Digital Imaging and Communications in Medicine (DICOM)

Supplement 93: Instance Availability Notification

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Prepared by:

DICOM Standards Committee, Working Group 6

1300 N. 17th Street, Suite 1847

Rosslyn, Virginia 22209 USA

Please send comments to Howard Clark, NEMA (how_clark@nema.org)

Table of Contents

Foreword

This supplement to the DICOM standard introduces a Service Class to provide availability notification about composite instances.

65   This document is a Supplement to the DICOM Standard. It is an extension to the following parts of the published DICOM Standard:

       PS 3.3   -   Information Object Definitions

       PS 3.4   -   Service Class Definitions

       PS 3.6   -   Data Dictionary

70   PS 3.16   -   Content Mapping Resource

Introduction - will not appear in final standard

Introduction

75 **I.1 SCOPE AND FIELD OF APPLICATION**

The proposed Instance Availability Notification Service Class proposed in this supplement addresses the need in an integrated workflow environment to track availability of images (and other evidence) for post-processing and diagnostic interpretation workflows.

In an integrated environment, workflow-management systems need to know when images and
80 other evidence are available as a result of acquisitions or other steps, (e.g., have been successfully transferred from the acquisition devices to the storage systems).

Knowledge of "availability" is required before subsequent steps (that need to be completed to fulfill a requested procedure) can be scheduled or performed. The knowledge of instance availability is required to properly govern the formation of worklists for subsequent workflow steps.

85 The scope of instances about which availability information is required is not restricted to just images; knowledge about availability of other evidence, such as Presentation States, Structured Reports, and Key Object Selection Documents, which may be produced in the course of an imaging procedure, is also required.

Knowledge of image availability is not limited to instances that first enter the system after
90 acquisition (generation). It continues to be important for images that remain in the system, or those that have been removed from it, or those that return to it through pre-fetching.

I.1.1 Limitations Of Current Standard

Currently, the only way for the workflow-management systems to determine the image availability is by performing a query (C-FIND) of the archive. This "polling" approach is unwieldy, particularly
95 when instances are not immediately available on an archive even though a PPS has been flagged as completed. Decisions as to when, and how frequently, to query, are difficult to make. Frequent queries add an unnecessary burden to the archive.

Basic Study Content Notification is not appropriate because the normative semantics do not match the proposed use-cases.

100 **I.1.2 Assumptions**

It is assumed by this service that identification of what instances are available by UIDs at the Instance, Series, Procedure Step and Study level is sufficient. Contextual information (such as which Study Instance UID is associated with which patient or request) is outside the scope of this service; it is expected that such information will be conveyed to the workflow-manager, for
105 example, by PPS services.

Even in the case where an acquisition device does not directly support MPPS, other devices and services are expected to convey contextual information to the workflow manager (such as creation of a PPS by some other proxy device or internally in the archive or PACS).

The intent is to avoid overloading the semantics of the Instance Availability Notification with
110 anything other than availability notification, and particularly to avoid semantics related to study or procedure step change management or completeness notification.

I.2 USE CASES

The use cases for instance availability notification are based on the radiological digital imaging, however, they may be extended to other environments, such as cardiology, radiotherapy, ophthalmology, etc.

It is common in today's radiology department to have studies planned and tracked by the workflow management systems (e.g. RIS or PACS), and to be concerned with the issues such as staff load, productivity, efficiency, equipment utilization, report turn-around time, proper identification of procedures performed. The list of use cases identified below is not intended to identify all cases where this instance availability notification may be used, nor to recommend any one of them. The Instance Availability Notification SOP Class will facilitate the support of each one of these use cases, although a number of other existing supporting services may also needed.

I.2.1 Radiology Modality Workflow Management Use Case

In this use case, the RIS closely monitors and actively manages the workload of interpreting radiologists by building lists of procedures to be interpreted. Content of such lists change dynamically based on such factors as average radiologist load, subspecialty, radiologist availability, and others.

The following is a typical sequence of events:

- Images and other DICOM instances are acquired or created on the modality.

- If so equipped, the modality uses MPPS to provide information to the RIS or the PACS (or both) about the results of the acquisition.

- When instances arrive at the PACS location from which they might be accessed for interpretation purposes, the PACS notifies the RIS about the availability of the instances.

    - If MPPS information is available to the PACS, the notification may be issued when all instances comprising a single MPPS have arrived and are available at the PACS.

    - If association of the instances with an MPPS is not possible, the timing of notification of those instances that are available is at the discretion of the PACS.

- The RIS uses the MPPS information received, and the availability status and location of instances, to build a worklist of requested procedures to be interpreted and generates General Purpose Scheduled Procedure Steps (including the references of instances included in the availability notification). The RIS should not depend on the timing and sequencing of the IAN and PPS notifications, which are not specified.

I.2.2 Studies resulting from Unscheduled or Misidentified Radiology Acquisitions Use Case

Instances are acquired by the modality when the information about the patient identity is not available and/or the examination performed is not yet being tracked by the RIS or PACS.

Such a situation may occur when patient is a trauma victim, or when the modality is not capable of obtaining proper identification through the Modality Worklist Service; in either case identification has to be entered manually by the modality operator.

To properly include such an examination into the departmental workflow, a RIS may need to track the existence of instances and associate them with corresponding patient and procedure identifiers.

The following is a typical sequence of events:

- Images and other DICOM instances are acquired or created on the modality.

155 - If so equipped, the modality uses MPPS to provide information to the RIS or the PACS (or both) about the results of the acquisition.

- When instances arrive at the PACS location from which they might be accessed for interpretation purposes, the PACS notifies the RIS about the availability of the instances.

  - If MPPS information is available to the PACS, the notification may be issued when all instances comprising a single MPPS have arrived and are available at the PACS.

  - If association of the instances with an MPPS is not possible, the timing of notification of those instances that are available is at the discretion of the PACS.

- The RIS has received procedure information (including patient and study information) via an MPPS, whether it be from the modality or the PACS. This allows the RIS to recognize that the study has been misidentified. The RIS should not depend on the timing and sequencing of the IAN and PPS notifications, which are not specified.

- The RIS performs resolution of the exception, either by an automated procedure or by manual intervention.

- The RIS uses MPPS information, availability status and location of instances to build a worklist of requested procedures to be interpreted and generates General Purpose Scheduled Procedure Steps (including the references of instances included in the availability notification).

I.2.3 Studies resulting from External Acquisitions

Images are initially acquired outside of the institution where they are to be used, and thus contain
175 patient and study identification that are unknown to the local RIS and PACS. To include these images into the workflow (for example, for comparison purposes), they need to be associated with a locally identified patient.

The following is a typical sequence of events:

- Images and other DICOM instances are imported locally (e.g., from interchange media) and assigned local patient identifiers. How such local patient information is obtained is outside the scope of this service.

- The imported instances are transmitted to PACS, after having been coerced to include the local patient identifiers replacing the external patient identifiers, both to avoid identifier collision and to use a single identifier for all of that patient's studies.

185 - When the imported set of instances are available on the PACS from which they might be accessed for interpretation purposes, the PACS notifies the RIS about the availability of the instances and communicates the key attributes of the study as recorded in the instances, using a GP-PPS or MPPS. The RIS should not depend on the timing and sequencing of the IAN and PPS notifications, which are not specified.

190 - The RIS uses MPPS information, availability status and location of instances to build a worklist of requested procedures to be interpreted and generates General Purpose Scheduled Procedure Steps (including the references of instances included in the availability notification).

I.2.4 Pre-fetching, Archival or Transfer of Studies Use Cases

195 A number of PACS do not keep all instances on-line (i.e. immediately available for retrieval) or at the same location. A PACS may change the storage level or archive location over time. A RIS or another PACS may need to track availability of instances in these configurations.

The following is the sequence of events:

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- Images and other DICOM instances are available on a PACS on-line. The PACS decides to move a set of instances to near-line or off-line storage or to another location. The instances are no longer available at the original storage level or location, hence notifications of "non-availability", or availability at a new location, are sent.

- At a later time, some of these instances are brought back on-line because a new requested procedure has been scheduled for that patient. The PACS would issue
205   instance availability notifications stating the location where these instances are now available.

The triggers initiating the instance movements are beyond the scope of this SOP Class.

I.2.5 Instance Availability Notification Destinations and Failure Modes

In all these use cases, the Instance Availability Notification SOP Class SCU needs to be
210 configured (manually or through the configuration management service) with the AE Title of the SCP(s) to be notified. There is no intent to provide for registration of interest by an SCP in all notifications, or a subset of notifications related to specific Studies or PPS.

The retry policies and behavior in cases where notification may have been lost (such as because an SCP was unavailable for a period of time) are also beyond the scope of this
215 Service Class. It is expected that an SCP "waiting" for a notification that never comes, or was lost, will perform a query after an appropriate interval.

I.2.7 Other Uses

Instance Availability Notification could also be used on workstation, quality control stations or post-processing systems. One can envision double-read scenarios where a second interpretation
220 workstation retrieves a reading worklist from the RIS and as such it knows that the images can be accessed on the other workstation that has issued the notification.

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230 **Changes to NEMA Standards Publication PS 3.3-2003**

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

Item #1 Add to Part 3, Section B (Normalized IODs) the following IOD:

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B.XX INSTANCE AVAILABILITY NOTIFICATION INFORMATION OBJECT DEFINITION

B.XX.1 IOD Description

An "Instance Availability Notification Information Object Definition" is a summary of the information that
240 describes the availability of a set of Composite Instances.

B.XX.2 IOD Modules

Table B.XX.2-1 lists the modules, which make up the Instance Availability Notification IOD.

Table B.XX.2-1
INSTANCE AVAILABILITY NOTIFICATION IOD MODULES

Module	Reference	Module Description
SOP Common	C.12.1	Contains SOP common information
Instance Availability Notification	C.4.XX	References the related SOPs and IEs.

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Item #2 Add to Part 3, Section C.4 (Study Modules) the following Module:

C.4.XX Instance Availability Notification Module

Table C.4.XX-1 specifies the Attributes used to describe which Instances are available and their
250 relationships.

Table C.4.XX-1
INSTANCE AVAILABILITY NOTIFICATION MODULE ATTRIBUTES

Attribute Name	Tag	Attribute Description
Referenced Performed Procedure Step Sequence	(0008,1111)	Uniquely identifies the Performed Procedure Step SOP Instance to which this availability notification instance is related, if any. The Sequence shall have zero or one Item. Notes: 1. This may refer to a different PPS than that encoded in the composite instances themselves. 2. It is typically used for notification about instances created as a consequence of some scheduled activity.
>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class of the Performed Procedure Step.
>Referenced SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance of the Performed Procedure Step.
>Performed Workitem Code Sequence	(0040,4019)	A sequence that conveys the (single) type of procedure performed.

		Only a single Item shall be permitted in this sequence.
>>*Include Code Sequence Macro Table 8.8-1*		*Baseline Context ID is CID 9231.*
Study Instance UID	(0020,000D)	Unique identifier for the Study of which all the Instances referenced in this notification are part.
Referenced Series Sequence	(0008,1115)	Sequence of Items where each Item includes references to Instances within the same Series. One or more Items shall be included in this Sequence.
>Series Instance UID	(0020,000E)	Unique identifier of the Series of which all the Instances referenced in this Item are part.
>Referenced SOP Sequence	(0008,1199)	Sequence of Items where each Item includes a reference to a single Instance within this Series. One or more Items shall be included in this Sequence.
>>Referenced SOP Class UID	(0008,1150)	Uniquely identifies the referenced SOP Class.
>>Reference SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
>>Instance Availability	(0008,0056)	The availability of the referenced Instance. See Section C.4.XX.1.1
>>Retrieve AE Title	(0008,0054)	Title of the DICOM Application Entity from which the referenced Instance may or may not be retrievable, i.e. the scope for which Instance Availability (0008,0056) applies. See Section C.4.XX.1.1.
>>Storage Media File-Set ID	(0088,0130)	The user or implementation specific human readable identifier that identifies the offline storage media on which the instance resides.
>>Storage Media File-Set UID	(0088,0140)	Uniquely identifies the offline storage media on which the instance resides.

C.4.XX.1   Instance Availability Notification Module Attribute Definitions

C.4.XX.1.1   Instance Availability

The Enumerated Values for Instance Availability (0008,0056) are:

— "ONLINE" means the instances are immediately available from the Retrieve AE Title (0008,0054), and if a C-MOVE were to be requested, it would succeed in a reasonably short time

— "NEARLINE" means the instances need to be retrieved from relatively slow media such as optical disk or tape, and if a C-MOVE were to be requested from the Retrieve AE Title (0008,0054), it would succeed, but may take a considerable time

— "OFFLINE" means that a manual intervention is needed before the instances may be retrieved, and if a C-MOVE were to be requested from the Retrieve AE Title (0008,0054), it would fail (e.g., by timeout) without such manual intervention.

— "UNAVAILABLE" means the instances cannot be retrieved from the Retrieve AE Title (0008,0054), and if a C-MOVE were to be requested, it would fail. Note that SOP Instances that are unavailable from this AE may be available from other AEs, or may have an alternate representation that is available from this AE.

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Changes to NEMA Standards Publication PS 3.4-2003

Digital Imaging and Communications in Medicine (DICOM)

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Part 4: Service Class Definitions

Item #3 Add new Annex X Instance Availability Notification Service:

Annex X   INSTANCE AVAILABILITY NOTIFICATION SERVICE CLASS
(Normative)

285 ## X.1   OVERVIEW

X.1.1 Scope

The Instance Availability Notification Service Class defines an application-level class-of-service that allows one DICOM AE to notify another DICOM AE of the presence and availability of SOP instances that may be retrieved. The AE from which such SOP Instances can later be retrieved
290 may or may not be the SCU performing the notification.

> Note: An example of usage of this Service Class is for the receiver of the instances to provide notification of their arrival and availability for subsequent workflow steps to a different entity, such as a separate workflow manager.

295 The SCU implementation defines the conditions under which it provides the notification. Certain SCUs may provide notification for arbitrary sets of SOP Instances, while other SCUs may provide notification when they determine that the instances associated with a Procedure Step or a Requested Procedure are available. The SCU is required to document in its Conformance Statement the nature of its notification decisions (e.g., frequency of notifications, retrieve
300 capabilities and latency, etc.).

Once the SCU has provided notification about availability of the SOP Instances, the SCP may use that information in directing further workflow, such as in populating the Input Information Sequence and Relevant Information Sequence when forming General Purpose Scheduled Procedure Step. These types of policies are outside the scope of this Standard, however, the
305 SCP is required to document these policies in its Conformance Statement.

The SCU of this Service Class is not required to assure that the study, procedure step or any workflow-related entity is "complete"; indeed no semantics other than the concept of "availability" is expressed or implied by the use of this service.

> Notes: 1. The Performed Workitem Code Sequence (0040,4019) attribute of a referenced GP-PPS
310 instance may provide the specific description of the work item that triggered the Instance Availability Notification.
>
> 2. The Instance Availability Notification is typically a service of the composite instance Storage SCP, since that application is responsible for making the instances available. The Instance Availability Notification allows that application to report the specific Retrieve AE Title, which
315 may differ from the Storage Service AE Title, and which may vary with different instance SOP Classes, or may vary over time.

X.2   CONFORMANCE OVERVIEW

The Instance Availability Notification Service Class consists of a single SOP Class: the Instance
320 Availability Notification SOP Class.

The SOP Class specifies Attributes, operations, and behavior applicable to the SOP Class. The conformance requirements shall be specified in terms of the Service Class Provider (SCP) and the Service Class User (SCU).

The Instance Availability Notification Service Class uses the Instance Availability Notification IOD as
325   defined in PS 3.3 and the N-CREATE DIMSE Service specified in PS 3.7.

X.3   INSTANCE AVAILABILITY NOTIFICATION SOP CLASS

X.3.1 DIMSE Service Group

The DIMSE Services shown in Table X.3.1-1 are applicable to the Instance Availability Notification IOD under the Instance Availability Notification SOP Class.

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Table X.3.1-1
DIMSE SERVICE GROUP

DIMSE Service Element	Usage SCU/SCP
N-CREATE	M/M

The DIMSE Services and Protocols are specified in PS 3.7.

Note: Though the terminology "notification" is used for this Service Class, the notification is in fact
335   performed through Operations rather than Notifications.

X.3.2 Operations

The Application Entity that claims conformance to this SOP Class as an SCU shall be permitted to invoke the following operations and the Application Entity that claims conformance as an SCP shall
340   be capable of providing the following operations.

X.3.2.1   N-CREATE Instance Availability Notification SOP Instance

This operation allows an SCU to create an instance of the Instance Availability Notification SOP Class and to provide availability information about Instances that are under the control of the SCU. This operation shall be invoked through the DIMSE N-CREATE Service.

345   #### X.3.2.1.1   Attributes

The Attribute list of the N-CREATE is defined as shown in Table X.3.2-1.

Table X.3.2-1
INSTANCE AVAILABILITY NOTIFICATION SOP CLASS N-CREATE ATTRIBUTES

Attribute Name	Tag	Req. Type N-CREATE (SCU/SCP)
Specific Character Set	(0008,0005)	1C/1C
		(Required if an extended or replacement character set is used)
All other Attributes of SOP Common Module		3/3
Referenced Performed Procedure Step Sequence	(0008,1111)	2/2

>Referenced SOP Class UID	(0008,1150)	1/1
>Referenced SOP Instance UID	(0008,1155)	1/1
>Performed Workitem Code Sequence	(0040,4019)	2/2
>>Code Value	(0008,0100)	1/1
>>Coding Scheme Designator	(0008,0102)	1/1
>>Code Meaning	(0008,0104)	1/1
>>All other Attributes from Performed Workitem Code Sequence		3/3
Study Instance UID	(0020,000D)	1/1
Referenced Series Sequence	(0008,1115)	1/1
>Series Instance UID	(0020,000E)	1/1
>Referenced SOP Sequence	(0008,1199)	1/1
>>Referenced SOP Class UID	(0008,1150)	1/1
>>Reference SOP Instance UID	(0008,1155)	1/1
>>Instance Availability	(0008,0056)	1/1
>>Retrieve AE Title	(0008,0054)	1/1
>>Storage Media File-Set ID	(0088,0130)	3/3
>>Storage Media File-Set UID	(0088,0140)	3/3

X.3.2.1.2 Service Class User

The SCU shall specify in the N-CREATE request primitive the SOP Class and SOP Instance UIDs of the Instance Availability Notification SOP Instance which is created and for which Attribute Values are to be provided.

The SCU shall provide Attribute values for the Instance Availability Notification SOP Class Attributes as specified in Table X.3.2-1.

The use of additional optional Attributes by the SCU is forbidden.

Note: The reason for forbidding optional attributes is to prevent the use of Standard Extended SOP Classes that might add contextual information such as patient and procedure identifiers.

The encoding rules for Instance Availability Notification Attributes are specified in the N-CREATE request primitive specification in PS 3.7.

There are no requirements on when N-CREATE requests are required to be performed.

In particular, there are no requirements that notification about the availability of the first instance of a Performed Procedure Step or Study be provided upon its reception, nor that availability notification be provided when an entire set of instances comprising a completed Performed Procedure Step or Study are available, though these are typical and common scenarios.

X.3.2.1.3   Service Class Provider

The SCP shall return, via the N-CREATE response primitive, the N-CREATE Response Status Code applicable to the associated request.

370 ### X.3.2.1.4   Status Codes

There are no specific status codes. See PS 3.7 for response status codes.

X.3.3 Instance Availability Notification SOP Class UID

The Instance Availability Notification SOP Class shall be uniquely identified by the Instance Availability Notification SOP Class UID, which shall have the value "1.2.840.10008.5.1.4.33".

375 ### X.3.4 Conformance Requirements

Implementations shall include within their Conformance Statement information as described below.

An implementation may conform to this SOP Class as an SCU or as an SCP. The Conformance Statement shall be in the format defined in Annex A of PS 3.2.

380 ### X.3.4.1   SCU Conformance

An implementation that is conformant to this SOP Class as an SCU shall meet conformance requirements for the operations that it invokes.

X.3.4.1.1   Operations

Any Attributes for which Attribute Values may be provided (using the N-CREATE) by the SCU
385 shall be enumerated in the SCU Conformance Statement. The SCU Conformance Statement shall be formatted as defined in Annex A of PS 3.2.

An implementation that conforms to this SOP Class as an SCU shall specify under which conditions during the performance of real-world activities it will create the SOP Class Instance.

The SCU Conformance Statement shall specify what is meant by each reported value of
390 Instance Availability (0008,0056).

The SCU Conformance Statement shall describe the relationship between the Instance Availability Notification and the Performed Procedure Step SOP Classes, if the latter are supported.

X.3.4.2   SCP Conformance

395 An implementation that is conformant to this SOP Class as an SCP shall meet conformance requirements for the operations that it performs.

X.3.4.2.1   Operations

The SCP Conformance Statement shall be formatted as defined in Annex A of PS 3.2.

The SCP Conformance Statement shall provide information on the behavior of the SCP (in terms
400 of real world activities) for each reported value of Instance Availability (0008,0056).

The SCP Conformance Statement shall describe the behavioral relationship between the Instance Availability Notification and the Performed Procedure Step SOP Classes, if the latter are supported.

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Changes to NEMA Standards Publication PS 3.6-2003

Digital Imaging and Communications in Medicine (DICOM)

Part 6: Data Dictionary

415   *Item #5 Add the following UID to Part 6 Annex A:*

UID Value	UID Name	UID Type	Part
1.2.840.10008.5.1.4.33	Instance Availability Notification SOP Class	SOP Class	Part 4

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Changes to NEMA Standards Publication PS 3.16-2003

Digital Imaging and Communications in Medicine (DICOM)

Part 16: Content Mapping Resource

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Item #6 Add the following term to the Context Group 9231 in Part 16 Annex B:

CID 9231   General Purpose Workitem Definition

Context ID 9231
435
General Purpose Workitem Definition

Type: Extensible Version: 20040615

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
DCM	110001	Image Processing
DCM	110002	Quality Control
DCM	110003	Computer Aided Diagnosis
DCM	110004	Computer Aided Detection
DCM	110005	Interpretation
DCM	110006	Transcription
DCM	110007	Report Verification
DCM	110008	Print
DCM	110009	No subsequent Workitems
DCM	**110013**	**Media Import**

440   Item #7 Add the following Definitions to Part 16 Annex D:

110013	Media Import	The procedure to read DICOM instances from DICOM interchange media, coerce identifying attributes into the local namespace if necessary, and make the instances available.	