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Using Email to Exchange Medical Data

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Technology Transfer

Introduction

The technological revolution that took place in radiology departments across the globe was first made easier by the implementation of viable Radiology Information Systems, followed by Picture Archiving and Communication Systems, while the DICOM standard was introduced in 1985 to help users communicate. By the end of the century, DICOM had become a matter of course for dealing with medical images - especially those deriving from a radiological background.

While simple, vendor-independent exchange of data among the countless imaging systems was dealt with by DICOM, IHE facilitated a user-led demand for technological implementation based on the more complex, real life scenarios they encountered in their own work. Workflow became the goal for the first decade of this century; at first inside one's own organisation, but soon after also for the integration of external partners. The IHE profile family Cross Enterprise Document Sharing (XDS) underlines that development. As these profiles required a rather complex infrastructure, not all countries have been able to provide the necessary means for establishing that infrastructure. Taking Germany as one of these negative examples, users and vendors took it into their own hands to provide an innovative solution of practical use to overcome these shortcomings.

A Novel Use for Email

In 2003, a group of users and vendors under the auspices of the German Roentgen Society, created a recommendation for using email as described in the MIME standard, with attached but encrypted DICOM data as proposed in Supplement 54 of the DICOM standard. Backed by a growing number of vendors who supported this recommendation, DICOM email enables users to build vendor independent networks with moderate requirements for the necessary infrastructure. Apart from the DICOM-based email-capable PACS components, all it takes to communicate is a standard email server configured for a high throughput of large amounts of emails over a short time. Figure 1 (see pg. 30) outlines the principle of a DICOM email communication. The payload (DICOM object) is encrypted using a Pretty Good Privacy (PGP) compatible Public-Key Encryption (Fig. 1 a). All e-mails with the attached encrypted data (Fig. 1 b) will be stored on an email server accessible through the Internet (Fig. 1 c). From this email server, the receiver polls its post-box and downloads the emails. Providing a successful signature check which guarantees the data integrity, the payload (Fig. 1 d) will be decrypted (Fig. 1 e) and the resulting DICOM objects are ready be integrated into the image workflow on the recipient's side (Fig. 1 f).

Origins of the Project

Considering the experiences and the success of the at present largest DICOM Email Network in Baden-Württemberg, Germany linking 100 participants, the idea was born, to establish a communication platform for the Ruhr region based on the DICOM email standard recommendation of the Teleradiology Network Ruhr. Organisations including Contec, Fraunhofer ISST, MEDECON Ruhr, VISUS and ZTG designed this platform for the vendor-independent support of radiology in the Ruhr region. Due to the involvement of industry in the project, it was clear that the administration of such a network must be neutral. Therefore, an independent operating company was established.

In contrast to its counterpart in Baden-Württemberg, the Teleradiology Network Ruhr planned to be centrally administrated in order to provide as much service as possible. To achieve this, the use of a kind of central directory service managing all information necessary for setting up a communication link was planned for the time the network enters its normal operation phase.

A Project in Two Phases

The whole project was divided into two phases; a sponsored pilot phase and a self-supporting routine operation phase. The pilot phase was planned with 20 participants starting in October 2010 and ending on December 31, 2011. In order to actually reach the critical number of necessary participants for such a network, all participants of the pilot phase have been granted a DICOM email gateway, together with project management, configuration and usage of the email server free of charge throughout the pilot phase. The objectives for the pilot were for the participants to test the usage of the platform as a mail replacement, for the network administration to execute the testing of the platform itself and the fine-tuning of the different workflows such as deployment, building the Public-Key Infrastructure and establishing the support.

The pilot phase was also designed for developing the software for the directory service as described above. However, as we did a survey prior to the kick-off of the network, it was obvious from the start that while a mere mail replacement is certainly of interest as a basic service, the survey showed participants' great interest in teleradiology scenarios to either share one's workload or provide reporting capacities. Due to high demand, the original number of pilot installations needed to be corrected from 20 to 35, which still left another 35 potential interested parties that are waiting to be connected with the start of the regular operation phase.

Pilot Installations of DICOM Email Gateways

The pilot installations of the DICOM email gateways went smoothly. The idea of opening ports from inside the firewalls in order to grant access to the email server on the internet caused no problems with any of the administrators. The greater challenge has been to actually get the necessary signatures from participants as their administration sometimes slowed the process down. That affected the whole rollout process of the gateways. Nevertheless by April 2011, the number of gateways installed reached 28.

Regarding the number of transmissions before and after that point, it became obvious that this was the "critical mass" for a healthy network. Suddenly, the mark for gigabytes being sent was pushed from around 10GB to 60GB per month. Due to its great success, the number of pilot participants was also extended to 35 gateways and 11 DICOM Mail Clients. Reaching an install base of about 20 gateways, the manual management of all the gateway connections became a demanding job, as with the installation of each new gateway all the already installed gateways needed to be updated with the communication data of the new gateway. This clearly shows the importance of having a directory service to manage these configurations.

Directory Service an Important Asset

The development of the directory service has made good progress and the first tests are promising for a start with the beginning of the normal operation phase intended during 2012. In order to provide the services vendor-independently, the DICOM Email recommendation is currently being set up to receive an update so that the directory service can be reached using DICOM Email only. The update can be expected for mid-2012.
Figure 2 outlines the data-flow between an image provider (hospital) and an image consumer (healthcare centre). The hospital sends its images directly from its PACS using the teleradiology gateway as a communication server, which transforms the DICOM images into DICOM Emails. These emails are being sent to the email server of the network. On the other side the teleradiology workstation downloads these emails and converts them into DICOM images, which can be displayed with the viewer of that workstation. This scenario shows a very effective and reliable setup for exchanging images electronically without the need for a big PACS infrastructure on either side.

Next Phase in the Works

With the beginning of normal operations, it's also planned to initiate the next development phase for enhancing the services of the platform for the support of Stroke Units, the treatment of heart patients as well as supporting research and education.

In conclusion, setting up a new network platform based on DICOM email has successfully been proven. It is necessary to reach a critical mass of users before a network has the potential to be of use in the future. To reach that "mass" it is of help to have some financial support for the starting phase but it is essential that the structure is able to be financially independent by the time it reaches its routine operation.

The technique of using email for exchanging medical data contributes to the success of network construction, as it limits the technical challenges to an absolute minimum. Using a dedicated email server with a configuration for high throughput doesn't seem to cause greater problems in regards to stability and transmission speed. Problems only occur if the sender has a substantially greater bandwidth than the receiver, leaving him no chance to draw all the emails from his account.

Entering routine operation is only the first step for the platform. The potential lies in the upcoming services, which will be provided over the next years with an application spectrum from simple mail replacement to real-time collaboration and a service spectrum from unattended to a 24/7 support.

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