WHITE PAPER

Enterprise Imaging

System Architecture

AGFA HealthCare

# Enterprise Imaging, architecture overview

1.   Introduction

The Enterprise Imaging architecture is designed to tackle the following base architectural goals:

- Modularity and configurability
- Serviceability
- Scalability
- High availability and reliability
- Real-time responsiveness
- Hardware and platform independent
- Usability

2.   Enterprise Imaging Architecture – High level overview

Enterprise Imaging runs all components on a JBoss application server, and all functionality can be hosted on a single application server. The main components are the (R)IS services and the imaging services, which expose their functionality through Enterprise JavaBeans (EJBs). These components are integrated using a Background Process Engine (BPE) connectivity engine. Using the BPE, the interoperability services have been built to accept both standardized (e.g. DICOM and HL7) and non-standardized data (e.g. proprietary ECG representations), and to convert it to internal services or to the Enterprise Imaging data model.

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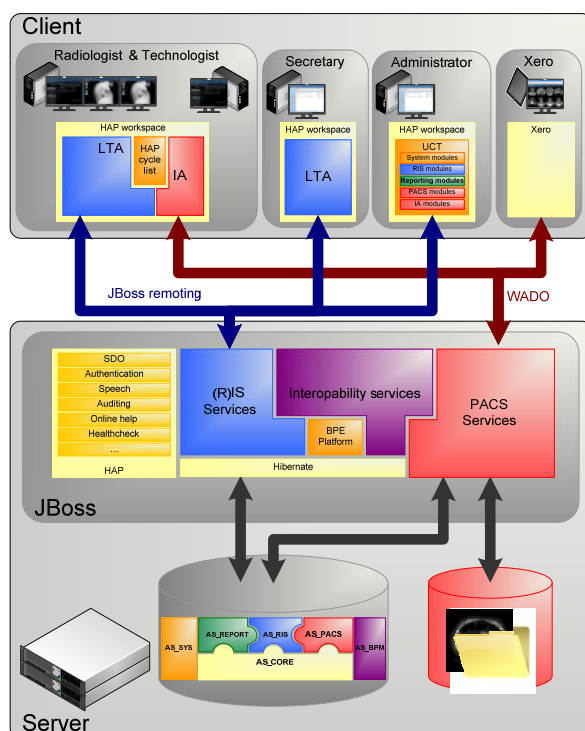
As in the IHE model, DICOM and HL7 standardization is key for the Enterprise Imaging platform. This standardization occurs both when connecting to external devices, and when communicating internally between the main components of the system.

The data model contains all (R)IS and imaging data linked to one patient record. The database is hosted within one instance of an Oracle database using UTF-8 (8-bit Unicode Transformation Format), which allows native support of many languages.

Separate build, test and release (R)IS, image server and Healthcare Application Platform (HAP) artifacts extend server-side functionality. This integration approach minimizes cross-component impact on the system by maintaining software quality during the development cycle. All components are integrated using a single, consistent security layer.

For clinician viewing, Enteprise Imaging comes with a lightweight, Web 2.0-based viewer with an imaging component based on Agfa HealthCare's XERO visualization platform.

3. Enterprise Imaging backend solution architecture

The new platform consolidates all of its main components - connectivity, speech, (R)IS, PACS, etc. - and runs them on a single JBoss application server. As JBoss is the most used Java application server on the market, the development community drives the standardization of many product features. Because JBoss runs under Java, it can operate cross-platform.

Enterprise Imaging can also run the application server in a cluster mode. In essence, the servers 'know' of each other's existence, share resources and process jobs collectively, rather than as separate nodes. Using clusters and shared queues, the unified imaging platform addresses scalability issues by automatically adding nodes to the cluster. It also increases availability, as all functionality remains available until the last server is removed from rotation.

Shared Queue Item
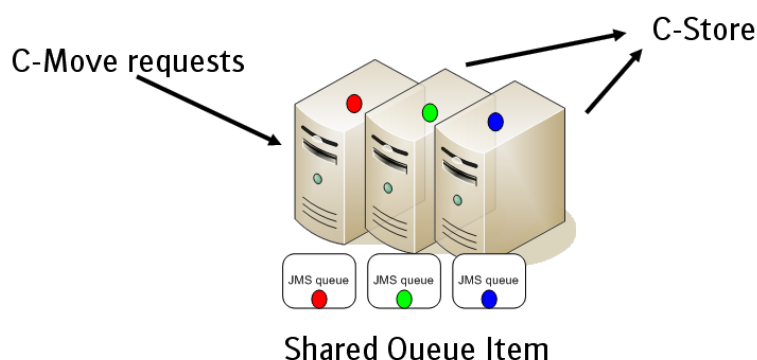
The Enterprise Imaging platform uses state-of-the-art workflow and rules engines to orchestrate both the frontend clinical workflows (such as the workflow between a technologist and a radiologist) and the backend workflows (such as the distribution and image lifecycle workflows).

DSL mapping of the rules and graphical representations of the workflows make them understandable to and configurable by the end-user. For example, the end-user could configure relevance rules or routing using simple sentences, without losing the full power of the rules engine.

3.1   Performance

There are some major performance optimizations in the Enterprise imaging solution:

- The method of object handling and caching is optimized, and closer to the DICOM standard. This results in much faster handling of DICOM object data.
- Pre-processing tasks are executed server-side to take advantage of the backend processing infrastructure, offloading the client resources and minimizing recalculation on the fly.
- The compression methodology has been modified to allow the dynamic presentation of different compression rates of image resolution towards the end-user in waves, without the decompression penalties of wavelet transfer methodologies.
- Proxy functionality has been created in the backend, which offloads some of the requests to the core systems.

These performance characteristics are continuously verified as part of the development process, using an embedded performance and test automation layer.

4. Enterprise Imaging frontend solution architecture

The Enterprise Imaging client is a Java thin client installed using Java Web Start, extended with proprietary netboot technology to streamline installation and upgrade processes over the various Enterprise Imaging desktops. The Java client is also fully UTF-8 compliant, and supports many different character sets, such as CJK or Latin.

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The client uses the OSGi framework: a modular system and service platform for the Java programming language, which implements a complete and dynamic component model. Using this technology offers flexibility for extending or modifying parts of the client code while maintaining stability. The stability is also verified during the build process using ATAF (Agfa Test Automation Framework) which is embedded in the Enterprise Imaging client.

The base client workspace (where the List and Text areas reside) uses JBoss remoting as a communication channel between client and application server. The client spreads the load between the different application servers using a proxy list mechanism:

- The client asks the application server for a proxy list for a specific service.
- The server responds with a proxy list of available application servers in the cluster that can process that type of request.
- The client uses this proxy list to load balance its requests between the different available servers.

When transferring database traffic between client and server, the system uses a combination of Hibernate and SDO (Server Data Objects) technology to minimize the dependency between an ever-changing database and its client functionality. Additionally, this technology allows a drastic minimization of the number of calls the clients must make to the server, further increasing real-time responsiveness (especially on high latency networks).

The image data transfer between the client and server uses standardized WADO (Web Accessible DICOM Object) communication, fine-tuned by image type. By combining this with an optional disk cache, the Enterprise Imaging platform can be used in a very wide variety of network connection types while still maintaining optimal imaging performance.

The Enterprise Imaging client is a multi-threaded application that can run in full 64-bit mode. Internally, it uses an event bus mechanism, pushing the imaging component to parallelize its operations over the various available CPU cores as much as possible, for optimal responsiveness.

The Radiology image area interprets volume-based image acquisitions as volumes instead of a sequence of slices. This allows the user to:

- Perform more volumetric optimizations when measuring over different slices.
- Create markup/measurement visualization in 3D space.
- Set the image location between 2D renderings and 3D renderings, and vice versa.
- Etc.

Enterprise Imaging for Radiology also natively supports 3D rendering.

The imaging workflow is based upon DICOM hanging protocols, which describe various image area functions and manipulations such as:

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- Hanging of the image
- Rendering type (2D or 3D renderings)
- Window level settings
- Linking
- Etc.

Hanging protocols can also set graphical user interface (GUI) optimizations; these can improve the viewing experience for each study type, and may be user-specific.

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