Digital Imaging and Communications in Medicine (DICOM)

Supplement 246: DICOMweb Modality Services

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# Document History

|  |  |  |  |
| --- | --- | --- | --- |
| 2024.08 | Version 00 | JM, DK | Initial version with proposed document structure and content. |
| 2024.11 | Version 01 | JM, DK | Second version with alternative approach included. |
|  |  |  |  |

# Open Issues

|  |  |
| --- | --- |
| 1 | **Context:** Work Item 2023-10-C states “Add the Modality Worklist and the Modality Performed Procedure Step services to DICOMweb, in principle based on the existing DICOMweb Worklist service (UPS-RS; see [PS3.18, section 11](https://dicom.nema.org/medical/dicom/current/output/html/part18.html#chapter_11)). This would boil down to creating an informative annex and any normative changes needed if gaps are discovered.”  **Issue**: With this statement (creating an informative annex on the mapping and add applicable normative corrections) interoperability is not served, as informative text would give only *a* way of doing the mapping from DIMSE MWL and MPPS to UPS-RS, and other ways for achieving the same would be equally valid.  **Proposal**: Create (mostly) normative text. This way, there would be only one vetted way of doing this mapping, and interoperability would be served. In this, it is proposed to have a section on Modality Services where the high-level structure of other sections in PS3.18 (sections 9-13) is followed as much as possible, to simplify the process of understanding for the reader.  **Decision**: [WGxx: YYYY-MM-DD] None yet. [WG06: 2024-08-22] Create it now as if it is normative. If we later conclude that it is not fitting normative, we can change it back to informative. It might the case that it can be done in an interleaved way in PS3.18, section 11, or it can be done in a separate section in PS3.18 with references to section 11. |
| 2 | **Context**: In DIMSE MPPS notifications do not require subscription and can be unsolicited, while the DICOMweb Worklist Service manages notifications by using subscriptions.  **Issue**: One cannot map between these two different kinds of mechanisms.  **Proposal**: Circumvent it the way it has been done for UPS and UPS-RS.  Next to taking the same approach, it would benefit the reader to elaborate on why this is done this way, as to take him or her along.  **Decision**: [WGxx: YYYY-MM-DD] None yet. |
| 3 | **Context**:MPPS notifications can only indicate state changes, see [PS3.4, F.9.2](https://dicom.nema.org/medical/dicom/current/output/chtml/part04/sect_F.9.2.html), while UPS (-RS) notifications allow for many more aspects to be reported on, see [PS3.4, CC.2.4](https://dicom.nema.org/medical/dicom/current/output/chtml/part04/sect_CC.2.4.html).  **Issue**: Due to the difference in what can be reported, it is not possible to make a two-way mapping; therefore, it is impossible to define bi-directional proxies. It is, for instance, not possible to have a UPS-RS origin server notify an MPPS SCU about newly added performed procedure steps, even with a proxy, as such an update does not involve a state change as defined for MPPS.  **Proposal**: Limit the kinds of supported notifications for the DICOMweb Modality Services to actual state changes. These can be mapped back and forth, so it is in principle possible to define bi-directional proxies for such (limited) notifications.  **Decision**: [WGxx: YYYY-MM-DD] None yet. |
| 4 | **Context**: The notified parties of the MPPS notification service as specified in [PS3.4, F.9](https://dicom.nema.org/medical/dicom/current/output/chtml/part04/sect_F.9.html).  **Issue**: This service does not specify how the MPPS Notification SCP knows what SCUs to notify on MPPS changes.  **Proposal**: Do not change the current way this behavior is specified; just add one or more notes to make clear that this aspect is something beyond the standard, and that a conceivable way to achieve this would be configuring the SCP with the SCUs to be notified.  Note that a consequence of this proposal is that Modality Services cannot specify the exact mapping from and to UPS-RS in this respect.  **Decision**: [WGxx: YYYY-MM-DD] None yet. |
| 5 | **Context**: The DIMSE modality services MWL and MPPS distinguish between workitems and modality performed procedure steps; UPS-RS models workitems as the union of a scheduled procedure step and a performed procedure step.  **Issue**: To be able to map DIMSE information onto DICOMweb information, it needs to be completely clear how a matching/corresponding UPS-RS workitem can be uniquely identified based on information in the MWL workitem.  **Proposal**: The applicable workitem can be uniquely identified by Study Instance UID, Accession Number, Requested Procedure ID, and Scheduled Procedure Step ID.  **Decision**: [WGxx: YYYY-MM-DD] None yet. |
| 6 | **Context**: Discontinue /Cancellation of Workitems.  **Issue**: UPS-RS knows about cancellation of Workitems, while MWL does not. There is the notion of discontinuing performed procedure steps, but that will not cancel a workitem.  **Proposal**: None yet. 1. Cancellation is a request, but not a guarantee. 2. Discontinue is equivalent performer-based cancellation, not the same as external based cancellation. 3. Diagrams for discussion are needed. 4. See PS3.17, Annex GGG (examples).  **Decision**:[WGxx: YYYY-MM-DD] None yet. |
| 7 | **Context:** Multiplicity of relations between scheduled and performed procedure steps  **Issue:** MWL and MPPS may relate between scheduled and performed procedure steps in an m:n multiplicity (for instance due to the append and group cases), while UPS only allows for 1:1 relations. This makes it ‘impossible’ to map between these two models.  **Proposal:** None yet. See earlier email; take proper examples/use cases (limit to what is used, instead of doing all). Another approach: do MWL/MPPS in DICOMweb not based on UPS-RS.  **Decision:** [WGxx: YYYY-MM-DD] None yet. |
| 8 | Context: All MWLs are HL7 v2.  Issue: What does FHIR change, if anything? ImagingServiceRequest is being worked on.  Proposal:  Decision: |

# Closed Issues

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# Scope and Field of Application

The DICOMweb Modality Services are an extension to the existing DICOMweb services, mimicking the Modality Worklist (MWL) and Modality Performed Procedure Step (MPPS) services that are already available in DIMSE. It has been designed with the intention of facilitating proxies from/to DIMSE to/from DICOMweb Modality Services.

This supplement describes the way to perform modality services MWL and MPPS based on DICOMweb’s UPS-RS.

**Changes to NEMA Standards Publications PS 3.18**

Add new section X Modality Services and Resources

# X Modality Services and Resources

## X.1 Overview

The Modality Services provide modality-oriented workflow management for user agents. These services correspond to the DIMSE Modality Worklist (MWL) and Modality Performed Procedure Step (MPPS) services as defined in Annexes K and F of PS3.4 respectively and have – where possible – the same semantics.

The Modality Services do not define their own resources but apply the Worklist Service as defined in Section 11. In effect, this defines a mapping from the MWL and MPPS services to the UPS-RS service. Sections B.xx-B.yy show examples of how mapping could be done using proxies.

### X.1.2 Scenarios (Informative)

The scope of the modality services is the management of acquisition modality-oriented workflows. While the Modality Services are not restricted to the scenarios identified in this section, these give a general impression of what can and is meant to be achieved using these services.

#### X.1.2.1 Scheduled Acquisition Workflow

In this workflow, the acquisition modality will query a worklist provider for workitems, each elaborating on what procedure step has been scheduled to perform. The operator of the acquisition modality will select the appropriate workitem and will perform acquisition according to that scheduled procedure step. The acquisition modality will notify the worklist provider when the acquisition of images, waveforms, etc. is starting. It will continue to update the worklist provider on the workitem during the acquisition process until it is done, after which it will mark the workitem as completed.

Figure X.1.2.1-1 shows typical interaction of an acquisition modality with a worklist provider in the context of a scheduled acquisition workflow.

Figure X.1.2.1-1. Typical Worklist Provider Interaction in a Scheduled Acquisition Workflow (Informative)

A screenshot of a computer

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#### X.1.2.2 Encounter-Based Acquisition Workflow

While the scheduled acquisition workflow as described in section X.1.2.1 always starts with a workitem including a description of what has been scheduled to be performed, an encounter-based imaging workflow does not have that; acquisition is performed ad-hoc. Hence, when it is wanted to properly record the performed procedure step(s), a workitem needs to be created, after which that workitem can be updated with the applicable information, even in one go, and the worklist provider can be told acquisition for the newly created workitem is done.

Figure X.1.2.2-1 shows typical interaction of an acquisition modality with a worklist provider in the context of an encounter-based acquisition workflow. ~~Here too, as in the scheduled acquisition workflow, the modality would typically play the role of the user agent, while the worklist provider would be the origin server.~~

Figure X.1.2.2-1. Typical Worklist Provider Interaction in an Encounter-Based Acquisition Workflow (Informative)

A diagram of a workflow

Description automatically generated

Naturally, it is also possible to update the created workitem per series instead of in one go.

Add 1:n workflow example.

#### X.1.2.3 Acquisition Workflow Monitoring

When there is a worklist provider serving several acquisition modalities, it can be imagined that there is a need to have an overview of what acquisition is to be performed and what acquisition has been performed in a dashboard fashion. Instead of polling, such a dashboard would need to be notified of events like workitem creation, update, and finalization.

Figure X.1.2.3-1 shows typical interaction of a worklist provider with acquisition modalities and an acquisition workflow dashboard in the context of acquisition workflow monitoring, where each action on a workitem is shown as an update abstractly. ~~Here the modalities and the dashboard would typically play the role of user agents, while the worklist provider would be the origin server.~~

Figure X.1.2.3-1. Typical Worklist Provider Interaction for Acquisition Workflow Monitoring (Informative)

A diagram of a project

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#### X.1.2.4 Reviewing Workflow

A worklist provider could be responsible for maintaining data related to performed procedure steps. A PACS reviewing workstation may need to display the images for any study viewed. For the PACS to link the images to the study, it may receive a notification whenever a procedure step has been performed. When the PACS receives this notification, it may link the images and the performed procedure step to the study within its internal database or may choose to take no action.

Figure X.1.2.4-1 shows typical interaction of a worklist provider with a PACS in the context of reviewing. In such a configuration the worklist provider is the origin server and the PACS is the user agent.

Figure X.1.2.4-1. Typical Worklist Provider Interaction for Storage and Reviewing Workflow (Informative)

A diagram of a workflow

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### X.1.3 Concepts

There are several conceptual differences between the DIMSE services that are mirrored by the Modality Services and the Worklist Service that is used to supply the Modality Services. These differences are elaborated on below.

#### X.1.3.1 Entities

The DIMSE MWL and MPPS services distinguish between two kinds of entities, namely Worklists (with Workitems, each denoting a Modality Scheduled Procedure Step) and Modality Performed Procedure Steps. Here, Workitems are merely the input of the acquisition process, and Modality Performed Procedure Steps represent the log of what has been done at the modality. The DICOMweb Worklist Service only knows about Workitems, where progress – the non-empty set of performed procedure steps – is an integral part of a Workitem.

An important consequence of using DIMSE MWL and MPPS is that SCUs must copy applicable information from a Workitem to related Modality Performed Procedure Steps, that also need to be created. Using the DICOMweb Worklist Service this is not needed, as all applicable information is present in one object: the Workitem.

There may, however, be differences in the creation of objects depending on the workflow. In the scheduled acquisition workflow as sketched before, there is no need that the acquisition modality creates a Workitem, while the encounter-based acquisition workflow requires such creation, also when utilizing the Worklist Service.

#### X.1.3.2 Notification

While the DIMSE MPPS service utilizes the SCP initiated N-EVENT-REPORT for unsolicited state change notifications (PS3.4, F.9), the Worklist Service has a subscription mechanism for notifying user agents for all kinds of changes (11.10-11.11), based on WebSockets (8.10.4). Here we have three conceptual differences:

1. DIMSE makes the distinction between operations and notifications (compare for instance MPPS sections F.8.2 and F.9.2 of PS3.4) while DICOMweb’s REST interfaces only provides transactions, that can be considered equivalent in behavior to DIMSE operations, namely being client initiated. DICOMweb’s approach for notifications is that of using subscriptions, which will map to actions initiated by the origin server; see section 8.10. An example of how this is used is available in sections 11.10-11.12. Due to this conceptual difference, DIMSE notifications will be mapped to DICOMweb subscription transactions in the mapping tables below.
2. There is a possible mismatch in information, as MPPS notifications can only convey state changes, and UPS-RS notifications can convey much more, for example a newly added performed procedure step. Due to this conceptual difference, the scope of notifications for Modality Services is limited to state changes only, so a proper two-way mapping can be made.
3. In PS3.4, F.9 it is left open how the SCP knows about what SCUs are to be notified at state changes of Workitems (a possible approach to this could be having this as a configuration item of the SCP) while UPS-RS is clear about subscriptions. Due to this conceptual difference, Modality Services leaves this part of the mapping out of scope.

Note Concerning the second difference above, one should be observant regarding the terminology. Workitems – both in MPPS and UPS – have a state attribute. While MPPS only notifies about state changes when this state attribute changes, UPS notifies about all changes to a Workitem and calls this a state change. That can be confusing.

#### X.1.3.3 Discontinue versus Cancellation

To be expanded.

In the Worklist Service it is possible to cancel a workitem (with a Reason For Cancellation and a Procedure Step Discontinuation Reason Code Sequence), while in MPPS one can only discontinue a performed procedure step.

#### X.1.3.4 Relations between Scheduled and Performed Procedure Steps

To be expanded.

MWL and MPPS may relate between scheduled and performed procedure steps in an m:n multiplicity (for instance due to the append and group cases), while UPS only allows for 1:1 relations. This makes it impossible to map between these two models.

## X.2 Conformance

Origin servers conforming to the Modality Services shall support the transactions listed as Required in Table X.2-1.

Table X.2-1. Required and Optional Transactions

| Transaction | Support | Section |
| --- | --- | --- |
| Create Workitem | Required | Section X.4 |
| Claim and Prepare Workitem | Required | Section X.5 |
| Retrieve Workitem | Required | Section X.6 |
| Report Progress on Workitem | Required | Section X.7 |
| Change Workitem State | Required | Section X.8 |
| Get Applicable Workitems | Required | Section X.9 |
| Subscribe to State Changes | Required | Section X.10 |
| Unsubscribe from State Changes | Required | Section X.11 |

Implementations conforming to the Modality Services shall specify their role in their Conformance Statement (see PS3.2): origin server, user agent or both.

In addition, for each supported transaction they shall specify:

* the supported Query Parameters, including optional Attributes, if any;
* the supported DICOM Media Types;
* the supported character sets (if other than UTF-8).

An origin server conforming to the Modality Services shall implement the Retrieve Capabilities Transaction, specifying its role (see Section 8.9 and Annex H).

Implementation-specific warning and error codes shall be included in the Conformance Statement.

…

## X.3 Transaction Overview

The Modality Services consist of the transactions shown in Table X.3-1.

Table X.3-1. Modality Services Transactions

| Transaction Name | Method | Payload | | Description |
| --- | --- | --- | --- | --- |
| Request | Success Response |
| Create Workitem | POST | dataset | none | Creates a new, in progress Workitem |
| PUT | none | none |
| Claim and Prepare Workitem | PUT | none | none | Claims a Target Workitem and fills it with the initial information |
| POST | dataset | none |
| Retrieve Workitem | GET | none | dataset | Retrieves the Target Workitem |
| Report Progress on Workitem | POST | dataset | none | Updates the Target Workitem with new information |
| Change Workitem State | PUT | none | none | Changes the state of the Target Workitem |
| Get Applicable Workitems | GET | none | results | Gets applicable Target Workitems |
| Subscribe to State Changes | POST | none | none | Subscribes to state changes of a Workitem |
| Unsubscribe from State Changes | DELETE | none | none | Unsubscribes to state changes of a Workitem |

Each of the Create Workitem and the Claim and Prepare Workitem transactions consist of two methods, due to the mapping from DIMSE Services to the DICOMweb Worklist Service. Table X.3-2 shows how the Modality Services transactions are mapped from the DIMSE MWL and MPPS operations and notifications to Worklist Service transactions.

Table X.3-2. Mapping Modality Services

| MWL and MPPS | | Modality Services | Worklist Service | |
| --- | --- | --- | --- | --- |
| Create | PS3.4, F.7.2.1 | Create Workitem | Create Workitem | 11.4 |
| Change Workitem State | 11.7 |
| Claim and Prepare Workitem | Change Workitem State | 11.7 |
| Update Workitem | 11.6 |
| Get Information | PS3.4, F.8.2.1 | Retrieve Workitem | Retrieve Workitem | 11.5 |
| Set Information | PS3.4, F.7.2.2 | Report Progress on Workitem | Update Workitem | 11.6 |
| Change Workitem State | Change Workitem State | 11.7 |
| Query | PS3.4, K.4 | Get Applicable Workitems | Search | 11.9 |
| Receive Event Notification | PS3.4, F.9.2 | Subscribe to State Changes | Subscribe | 11.10 |
| Provide Event Notification | Unsubscribe from State Changes | Unsubscribe | 11.11 |

Note Table X.3-2 is to be read middle-out. For instance, the Modality Services’ Change Workitem State transaction is mapped from DIMSE’s Set Information operation to the Worklist Service’s Change Workitem State transaction, and the Modality Services’ Claim and Prepare Workitem transaction is mapped from DIMSE’s Create operation to the Worklist Service’s Change Workitem State transaction, while the Modality Services’ Subscribe to State Changes transaction is mapped from DIMSE’s Receive and Provide Event Notifications to the Worklist Service’s Subscribe transaction.

## X.4 Create Workitem Transaction

### X.4.1 Request

See 11.4.1 and 11.7.1.

The Workitem contained in the payload is

### X.4.2 Behavior

The origin server shall create a new Workitem and set it in the IN PROGRESS state, returning a URL referencing the newly created Workitem in the Location header field of the response. A Workitem will only be added to the Worklist once.

The origin server shall create and maintain the Workitem as specified by the SCP behavior defined in Section CC.2.5.3 in PS3.4.

### X.4.3 Response

See 11.4.3.

## X.5 Claim and Prepare Workitem Transaction

### X.5.1 Request

See 11.7.1 and 11.6.1.

### X.5.2 Behavior

### X.5.3 Response

See 11.7.3 and 11.6.3.

## X.6 Retrieve Workitem Transaction

### X.6.1 Request

### X.6.2 Behavior

### X.6.3 Response

## X.7 Report Progress on Workitem Transaction

### X.7.1 Request

### X.7.2 Behavior

### X.7.3 Response

## X.8 Change Workitem State Transaction

### X.8.1 Request

### X.8.2 Behavior

### X.8.3 Response

### X.8.3.1 Status Codes

### X.8.3.2 Response Header Fields

### X.8.3.3 Response Payload

## X.9 Get Applicable Workitems Transaction

### X.9.1 Request

### X.9.2 Behavior

### X.9.3 Response

## X.10 Subscribe to Workitem Changes Transaction

### X.9.1 Request

### X.9.2 Behavior

### X.9.3 Response

## X.11 Unsubscribe to Workitem Changes Transaction

### X.9.1 Request

### X.9.2 Behavior

### X.9.3 Response

Add Sections to Annex B Examples

## B.x1 Example 1

## B.x2 Bi-directional Proxies

The Modality Services may be deployed in a hybrid environment, i.e., an environment in which both DICOMweb and DIMSE are used. In such a hybrid environment, a proxy can broker transactions from one service to the other, allowing a DICOMweb origin server or a DIMSE SCP to support modality services for a mixed set of DICOMweb user agents and DIMSE SCUs. DICOM does not require an implementation of proxies; however, since they would be particularly useful in a hybrid environment, the examples in this section show how this could be done.

Figure B.x2-1 shows how a proxy could facilitate a scheduled acquisition workflow from a DIMSE SCU to a DICOMweb origin server.

Figure B.x2-1. Scheduled Acquisition Workflow DIMSE Proxy for a DICOMweb Origin Server

A white rectangular object with black text

Description automatically generated

Adapt section 4 Symbols and Abbreviated Terms

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**JSON** JavaScript Object Notation

**MPPS Modality Performed Procedure Step service. See PS3.4, Annex F.**

**MWL Modality Worklist service (formally defined as the Basic Worklist Management Service. See PS3.4, Annex K.**

**QIDO-RS** Query based on ID for DICOM Objects by RESTful Services

…

**UID** Unique (DICOM) Identifier

**UPS Unified Procedure Step service. See PS3.4, Annex CC.**

**UPS-RS** Unified Procedure Step by RESTful Services

…

**Changes to NEMA Standards Publications PS 3.4**

Update section F.9 with a note of how the SCP know what SCUs to notify about changes

…

Note

…

1. The terms IS and PACS used in the previous example are provided for clarification purposes only. This document does not define nor constrain the purpose or role of any IS, PACS or acquisition Application Entity conforming to this Service Class Specification.
2. **It is beyond the scope of the specification to define how the SCP knows about what SCUs to notify about changes. A conceivable way would be to make this a configuration item of the SCP.**

…

**Alternative approach**

Rationale: There are several serious restrictions of using UPS-RS for MWL/MPPS in DICOMweb. Most of these have been identified in the main section of this document.

Approach: make a direct mapping of the operations and notifications in MWL and MPPS to new DICOMweb methods.

**Changes to NEMA Standards Publications PS 3.18**

Add new section X Modality Services and Resources

# X Modality Services and Resources

## X.1 Overview

The Modality Services provide modality-oriented workflow management for user agents. These services correspond to the DIMSE Modality Worklist (MWL) and DIMSE Modality Performed Procedure Step (MPPS) services as defined in Annexes K and F of PS3.4 respectively and have the same semantics.

### X.1.1 Resource Descriptions

The Modality Services manage a Modality Worklist and a collection of Modality Performed Procedure Steps.

The Modality Services define two resources given in Table X.1.1-1.

Table X.1.1-1. Modality Services Resource Descriptions

| Resource | Support |
| --- | --- |
| /modality-worklist | Modality Worklist managed by the origin server. |
| /modality-performed-procedure-steps | Modality Performed Procedure Steps managed by the origin server. |

Table X.1.1-2 lists the DIMSE Operations used in MWL and MPPS and their corresponding Modality Services Transactions.

Table X.1.1-2. Mapping of DIMSE Operations and Modality Services Transactions

| Operation | Reference | DIMSE Service | Modality Services Transaction |
| --- | --- | --- | --- |
| Query Worklist | PS3.4, K.4 | C-FIND | Query |
| Create MPPS Instance | PS3.4, F.7.2.1 | N-CREATE | Create |
| Set MPPS Information | PS3.4, F.7.2.2 | N-SET | Update |
| Get MPPS Information | PS3.4, F.8.2.1 | N-GET | Retrieve |

Next to Operations, MPPS also knows about Notifications, which, together with their related Modality Services Transactions, are listed in Table X.1.1-3.

Table X.1.1-3. Relation between DIMSE Notifications and Modality Services Transactions

| Notification | Reference | DIMSE Service | Modality Services Transaction |
| --- | --- | --- | --- |
| Receive Event Notification | PS3.4, F.9.2.1 | N-EVENT-REPORT | Subscribe |
| Provide Event Notification | PS3.4, F.9.2.2 | Unsubscribe |

Note The pair of Notifications relate to the pair of Transactions; there is *no* one to one mapping between DIMSE Notifications and Modality Services Transactions. See also Section 8.10 for more information about how DICOMweb deals with Notifications.

### X.1.2 Common Query Parameters

The origin server shall support Query Parameters as required in Table X.1.2-1.

The user agent shall supply in the request Query Parameters as required in Table X.1.2-1.

Table X.1.2-1. Common Query parameters

| Name | Value | Usage | | Section |
| --- | --- | --- | --- | --- |
| User Agent | Origin Server |
| Accept | media-type | O | M | Section 8.3.3.1 |
| Accept-Charset | charset | O | M | Section 8.3.3.2 |

### X.1.3 Common Media Types

The origin server shall support the media types specified as Default or Required in Table X.1.3-1.

Table X.1.3-1. Default, Required, and Optional Media Types

| Media Type | Usage | Section |
| --- | --- | --- |
| application/dicom+json | Default |  |
| application/dicom+xml | Required | Section 8.7.3.2 |
| multipart/related; type="application/dicom+json" | Required | Section 8.7.3.2 |
| multipart/related; type="application/dicom+xml" | Required | Section 8.7.3.2 |

## X.2 Conformance

An origin server conforming to the Modality Services shall, next to the Retrieve Capabilities Transaction (see Section 8.9 and Annex H), support at least one of the optional Transactions listed in Table X.2-1 and adhere to the condition mentioned next to that Transaction.

Table X.2-1. Required and Optional Transactions

| Transaction | Support | Condition | Section |
| --- | --- | --- | --- |
| Retrieve Capabilities | Required |  | Section 8.9 |
| Query | Optional |  | Section X.4 |
| Create | Optional | Requires support of the Update Transaction | Section X.5 |
| Update | Optional | Requires support of the Create Transaction | Section X.6 |
| Retrieve | Optional | Requires support of the Create Transaction | Section X.7 |
| Subscribe | Optional | Requires support of the Create and the Unsubscribe Transactions | Section X.8 |
| Unsubscribe | Optional | Requires support of the Create and the Subscribe Transactions | Section X.9 |

Implementations shall specify in their Conformance Statement (see PS3.2) and the Retrieve Capabilities Transaction the supported Transactions and the implementations’ role: origin server, user agent, or both.

In addition, for each supported Transaction they shall specify:

* The supported Query Parameters, including optional Attributes, if any.
* The supported DICOM Media Types.
* The supported character sets (if other than UTF-8).

## X.3 Transactions Overview

The Modality Services consist of the Transactions listed in Table X.3-1.

Table X.3-1. Modality Services Transactions

| Transaction Name | Method | Payload | | Description |
| --- | --- | --- | --- | --- |
| Request | Success Response |
| Search | GET | none | dataset according to PS3.4, Table K.6-1 | Searches for Workitems |
| Create | PUT | dataset according to PS3.4, Table F.7.2-1 (N-CREATE) | none | Creates a new Modality Performed Procedure Step |
| Update | PATCH | dataset according to PS3.4, Table F.7.2-1 (N-SET) | none | Updates the target Modality Performed Procedure Step |
| Retrieve | GET | none | dataset according to PS3.4, Table F.8.2-1 | Retrieves the target Modality Performed Procedure Step |
| Subscribe | POST | none | none | Subscribes to state changes of the target Modality Performed Procedure Step |
| Unsubscribe | DELETE | none | none | Unsubscribes to state changes of the target Modality Performed Procedure Step |

## X.4 Search Transaction

This Transaction searches the Modality Worklist for Workitems that match the specified Query Parameters and returns a list of matching Workitems. Each Workitem in the returned list includes return Attributes specified in the request. The Transaction corresponds to the DIMSE MWL C-FIND Operation (see PS3.4, Section K.4.1).

### X.4.1 Request

The request shall have the following syntax:

GET SP /modality-worklist?{&match\*}{&includefield}{&fuzzymatching}{&offset}{&limit} SP version CRLF

Accept: 1#media-type CRLF

\*(header-field CRLF)

CRLF

#### X.4.1.1 Target Resources

The Target Resource for this Transaction is the Modality Worklist.

#### X.4.1.2 Query Parameters

The origin server shall support Query Parameters as required in Table 8.3.4-1.

The user agent shall supply in the request Query Parameters as required in Table 8.3.4-1.

#### X.4.1.3 Request Header Fields

The origin server shall support header fields as required in Table X.4.1-1.

The user agent shall supply in the request header fields as defined in Table X.4.1-1.

Table X.4.1-1. Request Header Fields

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Values** | **Usage** | | **Description** |
| **User Agent** | **Origin Server** |
| Accept | media-type | M | M | The Acceptable Media Types of the response payload. |

See also Section 8.4.

#### X.4.1.4 Request Payload

The request shall have no payload.

### X.4.2 Behavior

The origin server shall perform a search according the requirements specified in Section 8.3.4.

For each matching Workitem, the origin server shall include in the results:

* All Modality Worklist Instance Attributes in Table K.6-1 “Attributes for the Modality Worklist Information Model” in PS3.4 with a Return Key Type of 1 or 2.
* All Modality Worklist Instance Attributes in Table K.6-1 “Attributes for the Modality Worklist Information Model” in PS3.4 with a Return Key Type of 1C for which the conditional requirements are met.
* All other Workitem Attributes passed as match parameters that are supported by the origin server as either matching or return Attributes.
* All other Workitem Attributes passed as includefield parameter values that are supported by the origin server as return Attributes.

### X.4.3 Response

The response shall have the following syntax:

version SP status-code SP reason-phrase CRLF

CRLF

[payload]

#### X.4.3.1 Status Codes

Table X.4.3-1 shows some common status codes corresponding to this transaction. See also Section 8.5 for additional status codes.

Table X.4.3-1. Status Code Meaning

|  |  |  |
| --- | --- | --- |
| **Status** | **Code** | **Meaning** |
| Success | 200 (OK) | The origin server returns the matching results. |
| 204 (No Content) | The origin server has no matching results. |
| Failure | 400 (Bad Request) | The origin server cannot handle the search request because of errors in the request headers or parameters. |
| 413 (Payload Too Large) | The origin server cannot return the results, as their combined size exceeds the maximum payload size supported. The user agent may repeat the request with paging or with a narrower query to reduce the size. |
| 503 (Service Unavailable) | The origin server cannot handle the query; this may be a temporal or permanent state. |

#### X.4.3.2 Response Header Fields

The origin server shall support header fields as required in Table X.4.3-2.

Table X.4.3-2. Response Header Fields

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Values** | **Origin Server Usage** | **Description** |
| Content-Type | media-type | C | See section 8.4.2. |
| Content-Encoding | encoding | C | See section 8.4.2. |
| Content-Length | uint | C | See section 8.4.3. |

All success responses shall also contain the Content Representation (see Section 8.4.2) and Payload header fields (see Section 8.4.3) with appropriate values.

It is recommended that the text returned in the Warning header field (see [RFC7234] Section 5.5) contain a DICOM Status Code (see PS3.4 and Annex C “Status Type Encoding (Normative)” in PS3.7) and descriptive reason. For example:

Warning: A700 <service>: Out of memory

#### X.4.3.3 Response Payload

A success response shall contain the search results in an Acceptable Media Type. See Section 8.7.5.

A failure response payload may contain a Status Report describing any failures, warnings, or other useful information.

## X.5 Create Transaction

This Transaction creates a Modality Performed Procedure Step with the given Attributes. It corresponds to the DIMSE MPPS N-CREATE Operation (see PS3.4, Section F.7.2.1).

### X.5.1 Request

The request shall have the following syntax:

PUT SP /modality-performed-procedure-steps/{mppsUID} SP version CRLF

Accept: 1#media-type CRLF

\*(header-field CRLF)

CRLF

payload

#### X.5.1.1 Target Resource

The Target Resource of this transaction is an individual Modality Performed Procedure Step identified by its MPPS UID.

#### X.5.1.2 Query Parameters

The request has no Query Parameters.

#### X.5.1.3 Request Header Fields

The origin server shall support Request Header Fields as required in Table X.5.1-1.

The user agent shall supply Request Header Fields as required in Table X.5.1-1.

Table X.5.1-1. Request Header Fields

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Values** | **Usage** | | **Description** |
| **User Agent** | **Origin Server** |
| Accept | media-type | M | M | The Acceptable Media Types of the response payload. |

#### X.5.1.4 Request Payload

The request payload shall be present and shall contain one representation consistent with the Content-Type header field. The representation shall conform to Media Types described in Section 8.7.3 DICOM Media Type Sets. The payload shall conform to Section 8.6 Payloads.

The request payload shall contain the Modality Performed Procedure Step attributes with which the user agent requests the origin server to create a Modality Performed Procedure Step resource.

The request payload shall contain a dataset according to PS3.4, Table F.7.2-1, requirement type N-CREATE (SCU).

### X.5.2 Behavior

The origin server shall create a Modality Performed Procedure Step identified by the provided MPPS UID and filled with the provided attributes in the payload.

### X.5.3 Response

The response shall have the following syntax:

version SP status-code SP reason-phrase CRLF

CRLF

[payload]

#### X.5.3.1 Status Codes

Table X.5.3-1 shows some common status codes corresponding to this transaction. See also Section 8.5 for additional status codes.

Table X.5.3-1. Status Code Meaning

|  |  |  |
| --- | --- | --- |
| **Status** | **Code** | **Meaning** |
| Success | 200 (OK) | The origin server has created the requested Modality Performed Procedure Step with the provided attributes. |
| Failure | 400 (Bad Request) | The origin server cannot handle the create request because of errors in the request headers or parameters. |
| 409 (Conflict) | The origin server cannot create the target Modality Performed Procedure Step because the provided Modality Performed Procedure Step UID is already in use. |
| 503 (Service Unavailable) | The origin server cannot handle the creation of the Modality Performed Procedure Step; this may be a temporal or permanent state. |

#### X.5.3.2 Response Header Fields

The origin server shall support header fields as required in Table X.5.3-2.

Table X.5.3-2. Response Header Fields

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Values** | **Origin Server Usage** | **Description** |
| Content-Type | media-type | C | See section 8.4.2. |
| Content-Encoding | encoding | C | See section 8.4.2. |
| Content-Length | uint | C | See section 8.4.3. |

All success responses shall also contain the Content Representation (see Section 8.4.2) and Payload header fields (see Section 8.4.3) with appropriate values.

It is recommended that the text returned in the Warning header field (see [RFC7234] Section 5.5) contain a DICOM Status Code (see PS3.4 and Annex C “Status Type Encoding (Normative)” in PS3.7) and descriptive reason. For example:

Warning: A700 <service>: Out of memory

#### X.5.3.3 Response Payload

A success response shall have no payload.

A failure response payload may contain a Status Report describing any failures, warnings, or other useful information.

## X.6 Update Transaction

This Transaction sets Attributes of an existing Modality Performed Procedure Step. It corresponds to the DIMSE MPPS N-SET Operation (see PS3.4, Section F.7.2.2).

### X.6.1 Request

The request shall have the following syntax:

PATCH SP /modality-performed-procedure-steps/{mppsUID} SP version CRLF

Accept: 1#media-type CRLF

\*(header-field CRLF)

CRLF

payload

#### X.6.1.1 Target Resources

The Target Resource of this transaction is an individual Modality Performed Procedure Step identified by its MPPS UID.

#### X.6.1.2 Query Parameters

The request has no Query Parameters.

#### X.6.1.3 Request Header Fields

The origin server shall support Request Header Fields as required in Table X.6.1-1.

The user agent shall supply Request Header Fields as required in Table X.6.1-1.

Table X.6.1-1. Request Header Fields

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Values** | **Usage** | | **Description** |
| **User Agent** | **Origin Server** |
| Accept | media-type | M | M | The Acceptable Media Types of the response payload. |

#### X.6.1.4 Request Payload

The request payload shall be present and shall contain one representation consistent with the Content-Type header field. The representation shall conform to Media Types described in Section 8.7.3 DICOM Media Type Sets. The payload shall conform to Section 8.6 Payloads.

The request payload shall contain the Modality Performed Procedure Step attributes with which the user agent requests the origin server to create a Modality Performed Procedure Step resource.

The request payload shall contain a dataset according to PS3.4, Table F.7.2-1, requirement type N-SET (SCU).

### X.6.2 Behavior

The origin server shall update the Modality Performed Procedure Step identified by the provided MPPS UID with the provided attributes in the payload.

### X.6.3 Response

The response shall have the following syntax:

version SP status-code SP reason-phrase CRLF

CRLF

[payload]

#### X.6.3.1 Status Codes

Table X.6.3-1 shows some common status codes corresponding to this transaction. See also Section 8.5 for additional status codes.

Table X.6.3-1. Status Code Meaning

|  |  |  |
| --- | --- | --- |
| **Status** | **Code** | **Meaning** |
| Success | 200 (OK) | The origin server has updated the Modality Performed Procedure Step with the provided attributes. |
| Failure | 400 (Bad Request) | The origin server cannot handle the update request because of errors in the request headers or parameters. |
| 404 (Not Found) | The origin server has no knowledge about the target Modality Performed Procedure Step. |
| 409 (Conflict) | The origin server cannot update the target Modality Performed Procedure Step, for instance because the changes provided are incompatible with the data in the target Modality Performed Procedure Step. |
| 410 (Gone) | The origin server knows that the target Modality Performed Procedure Step did exist but has been deleted. |
| 503 (Service Unavailable) | The origin server cannot handle the creation of the Modality Performed Procedure Step; this may be a temporal or permanent state. |

Note When it is requested that attributes are to be updated while these have not been made available at creation time, a 409 (Conflict) can be returned; this is the case when PS3.4, Table F.7.2-1 specifies that these attributes should have been made available at creation time.

#### X.6.3.2 Response Header Fields

The origin server shall support header fields as required in Table X.6.3-2.

Table X.6.3-2. Response Header Fields

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Values** | **Origin Server Usage** | **Description** |
| Content-Type | media-type | C | See section 8.4.2. |
| Content-Encoding | encoding | C | See section 8.4.2. |
| Content-Length | uint | C | See section 8.4.3. |

All success responses shall also contain the Content Representation (see Section 8.4.2) and Payload header fields (see Section 8.4.3) with appropriate values.

It is recommended that the text returned in the Warning header field (see [RFC7234] Section 5.5) contain a DICOM Status Code (see PS3.4 and Annex C “Status Type Encoding (Normative)” in PS3.7) and descriptive reason. For example:

Warning: A700 <service>: Out of memory

#### X.6.3.3 Response Payload

A success response should have no payload.

A failure response payload may contain a Status Report describing any failures, warnings, or other useful information.

## X.7 Retrieve Transaction

This Transaction retrieves an existing Modality Performed Procedure Step. It corresponds to the MPPS DIMSE N-GET Operation (see PS3.4, Section F.8.2.1).

### X.7.1 Request

The request shall have the following syntax:

GET SP /modality-performed-procedure-steps/{mppsUID} SP version CRLF

Accept: 1#media-type CRLF

\*(header-field CRLF)

CRLF

#### X.7.1.1 Target Resources

The Target Resource of this transaction is an individual Modality Performed Procedure Step identified by its MPPS UID.

#### X.7.1.2 Query Parameters

The request has no Query Parameters.

#### X.7.1.3 Request Header Fields

The origin server shall support Request Header Fields as required in Table X.7.1-1.

The user agent shall supply Request Header Fields as required in Table X.7.1-1.

Table X.7.1-1. Request Header Fields

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Values** | **Usage** | | **Description** |
| **User Agent** | **Origin Server** |
| Accept | media-type | M | M | The Acceptable Media Types of the response payload. |

#### X.7.1.4 Request Payload

The request shall have no payload.

### X.7.2 Behavior

If the Modality Performed Procedure Step exists on the origin server, this shall be returned in an Acceptable Media Type (see Section 8.7.4).

### X.7.3 Response

The response shall have the following syntax:

version SP status-code SP reason-phrase CRLF

CRLF

[payload]

#### X.7.3.1 Status Codes

Table X.7.3-1 shows some common status codes corresponding to this transaction. See also Section 8.5 for additional status codes.

Table X.7.3-1. Status Code Meaning

|  |  |  |
| --- | --- | --- |
| **Status** | **Code** | **Meaning** |
| Success | 200 (OK) | The origin server returned the target Modality Performed Procedure Step. |
| Failure | 400 (Bad Request) | The origin server cannot handle the retrieve request because of errors in the request headers or parameters. |
| 404 (Not Found) | The origin server has no knowledge about the target Modality Performed Procedure Step. |
| 410 (Gone) | The origin server knows that the target Modality Performed Procedure Step did exist but has been deleted. |
| 503 (Service Unavailable) | The origin server cannot handle the retrieval of the target Modality Performed Procedure Step; this may be a temporal or permanent state. |

#### X.7.3.2 Response Header Fields

The origin server shall support header fields as required in Table X.7.3-2.

Table X.7.3-2. Response Header Fields

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Values** | **Origin Server Usage** | **Description** |
| Content-Type | media-type | C | See section 8.4.2. |
| Content-Encoding | encoding | C | See section 8.4.2. |
| Content-Length | uint | C | See section 8.4.3. |

All success responses shall also contain the Content Representation (see Section 8.4.2) and Payload header fields (see Section 8.4.3) with appropriate values.

It is recommended that the text returned in the Warning header field (see [RFC7234] Section 5.5) contain a DICOM Status Code (see PS3.4 and Annex C “Status Type Encoding (Normative)” in PS3.7) and descriptive reason. For example:

Warning: A700 <service>: Out of memory

#### X.7.3.3 Response Payload

A success response should have a payload containing the requested Modality Performed Procedure Step in the Selected Media Type.

A failure response payload may contain a Status Report describing any failures, warnings, or other useful information.

## X.8 Subscribe Transaction

This Transaction creates a Subscription to an existing Modality Performed Procedure Step resource. It relates to the DIMSE MPPS N-EVENT-REPORT Notification (see PS3.4, Section F.9.1).

Once a Subscription has been created, the user agent will receive notifications regarding the state of the associated Modality Performed Procedure Step. To receive the notifications generated by Subscriptions, the user agent must first open a Notification Connection between itself and the origin server using the Open Notification Connection Transaction; see Section 8.10.4.

### X.8.1 Request

The request shall have the following syntax:

POST SP /modality-performed-procedure-steps/{mppsUID}/subscribers/{aetitle} SP version CRLF

Accept: 1#media-type CRLF

\*(header-field CRLF)

CRLF

#### X.8.1.1 Target Resources

The Target Resource of this transaction is an individual Modality Performed Procedure Step identified by its MPPS UID.

#### X.8.1.2 Query Parameters

The origin server shall support Query Parameters as required in Table 8.3.4-1.

The user agent shall supply in the request Query Parameters as required in Table 8.3.4-1.

#### X.8.1.3 Request Header Fields

The origin server shall support header fields as required in Table X.8.1-1.

The user agent shall supply in the request header fields as defined in Table X.8.1-1.

Table X.8.1-1. Request Header Fields

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Values** | **Usage** | | **Description** |
| **User Agent** | **Origin Server** |
| Accept | media-type | M | M | The Acceptable Media Types of the response payload. |

#### X.8.1.4 Request Payload

The request shall have no payload.

### X.8.2 Behavior

The origin server shall create and manage a Subscription to the Target Modality Performed Procedure Step for the user agent. It will notify the user agent when changes occur, see Section 8.10.

### X.8.3 Response

The response shall have the following syntax:

version SP status-code SP reason-phrase CRLF

CRLF

[payload]

#### X.8.3.1 Status Codes

Table X.8.3-1 shows some common status codes corresponding to this transaction. See also Section 8.5 for additional status codes.

Table X.8.3-1. Status Code Meaning

|  |  |  |
| --- | --- | --- |
| **Status** | **Code** | **Meaning** |
| Success | 200 (OK) | The origin server subscribed the user agent to the target Modality Performed Procedure Step. In case the user agent was already subscribed to this Modality Performed Procedure Step, there is no change. |
| Failure | 400 (Bad Request) | The origin server cannot handle the subscription request because of errors in the request headers or parameters. |
| 404 (Not Found) | The origin server has no knowledge about the target Modality Performed Procedure Step. |
| 410 (Gone) | The origin server knows that the target Modality Performed Procedure Step did exist but has been deleted. |
| 503 (Service Unavailable) | The origin server cannot handle the subscription to the target Modality Performed Procedure Step; this may be a temporal or permanent state. |

#### X.8.3.2 Response Header Fields

The origin server shall support header fields as required in Table X.8.3-2.

Table X.8.3-2. Response Header Fields

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Values** | **Origin Server Usage** | **Description** |
| Content-Type | media-type | C | See section 8.4.2. |
| Content-Encoding | encoding | C | See section 8.4.2. |
| Content-Length | uint | C | See section 8.4.3. |

All success responses shall also contain the Content Representation (see Section 8.4.2) and Payload header fields (see Section 8.4.3) with appropriate values.

It is recommended that the text returned in the Warning header field (see [RFC7234] Section 5.5) contain a DICOM Status Code (see PS3.4 and Annex C “Status Type Encoding (Normative)” in PS3.7) and descriptive reason. For example:

Warning: A700 <service>: Out of memory

#### X.8.3.3 Response Payload

A success response shall have no payload.

A failure response payload may contain a Status Report describing any failures, warnings, or other useful information.

## X.9 Unsubscribe Transaction

This Transaction removes a Subscription to a Modality Performed Procedure Step resource. It relates to the DIMSE MPPS N-EVENT-REPORT Notification (see PS3.4, Section F.9.1).

### X.9.1 Request

The request shall have the following syntax:

DELETE SP /modality-performed-procedure-steps/{mppsUID}/subscribers/{aetitle} SP version CRLF

Accept: 1#media-type CRLF

\*(header-field CRLF)

CRLF

#### X.9.1.1 Target Resources

The Target Resource of this transaction is an individual Modality Performed Procedure Step identified by its MPPS UID.

#### X.9.1.2 Query Parameters

The origin server shall support Query Parameters as required in Table 8.3.4-1.

The user agent shall supply in the request Query Parameters as required in Table 8.3.4-1.

#### X.9.1.3 Request Header Fields

The origin server shall support header fields as required in Table X.9.1-1.

The user agent shall supply in the request header fields as defined in Table X.9.1-1.

Table X.9.1-1. Request Header Fields

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Values** | **Usage** | | **Description** |
| **User Agent** | **Origin Server** |
| Accept | media-type | M | M | The Acceptable Media Types of the response payload. |

#### X.9.1.4 Request Payload

The request shall have no payload.

### X.9.2 Behavior

Upon receipt of an Unsubscribe request, the origin server shall remove the Modality Performed Procedure Step Subscription.

### X.9.3 Response

The response shall have the following syntax:

version SP status-code SP reason-phrase CRLF

CRLF

[payload]

#### X.9.3.1 Status Codes

Table X.9.3-1 shows some common status codes corresponding to this transaction. See also Section 8.5 for additional status codes.

Table X.9.3-1. Status Code Meaning

|  |  |  |
| --- | --- | --- |
| **Status** | **Code** | **Meaning** |
| Success | 200 (OK) | The origin server unsubscribed the user agent from the target Modality Performed Procedure Step. In case the user agent was not subscribed to this Modality Performed Procedure Step, there is no change. |
| Failure | 400 (Bad Request) | The origin server cannot handle the unsubscribe request because of errors in the request headers or parameters. |
| 404 (Not Found) | The origin server has no knowledge about the target Modality Performed Procedure Step. |
| 410 (Gone) | The origin server knows that the target Modality Performed Procedure Step did exist but has been deleted. |
| 503 (Service Unavailable) | The origin server cannot handle the unsubscribe request for the target Modality Performed Procedure Step; this may be a temporal or permanent state. |

#### X.9.3.2 Response Header Fields

The origin server shall support header fields as required in Table X.9.3-2.

Table X.9.3-2. Response Header Fields

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Values** | **Origin Server Usage** | **Description** |
| Content-Type | media-type | C | See section 8.4.2. |
| Content-Encoding | encoding | C | See section 8.4.2. |
| Content-Length | uint | C | See section 8.4.3. |

All success responses shall also contain the Content Representation (see Section 8.4.2) and Payload header fields (see Section 8.4.3) with appropriate values.

It is recommended that the text returned in the Warning header field (see [RFC7234] Section 5.5) contain a DICOM Status Code (see PS3.4 and Annex C “Status Type Encoding (Normative)” in PS3.7) and descriptive reason. For example:

Warning: A700 <service>: Out of memory

#### X.9.3.3 Response Payload

A success response shall have no payload.

A failure response payload may contain a Status Report describing any failures, warnings, or other useful information.

## X.10 Modality Performed Procedure Step Event Reports

The origin server uses the Send Event Report Transaction (see Section 8.10.5) to send a Modality Performed Procedure Step Event Report, containing the details of any state change in the Modality Performed Procedure Step to the user agent.

The origin server shall send Modality Performed Procedure Step Event Reports as described in Section CC.2.4.3 in PS3.4.

The Event Report shall contain all mandatory Attributes described in Table CC.2.4-1 “Report a Change in UPS Status - Event Report Information” in PS3.4 and Table 10.3-2 “N-EVENT-REPORT-RSP Message Fields” in PS3.7 .

The following is an example application/dicom+json Workitem Event Report payload:

Adapt Annex H <title> as Below