Conformance Assertions, Test Scenarios, Test Cases, Conformity Assessment Report, …
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Overview: Three ‘Levels’

DICOM Standard Architecture
• Linking assertions to the standard is essential for reasons of traceability and to prevent dangling assertions, test scenarios, and test cases.
• Assertions do not mention the role of the system (SCU or SCP), as that would be unnecessary duplication. The role of the system is a parameter of the scenario. Open issue: what mechanism?
• Clustering of Assertions, Test Scenarios and Test Cases should also be facilitated. For instance, one should be able to point to all storage related scenarios. Open issue: what mechanism?
Extending the contents, defining / identifying new elements, can be done **top-down**, e.g. when creating a new supplement, **middle-out**, e.g. when a field issue points to a yet unrecognized scenario, or **bottom-up**, e.g. bringing in a yet unhandled failure situation.
Overview: Physical Test Cases

- **Test Scenario**
  - **Logical Test Case**
    - **Assertion**
      - **DICOM Conformance Statement**
        - **Product specification**
          - **Role**
            - **filter**
              - **All in DICOM**
                - **Test Scenario**
                  - **Logical Test Case**
                    - **Parameter**
                      - **Instantiate**
                        - **Verify storage of CT object**

- **Product specific**
• **Approach is to create an annex for each part in which the assertions are described**
  – **Open issue**: do we specify these in annexes of existing parts, as a separate part, or as a separate document, or also as a separate document generated out of the annexes (requires tools), …

• **Requires changes in**
  – **PS3.1 – Introduction and Overview**
    ▪ Additions to section 6.2 Conformance
  – **PS3.2 – Conformance**
    ▪ Rewrite of section 7 Conformance Requirements
  – …
‒ …
‒ **PS3.8 – Network Communication Support for Message Exchange**
  • **Add annex X – Assertions**
  • Lists the assertions of the message exchange for network communication support
  • **Open issue: what level of detail is required?**
    – **Example, association behavior**
      » The system shall be able to send the applicable max PDU size it supports and stay within the limit of the max PDU size communicated by the peer.
      » A-ABORT shall close the connection and end the application service. After this the system shall be in the initial state.
    – **Example, application behavior**
      » The system shall be able to handle a single store request.
      » The system shall be able to handle the failure of a Store request.
  • **Open issue: assertion syntax (The system shall …)**
    » Assertions are *not* conditional based on what the system can do; that is filtering / instantiating.

‒ …
– ... 
– **PS3.7 – Message Exchange**
  - Add annex X – Assertions
    - Lists the assertions of the application level services when based on networking services
– **PS3.10 – Media Storage and File Format for Media Interchange**
  - Add annex X – Assertions
    - Lists the assertions of the application level services when based on file services
– **PS3.18 – Web Services**
  - Add annex X – Assertions
    - Lists the assertions of the exchange and application level services when based on web services
– ...
- ... 
- **PS3.4 – Service Class Specifications**
  - Add annex X – Assertions
    - Lists the assertions of the service classes 
- **PS3.3 – Information Object Definitions**
  - Add annex X – Assertions
    - List the assertions of information object definitions
    - **Open issue**: how to specify this? Simply have the assertion that an IOD needs to comply to the structure defined in the specific IOD table? Is that sufficient?
- ...
Test Scenarios

• Approach is to list all possible test scenarios, based on application service, role, and exchange service, e.g.
  – Verify that the system is able to perform a store operation. [As SCP, using Networking Communication Services]
  – Verify that the system can handle store requests for different SOP classes in one series. [same parameters as above]

• Requires change in PS3.2
  – Add section 8 Test Scenarios
  – Open Issue: do we want to have scenarios in the standard, or in a separate document? The latter might ease the CP process.

• Open issue: Is this sufficient? Do we also need to take into consideration transfer syntaxes, character sets, …
  – Or are these also parameters of the test scenarios?
Test Scenario Examples

• Store
  – Assertion
    ▪ The system shall be able to execute a network store operation.
  – Test Scenario$_1$ [SCP, Network Communication Services]
    ▪ Verify that the system is able to perform a store operation.
  – Test Scenario$_2$ [SCP, Network Communication Services]
    ▪ Verify that the system is able to perform store with various transfer syntaxes.
  – Test Scenario$_n$ [SCP, Network Communication Services]
    ▪ Verify that the system can handle a store operation which is performed with a different transfer syntax than the one that was negotiated.
    • Open issue: is “handle” the right way of wording this? In short, the system should return to the initial state.
• Approach is to give, per test scenario, the cases that need to be verified, e.g.
  – Duplicate image storage
  – Storage with wrong system type
• Requires change in PS3.2:
  – Add section 9 Test Cases

• Open issues
  – Do we want the test cases included in the DICOM Standard?
    ▪ Preferably outside DICOM Standard because of Change Management reasons – speed of changes (What change process do we want?)
  – Identification of the test case, step-wise description, …
Verify that the system is able to handle the storage of an object. [SCP, Networking Communication Services]

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Expected Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initiate the DICOM Storage request for an object to SUT which is encoded with Master SOP Class and configured Transfer Syntax</td>
<td>SUT shall send C-STORE-RSP message with Status=success (0x0000).</td>
</tr>
<tr>
<td>2</td>
<td>Refresh to observe on SUT’s Patient Directory for the single object received.</td>
<td>SUT shall display the single object with applicable Patient Name in the Patient Directory.</td>
</tr>
<tr>
<td>3</td>
<td>If SUT has viewing capability, load the object received to viewer.</td>
<td>SUT shall display the received object in the viewer which shall match with the reference screenshot of test data.</td>
</tr>
</tbody>
</table>

Note that this is an example of the format, not necessarily with approved test approach.
Given a DICOM Conformance Statement, how to select the applicable test cases?

- Requires change in PS3.2
  - Add section 10 Assessing the Conformance Claim
- Should be straightforward, and could, in principle, be (semi)automatic
  - Filtering based on claim
  - Instantiation based on claim
- A sub-selection of physical test cases that will be executed may be created, e.g. when performing regression testing
  - This is out of scope, as this is a procedural aspect (QMS)
• Provide a standard way of reporting the conformity assessment
  – Based on the selected test cases, a template can be created /
generated in which the results of the tests are captured
    ▪ May also list the test scenarios
  – It should also be possible to report on regression testing,
    with reference to earlier conformity assessment report
  – Also machine readable, as to facilitate the easy comparison
    of the (machine readable) DICOM Conformance Statement
    and the Conformity Assessment Report

• Requires change in PS3.2
  – Add section 11 Conformity Assessment Report
– Do we require that assertions are added during the development of new supplements?
  ▪ Advantages: testability, no back-log, …
  ▪ Disadvantages: extra barrier for new supplement, too early in process

– Same question as above for test scenarios and test cases.
Open issues

- What mechanism to use for test scenario parameters?
- How to cluster related test scenarios (e.g. all store related ones)?
- Where in the standard are assertions described?
- What level of detail is required for the description of an assertion?
- What syntax do we use for assertions?
- How to specify assertions for IODs?
- Where do we want to specify the test scenarios?
- Is listing the test scenarios sufficient?
- How are character sets and transfer syntaxes taken into account with test cases?
- Is ‘handling’ the right terminology for exceptional behavior?
- Do we want to have the test cases in the standard?
- Do we require that assertions are added during the development of new supplements?
  - Same question for test scenarios and test cases.
Part 2
Can we learn from OASIS?

- Test Assertions Guidelines
- Test Assertions Model
- Test Assertions Markup Language
- Conformance testing and Certification Framework
- Conformance Requirements for Specifications
- Guidelines to Writing Conformance Clauses for OASIS Specifications
- …
A statement in the Conformance section of a specification that provides a high-level description of what is required for an artifact to conform. The conformance clause may, in turn, refer to other parts of the specification for details. A conformance clause must reference one or more normative statements, directly or indirectly, and may refer to another conformance clause. [OASIS Test Assertion Guidelines]

A statement in a specification that lists all the criteria that must be satisfied by an implementation (data artifact or processor) in order to conform to the specification. The clause refers to a set of normative statements and other parts of the specification for details. [OASIS Test Assertions Model]

Of the previously presented model Assertions are in line with these.
A statement made in the body of a specification that defines prescriptive properties of an implementation, or requirements about it. The prescription level is reflected by the use of normative keywords such as in [RFC 2119] or [ISO/IEC Directives]. [OASIS Test Assertions Guidelines] Also known as Normative Requirement.

Both the normative statements and the conformance clauses are part of the specification.
- Suggests that this is a viable approach for DICOM too.
OASIS Definition
Test Assertion

• A testable expression for evaluating the adherence of part of an implementation to a normative requirement statement in a specification. A test assertion describes the expected output or behavior for the test assertion target within specific operation conditions, in a way that can be measured or tested. [OASIS Test Assertions Guidelines]

• Would match with Test Scenario of the previously presented model.
OASIS Test Assertion Structure

Test Assertion
- Test Assertion ID
- Normative Source
- Target
- Predicate
- Prescription level
- Prerequisite

Specification
- Normative statement

[caption]
[piece of] an Implementation of the Specification

tATEGORIES
refers to
expresses
indicates how Imperative
qualifies the Target for
A set of test tools, software or files (data, programs, scripts, or instructions for manual operations) that verifies the adherence of a test assertion target to one or more normative statements in the specification. Typically a test case is derived from one or more test assertions. Each test case includes: (1) a description of the test purpose (what is being tested – the conditions / requirements / capabilities which are to be addressed by a particular test), (2) the pass/fail criteria, (3) traceability information to the verified normative statements, either as a reference to a test assertion, or as a direct reference to the normative statement. [OASIS Test Assertions Guidelines]
Mapping of Terminology

<table>
<thead>
<tr>
<th>Unit in model as used before</th>
<th>Unit in OASIS model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assertion</td>
<td>Conformance Clause</td>
</tr>
<tr>
<td>Test Scenario</td>
<td>Test Assertion</td>
</tr>
<tr>
<td>Test Case</td>
<td>Test Case</td>
</tr>
</tbody>
</table>

Mapping is reasonably easy. No issue to adopt another terminology, e.g. OASIS’.

Now what about the relations?
A set of test assertions may be associated with a conformance clause in order to define more precisely what conformance entails for a candidate implementation. [OTAG]
Proposition for Way Forward with this Supplement

- Create a model of everything that relates to DICOM Conformance (base on existing standards)
  - When agreed upon, we have a solid base, which can be documented in Part 2.
  - Although agreement may take a while, it will lead to good discussions and deeper understanding
  - Model defines items and their respective relationship
DICOM Model of Conformance

Items

- Conformance Clause
- Normative Statement
- Normative Source
- Test Assertion
- Test Suite
- Test Case (Logical and Physical)
- Test Parameter
- Unit of Conformance
- DICOM Conformance Statement
- DICOM release / edition
- Product release
- Selection of test cases (filtering/instantiation)
- Prerequisite
- Prescription Level
- …
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• Create examples for the main items of this model
  – Conformance Clauses and Test Assertions for DIMSE Store and QIDO
  – These examples will help to validate DICOM Conformance Model