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# Ad hoc Participation in Professional Tele-Collaboration Platforms

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Abstract. Tele-collaboration between medical professionals is well established for specialties like radiology, cardiology or pathology. Typically these applications do not allow for ad hoc participation of non-registered users like patients and / or medical professionals. This paper describes an approach for extending these tele-applications to non-registered users and providing ad hoc participation with means for providing and accessing data. A light weight, web-based approach is used to assure acceptance and ease of use while maintaining and complying to the required regulations regarding authentication, authorization and protection of personal data. The approach has been implemented and is in use with a nationwide telecollaboration network in Germany.

Keywords. ad hoc participation, patient empowerment, health information exchange.

#### 1. Introduction

Conventional tele-applications e.g. teleradiology, telecardiology or telepathology typically involve professional users in a doctor to doctor setting. Being bound to institutions or organizations like hospitals, practices of specialists or general practitioners they support the use cases "second opinion", "expert consultation" or "emergency or transfer situations". Most of the tele-applications are focused on the transmission of images, typically as DICOM object and using DICOM transfer services [1-3]. Only some of the tele-applications support exchange of non-DICOM objects (e.g. office documents, PDF, TIFF, JPG) and if so mainly based on remote access to the RIS [3, 4]. Tele-collaboration based on synchronized viewers or workflow support for requesting, answering and documenting a second opinion or expert consultation is less available and communication often relies on phone [4]. Nearly all of the tele-applications lack the involvement and participation of ad hoc, non-registered users. Use cases would on the one hand include access to the data for viewing and download and on the other hand the ability to upload and provide data to institutions, organizations, or doctors for e.g. preparation for a patient visit or an expert consultation.

The objective of this paper was to present an approach for extending existing teleapplication systems by such an ad hoc functionality without compromising current use

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Figure 1: TKmed system architecture

and in particular privacy and data security. To illustrate the approach the established telecollaboration system TKmed [5] will be used.

#### 2. Methods

Starting from a short overview of the exemplar TKmed the requirements and the approach for the patient-centric use cases will be presented.

#### 2.1. The exemplar: TKmed

TKmed is a nationwide tele-collaboration service currently being used in more than 180 practices and hospitals mainly in Germany and in some of the adjacent nations in crossborder scenarios. It provides tele-applications like teleradiology and telecardiology and includes a consultation workflow support for about 2000 registered users.

Figure 1 shows the TKmed system architecture with a centralized infrastructure to allow for a store & forward approach for DICOM and non-DICOM objects. The user directory facilitates identity and access management for users, thereby including the organizational assignment of a user (e.g. to a department, a clinic). Two-factor authentication for safe remote access for doctors on duty is achieved by token services. The external trusted services (ESZ) guarantee an end-to-end encryption using keys provided at runtime to the different front-ends. They vary in the level of integration: While TK-Basis features a solely web-based viewer including access to local DICOM sources and data objects, TK-Router and TK-Gateways are applications executed on the user site to automatically route data objects to the centralized infrastructure or the destination, respectively. In addition, TK-Gateways include a PACS for keeping data objects prior to their further processing in the institutional data management and even support of mobile devices (TK-Gateway Professional). These levels may be seen as representatives for typical tele-application systems.

The TKmed Direkt front-ends serve for ad hoc participation and the concept will be introduced in the following chapters.

## 2.2. Use cases

Ad hoc participation requirements may originate from different stakeholders groups, namely patients and medical professionals. Such an application should be easy to use and avoid an extensive registration or identification process.

- Use case 1: Preparing a patient visit to a practice or hospital The patient should be able to transfer data objects residing on her/his personal device (e.g. PC, laptop, tablet) to a selected organizational unit or person in a healthcare organization (e.g. a private practice or hospital) by a web-based application.
- Use case 2: Accessing data objects in the context of a patient visit Personal data objects, selected by a responsible doctor, person or organization, should be available to the patient for multiple download and viewing during or after a patient visit.
- Use case 3: Ad hoc consultation for medical professionals Medical professionals should be able to provide data objects to identified members of a tele-collaboration platform without being registered users or having a contractual relationship with the platform provider. This facilitates direct contact with colleagues for second opinion, for preparing a patient admission to hospital or transfer to a specialist.

In addition, all three use cases gain added value in situations where the patient is located abroad and is in need of a second opinion from the doctors at home or if the attending doctor wants to consult the patient's family doctor or specialist.

# 2.3. Method for data object upload

From an IT point of view there is an unidentified and unregistered person or patient requiring access to a highly secured tele-application infrastructure. Two ways have been investigated for uploading one or more data objects:

- A direct upload of any data object to a selected destination (one of the registered personal or organizational users of the tele-application platform) is prone to spam with the danger of resulting in denial-of-service attacks. Therefore it has not been pursued.
- The indirect way involves two steps. The first step asks for the person's email address and the selection of a destination for the upload. It results in a link provided automatically to the specified email address. Once received, the activation of the link invokes the second step for selecting the local data objects for upload and performing the transfer. The transfer itself uses the same data protection and encryption methods (HTTPS) as for the tele-application, e.g. session key generation, runtime key provision from the external trusted services and end-to-end encryption (AES256) for the selected destination. In addition, in case of the patient conducting the upload, the issue of consent is intrinsically resolved. Otherwise, the medical professional has to obtain the patient's consent prior to the upload.

#### 2.4. Method for data object provision or download

The hospital or practice or the doctor, respectively, has to abide to medical confidentiality when allowing access to the patient's personal data. When access is granted to external persons (e.g. referrers, experts) this implies a signed patient consent. However, in case of the patient receiving access, consent is required at a much lower level for the transmission and the associated risks or implicit consent may be assumed based on the interaction with the patient, as described in the following paragraph.

The contact between the doctor or personnel with the patient serves for the authentication of the patient which has to be mapped to the requirement of a two-factor authentication in the IT domain [6]. Again, the patient will have to provide her/his email address to the doctor or the personnel for obtaining the link as a first factor. For the second factor, demographic information and a session key will be used to produce a token as a printout (text or QR-code) for the patient. The provided link together with the possession of the printout fulfills the two-factor authentication requirement. Both have to be used to access the information provided from the health care institution. Internally, the procedure results on the one hand in establishing a temporary data container for that patient data objects and on the other hand sending a link to the patient's email account. It is worth noting, that within the tele-application the patient only receives access to her/his data container when invoking the link. Her/his rights are limited to viewing and downloading the data or to directly selecting a destination for forwarding the data e.g. due to a planned visit to another doctor.



Figure 2: Request for the upload link

TKmed Direkt	: Upload to (Abteilung) Unfallchirurgie, Unfallchir Nachricht 4 von 67	•
Von	chili_notification@tkmed.org 上	
An	martin.staemmler@fh-stralsund.de 🚢	-
Datum	Mo 11:53	~
Dear Mr Martin Staemml	er,	
please use the following	link to upload your data with TKmed Direkt:	
Upload		
This link can be used fro Württemberg, Deutschla	m now on for the one-time sending to (Abteilung) Unfallchirurgie, Unfallchirurgie, Musterklinik, Musterstadt, t and.	Baden-
Valid until: Wednesday, Maximum data volume:	2017-04-05 12:53 PM 3.00 GB	
Yours sincerely,		
(Abteilung) Unfallchirurg	ie	

Figure 3: Email with the upload link

#### 3. Results

This chapter presents the results of the implementation, current usage and business case to achieve long-term sustainability.

#### 3.1. Implementation

The use cases were implemented using a Java application being executed in the browser. Figure 2 shows the approach for use case 1 (depicted as TKmed Direkt in Fig ure 1) for requesting a link by providing the name, email address and selecting the desired destination. The detailed list of destinations obtained does only include those, who have agreed to receive uploaded data. Usually they have generated a specific destination within their organizational units for receiving uploaded data. The request results in an email with a link for the upload (Figure 3).

Figure 4 shows the result from activation the link. The upload allows to select data objects (DICOM CD, DICOM images, directories, files) and to add a short message for informing the selected receiver. With "Send now" the transfer is started and visualized by a progress bar and the list of data objects transferred.

For use case 3 a slightly different approach has been implemented to simplify the upload for medical professionals (shown as TKmed Direkt Professional in Figure 1). Instead of repeatedly requesting links for uploads and performing the upload, medical professionals may be invited by a recipient e.g. a colleague or a hospital. In this case, the recipient generates a link for uploads and provides this link to the medical professional, e.g. via email. The link usage may be constrained by the number of usages, the accumulated data volume of successful transfers or by a time period for validity.

For use case 2 the person receives a link for accessing the data objects provided and uses the obtained token information to authenticate. As a result, access to the data objects is granted.

For all use cases it is worth noting that any data object is kept on the TKmed infrastructure for up to 14 days only in order to avoid objections based on data retention. The recipients, patients or medical professionals, are responsible for data object management, either locally or using a cloud-based record according to the relevant applicable data protection regulations.

Your name:	Martin Staemmler		
Your institution:	FH martin.staemmler@fh-stralsund.de (Abteilung) Unfallchirurgie, Unfallchirurgie, Musterklinik, Musterstadt, Baden-Württemberg, Deutschland		
Reply email address:			
Sending destination (Receiver):			
ata Data	volume: 546.8 KB (max.: 3,072 MB)	Message	
C:\tmp\dicom.dcm (applicat	ion/dicom) (application/msword) (application/pdf)	enclosed you`ll find some images and documents for preparing my admission next Monday. Best regards, Martin Staemmler	
dd files Patient CD File(s)	Remove	✓ I have read the <u>data protection notice</u> and confirm that I agree with it.	_

Figure 4: Upload of image(s) and / or document(s)

### 3.2. Business case and sustainability

Since - from a patient view - access is granted for upload and download without providing a long-term storage of patient data no costs for the patient are acceptable. This expectation is in line with experiences of providers, who offered personal health records for patients at reasonable costs and subsequently withdraw their offer from the market due to too low numbers of users and lack of revenue. A comparable reasoning applies to an ad hoc usage by medical professionals. On the other hand, the practice or hospital providing such a service and being already involved in tele-applications improves its standing and market provision, which justifies paying for the ad hoc transfer service. Payment schemes may be based on licensing this service, on the number of accounts being used / established or on the amount of data transferred. In the current implementation each organization registered with TKmed, who wants to provide this ad hoc transfer service, needs to obtain a license.

#### 3.3. Usage results

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The presented functionality has been released and is routinely used by about 35 of the currently 180 hospitals and practices, predominantly the larger organizations. The usage covers all three identified use cases and extends to patients from abroad in some organizations. A demand to facilitate inclusion of the described functionality in the web presence of organizations and to allow for branding has been issued and will be taken up in subsequent versions.

#### 4. Discussion

Exchange of information between the professional domain of doctors and healthcare institutions and with the patient is not new. In particular, patient participation has proven its usefulness for supporting patient compliance and taking an active role to maintain and improve the personal health status [7]. Depending on the type of information various means are used. Typically image data is provided using DICOM CD / DVD or USB sticks and including a vendor specific viewer for the DICOM objects [8]. By nature it is unidirectional and requires that the receiving practice or hospital can read and manage the related media. Telemonitoring applications mainly rely on proprietary means for communicating vital signs from the patient to a reading service which will contact the patient in case of relevant changes [9]. Again this communication is mainly unidirectional.

Portals, web-based services or web applications are mainly restricted to specific groups of stakeholders. For example, they allow to either a) provide information of the patient to a selected recipient or b) to obtain data from the patient [10] or c) they are targeted medical professionals for supporting referral and bridging between sectors [11]. Some of these approaches support only specific types of data. For example, the application xPIPE is targeted to images only [12] and limited with regard to the recipients in the University Hospital Münster, Germany.

Health clouds are available from PACS and medical image system vendors or from independent providers with a focus on medical images. For example, Health Data Space provides a secure, certified cloud approach available for patients and medical doctors, allowing for images and other data objects [13]. But, it does not support the ad hoc feature presented in this paper.

However, when comparing this approach with well-advanced health care systems featuring regional or even nationwide electronic health records [14, 15], these typically include images, reports, lab data, referrals and - depending on their scope - patient recordings as well. But, usually they require a much more sophisticated infrastructure to provide identity and access management based on a public key infrastructure (PKI) and tokens (smartcards, soft token) in the hands of the patient and professionals. Enhancing existing tele-applications is a more light-weight approach and targeted to achieve direct acceptance with clinical users based on the established environment.

Assessing the described approach with regard to standard conformance reveals that it complies to the DICOM standard [16] functionality (Part 4, 7), DICOM objects and their representation (Part 3, 5, 6) and for accessing DICOM objects (Part 10) or the comparable IHE PDI profile [17]. Store Over the Web (STOW-RS) or Web Access to DICOM Objects (WADO-RS) by RESTful Services (Part 18) have not been used since so far there is only limited support from existing information system or PACS. In addition, they are not well targeted for an end-to-end encryption with an intermediate store & forward infrastructure. For all other non-DICOM data objects the level of integration with the existing personal or professional legacy systems varies. Integration with such systems depends on their capability to provide out-going and as well in-coming interfaces based on HL7 messaging [18] or IHE source / consumer or creator / importer actors [19]. Both could be supported by the current implementation. However, due to the low amount of identifying information requested in transferring data objects to a particular patient. This deficiency could be compensated for by requesting the user to

provide sufficient information on patient demographics and context data but with the caveat of a limited ease of use and reducing user acceptance and usability.

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