DICOM 3.0 Conformance Statement

for

Navigator

Orchestrating Medical Imaging Workflow

Laurel Bridge Software, Inc.
302-453-0222
160 E Main St
Newark, DE 19711
info@laurelbridge.com
www.laurelbridge.com

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1 Conformance Statement Overview

Navigator is a software application that queries one or more DICOM modality worklist servers or is triggered by the receipt of HL7 order messages. Based on these triggers, Navigator manages the transfer of medical images or other DICOM instances between various DICOM devices. Navigator is often used to implement pre-fetching of prior studies based on the discovery of an order for a new study. Navigator functions primarily as an SCU of the Modality Worklist service as well as an SCU of various Query/Retrieve services.

Table 1-1 provides an overview of the DICOM network services supported by Navigator.

Table 1-1 Network Services

SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Query/Retrieve		
Patient Root Query/Retrieve Information Model - FIND	Yes	No
Patient Root Query/Retrieve Information Model - MOVE	Yes	No
Study Root Query/Retrieve Information Model - FIND	Yes	No
Study Root Query/Retrieve Information Model - MOVE	Yes	No
Patient/Study Only Query/Retrieve Information Model - FIND (Retired)	Yes	No
Patient/Study Only Query/Retrieve Information Model - MOVE (Retired)	Yes	No
Workflow Management		
Modality Worklist Information Model - FIND	Yes	No*
Verification	Yes	No*

2 Table of Contents

2.1 Tables

2.2 Figures

3 Introduction

3.1 Revision History

Document Version	Date of Issue	Author	Description
1.0	10 May 2018	MEL	Initial creation
2.1.8	11 May 2018	BRH	Initial Release

3.2 Audience

This document is written for the people that need to understand how Navigator will integrate into their healthcare facility. This includes both those responsible for overall imaging network policy and architecture, as well as integrators who need to have a detailed understanding of the DICOM features of the product. This document contains some basic DICOM definitions so that any reader may understand how this product implements DICOM features. However, integrators are expected to fully understand all the DICOM terminology, how the tables in this document relate to the product's functionality, and how that functionality integrates with other devices that support compatible DICOM features.

3.3 Remarks

The scope of this DICOM Conformance Statement is to facilitate integration between Navigator and other DICOM products. The Conformance Statement should be read and understood in conjunction with the DICOM Standard. DICOM by itself does not guarantee interoperability. The Conformance Statement does, however, facilitate a first-level comparison for interoperability between different applications supporting compatible DICOM functionality. This Conformance Statement is not supposed to replace validation with other DICOM equipment to ensure proper exchange of intended information. In fact, the user should be aware of the following important issues:

- The comparison of different Conformance Statements is just the first step towards assessing interconnectivity and interoperability between the product and other DICOM conformant equipment.
- Test procedures should be defined and executed to validate the required level of interoperability with specific compatible DICOM equipment, as established by the healthcare facility.

3.4 Terms and Definitions

Informal definitions are provided for the following terms used in this Conformance Statement. The DICOM Standard is the authoritative source for formal definitions of these terms.

Abstract Syntax – the information agreed to be exchanged between applications, generally equivalent to a Service/Object Pair (SOP) Class. Examples: Verification SOP Class, Modality Worklist Information Model Find SOP Class, Computed Radiography Image Storage SOP Class.

Application Entity (AE) – an end point of a DICOM information exchange, including the DICOM network or media interface software; i.e., the software that sends or receives DICOM information objects or messages. A single device may have multiple Application Entities.

Application Entity Title – the externally known name of an Application Entity, used to identify a DICOM application to other DICOM applications on the network.

Application Context – the specification of the type of communication used between Application Entities. Example: DICOM network protocol.

Association – a network communication channel set up between Application Entities.

Attribute – a unit of information in an object definition; a data element identified by a tag. The information may be a complex data structure (Sequence), itself composed of lower level data elements. Examples: Patient ID (0010,0020), Accession Number (0008,0050), Photometric Interpretation (0028,0004), Procedure Code Sequence (0008,1032).

Information Object Definition (IOD) – the specified set of Attributes that comprise a type of data object; does not represent a specific instance of the data object, but rather a class of similar data objects that have the same properties. The Attributes may be specified as Mandatory (Type 1), Required but possibly unknown (Type 2), or Optional (Type 3), and there may be conditions associated with the use of an Attribute (Types 1C and 2C). Examples: MR Image IOD, CT Image IOD, Print Job IOD.

Joint Photographic Experts Group (JPEG) – a set of standardized image compression techniques, available for use by DICOM applications.

Media Application Profile – the specification of DICOM information objects and encoding exchanged on removable media (e.g., CDs)

Module – a set of Attributes within an Information Object Definition that are logically related to each other. Example: Patient Module includes Patient Name, Patient ID, Patient Birth Date, and Patient Sex.

Negotiation – first phase of Association establishment that allows Application Entities to agree on the types of data to be exchanged and how that data will be encoded.

Presentation Context – the set of DICOM network services used over an Association, as negotiated between Application Entities; includes Abstract Syntaxes and Transfer Syntaxes.

Protocol Data Unit (PDU) – a packet (piece) of a DICOM message sent across the network. Devices must specify the maximum size packet they can receive for DICOM messages.

Security Profile – a set of mechanisms, such as encryption, user authentication, or digital signatures, used by an Application Entity to ensure confidentiality, integrity, and/or availability of exchanged DICOM data

Service Class Provider (SCP) – role of an Application Entity that provides a DICOM network service; typically, a server that performs operations requested by another Application Entity (Service Class User). Examples: Picture Archiving and Communication System (image storage SCP, and image query/retrieve SCP), Radiology Information System (modality worklist SCP).

Service Class User (SCU) – role of an Application Entity that uses a DICOM network service; typically, a client. Examples: imaging modality (image storage SCU, and modality worklist SCU), imaging workstation (image query/retrieve SCU)

Service/Object Pair (SOP) Class – the specification of the network or media transfer (service) of a particular type of data (object); the fundamental unit of DICOM interoperability specification. Examples: Ultrasound Image Storage Service, Basic Grayscale Print Management. Service/Object Pair (SOP) Instance – an information object; a specific occurrence of information exchanged in a SOP Class. Examples: a specific x-ray image.

Tag – a 32-bit identifier for a data element, represented as a pair of four-digit hexadecimal numbers, the “group” and the “element”. If the “group” number is odd, the tag is for a private (manufacturer-specific) data element. Examples: (0010,0020) [Patient ID], (07FE,0010) [Pixel Data], (0019,0210) [private data element]

Transfer Syntax – the encoding used for exchange of DICOM information objects and messages. Examples: JPEG compressed (images), little endian explicit value representation.

Unique Identifier (UID) – a globally unique “dotted decimal” string that identifies a specific object or a class of objects; an ISO-8824 Object Identifier. Examples: Study Instance UID, SOP Class UID, SOP Instance UID.

Value Representation (VR) – the format type of an individual DICOM data element, such as text, an integer, a person’s name, or a code. DICOM information objects can be transmitted with either explicit identification of the type of each data element (Explicit VR), or without explicit identification (Implicit VR); with Implicit VR, the receiving application must use a DICOM data dictionary to look up the format of each data element.

3.5 Basics of DICOM Communication

This section describes terminology used in this Conformance Statement for the non-specialist. The key terms used in the Conformance Statement are highlighted in italics below. This section is not a substitute for training about DICOM, and it makes many simplifications about the meanings of DICOM terms.

Two Application Entities (devices) that want to communicate with each other over a network using DICOM protocol must first agree on several things during an initial network "handshake". One of the two devices must initiate an Association (a connection to the other device), and ask if specific services, information, and encoding can be supported by the other device (Negotiation).

DICOM specifies a number of network services and types of information objects, each of which is called an Abstract Syntax for the Negotiation. DICOM also specifies a variety of methods for encoding data, denoted Transfer Syntaxes. The Negotiation allows the initiating Application Entity to propose combinations of Abstract Syntax and Transfer Syntax to be used on the Association; these combinations are called Presentation Contexts. The receiving Application Entity accepts the Presentation Contexts it supports.

For each Presentation Context, the Association Negotiation also allows the devices to agree on Roles – which one is the Service Class User (SCU - client) and which is the Service Class Provider (SCP - server). Normally the device initiating the connection is the SCU, i.e., the client system calls the server, but not always.

The Association Negotiation finally enables exchange of maximum network packet (PDU) size, security information, and network service options (called Extended Negotiation information).

The Application Entities, having negotiated the Association parameters, may now commence exchanging data. Common data exchanges include queries for worklists and lists of stored images, transfer of image objects and analyses (structured reports), and sending images to film printers. Each exchangeable unit of data is formatted by the sender in accordance with the appropriate Information Object Definition and sent using the negotiated Transfer Syntax. There is a Default Transfer Syntax that all systems must accept, but it may not be the most efficient for some use cases. Each transfer is explicitly acknowledged by the receiver with a Response Status indicating success, failure, or that query or retrieve operations are still in process.

Two Application Entities may also communicate with each other by exchanging media (such as a CD-R). Since there is no Association Negotiation possible, they both use a Media Application Profile that specifies "pre-negotiated" exchange media format, Abstract Syntax, and Transfer Syntax.

3.6 Abbreviations

AE	Application Entity
AET	Application Entity Title
CSE	Customer Service Engineer
DHCP	Dynamic Host Configuration Protocol
DICOM	Digital Imaging and Communications in Medicine
DNS	Domain Name System
GSDF	Grayscale Standard Display Function
GSPS	Grayscale Softcopy Presentation State
HIS	Hospital Information System
HL7	Health Level 7 Standard
IHE	Integrating the Healthcare Enterprise
IOD	Information Object Definition
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6

ISO	International Organization for Standards
JPEG	Joint Photographic Experts Group
LDAP	Lightweight Directory Access Protocol
LUT	Look-up Table
MPEG	Moving Picture Experts Group
MPPS	Modality Performed Procedure Step
MR	Magnetic Resonance Imaging
MSPS	Modality Scheduled Procedure Step
MTU	Maximum Transmission Unit (IP)
MWL	Modality Worklist
NTP	Network Time Protocol
O	Optional (Key Attribute)
OSI	Open Systems Interconnection
PACS	Picture Archiving and Communication System
PDU	Protocol Data Unit
R	Required (Key Attribute)
RIS	Radiology Information System.
SCP	Service Class Provider
SCU	Service Class User
SOP	Service-Object Pair
SPS	Scheduled Procedure Step
TCP/IP	Transmission Control Protocol/Internet Protocol
U	Unique (Key Attribute)
UL	Upper Layer
VL	Visible Light
VR	Value Representation

3.7 References

NEMA PS3 Digital Imaging and Communications in Medicine (DICOM) Standard, available for free at http://www.dicomstandard.org/

4 Networking

4.1 Implementation Model

4.1.1 Application Data Flow

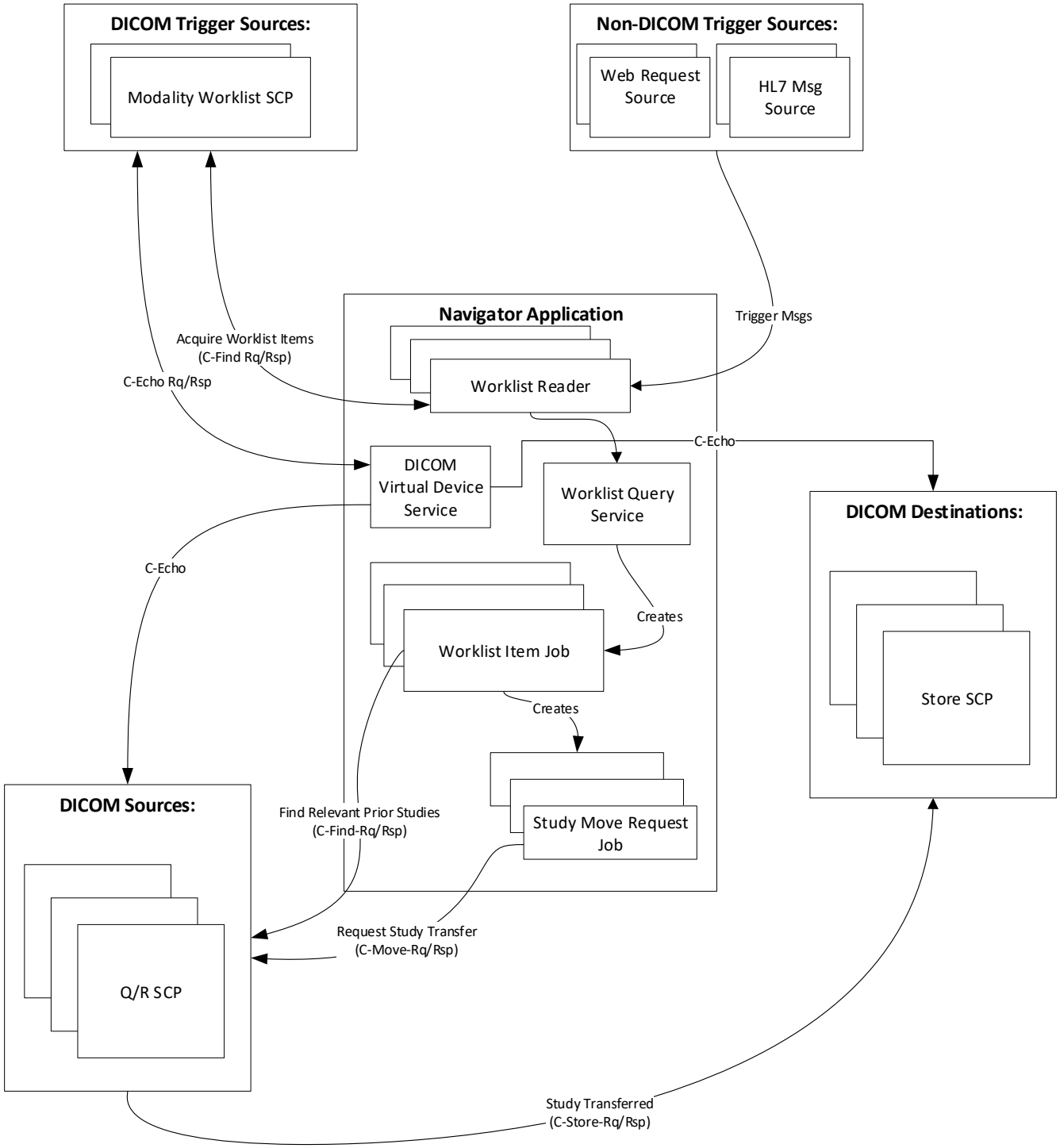

Figure 4-1 Navigator Application: High-Level DICOM Data Flow

4.1.2 Functional Definition of AE's

The Navigator Application is a multi-threaded program that makes use of multiple DICOM service classes as a client or SCU (Service Class User). In the simplest configuration, to external entities, the Navigator can be viewed as a single Application Entity that initiates associations for DICOM Verification, Modality Worklist and Query/Retrieve service classes (**Navigator SCU Application Entity).** The use of Query/Retrieve is divided between components performing C-Find requests and C-Move requests.

For the purpose of this document, detailed descriptions will be given for Verification-SCU, Modality Worklist C-Find SCU, Q/R C-Find-SCU and Q/R C-Move-SCU functionality.

All DICOM devices known to Navigator are defined as `DicomVDevices` or Virtual Devices.

Each `DicomVDevice` is defined with the parameters used to set up both the remote and local side of a DICOM connection:

- local-host-address
- local-port
- local (calling) AE title
- local configuration settings
- remote-host-address
- remote-port
- remote (called) AE title.

Additionally, DICOM Virtual Devices are configured with the roles that they can perform (trigger, source, destination).

- A Trigger device is one that implements Modality Worklist as an SCP.
- A Source device is one that implements Query/Retrieve as an SCP.
- A Destination device implements Store as an SCP.

A single device might implement multiple roles. Also, for various reasons, multiple configured DICOM Virtual Devices might refer to a single physical device.

4.1.2.1 Verification-SCU

The `DicomVDeviceService` (DICOM Virtual Device Service) is responsible for managing the storage of configuration information for DICOM devices and also for polling those devices to verify their status. On a configurable time period, every enabled `DicomVDevice` is queried using the Verification service class. See the section under Sequencing of Real-World Activities for more details. By default, the C-Echo-Request will have the following content:

```
C-ECHO-RQ:
Command:
(0000, 0000) UL(  4) Group Length                 56
(0000, 0002) UI( 18) Affected SOP Class UID       1.2.840.10008.1.1 (Verification SOP
Class)
(0000, 0100) US(  2) Command Field                48
(0000, 0110) US(  2) Message ID                   0
(0000, 0800) US(  2) Data Set Type                257
```

4.1.2.2 Modality Worklist C-Find SCU

On a configurable time period, the `WorklistQueryService` will query the SCP associated with each enabled DICOM MWL Worklist Reader using the C-Find-Request DIMSE message. See the section under Sequencing of Real-World Activities for more details. By default, the C-Find-Request will have the following content:

```
C-FIND-RQ:
Command:
(0000, 0002) UI( 22) Affected SOP Class UID          1.2.840.10008.5.1.4.31 (Modality
Worklist Information Model - FIND)
(0000, 0100) US(  2) Command Field                   32
(0000, 0110) US(  2) Message ID                      0
(0000, 0700) US(  2) Priority                        1
(0000, 0800) US(  2) Data Set Type                   256
Data:
(0008, 0020) DA(  0) Study Date
(0008, 0030) TM(  0) Study Time
(0008, 0050) SH(  0) Accession Number
(0010, 0010) PN(  0) Patient's Name
(0010, 0020) LO(  0) Patient ID
(0010, 0030) DA(  0) Patient's Birth Date
(0010, 0040) CS(  0) Patient's Sex
(0020, 000d) UI(  0) Study Instance UID
(0032, 1060) LO(  0) Requested Procedure Description
(0040, 0100) SQ( -1) Scheduled Procedure Step Sequence
   item[0]
    (0008, 0060) CS(  0) Modality
    (0040, 0001) AE(  0) Scheduled Station AE Title
    (0040, 0002) DA( 18) Scheduled Procedure Step Start Date         20180129-20180130
    (0040, 0003) TM(  0) Scheduled Procedure Step Start Time
```

Note that the only "match" field by default is the `scheduled-procedure-step-start-date` in the Scheduled Procedure Step Sequence, which is populated with an example date range of one day.

The remainder of the fields are "return" fields, i.e., they are empty in the request, but are expected to be populated in the response messages generated by the SCP.

Filters may be defined such that different queries may be sent – for example, the modality field might be populated with a particular value for matching – e.g., "MG". In most cases, the broad query is sent, and the Navigator application relies on post-processing of the received responses to isolate the desired items. The `WorklistQueryService` will create a `WorklistItemJob` for each new Modality Worklist Response that is returned by the SCP.

4.1.2.3 Query Retrieve C-Find SCU

`WorklistItemJob` objects that are created by the `WorklistQueryService` are added to a queue which is processed by a pool of threads. The number of threads that process these jobs is configurable. When a `WorklistItemJob` is dequeued and executed by a thread pool member a DICOM association is created for each configured source device and a DICOM C-Find-Request is sent to that device. By default, the content of the C-Find-Request message will be similar to the following:

```
C-FIND-RQ:
Command:
(0000, 0002) UI( 28) Affected SOP Class UID          1.2.840.10008.5.1.4.1.2.2.1 (Study
Root Query/Retrieve Information Model - FIND)
(0000, 0100) US(  2) Command Field                   32
(0000, 0110) US(  2) Message ID                      0
(0000, 0700) US(  2) Priority                        1
(0000, 0800) US(  2) Data Set Type                   256
Data:
(0008, 0020) DA( 10) Study Date                      20130101-
(0008, 0030) TM(  0) Study Time
(0008, 0050) SH(  0) Accession Number
(0008, 0052) CS(  6) Query/Retrieve Level            STUDY
(0008, 0054) AE(  0) Retrieve AE Title
(0008, 0060) CS(  0) Modality
(0008, 1030) LO(  0) Study Description
(0010, 0010) PN( 10) Patient's Name                  Doe^Jane
(0010, 0020) LO(  0) Patient ID                             12345
(0010, 0030) DA(  0) Patient's Birth Date
(0010, 0040) CS(  0) Patient's Sex
(0020, 000d) UI(  0) Study Instance UID
```

The query/retrieve level is fixed with the value "`STUDY`". Typically, either the patient's name or patient-id are included in the query. In the example, we show both. From the user interface, the user might configure Navigator to send a "fuzzy" name containing wild-card characters. For example: if the option "last name + first 3 characters of first" is selected for patient name, then the previous name would be sent as "`Doe^Jan*`". Depending on settings for selecting studies based on age, the Study Date field may be a date range in the form `YYYYMMDD-YYYYMMDD` where either one or both of the dates may be present. Filters may be defined such that different queries may be sent.

A source device can be configured such that a different Query/Retrieve SOP class is requested – i.e. Patient-Root or Patient-Study-Root-Retired can be selected.

After determining which C-Find-Responses indicate studies that are to be fetched from a given source to a given destination, the `WorklistItemJob` will create a `StudyMoveRequestJob` object for each *study-instance-uid + source + destination* combination identified.

4.1.2.4 Query Retrieve C-Move SCU

`StudyMoveRequestJob` objects that are created by `WorklistItemJob` objects are added to a queue which is processed by a pool of threads. The number of threads that process these jobs is configurable. The queue and the thread-pool for processing `StudyMoveRequestJobs` is separate from those for the `WorklistItemJobs`. When a `StudyMoveRequestJob` is dequeued and executed by a thread pool member a DICOM association is created to the source device and a DICOM C-Move-Request is sent to that device. By default, the content of the C-Move-Request message will be similar to the following:

```
C-MOVE-RQ:
Command:
(0000, 0000) UL(  4) Group Length                    98
(0000, 0002) UI( 28) Affected SOP Class UID          1.2.840.10008.5.1.4.1.2.2.2 (Study
Root Query/Retrieve Information Model - MOVE)
(0000, 0100) US(  2) Command Field                   33
(0000, 0110) US(  2) Message ID                      0
(0000, 0600) AE( 14) Move Destination                READING_STN_1
(0000, 0700) US(  2) Priority                        1
(0000, 0800) US(  2) Data Set Type                   256
Data:
(0008, 0052) CS(  6) Query/Retrieve Level            STUDY
(0020, 000d) UI(  6) Study Instance UID              3.1.1
```

The move destination `(0000,0600)` element will contain the called-ae-title for the configured Dicom Virtual Device that is the destination of the move request.

Note that the Navigator application does not participate in the association on which the C-Store move sub-operations are sent. If filtering or custom routing/multiplexing of instances (C-Store-Requests) is required, the Laurel Bridge Compass application may be configured as the move destination from the perspective of the source archive device.

4.1.3 Sequencing of Real-World Activities

4.1.3.1 New procedure/study is detected on modality worklist server, and prior studies are fetched from source archive to destination archive

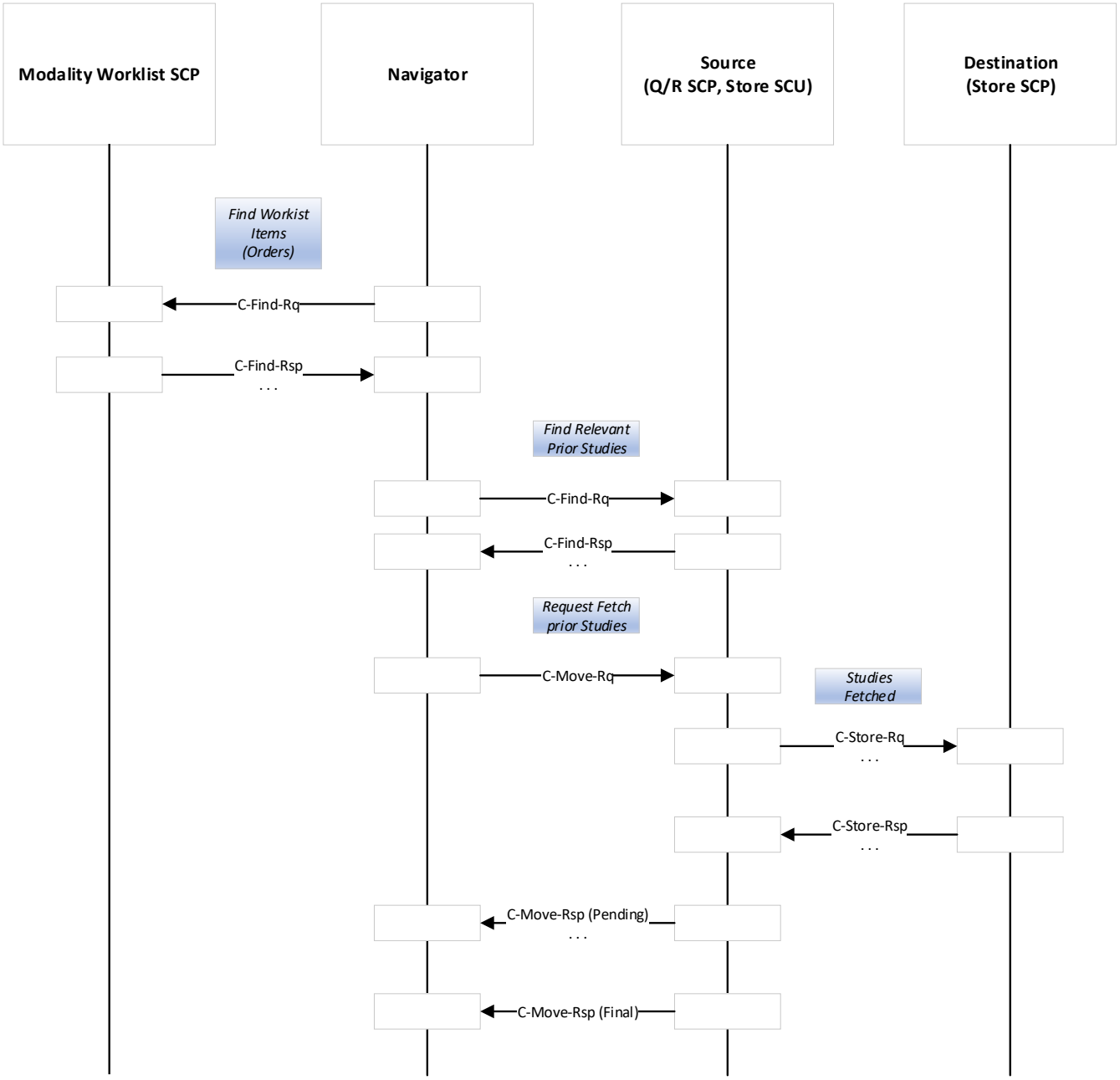

Figure 4-2 New procedure/study is detected on modality worklist

4.2 AE Specifications

4.2.1 Navigator SCU Application Entity (SCU AE) Specification

4.2.1.1 SOP Classes

Navigator provides Standard Conformance to the following DICOM V3.0 SOP Classes:

Table 4-1 SOP Classes for Navigator SCU AE

SOP Classes	SOP Class UID	SCU	SCP
Modality Worklist Information Model –FIND	1.2.840.10008.5.1.4.31	Yes	No
Query Retrieve – Patient Root FIND	1.2.840.10008.5.1.4.1.2.1.1	Yes	No
Query Retrieve – Patient Root MOVE	1.2.840.10008.5.1.4.1.2.1.2	Yes	No
Query Retrieve – Study Root FIND	1.2.840.10008.5.1.4.1.2.2.2	Yes	No
Query Retrieve – Study Root MOVE	1.2.840.10008.5.1.4.1.2.2.3	Yes	No
Query Retrieve – Patient Study Only Retired FIND	1.2.840.10008.5.1.4.1.2.3.2	Yes	No
Query Retrieve – Patient Study Only Retired MOVE	1.2.840.10008.5.1.4.1.2.3.3	Yes	No
Verification	1.2.840.10008.1.1	Yes	No

4.2.1.2 Association Policies

4.2.1.2.1 General

The SCU AE can only request the opening of an Association. It cannot accept requests to open Associations from external Application Entities.

The DICOM standard Application Context Name for DICOM is always proposed:

Table 4-2 DICOM Application Context for SCU AE

Application Context Name	1.2.840.10008.3.1.1.1

4.2.1.2.2 Number of Associations

The maximum number of simultaneous Associations is configurable.

Currently, the SCU AE will create only one simultaneous association for sending C-Echo (Verification) requests. A single thread in the `DicomVDeviceService` wakes up on a configurable period and sequentially creates an association and sends a single C-Echo-Request to each enabled device.

Similarly, the SCU AE will create only one simultaneous association for sending C-Find requests to each of the configured Modality-Worklist SCP's. A single thread in the `WorklistQueryService` wakes up on a configurable period and sequentially creates an association and sends a single C-Find-Request to each enabled Worklist Server device.

Worklist-item-jobs and study-move-request-jobs each have their own queue and an associated thread pool associated with that queue. The size of both thread pools is the same and is configurable. Threads in one of the pools service queued worklist-item jobs. Threads in the other pool service queued study-move-request jobs. Current the setting for number-of-processing-threads defines the size of each thread pool, so there are actually

2x the number of threads that may be initiating DICOM associations concurrently. Each device can be configured to limit the number of threads that will communicate concurrently with that device.

Each thread that is processing a worklist-item-job will attempt to create a DICOM association to one or more configured source devices in sequential order. One C-Find-Request DIMSE message will be sent over each connected association. If the association request or the C-Find-Request fails, the job will be queued for retry after a configurable period. The number of retries before the job is marked as FAILED is configurable. Each C-Find-Response represents a study that might need to be retrieved (i.e., Moved to some destination device). For each response that passes the configurable matching criterion, a Study-Move-Request-Job is created and queued for processing. A job may fail because of a network error, a bad DICOM status, or a timeout.

Each thread that is processing a study-move-request-job will attempt to create a DICOM association to the device that is the source for that study. One C-Move-Request DIMSE message will be sent to that source device. The destination device is indicated by the C-Move-Request message. If the association request or the C-Move-Request fails, the job will be queued for retry after a configurable period. The number of retries before the job is marked as FAILED is configurable. A job may fail because of a network error, a bad DICOM status, or a timeout.

Table 4-3 Number of Associations for SCU AE

Maximum number of simultaneous Associations	64 (Configurable)

4.2.1.2.3 Asynchronous Nature

The SCU AE does not support asynchronous communication (multiple outstanding transactions over a single Association). All Association requests must be completed and acknowledged before a new operation can be initiated.

Table 4-4 Asynchronous Nature for SCU AE

Maximum number of outstanding asynchronous transactions	1 (Not Configurable)

4.2.1.2.4 Implementation Identifying Information

Table 4-5 DICOM Implementation Class and Version for SCU AE

Implementation Class UID	1.2.840.114089.1.0.0.3.3.52
Implementation Version Name	DCF 3.3.52c

4.2.1.3 Association Initiation Policy

4.2.1.3.1 Activity – Query Studies on Source Archive Device

4.2.1.3.1.1 Description and Sequencing of Activity

The SCU AE will initiate a new Association to query for relevant prior studies.

- An Association Request is sent to the specified source device AE and upon successful negotiation of the required Presentation Context the query is sent.
- The Association will be released when a C-Find-Response with a final or non-pending status is received.
- If the configured timeout is reached (default 5 minutes or 300 seconds), or if the number of C-Find-Response messages exceeds the configured maximum (default 5000) before a final response is received, then the association will be ended by sending an A-Abort PDU to the SCP.

4.2.1.3.1.2 Proposed Presentation Contexts

The Navigator SCU AE is capable of proposing a presentation context consisting of any SOP class listed in Table 4.2-1 above and any transfer syntax listed in Table 4-6 below:

Table 4-6 Proposed Presentation Contexts

Abstract Syntax Name	Transfer Syntax Name	Transfer Syntax UID	SCU	SCP
*	Explicit VR Little Endian	1.2.840.10008.1.2.1	Yes	No
*	Implicit VR Little Endian	1.2.840.10008.1.2	Yes	No

* Indicates any SOP class from Table 4.2-1.

4.2.1.3.1.3 SOP Specific Conformance for SOP Classes

The SCU AE requires only basic conformance for all SOP classes that it uses.

4.2.1.3.2 Activity – Move Studies from Source Archive Device to Destination Archive Device

4.2.1.3.2.1 Description and Sequencing of Activity

The SCU AE will initiate a new Association to move a single study from the list of selected studies. An Association Request is sent to the specified source device AE and upon successful negotiation of the required Presentation Context the C-Move-Request is sent. The C-Move-Request message contains the SOP-Instance-UID of the study that is to be transferred and the Destination-AE-Title corresponding to the Destination device. The Association will be released when a C-Move-Response with a final or non-pending status is received. If the configured timeout is reached (default 5 minutes or 300 seconds) before a final response is received, then the association will be ended by sending an A-Abort PDU to the SCP.

4.2.1.3.2.2 Proposed Presentation Contexts

The Navigator SCU AE is capable of proposing a presentation context consisting of any SOP class listed in Table 4.2-1 above and any transfer syntax listed in Table 4.2-6 above.

4.2.1.3.2.3 SOP Specific Conformance for SOP Classes

The SCU AE requires only basic conformance for all SOP classes that it uses.

4.2.1.4 Association Acceptance Policy

The SCU AE does not accept Associations.

4.3 Network Interfaces

4.3.1 Physical Network Interface

Navigator supports any network interface that implements the TCP/IP protocol.

4.3.2 Additional Protocols

None.

4.3.3 IPv4 and IPv6 Support

This product currently only supports IPv4 connections.

4.4 Configuration

4.4.1 AE Title/Presentation Address Mapping

Local AE Titles: The specification of AE titles, TCP/IP addresses, and ports is user configurable.

Table 4-7 Application AE Title Configuration

Application Entity	Role	Default AE Title	Default TCP/IP Port
SCU AE	SCU	Navigator	<None>

The SCU Application can be configured to identify itself by any calling AE title. The calling AE title can be configured differently for each `DicomVirtualDevice`, which is an internal entity that represents a remote DICOM device used in a particular context.

4.4.2 Parameters

Table 4-8 below defines the subset of parameters in the Navigator application configuration file that are relevant to DICOM networking operations as a Service Class User of the Service Classes identified in this document.

Any parameters from the underlying DICOM Connectivity Framework ("DCF" - the Laurel Bridge DICOM toolkit: http://www.laurelbridge.com/products/dcf/) that are particular to server/SCP side activity or SCU's that are not used by Navigator are not included in this list. Many DCF parameters relating to image storage SOP classes, DICOM file-I/O or imaging related activities are likewise omitted. Parameters that control Navigator internal handling of workflow activities are also omitted.

Table 4-8 SCU AE Configuration Parameters

Parameter Name	Description/Range	Default Value
Parameters in the `java_app/Navigator` configuration group		
`auto_start_worklist_processing`	Set to TRUE if Navigator should begin querying worklist servers and processing orders on startup	FALSE
`worklist_query_poll_rate_seconds`	Delay in seconds between queries to Modality Worklist SCP devices	60
`number_of_threads`	Number of threads in each of the `WorklistItemJob` and `StudyMoveRequestJob` processing thread pools	6
`spss_start_date_past_days`	Number of days prior to the current date to use as the beginning of the date-range in the Worklist query	0
`spss_start_date_future_days`	Number of days after the current date to use as the end of the date-range in the Worklist query	1

Parameter Name	Description/Range	Default Value
max_job_retries	Number of attempts (including the first) for a failed WorklistItemJob or StudyMoveRequestJob before that job is marked with the state=FAILED	3
job_retry_delay_seconds	Number of seconds between retry attempts of WorklistItemJobs and StudyMoveRequestJobs	60
Parameters in the java_app/Navigator/DicomVDevices configuration group (apply to all virtual devices)		
device_echo_poll_rate_seconds	Delay in seconds between C-Echo checks on enabled devices	60
Parameters in an example of one java_app/Navigator/DicomVDevices/X configuration group (apply to virtual devices with configuration name "X"). There can be any number of these virtual devices defined		
description	Display name for this device	
calling_ae_title	DICOM calling Application Entity Title used when requesting an Association with this device	LBS_Navigator_01
calling_ip_address	IP address that will be bound to local side of socket before connecting to this device. Normally only used for multi-homed systems and for special situations	EMPTY
called_ae_title	DICOM called Application Entity Title used when requesting an Association with this device	
called_ip_address	IP for the remote device	
called_port	TCP port for the remote device	
max_threads	Maximum number of threads from the global thread pools that will be used for this device in any of the 3 defined roles (source/dest/trigger)	64
called_cfind_port	Set to >0 if C-Find's are handled by this device on a port different than called_port	-1
called_cmove_port	Set to >0 if C-Move's are handled by this device on a port different than called_port	-1
called_cecho_port	Set to >0 if C-Echo's are handled by this device on a port different than called_port	-1

Parameter Name	Description/Range	Default Value
query_modality_info_at_series_level	Set to TRUE if query results returned in the standard STUDY level query should be "walked down" to the SERIES level to fabricate a MODALITIES_IN_STUDY field	FALSE
enabled	TRUE if device should be used as a source or destination of C-Move operations. There can also be configuration data that will define schedule for enabled status – i.e. each hour of every day of week can be set to enabled or disabled status.	TRUE
ext_data1	User defined data field 1	
ext_data2	User defined data field 2	
ext_data3	User defined data field 3	
is_source	True if this device can be sent a Q/R C-Find Query or C-Move request	
is_destination	True if this device can be the Move-Destination given to the source in a C-Move operation	
is_trigger	True if this device can be sent a Modality Worklist C-Find Query	
session_settings_cfg_name	Name in Configuration data repository of DCF association or "session" specific settings. See DCS/default_session_cfg below for what parameters this can contain.	Empty
Parameters in the java_lib/DCS Configuration group		
extended_data_dictionary	Name in the Configuration data repository for the DICOM extended data dictionary. (See DCF documentation for more details)	/dicom/ext_data_dictionary
Parameters in the java_lib/DCS/default_session_cfg Configuration group		
max_read_pdu_size	Maximum received PDU size that will be negotiated during DICOM association setup	32768
max_write_pdu_size	Maximum sent PDU size that will be negotiated during DICOM association setup	32768
decode_un_seqs_in_ile	DICOM data parsing esoterica	TRUE
ignore_max_length_negotiation	For testing if you want to override max_read/write_pdu_size	FALSE

Parameter Name	Description/Range	Default Value
enable_streaming_mode	Allow DicomDataSet and/or DimseMessage objects to be created and handled without reading and fully buffering pixel data	TRUE
stream_mode_buffer_size	Size of I/O operations to transfer pixel data directly from source to destination in a streaming mode transfer	16384
pdu_write_delay_seconds	Seconds to wait before sending a PDU. Used for testing	0
pdu_read_delay_seconds	Seconds to wait before returning a PDU that was read	0
release_response_timeout_seconds	Seconds to wait for a Release-RP after sending Release-RQ before forcing association closed. A value of -1 means wait forever.	5
poll_frequency_per_second	Number of times per second that Socket poll will return to check for other events	10
disable_multi_pdv_pdus	If true, don't combine multiple PDV's in a single P-Data PDU	TRUE
input_filter_cfg_name	Name in the configuration data repository for a filter set that will be used to process incoming messages. Input filters can also be specified in-line in the session settings under the group named: input_filters	EMPTY
output_filter_cfg_name	Name in the configuration data repository for a filter set that will be used to process outgoing messages. Output filters can also be specified in-line in the session settings under the group named: output filters	EMPTY
remove_incoming_role_selection_items	If true, remove role selection user items from incoming A-Assoc-RQ/AC and assume default roles	FALSE
remove_outgoing_role_selection_items	If true, remove role selection user items from outgoing A-Assoc-RQ/AC and assume default roles	FALSE
scu_socket_receive_buffer_size	If non-0, override the default input buffer size for client-side sockets	0
scu_socket_send_buffer_size	If non-0, override the default output buffer size for client-side sockets	0

Parameter Name	Description/Range	Default Value
pdu_read_timeout_seconds	Seconds to wait when reading an expected P-Data PDU before timing out. A value of -1 means wait forever.	300
pdu_write_timeout_seconds	Seconds to wait when writing a P-Data PDU before timing out. A value of -1 means wait forever.	300
send_dimse_timeout_seconds	Seconds to wait to complete sending a DIMSE Message before timing out. A value of -1 means wait forever.	300
receive_dimse_timeout_seconds	Seconds to wait to complete receiving a DIMSE Message before timing out. Note for query operations, this is the time to wait for any response – pending or final. A value of -1 means wait forever.	300
Parameters in the java_lib/DSS/default_session_cfg Configuration group		
query_timeout_seconds	Number of seconds to wait for a C-Find or C-Move operation to complete. A value of -1 means wait forever.	300
progress_timeout_seconds	Number of seconds to wait for a C-Move-Response to indicate that the number of completed sub-operations has increased. A value of -1 means wait forever.	300
max_returned_results	Maximum number of C-Find-Response messages that will be received after sending a C-Find-Request.	5000

5 Media Interchange

Navigator does not support Media Interchange.

6 Transformation of DICOM to CDA

Navigator does not directly produce or consume SR objects.

7 Support of Extended Character Sets

All Navigator DICOM applications support the following:

ISO_IR 100 (ISO 8859-1:1987 Latin Alphabet No. 1 supplementary set) for routing decisions and filtering;

8 Security

It is assumed that Navigator is used within a secured environment. It is assumed that a secured environment includes at a minimum:

- Firewall or router protections to ensure that only approved external hosts have network access to Navigator.
- Firewall or router protections to ensure that Navigator only has network access to approved external hosts and services.
- Any communication with external hosts and services outside the locally secured environment use appropriate secure network channels (e.g. such as a Virtual Private Network (VPN)). Alternatively, Navigator can be configured to send and receive DIMSE messages via an encrypted mechanism such as TLS.

Other network security procedures such as automated intrusion detection may be appropriate in some environments. Additional security features may be established by the local security policy and are beyond the scope of this conformance statement.

8.1 Security Profiles

8.1.1 TLS Security

Coming Feature: *Navigator [will] supports the DICOM Basic TLS Secure Transport Connection Profile (See DICOM PS3.15 2015c Security and System Management Profiles, Appendix B.1) for authentication and encryption of communication between it and other DICOM clients and servers. Navigator supports TLS version 1.0 as required by this profile, as well as TLS versions 1.1 and 1.2.*

Currently, TLS communication between supported devices may be configured at an operating system level independent of the applications involved.

8.1.2 Anonymization

N/A for Navigator SCU AE

8.2 Association Level Security

N/A for Navigator SCU AE

8.3 Application Level Security

N/A for Navigator SCU AE

9 Annexes

N/A for Navigator SCU AE

- End -