

Interoperability and Security Provisioning for Distributed Diagnostic Imaging Systems

Diagnostic Imaging System

Diagnostic Imaging (DI) system records and manages the patient's medical images and relevant reports in digital formats, for the purpose of diagnosis and treatment of diseases, and medical science research. A modern distributed diagnostic imaging system includes Picture Archiving and Communication Systems (PACS), image viewers, and a large central repository (DI-r) that provides non-proprietary sharing of medical images among clinicians across geographically distributed hospitals or diagnostic centers.

Challenges

Interoperability among legacy PACS systems and Diagnostic Imaging repositories (DI-r) is a challenging task, since a proprietary PACS system is a closed environment without adequate interfaces. In terms of security, currently a trusted model is used such that each local system takes care of controlling the access of local users to resources. A major disadvantage of the trusted model is the lack of federated capabilities to manage authentication, authorization and consistent policy rules for access control.

Proposed Approach

We propose a secure "middleware" based on multi-agent technology, consisting of: data acquisition agents, administrative agents, central policy management, central policy repository, central metadata repository for images, as well as centralized authentication model and decentralized authorization model. The access control will be enforced by collaboration of centralized and distributed customizable agents. The proposed multi-agent architecture provides: system wide secure image sharing, federated identity management, agent customization, image caching, and local policy adjustment based on distributed user behavior.

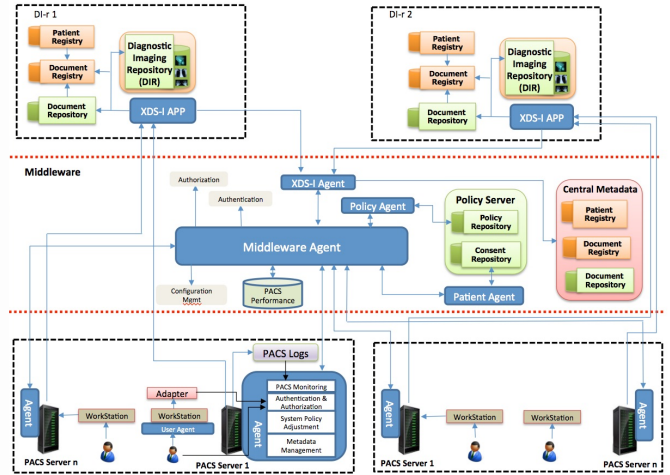
General Features:

- Multi-agent system for knowledge acquisition and decision making
- Customizable PACS Agent to monitor and analyze the PACS statistics and user behavior
- Incorporating IHE (Integrating the Healthcare Enterprise) profiles for XDS-I (Cross Enterprise Document Sharing for Images) protocols

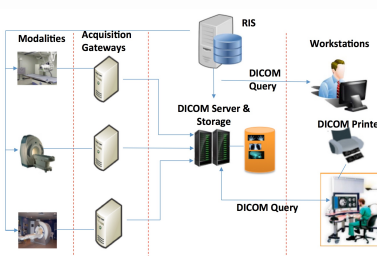
Security Features:

- Multi-level access control, using PACS Agents (local) and Middleware Agent (central)
- OpenID for authentication and OAuth for authorization
- Converting Trust-based access control to Secure access control based on central policy and distributed-behavior

Architecture



Picture Archiving and Communication System (PACS)

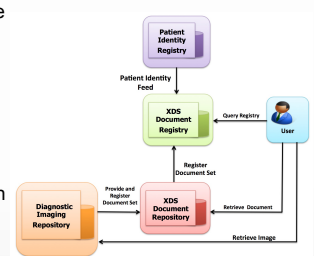


- A complex system to digitize and store patient images acquired from imaging equipment (different modalities)
- Transmit the images over a network
- Display images and communicates reports for diagnosis or treatment

Restrictions

- Legacy PACS are closed systems with no external interfaces
- PACS vendors did not follow a common data scheme and workflow for communication

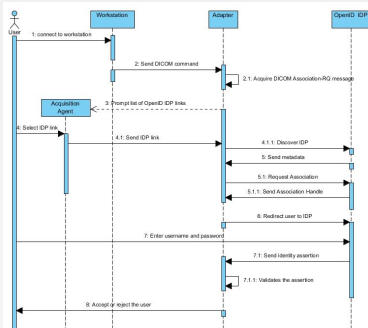
IHE XDS-I Profile



Implementation

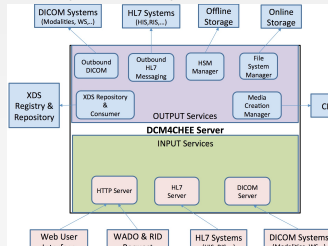
Authentication Workflow

OpenID provides a Single Sign-On (SSO) facility for authentication of PACS and DI-r users.

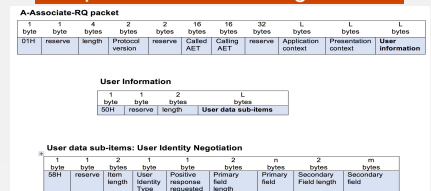


DCM4CHE: Open Source PACS Software

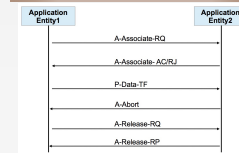
Dcm4che is a Java based open source application that provides web-based access to services for storing, querying, and retrieving any type of DICOM (Digital Imaging and Communications in Medicine) objects (images) and provides facilities to develop prototype PACS systems.



Adapter: DICOM Message Parser



Sequence of DICOM Messages



DICOM standard is the backbone of modern medical imaging systems. DICOM controls the acquisition, recording, transferring, and interpretation of the workflow within an imaging system. DICOM needs a point to point connection and does not support any built in security.