)	52N-swe-sps-1.0.0	23 / 36	23 / 36

All results are the same except for a few discrepancies in the WFS 1.1 Rev D test suite. Tests wfs:GetGmlObject-POST-XML-4, wfs:GetGmlObject-POST-XML-5, and their subtests passed in TEAM 1.0 but fail in TEAM 2.0. The four failed WFS 1.1 tests involve schematron validation for WFS results. The correct test result is failure as reported by TEAM 2.0.

9 Lessons Learned

The following lessons learned came from the OWS-6 CITE project.

1. The testing of externally created profiles that are not OGC standards is inconsistent with the OGC's compliance certification processes. Service developers are unsure whether the profile and compliance are required for the existing standards and tests. The OGC should either establish a method to

- incorporate these profiles into the OGC baseline or set-up a parallel compliance test for other organizations, along with a policy regarding certification of externally created profiles.
2. As the regression test results indicate, many reference implementations are less than 100% compliant to the OGC standards. Configuration and maintenance of reference implementations is one cause of non-compliance. After the OWS initiative is completed, the compliant configuration is often not captured completely and maintained in a compliant state. After the beta test period is completed, the reference implementation and compliance test should be tested by the OGC or an independent party. This test should install the reference implementation, configure, test and verify 100% compliance to the beta compliance test. The OGC should resolve any discrepancies with either the RI developer or the compliance test author before completion of the OWS initiative. The post-beta test period and required support should be planned in future OWS initiatives. After the OWS initiative is completed, the reference implementation should be maintained in a compliant state by the OGC or OGC member for future regression testing.
 3. Tracking and Resolution of bugs with the test scripts and TEAM Engine has increased in frequency and complexity. The current means of tracking problems with compliance tests uses multiple means of communication (CITE portal, public forum, CITE email lists, direct email). This multiplicity makes it difficult to determine the status of each problem, the assessment, and resolution of the problem. Providing member's access to problem assessments and resolution would save time in problem investigation and avoid recurrence of the same problem. A single collaborative issue tracking system for all sources of compliance problems is critical to the continued maintenance of test scripts, TEAM to successfully sustain the OGC's certification program.

10 Recommendations for future work

As a result of our development of TEAM and participation in the OWS-6 CITE thread, Northrop Grumman recommends the following work items be addressed in the next phases of CITE.

Update Test Scripts

1. To evaluate the effectiveness of modular requirements specifications into composition of conformance test scripts, develop a compliance test following modular conformance tests defined in the new OGC specification model (08-131r1). The following test case is recommended.
 - a) OWS-5 OGC WFS core and extensions (08-079) is a good candidate as it adheres to the model.

- b) A specification for WFS following this model has been published as a discussion paper (08-079). This will guide the implementation of the specification model as OGC implements it and reformulates OWS common.
2. Modify an existing compliance test to include SOAP interface while utilizing the SOAP header tags in added recently to CTL and enhanced in TEAM engine by Intecs for the ESA ERGO project.
 - a) CSW 2.0.2 is a candidate because ESA has already developed a compliance test that uses SOAP for the Earth Observation profile of CSW

TEAM Engine Enhancements

1. Enhance TEAM engine to support modular conformance test specification (#1 above).
2. Store the test script version, profile selection, and options selected in the test log for reference. This information should be documented with the certification of services for reference by users of the service.
3. The compliance test logs should be linked to the OGC certification. TEAM should allow the user to publish the test result summary so the OGC can link the test logs as HTML documents. This allows users of the service and the OGC to investigate how the compliant service performed when tested against any assertion.