The software architecture of a telecommunication system for a nationwide trauma network

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Keywords Trauma network · Teleradiology · PACS · Germany · Nationwide

Purpose

The aim of the TraumaNetwork[D] of the German Society for Trauma Surgery (DGU) is to provide the best medical care possible for severely injured patients anytime any place in Germany by implementing standardized quality measurements [1]. The Academy of Trauma Surgery (Akademie der Unfallchirurgie AUC) a daughter of the DGU consequently developed a concept for implementing networks of trauma surgery hospitals adapted to local conditions which have been defined in a white paper published by the DGU in 2006 [2]. While participating in a network, hospitals fulfil different tasks regarding to their classification as local, regional or national trauma center. A national trauma centre must commit itself to taking in seriously injured patients at any time, as well as being able to treat two seriously injured patients simultaneously. Also, the management level of basic care centers should comprise a specialist physician with additional qualifications in trauma surgery, and the centre should provide a 24-h emergency service for the emergency treatment of seriously injured patients. Furthermore, the white paper requires the usage of telemedicine applications for the transmission of radiological images.

About 55 trauma networks with about 15 hospitals per network have been established by now. This means 700–800 hospitals in Germany. Several local teleradiology networks have been implemented for this purpose in the last years. But most trauma networks were not able to establish a telemedicine infrastructure due to financial and organizational problems and strong legal requirements regarding data privacy. Thus, the DGU decided to establish and fund a national network with a centralized infrastructure which is open to existing networks and takes data security requirements into account. The purpose of this telemedicine network should be emergency consultation and second opinion. Other application scenarios should be possible as well.

Methods

The German Academy of Trauma Surgery (Akademie der Unfallchirurgie, AUC) of the DGU published a tender with the requirements for a national telemedicine network. Several companies wrote proposals for the tender which have been evaluated by an expert group coming from trauma surgery as well as from medical informatics and teleradiology. CHILI GmbH (Heidelberg, Germany) as a long-term expert and provider of teleradiology and PACS solutions and pegasus gmbh (Regenstauf, Germany), an IT-security specialist, have been selected as the providers of the technical solution. The software architecture of the selected system is presented in this paper. Most components are based on standard CHILI software modules [3] which have been adapted to the specific project needs, mainly to cover the high demands on data privacy.

Results

Global structure

The global structure of the network consists of

- A central portal (TK Portal),
- a central web server (TK Server) which provides
- the web-based viewer (TK Viewer) and which can be used by the users.

Hospitals connected to the trauma network can either use the portal with the web-based viewer to upload and view medical images and other relevant data or install their own technical infrastructure to improve speed and convenience. These are:

- a software router (TK Router),
- a teleradiology gateway (TK Gateway) with optional software modules.

Legal regulations require that all data is encrypted both during the transmission over the internet as well as when they are stored temporary on the central server at the provider's site. The encryption keys are stored and administered at a neutral location and organization which acts as an

- External security center (ESZ).

The central portal and the web server are hosted by a provider in the internet.

TK portal and TK server

The portal is the entrance door for the users to the telecommunication network. In the first step, only hospitals are granted accesses which belong to the TraumaNetwork[D] of the German Society for Trauma Surgery. All users are administered in a central LDAP database.

After a successful login users can either upload data from a file system or DICOM CD. Furthermore, the web-based java upload applet can receive images locally via DICOM C-Store directly from a modality or the local PACS. The applet encrypts all data and transfers them on an encrypted internet connection to the central TK server to the inbox of another user and, if available, also to a TK Router of TK Gateway in the receiver's hospital.

TK viewer

The web-based TK Viewer is the most important tool for the users. It is a medical product class IIb according the European Medical Device Directive (MDD) and can be used for diagnostic reporting of medical images. The viewer is based on the CHILI web client which is already running in many PACS and teleradiology installations [4]. It is independent of the used internet browser. The only prerequisite at the client site is that the java runtime environment is installed. The viewer has all necessary functions of a diagnostic workstation, including multi-monitor support. Images can be exported to the file system in different formats and be sent to other locations with different protocols, such as DICOM C-Store or DICOM e-mail. In addition, the viewer is able to receive images directly via DICOM C-Store and import DICOM data from the file system or DICOM compatible media.

TK router

This software module can be installed on a computer in the hospital. It receives images from DICOM sources, encrypts the received data and transmits them automatically to the intended communication partner

at the central TK server, or to the local infrastructure in the receiver's hospital respectively. The advantage of the TK Router is that the users can automatically modify, encrypt and transmit images to other sites sent from the existing modality, workstation or PACS without further user interaction. Furthermore, the TK Router can receive data from the central TK server and forwards it directly to the local PACS or other DICOM devices. The TK Router has no user interface for the viewing of medical data. The central viewer serves for that purpose. The advantage of the router is that the users can remain in their normal working environment to send, receive and view trauma data.

TK gateway

The TK Gateway has the same basic functionality as a TK Router, but includes a teleradiology server with its own data base and web-based viewer and further functionality [4]. It can be extended by additional software options, such as reading, importing and creating DICOM CDs. External data can optionally be reconciled with internal patient demographics and organizational data and imported in a clean and IHE compliant way into the local PACS infrastructure. Thus, the gateway can act as an intermediate PACS for all external data.

External security center

All data is transmitted over encrypted connections. Furthermore, all data is encrypted by the application at the sending user's site, temporarily stored encrypted on the central server and only decrypted by the application at the receiving user's site (end-to-end encryption). Thus, even the administrators of the central servers have no access to patient data. The key servers are hosted at an external data center which is independent of the provider of the central servers.

Furthermore, a data privacy manual has been developed for the network which has already been approved by two of sixteen data protection commissioners of the federal states of Germany. The Independent Centre for Privacy Protection (Unabhängiges Landeszentrum für Datenschutz Schleswig–Holstein, ULD) [5] is currently auditing the privacy measures of the implemented system.

Conclusions

The concept for a Telecommunication System for a Nationwide Trauma Network in Germany has been defined in a tender of the Academy of Trauma Surgery. A pilot network has been implemented during the last half year. Nearly twenty hospitals of two regional trauma networks have been connected and the software has been evaluated by an expert group of the AUC. Several improvements have been implemented based on the gathered experiences of the pilot phase. Many other hospitals will now follow during the productive phase of the network which improves reliability, interoperability and privacy of the technical communication infrastructure and is an important key stone to provide the best medical care possible for severely injured patients anytime any place in Germany.

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