# WorklistBridge

## DICOM Conformance Statement
## Modality Worklist Provider

**Product:** WorklistBridge, DICOM Modality Worklist Provider (`DicomMwlServer`)

**Manufacturer:** Clevus LTD, https://worklistbridge.com

**Software version:** source revision `de6862d` (release build, 26 October 2026)

**DICOM toolkit:** fo-dicom 5.2.5 on .NET 8

**Document revision:** 1.3, 26 October 2026

**Conformance to:** DICOM PS3 (current edition); document structure follows PS3.2 Annex A

# 1. Conformance Statement Overview

WorklistBridge receives radiology orders from a Hospital or Radiology Information System (HIS/RIS) as HL7 v2 messages (files or MLLP) or FHIR R4 ServiceRequests, stores them in a Microsoft SQL Server database, and publishes them to imaging modalities as a DICOM Modality Worklist (MWL).

On the DICOM network the product implements one Application Entity process, the **MWL Provider**, that acts as a Service Class Provider (SCP) for the Modality Worklist Information Model – FIND and for Verification. It never initiates associations, does not create, store or retrieve images, and does not support Media Interchange.

**Table 1-1. Network services**

| SOP Class | SOP Class UID | User of Service (SCU) | Provider of Service (SCP) |
|---|---|---|---|
| **Workflow Management** | | | |
| Modality Worklist Information Model – FIND | 1.2.840.10008.5.1.4.31 | No | Yes |
| **Verification** | | | |
| Verification | 1.2.840.10008.1.1 | No | Yes |

**Table 1-2. Media services:** none. The product does not read or write DICOM media.

Not supported: Modality Performed Procedure Step, Storage Commitment, Query/Retrieve, Storage, Instance Availability Notification, Unified Procedure Step, and any private SOP classes.

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# 3. Introduction

## 3.1 Revision history

| Revision | Date | Software revision | Description |
|---|---|---|---|
| 1.0 | 12 October 2026 | `1c45555` | First release |
| 1.1 | 12 October 2026 | `81cd490` | Licence-dependent C-FIND failure status (Table 4.2-12); HL7 v2.5.1 / OMI^O23, MLLP and FHIR R4 order intake (Annex A) |
| 1.2 | 12 October 2026 | `8ed42d7` | Matching on Patient’s Name and Scheduled Procedure Step Start Time; Modality wildcards and universal match; C-CANCEL supported; optional calling AE allow-list (Tables 4.2-6, 4.2-9, 4.2-12, 4.4-3; Section 7.2) |
| 1.3 | 26 October 2026 | `de6862d` | Product name WorklistBridge and manufacturer Clevus LTD added; licence Error Comments now start “WorklistBridge” (Table 4.2-12). No other change in DICOM behaviour |

## 3.2 Audience

This document is written for integration engineers, modality service engineers, PACS and RIS administrators, and anyone who needs to connect an imaging modality (or any other MWL SCU) to WorklistBridge. Readers are assumed to be familiar with the DICOM Standard and with HL7 v2.

## 3.3 Remarks

This Conformance Statement does not by itself guarantee interoperability. Compare it with the Conformance Statement of each modality, and test the connection on site before clinical use. The behaviour described here was taken from the source code at the revision named above and checked against a running server (Annex B).

The product follows the DICOM Standard where this document does not say otherwise. Every intentional deviation and limitation is listed in the section that it concerns and summarised in Section 4.2.1.6.

## 3.4 Terms and definitions

| Term | Meaning |
|---|---|
| AE / AE Title | DICOM Application Entity and its title (up to 16 characters). |
| Called AE Title | The AE Title the modality addresses when it opens an association (the “worklist AET” of the modality’s configuration). |
| Calling AE Title | The modality’s own AE Title, sent in the association request. |
| Device | A modality as configured in the product. Each Device has a *Device AE Title* (the modality’s own AE Title) and a *Worklist Provider AE Title* (the Called AE Title the modality uses). |
| MWL | Modality Worklist. |
| SCP / SCU | Service Class Provider / Service Class User. |

| Term | Meaning |
|---|---|
| SPS | Scheduled Procedure Step. |
| Placer Order Number | The order identifier assigned by the RIS (HL7 OBR-2). |

### 3.5 Basics of DICOM communication

Two Application Entities that want to communicate first negotiate an *association*. The initiator proposes presentation contexts, each pairing an abstract syntax (the SOP class) with one or more transfer syntaxes (the encoding). The acceptor accepts or rejects each context. For a worklist query, the modality (SCU) then sends a C-FIND request containing *matching keys* (values to filter on) and *return keys* (attributes it wants back). The SCP answers with one *pending* response per matching worklist item and a final *success* or *failure* response.

### 3.6 References

- NEMA PS3, Digital Imaging and Communications in Medicine (DICOM) Standard, current edition: PS3.2 (Conformance), PS3.3 (Information Object Definitions), PS3.4 (Service Class Specifications, Annex K Basic Worklist Management Service), PS3.5 (Data Structures and Encoding), PS3.7 (Message Exchange), PS3.8 (Network Communication Support).
- HL7 Version 2.3 and 2.5.1, Chapter 4 (Order Entry).
- HL7 FHIR Release 4 (4.0.1): Bundle (transaction), Patient, ServiceRequest.
- IHE Radiology Technical Framework, Scheduled Workflow profile (transaction RAD-5, Query Modality Worklist).

## 4. Networking

### 4.1 Implementation model

#### 4.1.1 Application data flow

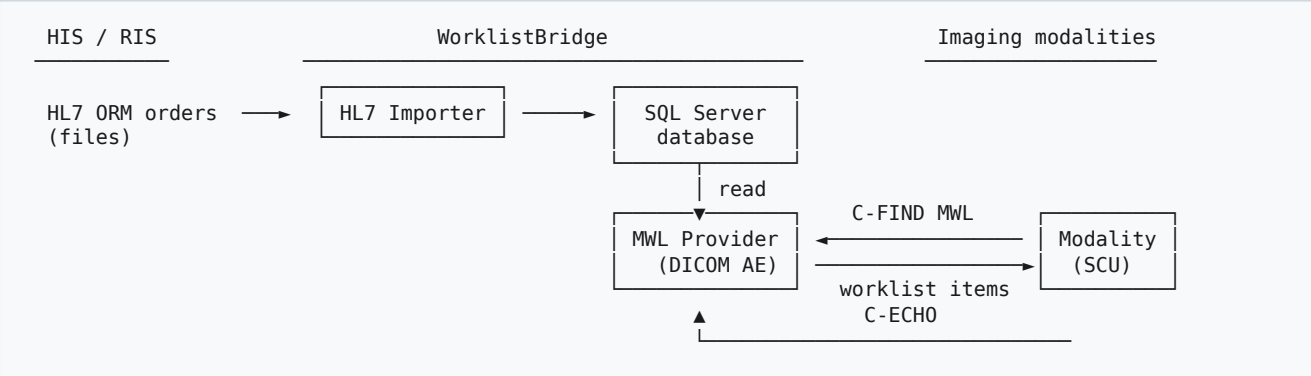



*Figure 4.1-1. Application data flow*

- The **HL7 Importer** (not a DICOM AE) reads HL7 order messages from files or, optionally, over MLLP; an optional **FHIR R4 intake** accepts the same orders as FHIR. Both assign each order to a Device by the configured routing rules, generates the Study Instance UID, and writes the worklist items to the database. See Annex A.

- The **MWL Provider** is the only DICOM Application Entity. It waits for associations from modalities, resolves the Device from the AE Titles of the association, reads the matching worklist items from the database and returns them. The worklist always reflects the current content of the database; nothing is cached between queries.
- A web dashboard (HTTP, not DICOM) is used to configure Devices and routing rules and to view incoming orders, served worklist items and the query log.

### 4.1.2 Functional definition of the Application Entity

The MWL Provider is a Windows service (it also runs as a console process). At start-up it opens one TCP listening port and accepts associations from any network peer. For each association:

1. Presentation contexts for Modality Worklist FIND and Verification are accepted; all others are rejected.
2. A C-ECHO request is answered with status Success.
3. A C-FIND request is handled as follows:
    - If the product licence does not allow serving, the query is answered with Failure 0110 and an Error Comment naming the reason (Table 4.2-12).
    - The Called AE Title selects the set of Devices whose *Worklist Provider AE Title* equals it. Devices beyond the number the licence allows are left out; if none remain, the query fails with 0110 “Device not licensed”.
    - The Calling AE Title is applied per Device according to that Device’s calling-AET filter (Section 4.2.1.4.2).
    - The worklist items of the remaining Devices are read from the database, filtered by the supported matching keys, and returned one per pending response, ordered by scheduled start date and time, then patient name.
    - Every query is recorded in the database query log (Section 7.3).

### 4.1.3 Sequencing of real-world activities

A worklist item can be returned only after the HL7 Importer has stored the corresponding order. An order cancelled by the RIS (Annex A.4) is no longer returned from the next query on. A re-sent order with the same Placer Order Number updates the existing item; the Study Instance UID stays the same.

## 4.2 AE specifications

### 4.2.1 MWL Provider

#### 4.2.1.1 SOP classes

**Table 4.2-1. SOP classes of the MWL Provider**

| SOP Class | SOP Class UID | SCU | SCP |
|---|---|---|---|
| Modality Worklist Information Model – FIND | 1.2.840.10008.5.1.4.31 | No | Yes |
| Verification | 1.2.840.10008.1.1 | No | Yes |

### 4.2.1.2 Association policies

#### *4.2.1.2.1 General*

The DICOM Application Context Name is the only one supported.

**Table 4.2-2. DICOM Application Context**

| **Application Context Name** | **1.2.840.10008.3.1.1.1** |
|---|---|

**Table 4.2-3. PDU size**

| **Maximum PDU size received** | **262 144 bytes (advertised in the A-ASSOCIATE-AC)** |
|---|---|
| Maximum PDU size sent | the value the SCU advertises |

#### *4.2.1.2.2 Number of associations*

**Table 4.2-4. Number of associations as acceptor**

| **Maximum number of simultaneous associations** | **Not limited by the application (limited by host resources). Ten simultaneous associations were verified.** |
|---|---|

The MWL Provider never initiates associations.

#### *4.2.1.2.3 Asynchronous nature*

The Asynchronous Operations Window sub-item is answered with the values the SCU proposed. SCUs should nevertheless send one request at a time and wait for the final response, as all common MWL SCUs do; asynchronous use has not been tested.

#### *4.2.1.2.4 Implementation identifying information*

**Table 4.2-5. Implementation identification**

| **Implementation Class UID** | **1.3.6.1.4.1.30071.8** |
|---|---|
| Implementation Version Name | fo-dicom 5.2.5 |

Both values belong to the fo-dicom toolkit and change when the toolkit is upgraded.

### 4.2.1.3 Association initiation policy

The MWL Provider does not initiate associations.

### 4.2.1.4 Association acceptance policy

#### *4.2.1.4.1 Activity – Accept Verification and Worklist queries*

**Description and sequencing of activities.** By default the MWL Provider accepts every association request, whatever the Called and Calling AE Titles. When the optional calling AE allow-list is enabled (Section 7.2), an association from a Calling AE Title that is not on the list is rejected (Table 4.2-6). Unknown Called AE Titles never cause a rejection; instead, an unknown Called AE Title, or a Calling AE Title that a Device's filter excludes, results in a C-FIND response with zero matches (Section 4.2.1.4.2). An association with no acceptable presentation context is still accepted at the association level, with every context rejected; most SCUs then abort it.

The association is closed when the SCU releases it, when the SCU aborts it, or when the TCP connection is lost. The MWL Provider sets no application-level timeout of its own.

**Table 4.2-6. Association rejection reasons**

| Result | Source | Reason / Diagnosis | When |
|---|---|---|---|
| rejected-permanent (1) | DICOM UL service-user (1) | calling-AE-title-not-recognized (3) | The calling AE allow-list is enabled and the Calling AE Title is neither on the list nor, when allowed, the Device AE Title of an active Device. The rejection is recorded in the query log. |
| rejected-transient (2) | DICOM UL service-provider, presentation related function (3) | temporary-congestion (1) | The calling AE allow-list is enabled and the database could not be read to check it. |

With the allow-list disabled (the default), the MWL Provider does not send A-ASSOCIATE-RJ. Malformed PDUs are handled by the fo-dicom toolkit, which aborts the association (A-ABORT).

**Table 4.2-7. Acceptable presentation contexts**

| Abstract Syntax | UID | Transfer Syntax | UID | Role | Extended Negotiation |
|---|---|---|---|---|---|
| Modality Worklist Information Model – FIND | 1.2.840.10008.5.1.4.31 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCP | None |
| | | Explicit VR Little Endian | 1.2.840.10008.1.2.1 | SCP | None |
| | | Deflated Explicit VR Little Endian | 1.2.840.10008.1.2.1.99 | SCP | None |
| Verification | 1.2.840.10008.1.1 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCP | None |
| | | Explicit VR Little Endian | 1.2.840.10008.1.2.1 | SCP | None |
| | | Deflated Explicit VR Little Endian | 1.2.840.10008.1.2.1.99 | SCP | None |

- **Transfer syntax selection.** When several acceptable transfer syntaxes are proposed in one presentation context, the first acceptable one in the SCU's proposal order is accepted.

- **Explicit VR Big Endian** (retired) and all compressed transfer syntaxes are rejected with result *transfer-syntaxes-not-supported* (4).
- **Any other abstract syntax**, including the Query/Retrieve FIND models, Modality Performed Procedure Step and Storage Commitment, is rejected with result *abstract-syntax-not-supported* (3).
- **SCP/SCU Role Selection.** If proposed, the toolkit echoes the proposed roles; the MWL Provider only ever acts as SCP.
- **User Identity Negotiation.** If proposed, a positive response is returned when one is requested, but the identity is neither checked nor used (Section 7).
- **No SOP Class Extended or Common Extended Negotiation** is supported; relational queries are not supported.

#### *4.2.1.4.2 SOP specific conformance – Modality Worklist Information Model – FIND*

**Device context.** Each C-FIND is answered from the worklist of one or more Devices:

1. All active Devices whose *Worklist Provider AE Title* equals the Called AE Title are candidates. Several Devices may share one Worklist Provider AE Title (a shared pool, for example several ultrasound rooms on one worklist).
2. Each candidate Device then applies its own *calling-AET filter* to the Calling AE Title of the association:

**Table 4.2-8. Calling-AET filter (per Device)**

| Setting | The Device's items are returned when |
|---|---|
| Ignore (default) | always |
| IfProvided | the Calling AE Title equals the Device AE Title, or no Calling AE Title is present |
| Required | the Calling AE Title equals the Device AE Title |

Because the Calling AE Title is always present in a DICOM association request, *IfProvided* and *Required* behave the same for DICOM SCUs. The Calling AE Title comparison is exact and case-sensitive. The Called AE Title comparison follows the database collation, which is case-insensitive in a default SQL Server installation.

3. The items of the remaining Devices are returned as one combined result. If no Device remains, the response has zero matches and status Success, and the reason is recorded in the query log.

**Matching keys.** Matching follows PS3.4 C.2.2.2 for the keys listed as supported. A key that is absent, zero-length or consists only of `*` matches everything. Keys not listed as supported are not used to filter (they behave as universal matches).

**Table 4.2-9. Matching keys**

| Attribute | Tag | VR | PS3.4 Matching Key Type | Supported | Matching |
|---|---|---|---|---|---|
| **Scheduled Procedure Step** | | | | | |
| Scheduled Procedure Step Sequence | (0040,0100) | SQ | R | Yes | Sequence matching; only the first item of the request is evaluated. |

| Attribute | Tag | VR | PS3.4 Matching Key Type | Supported | Matching |
|---|---|---|---|---|---|
| > Scheduled Station AE Title | (0040,0001) | AE | R | Yes | Single value or wildcard (`*`, `?`), case-insensitive, against the Device AE Title of the item. Also read from the top level of the identifier. |
| > Scheduled Procedure Step Start Date | (0040,0002) | DA | R | Yes | Single value or range (`date1-date2`, `date1-`, `-date2`), see “Date matching” below. |
| > Scheduled Procedure Step Start Time | (0040,0003) | TM | R | Yes | Single value or range (`time1-time2`, `time1-`, `-time2`), see “Time matching” below. |
| > Modality | (0008,0060) | CS | R | Yes | Single value or wildcard (`*`, `?`), case-insensitive; `*` matches every item. Also read from the top level of the identifier; the top level takes precedence. |
| > Scheduled Performing Physician’s Name | (0040,0006) | PN | R | Yes | Accepted. The product holds no value for this attribute, and a zero-length value matches any key (PS3.4 C.2.2.2.4), so this key never excludes an item. Returned zero-length. |
| > Scheduled Station Name | (0040,0010) | SH | O | Yes | Single value or wildcard, case-insensitive. Items with no station name match any value. Also read from the top level of the identifier. |
| **Patient Identification** | | | | | |
| Patient’s Name | (0010,0010) | PN | R | Yes | Single value or wildcard (`*`, `?`), case-insensitive, on the alphabetic component group. Trailing component separators are ignored, so `DOE^JANE^^^` equals `DOE^JANE`. A single value must match the whole name: `DOE` does not match `DOE^JANE`, `DOE*` does. |
| Patient ID | (0010,0020) | LO | R | Yes | Single value or wildcard (`*`, `?`), case-insensitive. |
| **Imaging Service Request** | | | | | |
| Accession Number | (0008,0050) | SH | O | Yes | Single value or wildcard (`*`, `?`), case-insensitive. |
| **Requested Procedure** | | | | | |
| Requested Procedure ID | (0040,1001) | SH | O | No | Not used for matching; returned. |

No other matching keys are supported. All Required matching keys of PS3.4 Table K.6-1 are supported.

**Date matching.** The requested Scheduled Procedure Step Start Date (single date or range) is compared with the date part of the item’s scheduled start. Each Device can widen the requested range: the lower bound is moved back by the Device’s *days after* setting and the upper bound

forward by its *days before* setting (0–99 days each; both 0 by default), so that items scheduled shortly before or after the requested date remain visible. An unparseable date value is treated as no date. A query without any date returns all items of the Device when the Device's *allow worklist without date filter* setting is on (the default), and no items when it is off.

**Time matching.** The requested Scheduled Procedure Step Start Time is a single value (`HH`, `HHMM`, `HHMMSS` or `HHMMSS.FFFFFF`) or a range. A value covers its own precision: `08` matches 08:00:00 to 08:59:59, and the range `0800-0900` matches 08:00:00 to 09:00:59. Without a start date, the time is matched on the item's time of day. With a start date, date and time are combined into one date-time range as PS3.4 C.2.2.2.5.1 requires: `20261012-20261014` with `1000-1500` matches from 12 October 10:00 to 14 October 15:00, including the whole of 13 October. The Device's date widening applies to the date part. Items without a scheduled start never match a time key. An unparseable time value is treated as no time.

**Items never returned.** Items of cancelled orders and items of inactive Devices are never returned. An order that matches no routing rule is stored but produces no worklist item (Annex A).

**Return keys.** Table 4.2-10 lists the attributes the MWL Provider returns. In addition, every attribute the SCU includes in the request identifier that the item has no value for is returned zero-length (an empty sequence for SQ), also inside the returned sequences (Scheduled Procedure Step Sequence and the code sequences). Values the MWL Provider has are never replaced by request values. Private attributes, group 0000/0002 attributes and attributes of VR UN are not returned this way. Attributes are returned even when the SCU did not request them.

**Table 4.2-10. Return keys**

| Module / Attribute | Tag | VR | PS3.4 Return Key Type | Source and notes |
|---|---|---|---|---|
| **SOP Common** | | | | |
| Specific Character Set | (0008,0005) | CS | 1C | The Device's character set (Section 6). Omitted for the default repertoire (ISO_IR 6). |
| **Scheduled Procedure Step** | | | | |
| Scheduled Procedure Step Sequence | (0040,0100) | SQ | 1 | Always exactly one item. |
| > Modality | (0008,0060) | CS | 1 | Modality of the Device. |
| > Scheduled Station AE Title | (0040,0001) | AE | 1 | Device AE Title (the modality's own AE Title). |
| > Scheduled Station Name | (0040,0010) | SH | 2 | Station name of the Device; zero-length if not configured. |
| > Scheduled Procedure Step Start Date | (0040,0002) | DA | 1 | HL7 OBR-36 (date part), local time of the server. |
| > Scheduled Procedure Step Start Time | (0040,0003) | TM | 1 | HL7 OBR-36 (time part, HHMMSS), local time of the server. |
| > Scheduled Procedure Step Description | (0040,0007) | LO | 1C | HL7 OBR-4 text. |
| > Scheduled Protocol Code Sequence | (0040,0008) | SQ | 1C | One item with the procedure code (Table 4.2-11); omitted when no usable code exists. |

| Module / Attribute | Tag | VR | PS3.4 Return Key Type | Source and notes |
|---|---|---|---|---|
| > Scheduled Procedure Step ID | (0040,0009) | SH | 1 | HL7 OBR-20 if present and at most 16 characters, otherwise the OBR sequence number. Always present. |
| > Scheduled Performing Physician’s Name | (0040,0006) | PN | 2 | Not available; returned zero-length when requested. |
| **Requested Procedure** | | | | |
| Requested Procedure ID | (0040,1001) | SH | 1 | OBR sequence number within the order (“1” for a single-procedure order). Always present. |
| Requested Procedure Description | (0032,1060) | LO | 1C | HL7 OBR-4 text. |
| Requested Procedure Code Sequence | (0032,1064) | SQ | 1C | Same item as the Scheduled Protocol Code Sequence; omitted when no usable code exists. |
| Study Instance UID | (0020,000D) | UI | 1 | Generated by the product (Section 8.3), one per order; shared by all requested procedures of the order. |
| **Imaging Service Request** | | | | |
| Accession Number | (0008,0050) | SH | 2 | HL7 OBR-2 (Placer Order Number). |
| Requesting Physician | (0032,1032) | PN | 2 | HL7 OBR-16. |
| Referring Physician’s Name | (0008,0090) | PN | 2 | HL7 OBR-16 (same value as Requesting Physician). |
| **Patient Identification / Demographics** | | | | |
| Patient’s Name | (0010,0010) | PN | 1 | HL7 PID-5. |
| Patient ID | (0010,0020) | LO | 1 | HL7 PID-3, first component, exactly as received (no normalisation). |
| Patient’s Birth Date | (0010,0030) | DA | 2 | HL7 PID-7. |
| Patient’s Sex | (0010,0040) | CS | 2 | HL7 PID-8. |
| **Additional (not part of the MWL return keys)** | | | | |
| Study Description | (0008,1030) | LO | — | HL7 OBR-4 text, for modalities that take the study description from this attribute. |

Attributes without a value in the database are left out of the response (or returned zero-length when requested), never filled with placeholders. Patient’s Birth Date, Patient’s Sex, Accession Number and the physician names may therefore be absent or zero-length.

**Table 4.2-11. Procedure code item** (used in (0032,1064) and (0040,0008))

| Attribute | Tag | VR | Source |
|---|---|---|---|
| Code Value | (0008,0100) | SH | HL7 OBR-4.1 |
| Coding Scheme Designator | (0008,0102) | SH | HL7 OBR-4.3; `L` (local coding scheme) when empty or longer than 16 characters |
| Code Meaning | (0008,0104) | LO | HL7 OBR-4.2; OBR-4.1 when the text is empty |

The code sequences are left out when OBR-4.1 is empty or longer than 16 characters, because a truncated code could select the wrong protocol on the modality.

**Value length handling.** The database keeps the full text received from HL7. When a value is longer than its VR allows (for example a procedure description over 64 characters), it is shortened at DICOM encoding to the VR maximum, ending in `...`, and a warning is written to the query log. Identifiers are never shortened: if the Accession Number, Patient ID, Study Instance UID, Scheduled Station AE Title or Scheduled Procedure Step ID exceeds its VR maximum, that one item is not returned (the others are) and an error is logged. Each Person Name component, and the whole name, is limited to 64 characters.

**Person names.** HL7 names are converted to the DICOM PN alphabetic component group, `Family^Given^Middle^Prefix^Suffix`, keeping the order received. For physician fields (HL7 XCN), a leading identifier component is removed and family and given name are used. Ideographic and phonetic component groups are not produced.

**Table 4.2-12. C-FIND response status**

| Service Status | Status Code | Meaning in this product |
|---|---|---|
| Pending | FF00 | One response per matching worklist item. FF01 is not used. |
| Success | 0000 | All matches sent. Also returned for zero matches, including an unknown Called AE Title or a Calling AE Title excluded by the Device filter. |
| Failure | 0110 (Processing failure) | The database could not be read. Short connection failures are retried up to three times before this status is returned. |
| Failure | 0110 (Processing failure) with Error Comment (0000,0902) | The licence does not allow serving. Error Comment is one of: `No WorklistBridge licence installed`, `WorklistBridge licence key not valid`, `WorklistBridge licence is for another installation`, `WorklistBridge evaluation licence expired`, `WorklistBridge subscription expired`, `WorklistBridge licence check failed: clock behind`, or `Device not licensed` (the Called AE Title maps only to Devices beyond the licensed number). No worklist items are sent. |
| Failure | 0122 (SOP Class not supported) | C-FIND on a presentation context that is not Modality Worklist FIND. |
| Cancel | FE00 (Matching terminated due to Cancel request) | The SCU sent C-CANCEL while the C-FIND was in progress (see below). |

**C-CANCEL.** C-CANCEL is supported. When a C-CANCEL-RQ arrives for a C-FIND in progress, the MWL Provider stops producing pending responses (a few responses already queued for sending may still arrive) and ends the C-FIND with status Cancel (FE00), also when the cancel arrives after the last pending response but before the final one. The association remains open. A C-CANCEL for a C-FIND that has already completed, or with an unknown Message ID Being Responded To, is ignored. A C-CANCEL that arrives before its C-FIND is processed ends that C-FIND with Cancel and no matches.

#### *4.2.1.4.3 SOP specific conformance – Verification*

The MWL Provider answers every C-ECHO request with status Success (0000). C-ECHO does not check the database or the Device configuration.

#### 4.2.1.5 Configuration-dependent behaviour

All Device settings are made in the web dashboard and take effect from the next query; no restart is needed. See Section 4.4.

#### 4.2.1.6 Summary of deviations and limitations

- Scheduled Performing Physician’s Name is accepted as a matching key but never excludes items, because the product holds no value for it.
- Only the first item of a Scheduled Procedure Step Sequence in the request is evaluated.
- String matching of the supported keys is case-insensitive.
- Associations are rejected only when the optional calling AE allow-list is enabled; otherwise access control is applied per query (Section 7).
- Specific Character Set of the request is not used to restrict the response character set; the response always uses the Device’s configured character set (Section 6).

## 4.3 Network interfaces

### 4.3.1 Physical network interface

The product uses the network interfaces of the host operating system and is independent of the physical medium.

### 4.3.2 Additional protocols

DICOM upper layer over TCP/IP (PS3.8). The listening socket is bound to all IPv4 interfaces of the host. No DHCP, DNS or other protocol is used by the DICOM AE. The database connection (Microsoft SQL Server, TDS) and the dashboard (HTTP) are separate from the DICOM interface.

### 4.3.3 IPv4 and IPv6 support

IPv4 is supported. IPv6 has not been tested and is not supported.

## 4.4 Configuration

### 4.4.1 AE Title / presentation address mapping

The MWL Provider has no single AE Title of its own. It answers on every Called AE Title, and the Called AE Title selects the Devices (Section 4.2.1.4.2). For each modality two AE Titles are configured:

**Table 4.4-1. AE Titles per Device**

| Setting | Meaning | Example |
|---|---|---|
| Device AE Title | The modality’s own AE Title. Returned in Scheduled Station AE Title and compared with the Calling AE Title. | `CT1` |
| Worklist Provider AE Title | The AE Title the modality is configured to query (its “worklist server” AE Title). | `CT1_WL` |

Both must be 1 to 16 printable ASCII characters without backslash and without leading or trailing spaces, and they must differ from each other. Several Devices may share a Worklist Provider AE Title; one Device AE Title may appear on several Devices.

**Table 4.4-2. Presentation address**

| Setting | Default |
|---|---|
| TCP port | 104 when not configured; the shipped configuration uses 4104 (`DicomServer:Port`). |
| IP address | All IPv4 interfaces of the host. |

## 4.4.2 Configurable parameters

**Table 4.4-3. Configuration parameters**

| Parameter | Where | Default | Effect |
|---|---|---|---|
| Listening port | `appsettings.json`, `DicomServer:Port` | 104 | Service restart required. |
| Device AE Title, Worklist Provider AE Title | Dashboard, per Device | — | Section 4.4.1. |
| Modality | Dashboard, per Device | — | Modality returned in the SPS and compared with the Modality matching key. |
| Station Name | Dashboard, per Device | empty | Returned in Scheduled Station Name. |
| Calling-AET filter | Dashboard, per Device | Ignore | Table 4.2-8. |
| Calling AE allow-list | `appsettings.json`, `DicomServer:CallingAeAllowList:Enabled` | false | Reject associations from Calling AE Titles not allowed (Section 7.2). Service restart required. |
| Allow active Device AE Titles | `appsettings.json`, `DicomServer:CallingAeAllowList:AllowActiveDevices` | true | With the allow-list enabled, the Device AE Title of every active Device is allowed; Device changes apply to the next association. |
| Allowed AE Titles | `appsettings.json`, `DicomServer:CallingAeAllowList:AETitles` | empty | Further allowed Calling AE Titles (for example test tools), case-insensitive. |
| Days before / days after | Dashboard, per Device | 0 / 0 | Widening of the requested date range (Section 4.2.1.4.2). |
| Allow worklist without date filter | Dashboard, per Device | On | Whether a query without a date returns items. |
| Character set | Dashboard, per Device | ISO_IR 192 | Section 6. |
| Active | Dashboard, per Device | On | Inactive Devices are never queried. |
| Licence key | Dashboard, Licence page | — | Whether queries are answered, and how many active Devices are served (the first N by Device ID; Table 4.2-12). |
| Query diagnostics | Dashboard, Diagnostics page | Off | Off / Debug / Trace detail in the query log (Section 7.3). Never changes the returned worklist. |
| Study Instance UID root | `appsettings.json` of the HL7 Importer, `DicomUid:Root` and `DicomUid:SystemId` | — | Section 8.3. |

| Parameter | Where | Default | Effect |
|---|---|---|---|
| Maximum PDU size, timeouts | Not configurable | 262 144 bytes; none | Section 4.2.1.2. |

# 5. Media Interchange

Not supported.

# 6. Support of Character Sets

The character set of the response is configured per Device. The database stores all text as Unicode; conversion to the Device's character set happens only when the DICOM response is encoded.

**Table 6-1. Supported Specific Character Set values**

| Defined Term | Character set | (0008,0005) in response |
|---|---|---|
| ISO_IR 192 | Unicode in UTF-8. Default. Every character is preserved. | `ISO_IR 192` |
| ISO_IR 100 | Latin alphabet No. 1 (Western European) | `ISO_IR 100` |
| ISO_IR 101 | Latin alphabet No. 2 (Central European) | `ISO_IR 101` |
| ISO_IR 110 | Latin alphabet No. 4 (Northern European / Baltic) | `ISO_IR 110` |
| ISO_IR 144 | Cyrillic | `ISO_IR 144` |
| ISO_IR 6 | Default repertoire (ASCII) | omitted |

Code extension techniques (ISO 2022 escape sequences) and multi-byte sets other than UTF-8 are not supported. Only one character set is used in a response.

**Characters outside the configured set.** For single-byte sets, every text value of the response is converted character by character:

1. A character the set contains is kept.
2. A small number of letters without a decomposition are spelled out (for example `ß` → `ss`, `Æ` → `AE`, `Ø` → `O`, `Ł` → `L`).
3. Otherwise the character's diacritical marks are removed if the base letter fits (for example `Ė` → `E`, `Ž` → `Z`).
4. Anything else becomes `?` (for example Cyrillic letters in a Latin set).

The conversion happens before VR length limits are applied, so a spelled-out letter cannot make a value exceed its maximum length. Identifiers such as Patient ID are converted the same way; sites that use non-ASCII characters in identifiers should use ISO_IR 192. Use ISO_IR 192 wherever the modality supports it.

**Requests.** The Specific Character Set of the request is used to decode the request identifier. Matching on non-ASCII values in the supported keys is done on the decoded Unicode text.

# 7. Security

## 7.1 Security profiles

No DICOM security profiles are supported. DICOM communication is not encrypted (no TLS) and not authenticated. User Identity Negotiation is answered but not evaluated.

## 7.2 Association-level and query-level access control

By default, associations are accepted from any host and any AE Title. An optional calling AE allow-list (`DicomServer:CallingAeAllowList`, Table 4.4-3) rejects associations whose Calling AE Title is neither the Device AE Title of an active Device nor on a configured list, with A-ASSOCIATE-RJ *calling-AE-title-not-recognized* (Table 4.2-6); each rejection is recorded in the query log. In all cases, access to worklist content is controlled per query by the Called AE Title (which selects the Devices) and the per-Device calling-AET filter (Table 4.2-8). Set the calling-AET filter to *Required* where a worklist must be visible only to the modality it belongs to. Neither is an authentication mechanism, because AE Titles can be chosen freely by any network peer.

The product is intended for a protected hospital network. Restrict access to the DICOM port with firewall rules or network segmentation to the modalities that need it.

## 7.3 Audit and logging

Every C-FIND, and every association rejected by the calling AE allow-list, is recorded in the database query log with the time (local and UTC), Called and Calling AE Title, remote IP address, resolved Device, requested modality, date and identifier keys (Patient’s Name, start time and performing physician keys appear in the interpreted request with diagnostics on), number of returned items, success flag and any error or warning, together with the list of returned items. With diagnostics set to *Debug*, the interpreted request and the reasons for an empty result are added. With *Trace*, the raw request identifier and the reason each item was excluded are also stored; Trace can store patient-identifying data and is meant only for troubleshooting. The log is visible on the dashboard.

Service events (associations, releases, aborts and errors) are written to the application log; when running as a Windows service, warnings and errors also go to the Windows Event Log.

## 7.4 Dashboard and database

The web dashboard requires an administrator sign-in (hashed password, session cookie with an 8-hour sliding expiry, anti-forgery protection). It listens on `localhost` by default; when exposed to the network it should be placed behind HTTPS. Access to the SQL Server database is protected by SQL Server authentication and the database’s own access controls.

# 8. Annexes

## 8.1 IOD contents

### 8.1.1 Created SOP instances

The product does not create, store or send composite SOP instances. The MWL response identifiers are described in Table 4.2-10.

### 8.1.2 Usage of attributes from received IODs

Not applicable; no IODs are received.

### 8.1.3 Attribute mapping

The mapping of HL7 order fields to the returned worklist attributes is given in Table 4.2-10 and Annex A. The values the modality copies from the worklist into its images (Patient ID, Accession Number, Study Instance UID, Requested Procedure ID, procedure codes) let the PACS and RIS match the acquired study to the order.

### 8.1.4 Coerced or modified fields

The product does not receive DICOM objects and therefore does not coerce received values. Values sent are modified only as described in Section 4.2.1.4.2 (length handling, person-name conversion) and Section 6 (character set conversion).

## 8.2 Data dictionary of private attributes

No private attributes are used.

## 8.3 Study Instance UID generation

The Study Instance UID is generated once per order (Placer Order Number) by the HL7 Importer, stored, and returned unchanged for every later query and every update of the order. It has the form

```
<root>.<system id>.<device id>.<yyyyMMddHHmmss>.9<7-digit internal order number>.<5-digit random>
```

where *root* and *system id* are configured by the site (the root must be an OID the site or vendor controls, or a `2.25` UUID-derived root). All requested procedures (OBR segments) of one order share the same Study Instance UID.

## 8.4 Coded terminology and templates

The procedure code is taken from HL7 OBR-4 (Table 4.2-11). The coding scheme designator is the one sent by the RIS in OBR-4.3, or `L` (local) when none is sent. No context groups or templates are used.

## 8.5 Grayscale image consistency

Not applicable.

### 8.6 Standard extended, specialized and private SOP classes

None.

### 8.7 Private transfer syntaxes

None.

## Annex A. HL7 Order Interface

This annex summarises the HL7 side because it determines the content of the worklist. It is not part of DICOM conformance.

### A.1 HL7 v2 interface

| Item | Support |
|---|---|
| Messages | HL7 v2.3 – v2.5.1 ORM^O01 (General Order) and v2.5+ OMI^O23 (Imaging Order, IHE Scheduled Workflow). Other message types are rejected. |
| Transport | Files placed in a configured folder; processed files are moved to a processed or error folder. Optionally MLLP over TCP (default port 2575, optional client IP allow-list): each message is imported before an original-mode ACK is returned, `AA` imported, `AE` the message cannot be imported, `AR` not imported for a reason outside the message (database unavailable, licence stopped with the reason in MSA-3, too large, no MSH). |
| Segments used | MSH, PID, ORC, TQ1 (v2.5+), OBR (one or more per message), IPC (OMI^O23). Optional segments may be absent. |
| Delimiters | Taken from MSH-1 and MSH-2; HL7 escape sequences are decoded. |
| Character encoding | UTF-8; input that is not valid UTF-8 is read in the ISO 8859 part declared in MSH-18, else Windows-1257. |
| Order identity | OBR-2.1 (Placer Order Number). A message with an existing Placer Order Number updates the order. |
| One worklist item per | OBR segment. With OMI^O23, only the first IPC segment of an OBR is used. |
| Routing to a Device | Configurable rules on OBR-18, OBR-19 or IPC-9. An order that matches no rule, or that matches a Device beyond the licensed number, is stored without a worklist item, and the failure is logged with the Placer Order Number and the routing values. A cancellation without routing information still withdraws every item of the order. |
| Cancellation | ORC-1 control codes (default `CA, OC, CR, DC, OD, DR`) and/or ORC-5 order status (default `CA, DC`), configurable. A cancelled order is removed from the worklist. |
| Atomicity | Each message is stored in one database transaction (all OBR segments or none). |
| Licence stopped | Files stay in the input folder and are imported once a valid licence key is entered; MLLP messages are answered `AR`. |

**Table A-1. Field mapping**

| HL7 field | DICOM attribute |
|---|---|
| PID-3.1 | Patient ID (0010,0020) |
| PID-5 | Patient’s Name (0010,0010) |

| HL7 field | DICOM attribute |
|---|---|
| PID-7 | Patient's Birth Date (0010,0030) |
| PID-8 | Patient's Sex (0010,0040) |
| OBR-2.1 (OMI^O23: IPC-1, when present) | Accession Number (0008,0050) |
| OBR-4.1 / 4.2 / 4.3 | Procedure code item; 4.2 also Requested Procedure Description, SPS Description, Study Description |
| OBR-16 | Requesting Physician (0032,1032), Referring Physician's Name (0008,0090) |
| OBR-18 / OBR-19 / IPC-9 | Device routing (determines Modality, Scheduled Station AE Title, Station Name) |
| OBR-20 (OMI^O23: IPC-4, when present) | Scheduled Procedure Step ID (0040,0009) |
| OBR-36, else TQ1-7 | Scheduled Procedure Step Start Date and Time (0040,0002 / 0040,0003) |
| OBR-1 (Set ID; position of the OBR when empty) | Requested Procedure ID (0040,1001); Scheduled Procedure Step ID when no other value is given |

### A.2 FHIR R4 order interface (optional)

| Item | Support |
|---|---|
| Endpoint | `POST [base]/fhir` with a FHIR R4 JSON transaction Bundle; `GET [base]/fhir/metadata` returns a CapabilityStatement. |
| Content | One Patient, one or more ServiceRequests, optionally a Practitioner. Orders are upserted by the ServiceRequest identifier of type `PLAC`. |
| Authentication | Bearer token per sending system. |
| Routing to a Device | Configurable rules on `ServiceRequest.locationCode`, else `locationReference` (routing source FHIR-LOCATION), with the same unrouted and unlicensed-Device handling as HL7. |
| Withdrawal | ServiceRequest status `revoked`, `entered-in-error`, `draft` or `on-hold` (configurable) removes the order from the worklist. |
| Responses | 200 transaction-response (per-entry warning for an unrouted order), 400, 401, 403 (licence stopped; nothing stored), 413, 415, 422, 503. |

Orders received through FHIR go through the same database path as HL7 orders and appear on the worklist in the same way.

## Annex B. Verification Record

Revision 1.0 was derived from the source code at revision `1c45555` and checked on 12 October 2026 against a running instance: SQL Server 2022, the HL7 Importer and the MWL Provider built from that revision, loaded with 14 test orders on four Devices (calling-AET filters Ignore, IfProvided and Required).

| Area | Tool | Result |
|---|---|---|
| C-ECHO | dcmtk `echoscu` 3.6.7 | Success |
| Implementation identity, maximum PDU | dcmtk, pynetdicom 3.0.4 | 1.3.6.1.4.1.30071.8 / fo-dicom 5.2.5 / 262 144 bytes |

| Area | Tool | Result |
|---|---|---|
| Transfer syntaxes, each proposed alone | pynetdicom | Implicit LE, Explicit LE, Deflated accepted; Explicit Big Endian and JPEG Baseline rejected (4) |
| Unsupported abstract syntaxes | pynetdicom, dcmtk `findscu -P/-S` | Patient Root and Study Root FIND, MPPS, Storage Commitment rejected (3) |
| Unknown Called AE Title | pynetdicom, findscu | Association accepted; C-FIND returns 0 matches, Success |
| Calling-AET filter | findscu | Ignore, IfProvided and Required behave as Table 4.2-8 |
| Cancelled order | findscu | Not returned |
| Matching keys | findscu (17 queries) | As Table 4.2-9, including wildcards, case-insensitivity, date widening and the unsupported keys |
| Return keys, zero-length requested keys | findscu + dcmdump | As Table 4.2-10 |
| Character sets | findscu + dcmdump, Device switched through all six values | As Table 6-1 and the conversion rules |
| C-CANCEL | findscu `--cancel 1` | All responses and final Success sent, then association aborted |
| Extended negotiation | pynetdicom | Role selection and asynchronous window echoed; User Identity positive response |
| Concurrent associations | pynetdicom | 10 of 10 established, C-ECHO Success on each |
| Idle association | pynetdicom | Still open after 600 s without traffic; C-ECHO then Success |

Revision 1.1 (source revision `81cd490`) was checked the same day on SQL Server 2022 with the HL7 Importer (files and MLLP), the FHIR intake, the MWL Provider and the dashboard, using a perpetual licence key for two of three Devices and an expired subscription key:

| Area | Tool | Result |
|---|---|---|
| C-FIND without a licence key | pynetdicom | 0110, Error Comment `No WorklistBridge licence installed`, no items |
| C-FIND with an expired subscription | pynetdicom | 0110, Error Comment `WorklistBridge subscription expired` |
| C-FIND to a Device beyond the licensed number | pynetdicom | 0110, Error Comment `Device not licensed`; the licensed Devices return their items with status 0000 |
| Orders from files, MLLP (v2.3 ORM, v2.5.1 OMI^O23 in ISO 8859-4) and FHIR R4 | pynetdicom | All returned on the routed Device; non-ASCII Baltic names intact |

Revision 1.2 (source revision `8ed42d7`) was checked the same day on SQL Server 2022 with the HL7 Importer and the MWL Provider, using the 14 test orders above and a perpetual licence key:

| Area | Tool | Result |
|---|---|---|
| Modality `*`, `C*`, `MR` on a CT Device | findscu | 3, 3 and 0 matches |
| Patient's Name `NOV*`, exact name with trailing `^^^`, family name only, `ZZZ*` | findscu | 1, 1, 0 and 0 matches |

| Area | Tool | Result |
|---|---|---|
| SPS Start Time `0800-0900`, `0900-`, `2200-2300`; date plus time range | findscu | 1, 2 and 0 matches; date-time range as Section 4.2.1.4.2, including Device widening |
| Scheduled Performing Physician's Name with a value | findscu | All items returned |
| C-CANCEL after 5 responses on a 3000-item worklist | findscu `--cancel 5` | Final status Cancel (FE00); association released normally |
| C-CANCEL for a completed C-FIND | pynetdicom | Ignored; next C-FIND on the same association Success |
| Calling AE allow-list enabled with `FINDSCU` listed | dcmtk `echoscu` | `CT1` (active Device) and `FINDSCU` accepted; `OTHER` rejected (rejected-permanent, service-user, calling-AE-title-not-recognized), query log row written |

The scripts used are kept with this document (`verification/verify-conformance.sh`, `verification/negotiation_checks.py`) and with the release hand-off (`handoffs/pr-stack/stack_e2e.py`).