DICOM CONFORMANCE STATEMENT

StrokeSENS v2.2
July 31, 2024

1 CONFORMANCE STATEMENT OVERVIEW

StrokeSENS is a decision-aid software package to be used by clinicians to perform image processing, analysis, viewing and communication of computed tomography (CT) scans of the brain in patients with suspected acute stroke. Data and images are acquired through DICOM-compliant imaging devices prior to processing and analysis in StrokeSENS.

The StrokeSENS software provides analysis capabilities for imaging datasets acquired with standard (non-contrast) CT imaging (NCCT), contrast-enhanced CT Angiography (CTA), and dynamic (multi-phase) contrast-enhanced CT angiography (mCTA) imaging modalities. Analysis of non-contrast CT images includes assessment of regions with suspected acute ischemic tissue. Analysis of contrast-enhanced CT images includes automated detection of suspected large vessel occlusion (LVO) and dynamic contrast-enhanced analysis which provides visualizations of areas of the brain with increased delay and reduced blood flow. In all cases, the output of StrokeSENS can be exported as DICOM files which conform to the DICOM standard by following the Multi-Frame True Color Secondary Capture Image IOD (Information Object Definition).

In the case of a suspected LVO, the system will send a notification to a pre-configured destination(s) (members of the acute stroke team), notifying them of the existence of a suspected LVO that requires review. The notification system is intended to be used in parallel to the standard of care workflow to notify clinicians of the existence of the case earlier than they may have been notified as part of the standard of care workflow. Images are available for viewing on a mobile device and on a standard radiology workstation. Images that are previewed on a mobile device are for informational purposes only and are not intended for diagnostic use beyond notification.

StrokeSENS supports several DICOM Service Classes, using the OFFIS DICOM Toolkit (DCMTK), to provide the following capabilities:

- Receive DICOM images and store them in the local system.

Table 1-1 provides an overview of the network services supported by **StrokeSENS**. Table 1-2 lists all supported media services.

Table 1-1
NETWORK SERVICES

Networking SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Transfer		
Computed Radiography Image Storage	No	Yes
CT Image Storage	No	Yes
Digital X-Ray Image Storage For Presentation	No	Yes
Digital X-Ray Image Storage For Processing	No	Yes
Enhanced CT Image Storage	No	Yes
Enhanced MR Image Storage	No	Yes
MR Image Storage	No	Yes
Multi-frame Single Bit SC Image Storage	No	Yes
Multi-frame Grayscale Byte SC Image Storage	No	Yes

Multi-frame Grayscale Word SC Image Storage	No	Yes
Multi-frame True Color SC Image Storage	No	Yes
Nuclear Medicine Image Storage	No	Yes
Positron Emission Tomography Image Storage	No	Yes
Secondary Capture Image Storage	Yes	Yes
Ultrasound Image Storage	No	Yes
Ultrasound Multi-frame Image Storage	No	Yes
X-Ray Angiographic Image Storage	No	Yes

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3 Introduction

This DICOM Conformance Statement specifies the behavior and functionality of the **StrokeSENS** system, with regard to supported DICOM networking SOP Classes and Media Storage Application Profiles. **StrokeSENS** is a workstation for comprehensive evaluation of Neurovascular CT images.

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3.1 Revision History

Document Version	Date of Issue	Author	Description
Version 1.0	Nov 13 2020	Cynthia Chiu	Initial release of this document
Version 1.1	Dec 18 2020	Cynthia Chiu	Updates for StrokeSENS v1.1
Version 1.2	May 20 2021	Gavin Gao	Updates for StrokeSENS v1.2
Version 1.3	Nov 18, 2021	Qiao Wei	Updates for StrokeSENS v1.3
Version 1.4	Sep 23, 2022	Rotem Golan	Updates for StrokeSENS v1.4
Version 1.5	Dec 7, 2022	Rotem Golan	Updates for AI-Engine v1
Version 1.6	March 28 2024	Manuel Zea, Rotem Golan	Updates for address, Updates for StrokeSENS v2.1
Version 1.7	June 6, 2024	Matthew Milne	Circle Address Updated
Version 1.8	July 31, 2024	Ronnie Louie	Update for StrokeSENS 2.2

3.2 Audience

This document is written for the people that need to understand how **StrokeSENS** 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 **StrokeSENS** 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 [DICOM] 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.

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, and transfer of image objects and analyses (structured reports). 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

The following list illustrates all abbreviations that are used in this document.

ACSE	Association Control Service Element
AE	Application Entity
CD-R	Compact Disc – Recordable
CT	Computed Tomography
DICOM	Digital Imaging and Communications in Medicine
DIMSE	DICOM Message Service Element
DVD	Digital Versatile Disc
FSC	File-Set Creator
FSR	File-Set Reader
FSU	File-Set Updater
IOD	Information Object Definition
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group
MPPS	Modality Performed Procedure Step
MPR	Multiplanar Reconstruction
MWL	Modality Worklist
PACS	Picture Archiving and Communication System
PDU	Protocol Data Unit
SC	Secondary Capture
SCP	Service Class Provider
SCU	Service Class User
SOP	Service Object Pair

TCP/IP	Transmission Control Protocol / Internet Protocol
UID	Unique Identifier
US	Ultrasound
VM	Value Multiplicity
VR	Value Representation
XA	X-Ray Angiography

3.7 References

[DICOM] NEMA Standards Publication PS 3.1-18, Digital Imaging and Communications in Medicine (DICOM), 2009, available at http://medical.nema.org/

4 Networking

4.1 Implementation Model

4.1.1 Application Data Flow

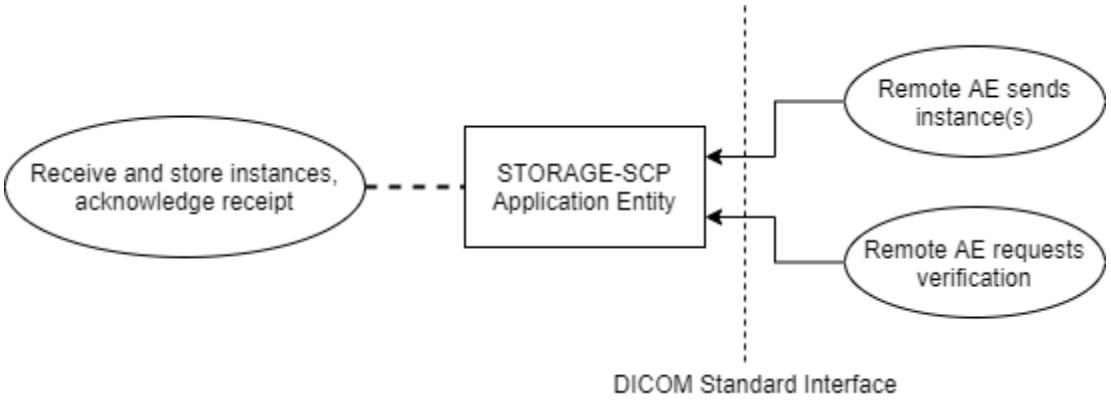

Figure 4-1. Application Data Flow Diagram

Conceptually, the networking services which are implemented in the **StrokeSENS** system may be modeled as the following separate AEs.

4.1.2 Functional Definitions of AEs

4.1.2.1 STORAGE-SCP

STORAGE-SCP listens for connection requests at the port number configured for it. It will accept Presentation Contexts for Storage and Verification SOP Classes. Upon receipt of a Verification Request, STORAGE-SCP will respond with a successful Verification response. Upon receipt of a Storage Request, STORAGE-SCP will store the object that has been successfully received in the local system. The stored instances are subsequently listed and may be viewed through the user interface.

4.1.3 Sequencing of Real-World Activities

All SCP activities are performed asynchronously in the background and are not dependent on any sequencing. The only limitation is that the STORAGE-SCP only accepts one association at a time if configured accordingly (which is the default behavior).

All SCU activities are initiated in the user interface. For each remote AE, a new background is started which allows for multiple associations at the same time.

4.2 AE Specifications

4.2.1 STORAGE-SCP

4.2.1.1 SOP Classes

STORAGE-SCP provides standard conformance to the following DICOM SOP classes.

Table 4.2-1

SOP CLASSES FOR AE STORAGE-SCP

SOP Class Name	SOP Class UID	SCU	SCP
Verification SOP Class	1.2.840.10008.1.1	No	Yes
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	No	Yes
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	No	Yes
Digital X-Ray Image Storage For Presentation	1.2.840.10008.5.1.4.1.1.1.1.1	No	Yes
Digital X-Ray Image Storage For Processing	1.2.840.10008.5.1.4.1.1.1.1	No	Yes
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1	No	Yes
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	No	Yes
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	No	Yes
Multi-frame Single Bit SC Image Storage	1.2.840.10008.5.1.4.1.1.7.1	No	Yes
Multi-frame Grayscale Byte SC Image Storage	1.2.840.10008.5.1.4.1.1.7.2	No	Yes
Multi-frame Grayscale Word SC Image Storage	1.2.840.10008.5.1.4.1.1.7.3	No	Yes
Multi-frame True Color SC Image Storage	1.2.840.10008.5.1.4.1.1.7.4	No	Yes
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	No	Yes
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	No	Yes
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	No	Yes

Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	No	Yes
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	No	Yes
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	No	Yes

4.2.1.2 Association Policies

4.2.1.2.1 General

STORAGE-SCP accepts but never initiates associations. The DICOM standard application context name, which is always proposed, is:

Table 4.2-2

DICOM APPLICATION CONTEXT

Application context name	1.2.840.10008.3.1.1.1

The PDU size is in the range 4096 to 131072 bytes. The default is 16384 bytes.

SOP Class extended negotiation is not supported.

4.2.1.2.2 Number of Associations

Table 4.2-3

NUMBER OF ASSOCIATIONS AS AN ASSOCIATION ACCEPTOR FOR AE STORAGE-SCP

Maximum number of simultaneous associations	Depends on the configuration

4.2.1.2.3 Asynchronous Nature

Asynchronous mode of operation is not supported.

4.2.1.2.4 Implementation Identifying Information

Table 4.2-4

DICOM IMPLEMENTATION CLASS AND VERSION FOR AE STORAGE-SCP

Implementation Class UID	1.3.6.1.4.1.53684.1.0.3.6.0
Implementation Version Name	CVI42_DCMTK_360

4.2.1.3 Association Initiation Policy

STORAGE-SCP does not initiate associations.

4.2.1.4 Association Acceptance Policy

STORAGE-SCP accepts any association for which at least one presentation context is accepted. The calling and called application entity titles are ignored. The responding application entity name will always be identical to the called application entity title which was specified by the remote AE. Association requests may be rejected with the following status codes and reasons.

Table 4.2-5

ASSOCIATION REJECTION REASONS

Result	Source	Reason	Description

Rejected permanent	Provider, presentation related	Temporary congestion	Resource limitation: process creation failed
Rejected transient	User	Application context name not supported	Incorrect application context name

4.2.1.4.1 Activity – Remote AE sends instance(s)

4.2.1.4.1.1 Description and Sequencing of Activities

As one instance is received from a remote AE, STORAGE-SCP will store this instance in the local file system and insert a record into the local database. If the received instance is a duplicate of a previously received instance, the new instance will be discarded.

4.2.1.4.1.2 Accepted Presentation Contexts

Table 4.2-6

ACCEPTABLE PRESENTATION CONTEXTS FOR AE STORAGE-SCP AND REAL-WORLD ACTIVITY 'REMOTE AE SENDS INSTANCE(S)'

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Ext. Neg.**
Name	**UID**	**Name List**	**UID List**		
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70,	SCP	None

			1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91		
Digital X-Ray Image Storage For Processing	1.2.840.10008.5.1.4.1.1.1.1.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 , 1.2.840.10008.1.2.4.51 , 1.2.840.10008.1.2.4.70 , 1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91	SCP	None
Digital X-Ray Image Storage For Presentation	1.2.840.10008.5.1.4.1.1.1.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 , 1.2.840.10008.1.2.4.51 , 1.2.840.10008.1.2.4.70 , 1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91	SCP	None
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 , 1.2.840.10008.1.2.4.51 , 1.2.840.10008.1.2.4.70 , 1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91	SCP	None
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian,	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2,	SCP	None

		Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 , 1.2.840.10008.1.2.4.51 , 1.2.840.10008.1.2.4.70 , 1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91		
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 , 1.2.840.10008.1.2.4.51 , 1.2.840.10008.1.2.4.70 , 1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91	SCP	None
Multi-frame Single Bit SC Image Storage	1.2.840.10008.5.1.4.1.1.7.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 , 1.2.840.10008.1.2.4.51 , 1.2.840.10008.1.2.4.70 , 1.2.840.10008.1.2.4.90 , 1.2.840.10008.1.2.4.91	SCP	None
Multi-frame Grayscale Byte SC Image Storage	1.2.840.10008.5.1.4.1.1.7.2	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless,	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99 , 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50 ,	SCP	None

		JPEG 2000 Lossy	1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91		
Multi-frame Grayscale Word SC Image Storage	1.2.840.10008.5.1.4.1.1.7.3	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None
Multi-frame True Color SC Image Storage	1.2.840.10008.5.1.4.1.1.7.4	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90,	SCP	None

			1.2.840.10008.1.2.4.91		
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None

Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian, Deflated Explicit VR LE, RLE Lossless, JPEG Baseline (P1), JPEG Extended (P2+4), JPEG Lossless (P14SV1), JPEG 2000 Lossless, JPEG 2000 Lossy	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2, 1.2.840.10008.1.2.1.99, 1.2.840.10008.1.2.5, 1.2.840.10008.1.2.4.50, 1.2.840.10008.1.2.4.51, 1.2.840.10008.1.2.4.70, 1.2.840.10008.1.2.4.90, 1.2.840.10008.1.2.4.91	SCP	None

4.2.1.4.1.2.1 Extended Negotiation

No extended negotiation is performed.

4.2.1.4.1.3 SOP Specific Conformance

4.2.1.4.1.3.1 SOP Specific Conformance to Storage SOP Classes

STORAGE-SCP provides standard conformance to the Storage Service Class.

STORAGE-SCP will receive any supported DICOM instances transmitted on the open association provided that the correct presentation context is used. If an instance is received successfully, it is stored on the local file system and a record is inserted in the local database. For all supported storage SOP classes, no integrity checks of the received instances are performed beyond tests of a very basic structural integrity. In particular, the sending system is not prevented from transmitting incomplete or incorrect IODs. When storing an instance in the local system, group length values and sequence lengths of an instance are re-computed by STORAGE-SCP; these values may, therefore, be changed.

4.2.1.4.1.3.2 Presentation Context Acceptance Criterion

STORAGE-SCP will accept all presentation contexts which contain one of the supported SOP classes and one of the supported transfer syntaxes.

4.2.1.4.1.3.3 Transfer Syntax Selection Policies

In case of uncompressed transmission, the default behavior of STORAGE-SCP is to select for each presentation context containing a supported SOP class the explicit VR transfer syntax with the byte order matching the local machine byte order. If this transfer syntax is not available, the explicit VR transfer syntax with opposite byte order is selected. If this is also unavailable, implicit VR little endian is selected if available, otherwise the presentation context is rejected.

4.2.1.4.1.3.4 Response Status

STORAGE-SCP will behave as described in the Table below when generating the C-STORE response command message.

Table 4.2-7

RESPONSE STATUS FOR AE STORAGE-SCP AND
REAL-WORLD ACTIVITY 'REMOTE AE SENDS INSTANCE(S)'

Service Status	Further Meaning	Error Code	Behavior
Refused	Out of resources	A700	Application out of memory, file system or database write error (e. g. disk full or missing rights). The DICOM instance was not stored. An error message is output to the service logs.
Error	Data set does not match SOP class	A900	The SOP Class UID or SOP Instance UID in the C-STORE-RQ does not match the corresponding UID in the received dataset. The DICOM instance was stored anyway. An error message is output to the service logs.
	Cannot understand	C000	The received DICOM instance did not include a SOP Class UID or SOP Instance UID. The DICOM instance was stored anyway. An error message is output to the service logs.
Warning	Coercion of Data Elements	B000	Never sent, no coercion is ever performed.
	Data Set does not match SOP Class	B007	Never sent.
	Elements Discarded	B006	Never sent.
Success	Success	0000	The DICOM instance was successfully received and stored in the local system.

4.2.1.4.2 Activity – Remote AE requests Verification

4.2.1.4.2.1 Description and Sequencing of Activities

A remote AE sends an Echo Request to verify that STORAGE-SCP is awake and listening. STORAGE-SCP responds with success status as long as the request can be parsed.

4.2.1.4.2.2 Accepted Presentation Contexts

Table 4.2-8
ACCEPTABLE PRESENTATION CONTEXTS FOR AE STORAGE-SCP AND REAL-WORLD ACTIVITY 'REMOTE AE REQUESTS VERIFICATION'

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Ext. Neg.**
Name	**UID**	**Name List**	**UID List**		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian, Explicit VR Little Endian, Explicit VR Big Endian	1.2.840.10008.1.2, 1.2.840.10008.1.2.1, 1.2.840.10008.1.2.2	SCP	None

4.2.1.4.2.2.1 Extended Negotiation

No extended negotiation is performed.

4.2.1.4.2.3 SOP Specific Conformance

4.2.1.4.2.3.1 SOP Specific Conformance to Verification SOP Classes

STORAGE-SCP provides standard conformance to the Verification Service Class.

4.2.1.4.2.3.2 Presentation Context Acceptance Criterion

STORAGE-SCP will accept all presentation contexts which contain the supported SOP class and one of the supported transfer syntaxes.

4.2.1.4.2.3.3 Transfer Syntax Selection Policies

The default behavior of STORAGE-SCP is to select for each presentation context containing a supported SOP class the explicit VR transfer syntax with the byte order matching the local machine byte order. If this transfer syntax is not available, the explicit VR transfer syntax with opposite byte order is selected. If this is also unavailable, implicit VR little endian is selected if available, otherwise the presentation context is rejected.

5 Physical Network interfaces and configuration

5.1 Physical Network interfaces

5.1.1 Physical Network Interface

The DICOM applications of **StrokeSENS** are indifferent to the physical medium over which TCP/IP is used.

5.1.2 Additional Protocols

When host names rather than IP addresses are used in the configuration to specify presentation addresses for remote AEs, the application is dependent on the name resolution mechanism of the underlying operating system.

5.1.3 IPv4 and IPv6 Support

StrokeSENS only supports IPv4 connections.

5.2 Configuration

The configuration can be changed by the user in the network management dialog. Details are described in the user manual.

5.2.1 AE Title / Presentation Address Mapping

The Calling AE Title of the local AEs is configurable in the Network Management page. The mapping of the logical name by which remote AEs are described in the user interface to Called AE Titles as well as presentation address (hostname or IP address and port number) is configurable in the network management dialog.

5.2.1.1 Local AE Titles

Table 4.4-1

AE TITLE CONFIGURATION TABLE

Application Entity	Default AE Title	Default TCP/IP Port
STORAGE-SCP	NVI_AWS	1234

5.2.1.2 Remote AE Titles

The AE Title, host name or IP address and port number of remote AEs are configured in the network management dialog.

5.2.2 Configurable Parameters

Concerning the STORAGE-SCP application entity, the following parameters are configurable at installation time. For additional parameters, see the user manual.

Table 4.4-2

CONFIGURABLE PARAMETERS FOR AE STORAGE-SCP

Parameter	Configurable	Default Value
Run background process with STORAGE-SCP	Yes	Enabled
Time-out for ACSE messages	Yes	60 seconds
Time-out for DIMSE messages	Yes	60 seconds
Maximum PDU size the AE can receive	No	16384
Maximum number of simultaneous associations	No	Dependent on system specifications

6 Support of extended character sets

StrokeSENS v2.1 does not support extended character sets.

7 SECURITY

7.1 Security Profiles

StrokeSENS does not support any security profiles.

7.2 Association Level Security

The STORAGE-SCP accepts associations from all remote AEs in the default configuration, i. e. there is no restriction to certain AE titles and/or IP addresses. The STORAGE-SCP can be configured to accept only associations from known AEs.

7.3 Application Level Security

StrokeSENS does not support any application level security.

8 Annexes

8.1 IOD Contents

8.1.1 Created SOP Instances

8.1.1.1 Multi-frame True Color SC Image IOD

StrokeSENS creates Multi-frame True Color SC Image objects containing algorithm outputs. The following tables describe the modules and attributes of the underlying IOD. Most attributes that are never present in a created SOP instance are omitted from the tables to increase readability.

Table 8.1-4

MULTI-FRAME TRUE COLOR SC IMAGE IOD MODULES

IE	Module	Reference	Presence of Module
Patient	Patient	Table 8.1-6	Always
	Clinical Trial Subject	–	Never
Study	General Study	Table 8.1-7	Always
	Patient Study	–	Never
	Clinical Trial Study	–	Never
Series	General Series	Table 8.1-8	Always
	Clinical Trial Series	–	Never
Equipment	General Equipment	Table 8.1-9	Always
	SC Equipment	Table 8.1-10	Always
Frame of Reference	Frame of Reference	–	Never
	Synchronization	–	Never
Image	General Image	Table 8.1-11	Always
	Image Pixel	Table 8.1-20	Always
	Image Plane[1] *(selected attributes only)*	Table 8.1-13	Not always
	Cine	–	Never
	Multi-frame	Table 8.1-12	Always
	Frame Pointers	–	Never
	Device	–	Never
	Specimen	–	Never
	Multi-frame Functional Groups	–	Never
	Multi-frame Dimension	–	Never
	SC Image	–	Never
	SC Multi-frame Image	Table 8.1-21	Always
	SC Multi-frame Vector	–	Never

[1] According to the DICOM standard, this module is not required for this IOD (also see Section 8.5).

SOP Common	Table 8.1-22	Always
Common Instance Reference	Table 8.1-23	Always
Frame Extraction	–	Never

8.1.1.2 Common Secondary Capture Image Modules

Table 8.1-6
PATIENT MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Patient's Name	(0010,0010)	PN	From original DICOM image	Always
Patient ID	(0010,0020)	LO	From original DICOM image	Always, might be empty
Issuer of Patient ID	(0010,0021)	LO	From original DICOM image	Always, might be empty
Type of Patient ID	(0010,0022)	CS	From original DICOM image	Always, might be empty
Patient's Birth Date	(0010,0030)	DA	From original DICOM image	Always, might be empty
Patient's Sex	(0010,0040)	CS	From original DICOM image	Always, might be empty
Other Patient IDs	(0010,1000)	LO	From original DICOM image	Always, might be empty

Table 8.1-7
GENERAL STUDY MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Study Date	(0008,0020)	DA	From original DICOM image	Always, might be empty
Study Time	(0008,0030)	TM	From original DICOM image	Always, might be empty
Accession Number	(0008,0050)	SH	From original DICOM image	Always, might be empty
Referring Physician's Name	(0008,0090)	PN	From original DICOM image	Always, might be empty
Study Description	(0008,1030)	LO	From original DICOM image	Always, might be empty
Study Instance UID	(0020,000D)	UI	From original DICOM image	Always
Study ID	(0020,0010)	SH	From original DICOM image	Always, might be empty

Table 8.1-8

GENERAL SERIES MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Series Instance UID	(0020,000E)	UI	Generated automatically with a unique value (same for all instances in the series)	Always
Series Number	(0020,0011)	IS	Generated automatically starting with a value of 501 (same for all instances in the series)	Always
Series Description	(0008,103E)	LO	Dependent on feature	Always
Laterality	(0020,0060)	CS		Empty
Patient Position	(0018,5100)	CS		Never
Modality	(0008,0060)	CS	See Table 8.1-10	

Table 8.1-9

GENERAL EQUIPMENT MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Manufacturer	(0008,0070)	LO	“Circle Cardiovascular Imaging”	Always
Manufacturer's Model Name	(0008,1090)	LO	“StrokeSENS”	Always
Software Versions	(0018,1020)	LO	Product software version (e.g., “2.0.0_(80)”)	Always
Institution Name	(0008,0080)	LO	From original DICOM image	Always, might be empty
Station Name	(0008,1010)	SH	From original DICOM image	Always, might be empty

Table 8.1-10

SC EQUIPMENT MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Conversion Type	(0008,0064)	CS	“WSD”	Always
Modality	(0008,0060)	CS	From original DICOM image	Always
Secondary Capture Device Manufacturer	(0018,1016)	LO	“Circle Cardiovascular Imaging”	Always
Secondary Capture Device Manufacturer's Model Name	(0018,1018)	LO	“LVO”/”ASPECTS”	Always

Secondary Capture Device Software Versions	(0018,1019)	LO	Algorithm software version (e.g., “2.1.0”)	Always

Table 8.1-11
GENERAL IMAGE MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Image Type	(0008,0008)	CS	"DERIVED\SECONDARY\PROCESSED"	Always
Content Date	(0008,0023)	DA	Date of the content creation	Always
Content Time	(0008,0033)	TM	Time of the content creation	Always
Instance Number	(0020,0013)	IS	Sequential number increased for each instance within a series	Always
Patient Orientation	(0020,0020)	CS		Empty

Table 8.1-12
MULTI-FRAME MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Number of Frames	(0008,0008)	IS	“1”	Always
Frame Increment Pointer	(0028,0009)	AT	See Table 8.1-15	

Table 8.1-13
IMAGE PLANE MODULE OF CREATED SOP INSTANCES (SELECTED ATTRIBUTES)

Attribute Name	Tag	VR	Value	Presence of Value
Pixel Spacing	(0028,0030)	DS	Dependent on output space	Always
Image Orientation (Patient)	(0020,0037)	DS	Dependent on output space	Always
Image Position (Patient)	(0020,0032)	DS	Dependent on output space	Always
Slice Thickness	(0018,0050)	DS	Dependent on output space	Always, might be empty
Slice Location	(0020,1041)	DS	Dependent on output space	Always

8.1.1.3 Multi-frame True Color SC Image Modules

Table 8.1-20
IMAGE PIXEL MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Samples Per Pixel	(0028,0002)	US	3	Always
Photometric Interpretation	(0028,0004)	CS	“RGB”	Always
Planar Configuration	(0028,0006)	US	0	Always
Rows	(0028,0010)	US	Depends on the height of the image	Always
Columns	(0028,0011)	US	Depends on the width of the image	Always
Pixel Aspect Ratio	(0028,0034)	IS		Never
Bits Allocated	(0028,0100)	US	8	Always
Bits Stored	(0028,0101)	US	8	Always
High Bit	(0028,0102)	US	7	Always
Pixel Representation	(0028,0103)	US	0	Always
Pixel Data	(7FE0,0010)	OW	Depends on the content of the image	Always

Table 8.1-21

SC MULTI-FRAME IMAGE MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Frame Increment Pointer	(0028,0009)	AT		Never
Burned in Annotation	(0028,0301)	CS	“YES”	Always

Table 8.1-22

SOP COMMON MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Specific Character Set	(0008,0005)	CS	“ISO_IR 192”	Always
SOP Class UID	(0008,0016)	UI	“1.2.840.10008.5.1.4.1.1.7.4”	Always
SOP Instance UID	(0008,0018)	UI	Generated automatically with a unique value (unique for each instance in the series)	Always

Table 8.1-23

COMMON INSTANCE REFERENCE MODULE OF CREATED SOP INSTANCES

Attribute Name	Tag	VR	Value	Presence of Value
Referenced Series Sequence	(0008,1115)	SQ	Sequence of Items each of which includes the Attributes of one Series	Always
>Series Instance UID	(0020,000E)	UI	From original DICOM image	Always
>Referenced Instance Sequence	(0008,114A)	SQ	Sequence of Items each providing a reference to an Instance that is part of the Series defined by Series Instance UID (0020,000E) in the enclosing Item	Always
>>Referenced SOP Class UID	(0008,1150)	UI	From original DICOM image	Always
>>Referenced SOP Instance UID	(0008,1155)	UI	From original DICOM image (of the first image in the referenced series)	Always

8.1.2 Usage of Attribute from Received IODs

The STORAGE-SCP application entity makes use of the following attributes from an incoming DICOM object.

Table 8.1-34

USED FIELDS IN RECEIVED IOD FOR AE STORAGE-SCP

Attribute Name	Tag	Comment
SOP Class UID	(0008,0016)	Used to determine whether SOP Class is supported by the application
SOP Instance UID	(0008,0018)	Used to derive local filename
Study Instance UID	(0020,000D)	Used for the local database
Series Instance UID	(0020,000E)	Used for the local database

All four attributes listed in Table 8.1-34 must be present in the received instances with non-empty values to be processed by the system.

8.1.3 Attribute Mapping

StrokeSENS does not use any attribute mapping.

8.1.4 Coerced / Modified Fields

StrokeSENS does not modify any fields.

8.2 Data Dictionary of Private Attributes

StrokeSENS does not make use of a Data Dictionary of Private Attributes.

8.3 Coded Terminology and Templates

StrokeSENS does not use any coded terminology or templates.

8.4 Grayscale Image Consistency

StrokeSENS does not make use of the DICOM Grayscale Standard Display Function.

8.5 Standard Extended / Specialized / Private SOP Classes

StrokeSENS uses a standard extended SOP class for the various Secondary Capture Images by adding selected attributes from the Image Plane Module. In addition, the system uses a private data module for the Multi-frame True Color SC Image IOD. See section 8.1.1 for details.

The system does not support any specialized or private SOP classes.

8.6 Private Transfer Syntaxes

StrokeSENS does not use any private transfer syntaxes.