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Web Access of DICOM Objects (WADO)

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Abstract:

Introduction

Users of EHR/PACS/RIS/LIS demand fast efficient access to radiology reports,laboratory results, medical images, clinical history .**WADO** is a special communication protocol to enable DICOM objects to be used through low bandwidth Web connections.

That helpsenterprise users to access to their patients data from anywhere independently. WADO is a simple mechanism for accessing a DICOM persistent object from HTML pages or XML documents, through HTTP/HTTPs protocol, using the DICOM UIDs.

SCOPE

A patient isregistered (admitted) for medication (lab ,rad ,drugs,…) in a hospital **H1**, the referring physician requests an urgent advice from the hospital for this current patient, to reach such need, he needs to call each department to collect separate and different information, this is time & effort consuming and such delay can affect the patient health.

In proposed case; the referring physician hasonly to query the hospital server through his workstation/ PC (work/home) / Tablet or even his personal smart phone the patient ID to get all results in one package in a well-structured way.

Overview

Accessing DICOM information has never been simpler. With Web Access to DICOM Persistent Objects (WADO), any Web client can request DICOM persistent objects, such as images or medical imaging reports, from a remote repository.

Keywords

Web technology, Wide area network (WAN), Systems integration, PACS integration, Image distribution, Integrating healthcare enterprise (IHE), Internet technology, Enterprise PACS, Digital imaging and communications in medicine (DICOM)

Conclusion

The WADO server/protocol simplifies the access to any DICOM repository by providing a simple mechanism for accessing DICOM persistent objects through HTTP/HTTPS, using the DICOM Unique Identifier (UID); this is becoming a native system component and requirement side by side of DICOM and HL7 protocols.With WADO you can reach DICOM information from anywhere over the Web.

Today, DICOM objects are stored in repositories, such as PACS, for specified periods of time. When a medical information system wishes to connect to the repository and fetch stored DICOM objects, it must be familiar with the specific, and usually proprietary, protocol for 'talking' with the repository. This means that substantial efforts must be invested in developing an application that can connect to the DICOM repository. Moreover, these applications are generally not flexible enough to use when moving from one repository to another.

The digital imaging and communications in medicine (DICOM) 3.0 standardswere first officially ratified by the national electrical manufacturers association in 1993. The success of the DICOM open standard cannot be overstated in its ability to enable an explosion of innovation in the best of breed picture archiving and communication systems (PACS) industry. At the heart of the success of allowing interoperability between disparate systems have been three fundamental DICOM operations: C-MOVE, C-FIND, and C-STORE. DICOM C-MOVE oversees the transfer of DICOM Objects between two systems using C-STORE. DICOM C-FIND negotiates the ability to discover DICOM objects on another node. This paper will discuss the efforts within the DICOM standard to adapt this core functionality to Internet standards. These newer DICOM standards look to address the next generation of PACS challenges including highly distributed mobile acquisition systems and viewing platforms.

The digital imaging and communications in medicine (DICOM) standard is not a static document. Each year, new objects are defined to support new imaging modalities, new ways of representing data, and new ways to communicate that data among multiple systems. The DICOM standard committees are composed of over 750 experts from vendors, professional societies, government agencies, and general interest members. There have been 155 supplements to the DICOM standard between 1993 and 2011.

The DICOM standards committee has taken several steps in developing standards that enable delivery of DICOM objects and metadata over hypertext transfer protocol (HTTP). In 2004, DICOM Part 18, web access to DICOM persistent objects (WADO), was ratified by DICOM working group 27 [1]. The standard was further advanced in 2011 with the final text addition of DICOM Part 18, Supplement 148 WADO by means of web services [2]. These DICOM standards are directly related to delivering medical imaging solutions over the Internet using HTTP.

This paper outlines the developmental progress of these standards and how they apply to the basic functions of a web-based imaging application. It will also provide an overview of the integrating the healthcare enterprise® (IHE) [3] integration profiles that use these standards.

What is WADO?

WADO standard specifies a Web-based service for accessing and presenting DICOM persistent objects, such as images and medical imaging reports. WADO is intended for distribution of results and images to healthcare professionals. It provides a simple mechanism for accessing a DICOM persistent object from HTML pages or XML documents, through HTTP/HTTPS, using DICOM UIDs. Data can be retrieved either in a presentation-ready form as specified by the requestor (e.g., JPEG or GIF) or in a native DICOM format.

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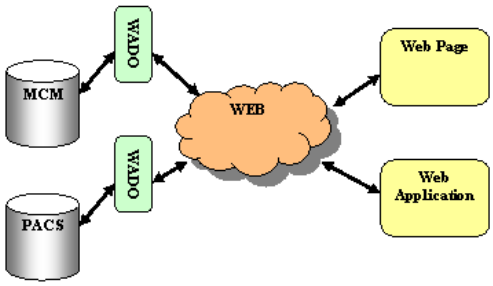

Evolution of WADO towards Web Services

Missions of DICOM

because no specific Ad Hoc Group on Biomedical Imaging will be set up in ISO / TC215, new works on medical imaging must be done into DICOM (with a Type A Liaison Group between both) more and more it will be important that DICOM makes recommendations on the medical imaging aspects within non «pure» DICOM protocols

Present limitation of WADO

1. One SOP Instance (no way for retrieving all the images of a series/study in one call)
2. Suited for Web Browser based solution, less for direct communication to DICOM server
3. The URL based query is easy to write, but not adapted for being parsed
4. No easy way to help the application development through WSDL mechanism

Leveraging Internet Technologies with DICOM WADO

In order to provide functional web-based imaging study delivery, a set of basic services are desired. Content discovery services provide a query and/or notification interface to discover available imaging studies. Metadata retrieval services provide the information required to deliver study data and images in the correct context. Object retrieval services deliver imaging objects such as an image or report to the object consumer. Renditions allow for the content consumer to view objects in non-DICOM format. Transformation services apply manipulations to the imaging objects such that they may be retrieved and viewed in the desired presentation format. These services are currently provided through the existing non-web-based DICOM standard using the service-object pair class model of DICOM, where information object definitions are paired with services like DICOM C-MOVE and C-FIND to provide the necessary transactions. Refer to Table 1below for an outline of the DICOM web standards and IHE frameworks including coverage of basic services desired for imaging applications. IHE cross-enterprise document sharing for imaging (XDS-I) [8] and cross-community access for imaging (XCA-I) [9] integration profiles include components common to the WADO standard.

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Table 1

An overview of basic web image service coverage by current DICOM standards and IHE profiles

Framework	Content discovery	Metadata retrieval	Object retrieval	Transformations	Renditions
WADO			Yes	Optional	Yes
WADO via WS		Yes	Yes	Optional	Yes
XDS-I	Yes	Limited	Yes	Optional	Optional
XCA-I	Yes		Yes	Optional	

In a typical picture archiving and communication systems (PACS) environment, these high-level services are provided using DICOM methods that may not easily lend themselves to web integrations. As medical image data access is desired beyond PACS workstations, it is more expensive to move all original DICOM objects in a study to the display application, especially when it is not needed for the use case. The ubiquitous platform for providing enterprise access to data today is through the web. The typical web browser can place constraints on the type of data that may be provided and may require additional services such as renditions in order to display images within the native browsing interface as noted in Table 2 below.

- Content discovery

Sample discovery queries:

- What exams are available for this patient?
- Who has had an imaging exam performed today?

Table 2

DICOM standards for web and non-web basic image service delivery

Framework	Content Discovery	Metadata Retrieve	Object Retrieval	Transformations	Renditions
Web-based DICOM standards	–	WADO via WS	WADO, WADO via WS	WADO, WADO via WS	WADO, WADO via WS
Non-Web DICOM standards	C-FIND	C-FIND	C-MOVE C-GET	–	–

The DICOM standard provides a single method for discovery of patient and studies using a service named C-FIND. The DICOM C-FIND service is not easily integrated to web standards without creating middleware services. Internet standards could be applied to replicate C-FIND functionality in a browser environment. Today, in common web-based consumer image sharing applications, albums, people, and images can be discovered through a simple URL call. The DICOM standard committees have not yet defined a web standard to address direct imaging content discovery. There are other methods often used when discovering studies to be displayed in the browser; a patient centric application such as an electronic medical record (EMR) or personal health record may already have been updated with a list of imaging patients/studies through a pushed HL7 message, or may also have implemented an XDS-I or XCA-I registry for content discovery.

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- Metadata retrieval

Sample metadata requests:

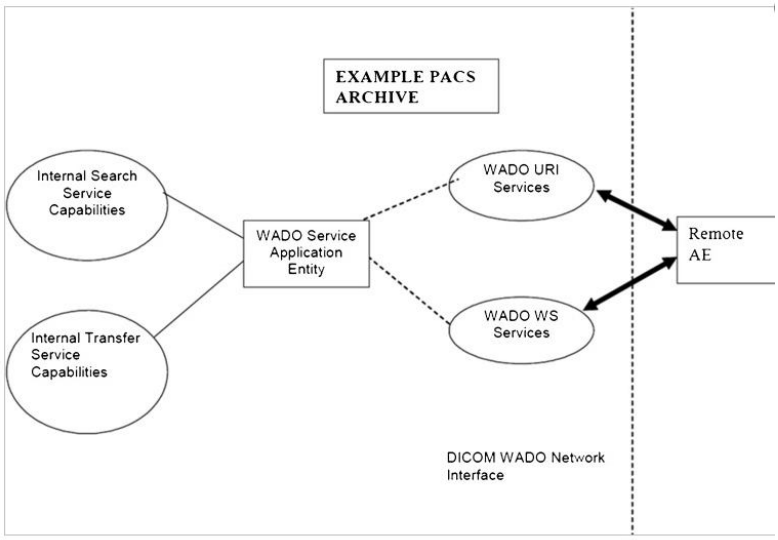
- What is the size of the target image?
- How many images are in this series?
- How many series are there in this study?
- Are there any Key Image Note (IHE:KIN), DICOM Greyscale Softcopy Presentation State, or IHE Consistent Presentation of Images objects?

DICOM provides important structural, descriptive, and technical data (metadata) with each individual object header within a study. In order to discover this metadata, an object must be retrieved and parsed. Performing this step in compliance to traditional DICOM standards requires an entire DICOM object to be transferred to the target application. This transfer becomes a significant burden to web-based applications, due to the need to retrieve the entire object with all structural data for the simple purpose of retrieving metadata. As of August 2011, DICOM has provided a standard method for accessing metadata; WADO via web services (DICOM Part 18, Supp. 148)[1]. This standard allows metadata to be retrieved for multiple DICOM objects over SOAP web services without the need to transfer the entire DICOM structural data.

Overview of the Base DICOM WADO Standard (DICOM Part 18)

DICOM WADO provides the capability to return DICOM content identified through URL interface over HTTP(S). To access DICOM content, the integrator needs only to provide a simple URL. The WADO standard defines services for object retrieval, transformations, and renditions. Some portions of these services are optional, and are thus not guaranteed with all WADO service providers (Fig. 1).

Fig. 1



DICOM WADO interaction [1]

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Minimum required service:

- Retrieval of a single DICOM object, lossy JPEG, or text object per HTTP request

Recommended (optional) services:

- Transformations:
  - Flip, rotate, scale, region (cropping)
  - Application of DICOM image presentation states
  - Anonymization of image renditions
  - Annotations
- Renditions:
  - Variableimage quality factor for JPEG compression
  - Single frame rendered image from multi-frame objects.
  - Non-JPEG renditions
  - PDF, XML, and HL7 clinical document architecture support
  - DICOM transfer syntax support
- Excluded basic image services:
  - Metadata retrieval
  - Reconstructions
  - Object discovery (query and notification)

Recommended services are implemented at the discretion of the implementer. Each of the services listed as recommended should be evaluated prior to choosing an implementation.

Example request formats:

- An example WADO URL call to retrieve an object for Display:
  http://server.hospital.com/wado?requestType=WADO&studyUID=1.2.12&seriesUID=1.2.40&objectUID=1.2.40

Fig. 2

Unmodified JPEG returned through WADO

- An example WADO URL used to retrieve the same object with transformations:

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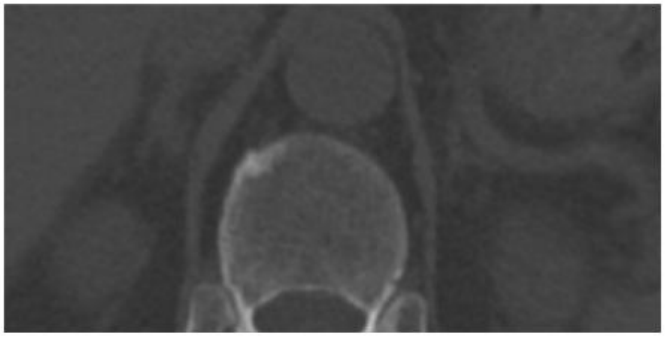
http://server.hospital.com/wado?requestType=WADO&studyUID=1.2.3&seriesUID=1.3.1&objectUID=1.3.2&windowWidth=2000&windowCenter=500&region=0,0,1,0.5&rows=200&columns=200

Fig. 3



Transformed JPEG returned through WADO

DICOM WADO exists today and is a platform of growth for future DICOM communications. WADO and WADO via web services provide value and advance the delivery of image enabling applications. Organizations can provide key images to be displayed in reports, deliver series of images for review, and provide web-based PACS applications [10]. The WADO standard has been adopted by IHE within the XDS-I and XCA-I integration profiles as the foundation of cross-enterprise and cross-community access of imaging data over HTTP(S). XDS-I, as defined, is a study-level DICOM object retrieve when using WADO. By default, an IHE XDS-I Imaging Document Consumer will request and retrieve all study objects, as the XDS Registry and manifest does not provide enough metadata for the Imaging Document Consumer to choose individual objects.

There are still important next steps for DICOM WADO and WADO via web services standards. As shown in Table 2, the most notable absence is the ability to discover imaging content through a web-based query. This would provide content discovery functionality over HTTP. WADO via web services could be extended to include metadata queries within the existing SOAP based protocol. Adding this functionality would allow integrators to query for a patient's imaging studies through on-demand HTTP(S) requests. Study discovery for many applications, such as an EMR, require integrators to implement a cache to store and synchronize pushed HL7 ORM messages. There have been published efforts to propose extensions to WADO such as the web access to DICOM archives (WADA) service [11]. The WADA service was proposed as a query and reporting extension to WADO with the application of access controls to allow for PACS level functionality. DICOM working group 27 has also approved the creation of work items to provide query based on ID for DICOM object(s) (QIDO), as well as notification of availability DICOM object(s) (NADO) [12]. Both NADO and QIDO are designed to provide content discovery to image enabling applications, further extending the power of DICOM on the WEB. These work items have yet to be produced as a formal draft.

Advanced visualization and 3D image processing services could potentially benefit from a standardized web service similar to WADO and WADO via web services. This could allow unified user interfaces for any advanced visualization system [13]. Delivering advanced visualization renditions via a standard interface such as HTTP may also provide advantages in modularization of server based rendering components [13].

The standardization of web-based DICOM services provides common interfaces for web applications to integrate medical imaging. Web-based applications may also be currently integrating existing DICOM

imaging interfaces and protocols in the absence of web-based standards. It is important that the DICOM working groups provide standards for services that pair the semantics of the existing standards with the semantics of new web services. This pairing of semantics may help to lower the technical barrier for implementing the web services as a proxy service to the existing standard and encourage integrators to adopt the standards.

Web-based applications are being adopted by healthcare organizations as health information systems evolve. DICOM WADO and WADO via web services are two important stepping-stones to ensure that medical images will be easily accessible within these web-based applications through an open standard. The DICOM WADO standard and the WADO for web services supplement do not define all of the necessary services for access to medical imaging data. Regardless of these limitations, the capabilities provided by these standards will allow integrators to include images within the patient record securely and without the need to implement high bandwidth connections to end users. The goal is to be able to provide all medical imaging services through the web using open standards to ensure interoperability and innovatio

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