



**PARCA Certified PACS Interface Analyst  
(CPIA)  
Requirements**

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## **Certified PACS Interface Analyst (CPIA) requirements**

This document contains the detailed requirements for the certification of a CPIA or Certified PACS Interface Analyst. The requirements for the Interface analyst focus on connectivity and integration of the PACS, RIS and the modalities. Achieving the PARCA CPAS or Certified PACS Associate certification is a requirement for this certification. There is a strong emphasis on understanding the technical aspects of the System Administration functions.

### **A. DICOM standard**

#### **1. DICOM introduction and negotiation**

- 1.1 DICOM architecture and background: DICOM has several “layers” or “dimensions” with regard to functionality, has been defined based on the ACR-NEMA standard, has implicit version control through its negotiation mechanism. – Know to distinguish the DICOM functionality layers, relationship with ACR-NEMA and occurrence of “retired” attributes and services, as well as meaning of DICOM v 3.0.
- 1.2 Common issues: “DICOM is not always DICOM”, it deals with interconnectivity, not interoperability. Many vendors use proprietary data elements in the image header, there are issues with missing attributes, as well as the use of interface boxes, and the many optional features in the standard. – Know the limitations and issues with the DICOM standard, most frequent problems and misconceptions.
- 1.3 Importance of Information model: The DICOM standard has a comprehensive information model: for example, for most images the major constituents of the model are Patient, Study, Series, and Image. – Know the importance and limitations of the DICOM information model, especially with regard to the image-related model.
- 1.4 AE, SCU/SCP, FSR/FSC/FSU: DICOM Application Entities have different roles for the different DICOM services, both communication and media. – Know meaning of the roles and how to specify the roles depending on the required functionality.
- 1.5 Negotiation; ID, Abstract Syntax, Transfer Syntax: Part of the negotiation between two AE’s is the exchange of the Presentation Context. – Know meaning and contents of the Presentation ID, Abstract and Transfer Syntax.
- 1.6 Association: DICOM Associations are negotiated by AE’s. – Know potential issues with Association lengths and meaning.

#### **2. DICOM messages and objects**

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- 2.1 SOP Class concept: DICOM functionality is defined as SOP Classes, while the exchange is in the form of SOP Instances. – Know definition of SOP Class and Instances and UID identification.
- 2.2 Composite (Image) Message Structure: Images are structured as IE's Modules and than Attributes. Know the basic structure of the composite DICOM objects, how to distinguish Composite and Normalized services and objects, and rules for creating anew persistent object.
- 2.3 Data Elements: The basic building blocks of DICOM messages consist of a Tag-Length-VR-Data Value string. - Know how to identify these elements in a DICOM dump, the importance of “group-element” numbers, as well as private groups and LE and BE byte ordering.
- 2.4 Value Representations: Value Representations define the encoding rules for DICOM attributes, they can be included in the DICOM messages (explicit VR). – Know how to decode most common VR's, importance of VM, maximum/fixed length restrictions, including padding requirements to make even length data elements.
- 2.5 Specialization and privatization: Information can be added to DICOM objects that is not defined as part of the SOP Class definition. – Know how private groups are allocated and identified and the importance of specialization.

### **3. DICOM storage and image management services**

- 3.1 Storage Service Class: The Storage Service Class contains the SOP Classes for exchanging image objects, identified by UID's. – Know how to identify between “old” and “new” SOP Classes, limitations and options of Storage SOP Classes.
- 3.2 Important Storage Service Classes: There are single and multi-frame Storage SOP Classes, the most recent (CT,MR) having a sophisticated mechanism to identify how images relate. Images can be identified by a SC, the “native” single frame modality and multiframe. Some can be identified by new versions such as CR and DX, with DX having For Processing and For Presentation SOP Class.. – Know characteristics of SC, single and multiframe, and importance of specifying new SOP Classes, as well as differences between CR, DX, for Processing, Presentation and basic structure of new generation SOP Classes (CT, MR).
- 3.3 STC: Storage Commitment provides a “hand-off” from a modality to the PACS, and can be used either with a single or separate Association for the request and response. – Know the information that is exchanged and potential issues with error information and Association implementation as well as PACS workflow impact.
- 3.4 MPPS: Modality Performed Procedure Step exchanges five important pieces of information to the MPPS manager, forwarding this to the RIS and PACS. - Know to identify the five critical information and impact on PACS workflow.
- 3.5 MWL: Modality Worklist is critical from an efficiency and data integrity perspective. Its information model needs to match the RIS orders and results. It uses a clientserver model and can be used for real time query and polling. – Know how to identify the attributes and relate to the information model, potential issues with

RIS orders and result mapping. Also, issues with polling and the need to map the order/request form to allow an institution to go paperless.

#### **4. DICOM print, query/retrieve and SR**

- 4.1 Print: DICOM Print is used to make hardcopies (paper or film), typically for referring physicians or specialists. It is critical to match the image quality between the image on the monitor and hardcopy, and, in some cases, to make a “true size” print. – Know the normalized service elements used for creating a Print Session and the mechanisms to change the image quality (CI and Presentation LUT), and image size.
- 4.2 Print extensions: Additional print services might be used to provide text on the films and to check the printer status. – Know the function and how to use Annotation Box as well as Print Job.
- 4.3 Query/Retrieve-FIND: Queries to an AE can be performed using three different Information models with Unique, Required or Optional Keys. Different type of matching can be performed (exact, range, etc.). – Know the difference between the three information models, examples of matching, the importance of matching the keys of the SCU and SCP and why we need a Cancel.
- 4.4 Query/Retrieve-MOVE-GET: Information can be retrieved using either MOVE or GET which results in either a separate or same Association for the responses.- Know mechanism of MOVE/GET, function of the Response and Cancel.
- 4.5 SR: DICOM Structured Reports are typically used for measurements, observations or special applications such as Key Images. They use templates to pre-define the object structure in a greater detail. – Know the three different generic SR SOP Classes, the Key Object Note structure and how SR is used for applications such as cardiology, OB/GYN and CAD.

#### **5. DICOM image quality**

- 5.1 Pixel representation: Pixel data is stored with a certain pixel range (number of bits) in specific manner in the DICOM images representing grayscale or color. – Know how to identify the pixel attributes (Allocated, Stored, High bit), the representation (monochrome, color) as well as signed/unsigned identification.
- 5.2 Image pixel pipeline: Pixels undergo a series of conversions and/or mappings prior to be sent to a display subsystem, which includes the Modality LUT, optional Mask, VOI LUT, and potentially Presentation LUT. – Know meaning and function of these transformations, as well as potential issues and configuration impact.
- 5.3 GSDF: To achieve a consistent presentation of the images among different displays and hardcopy, a standard mapping from digital values to density or luminance is defined. Devices require calibration to comply with this mapping. – Know importance of calibration, and popular commercial calibration methods.

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- 5.4 Presentation State: To preserve the specific image presentation, the DICOM Presentation State allows the annotations, manipulations, etc. to be preserved in a dedicated DICOM object.- Know function of DICOM presentation state and importance for the preservation of presentation information in a standard (nonproprietary) manner.
- 5.5 Overlays: Overlays can be exchanged in different manners, i.e. in the pixel data, as an overlay plane in the image, or as separate DICOM objects. This is often configurable. – Know how to distinguish between the different options and advantages as well as disadvantages of each option.
- 5.6 Compression: Compression is used for archiving and communication. There are several compression algorithms, that are negotiated, JPEG, MPEG, RLE, Wavelet, some of them either lossless or lossy. – Know the most common compression ratios for lossless and lossy, characteristics of RLE, Lossy and Lossless in JPEG Wavelet, and MPEG, and how compression ratios are negotiated by AE's.

### 6. DICOM media

- 6.1 Media specifications: DICOM media specifications include the physical media, file structure, DICOMDIR and Application profiles. – Know importance of media specifications for compatibility, structure of the DICOMDIR, and why Application profiles are critical.
- 6.2 DICOM Part 10 files: The logical file structure or encapsulation of the DICOM objects is defined in Part 10 of the DICOM standard. – Know importance of Group 2, and structure as well as contents of Metafile header.
- 6.3 Application Profiles: Application profiles are used to constrain the options for information exchange. – Know the constraints for the General Purpose Application Profile.
- 6.4 CD interchange issues: CD's are increasingly being used to exchange patient files between institutions, however, their compatibility track record is somewhat poor. – Know of the most common compatibility issues with exchange CD's.

### 7. DICOM conformance statements

- 7.1 Comparing conformance statements: In order to determine whether there are any compatibility issues between two devices, there are certain key area's to compare these. – Know the seven critical areas to compare conformance statements against.
- 7.2 Gap Analysis: An institution has specific requirements regarding SOP Class support, transfer syntaxes, attributes in the image header, and information exchanged with the Query and Modality Worklist. – Be able to perform a proper gap analysis using a spreadsheet to show whether there are any conformance gaps.

### 8. DICOM networking

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- 8.1 Message structure in detail: DICOM messages are broken down in packets (PDU, PDV) while the “command” is contained in a special group 0. – Know importance of PDU, how to configure this and potential performance impact, to recognize group “0” information and how the break down is from the object to the TCP/IP packets.
- 8.2 Set up and configure DICOM devices: DICOM AE’s communicate with each other using certain addresses, port numbers, etc. – Know how to configure AE titles, port numbers, and IP addresses and importance of uniqueness.
- 8.3 Sniffers and active test software: There are several tools available to troubleshoot DICOM connections, both active and passive. – Know function and how to use active and passive DICOM test tools.
- 8.4 Interpret logs and DICOM dumps: DICOM dumps showing the Association set-up and image header information that is sent/received are critical in order to determine whether an issue is related to an incorrect interpretation of a message or due to an issue with the message itself. – Know how to interpret DICOM dumps and logs.

### **9. DICOM troubleshooting**

- 9.1 Send/receive TCP/IP Ping: The first step to verify connectivity issues is to issue a ping to a potential receiving device. – Know how to ping a device.
- 9.2 DICOM Verification (Echo): Verification (DICOM Ping) is the second step to verify connectivity. – Know how to issue a DICOM Echo and how to receive it.
- 9.3 Send/receive test messages: Prior to connecting a new device to a PACS system, one might send images from the new device to a well-known node, such as a workstation, to see whether there are any issues with the images. – Know how to send an image to a specific DICOM receiver and how to receive one.
- 9.4 Send/receive images with different SOP Classes and transfer syntaxes: Some issues are related to sending specific SOP classes and/or transfer syntaxes to a device. – Know how to change and/or select different SOP Classes and transfer syntaxes (implicit, explicit, LE, BE, compression) and to send/receive them.
- 9.5 Modify image headers and anonymization: An issue might be caused by specific header information being missing, incorrect, or being incorrectly interpreted. Changing the header and re-sending it could assist in troubleshooting. Anonymizing data is required when sharing images with a “non-trusted” node and/or to create files for teaching or other public use. – Know how to modify a header and to anonymize it.

## **B. HL7 V 2 standard**

### **10. HL7 messaging, theory**

- 10.1 Message Structure: Each HL7 message consists of several segments. – Know how to identify the various message elements and their functions as well as the encoding characters used.
- 10.2 Patient registration (ADT): The ADT message is used for exchanging patient demographics. – Know the different segments of the ADT message as well as its usage (i.e. trigger events).
- 10.3 Data Types: Data types are used to specify the encoding of the different fields. – Know the definition of the most commonly used data types, i.e. ST, TX, FT, NM, DT, TM, TS, DR and the ones used for code sets.
- 10.4 Segments: MSH, EVN, PID, PV1, ORC, OBR, OBX, and AL1 are the most common segments of the messages used in the radiology domain. – Know their contents and how to use these segments.
- 10.5 Acknowledgements: Original and enhanced message acknowledgement can be used in HL7. – Know when to use either one as well as the flows and acknowledgment codes used for each.
- 10.6 Error messages: Error messages are critical to exchange potential error conditions. – Know structure of error messages and how to interpret these.
- 10.7 General Order messages and responses: ORC, OBR, ORU segments are used as components for the order information to perform exams. – Know the structure and contents of these segments.
- 10.8 Interpret HL7 message profiles: Message profiles are critical for interoperability. – Know of HL7 message profiles, how to interpret these and where to find them.

### **11. HL7 V2 troubleshooting**

- 11.1 Messaging dialogue: The ability to analyze messages using public domain tool(s) is critical for integration and troubleshooting. – Know how to use these tools.
- 11.2 Capture and parse messages: Messages can be captured and parsed into their components. – Know how to send a HL7 message in both production and test environments and be able to capture it and analyze it.
- 11.3 Change/expand messages: In developing messages, both for new and existing deployments, one might want to make changes to detect whether the behavior of the receiver would change. This is also important for testing new messages and/or versions. – Know how to change/expand HL7 messages.
- 11.4 Reverse engineering of HL7 messages: When receiving HL7 messages, one could reverse-engineer the message instances to detect any potential issues. – Know how to reverse engineer HL7 message instances for troubleshooting.
- 11.5 Create typical order message and acknowledgement message: To test one's application, one can create a new order as well as its acknowledgement from scratch. – Be able to create a typical order and ACK message.

## C. Other important standardization and specification efforts

### 12. IHE

- 12.1 IHE Introduction: Integrating the Healthcare Enterprise (IHE) is an important initiative using standards such as DICOM and HL7 to specify profiles for integration in various medical care domains. Using standard message profiles reduces gaps and overlaps in functionality, and allows clear specification of the functionality and transactions between IHE actors. – Know meaning and importance of actors, transactions, profiles and vendor integration statements.
- 12.2 IHE actors: The functionality in the IHE profiles is based on features of so-called actors. – Know the actors that are involved with the Scheduled Workflow profile.
- 12.3 Profiles: Several radiology profiles are important for successful integration of the RIS, PACS and modalities. – Know the function of the Scheduled Workflow, Consistent Presentation of Images, Presentation of Grouped Procedures, Key Image Note and Basic Security Profiles.
- 12.4 IT infrastructure: The IHE infrastructure has defined profiles that span more than radiology. - Know meaning of Enterprise User Authentication, Patient Synchronization and Consistent Time profiles.
- 12.5 NM and PDI profiles: Profiles are also defined to clarify certain standards and prevent implementers from frequently made errors or misinterpretations. – Know value and contents of Nuclear Medicine and Portable Data Interchange (CD) profile.