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ASP archiving solution of regional HUSpacs

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Abstract The application service provider (ASP) model is not novel, but widely used in several non-health care-related business areas. In this article, ASP is described as a potential solution for long-term and back-up archiving of the picture archiving and communication system (PACS) of the Hospital District of Helsinki and Uusimaa (HUS). HUSpacs is a regional PACS for 21 HUS hospitals serving altogether 1.4 million citizens. The ultimate goal of this study was to define the specifications for the ASP archiving service and to compare different commercial options for archiving solutions (costs derived by unofficial requests for proposal): in-house PACS components, the regional ASP concept and the hospital-based ASP concept. In conclusion, the large scale of the HUS installation enables a cost-effective regional ASP archiving, resulting in a four to five times more economical solution than hospital-based ASP.

Keywords Picture archiving and communication system · Application service provider · Long-term archiving · Radiology

Introduction

In the application service provider (ASP) model, an application is provided to a user as a service instead of locally bought in-house hardware and software components. This model is widely used in several business areas, but only recently has been introduced in health care.

In the ASP model of a picture archiving and communication system (PACS), the application and image data are executed and stored, respectively, on a remote file server that is not owned by the health care delivery entity. Only the result of an operation is transferred to the client computer and displayed for the end-user.

There is a variety of ASP models that can be used in PACS, ranging from archiving solutions to more extensive versions where the total PACS is arranged as an ASP service: modality interfaces, networking, diagnostic workstations, web servers for the delivery of images to the clinicians and general practitioners (GPs), short-term archives, databases, etc. Some ASP services are for disaster recovery (back-up) or redundancy purposes only [1]. There are only a few PACS installations where the ASP model has been introduced in Europe [2, 3]. ASP is, however, more common in the USA [4].

In this article, the ASP solution of HUSpacs, the PACS of the Hospital District of Helsinki and Uusimaa (HUS), is described and discussed. The aim of the study was to define the ASP service specifications for the long-term and back-up archiving of the regional HUSpacs. These specifications were used in the unofficial requests to vendors in order to compare the costs of in-house and ASP long-term archiving as well as in the final request for proposal for the ASP service. The purpose was also to compare the costs for the regional and individual ASP solutions for the hospitals comprising HUS.

Methods

Technical architecture of HUSpacs

HUSpacs is a regional PACS for 21 HUS hospitals, 9 primary health care hospitals and 53 primary health care centres in the

HUS region. There are altogether 1.4 million citizens served by these health care delivery entities. To our knowledge, HUSpacs is one of the largest PACS installations in the world (about 20 TB image data and one million examinations annually) and one of the largest ASP concepts as well. The HUSpacs project started in 1997, and the first hospital was made filmless in 1999. At the end of 2000, there were 2 filmless hospitals, 18 hospitals in 2002 and 21 hospitals in 2003.

In the technical architecture of HUSpacs, features from centralised and decentralised systems are combined. There is one common image database for the whole hospital district as well as centralised long-term and back-up image storage. However, each hospital or group of hospitals has its own local redundant arrays of inexpensive disks (RAIDs) for short-term online archiving. Error-tolerant RAIDs contain images produced or pre-fetched during the past year. The centralised database controls both short- and long-term archiving.

HUSpacs is a mixture of in-house and ASP solutions: modality interfaces (200–250 imaging modalities), the image database, 120 diagnostic workstations, 12 web servers and 8 local RAIDs are in-house-bought PACS components. However, the ASP model is used for long-term and back-up archiving. Agfa-Gevaert (Agfa-Gevaert Group, Mortsel, Belgium) is the prime vendor of both the in-house and ASP solutions. The ASP model has been extended to the network connecting HUS hospitals and the link directory containing links to locate patient records, images, referrals and reports. The link directory service is used in order to view patient information across organisational boundaries with the patient's informed consent. The network is provided by TeliaSonera (TeliaSonera AB, Farsta, Sweden) and the link directory service by Elisa Corporation (Elisa Oyj, Helsinki, Finland).

PACS has been integrated to the radiology information system (RIS) using Health level 7 (HL7) standard [5] and an integration platform (PACS broker). RIS sends HL7 messages to the broker concerning scheduling, referrals and certain ward reservations. The broker saves the messages to its database and uses them to form modality-specific worklists and to trigger pre-fetching of relevant priors to the local RAID memory. The pre-fetching criteria include the anatomical target, time and number of previous examinations. Routing of relevant priors is based on the same criteria as the routing of recently produced images. In Finland, there are national codes for radiological examinations (made by the Association of Finnish local and regional authorities). The anatomical target is derived from the electrical radiological referral to the Dicom modality worklist with the first two characters of the code indicating the exact anatomical target. New images are sent both to the on-site RAID server and the off-site long-term data centre.

Every user has his own unique user ID and a secret password. Patient information can be viewed only to the extent that is necessary for the role of the professional. In HUSpacs, there are different roles and user profiles defined, e.g., radiologist, technician, clinician, administrative and service personnel. In 2004–2005, authentication of external users will be performed using smart cards. All user activities including the time and date of the activities are logged. This not only concerns image transfer, but also image browsing and searching criteria. Patient's informed consent is mandatory when transferring data to another organisation. When transferring data outside HUS, they are strongly encrypted.

Electronic referrals from the primary health care control the image traffic in a similar fashion. Images ordered by GPs are delivered through web servers dedicated to external use. Data security is assured by virtual private network technology (VPN) and strong authentication (Fig. 1).

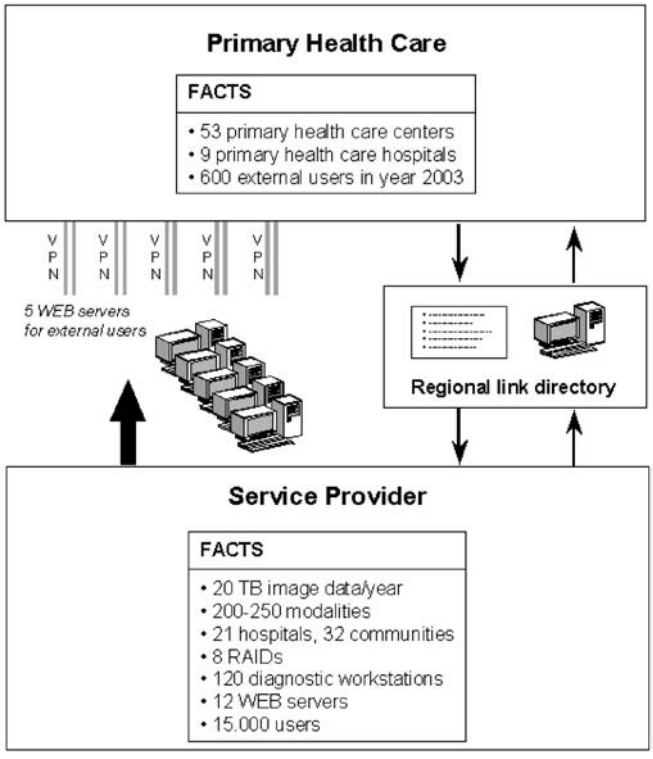

Fig. 1 Image delivery to primary health care through **a** web servers and **b** through link directory service. Link directory is used when GPs view images not belonging to their organisation

ASP service for long-term and back-up archiving

The ASP service includes long-term and back-up image archiving. The regional image database serving the whole hospital district was previously bought as an in-house PACS component and is excluded from the ASP service. The long-term archiving is based on RAID, whereas in the back-up archiving tape technology is utilised. Payment is per stored examination, which can include several image series. Searching from the digital archive is not charged separately.

ASP service for the network

Because of its centralised and partly ASP-based design, HUSpacs sets high demands on the network requiring efficient control and management functions, redundant topology, high capacity and guaranteed bandwidth.

The ASP service for the frame network, HUSnet, includes the connections between the campus areas of HUS hospitals. HUSnet is based on asynchronous transfer mode (ATM) technology with the constant bit rate (CBR) service class: the whole bandwidth is guaranteed for HUS. Each campus area has its own 40- or 155-Mbps connection with all physical links and active components doubled. The vendor has committed to the usability of 99.98%, i.e., 1.7 h down time per year. All crucial PACS servers are connected directly to the backbone switches of the HUSnet frame network with a redundant connection.

Unofficial requests for proposal

A comparison of the estimated costs for arranging long-term archiving operation in-house with the outsourcing costs was performed in HUS before launching the ASP program in autumn

2001. The method used was unofficial requests for proposal that were sent to three potential ASP vendors.

Results

Specifications for the ASP archiving service

Commitment to digital imaging and communications in medicine (Dicom) standard [6, 7]

The required Dicom service classes are at minimum: Dicom Storage service class user (SCU)/service class provider (SCP), Query/Retrieve SCU/SCP, Storage Commitment SCP and Verification SCU/SCP.

Commitment to archiving of all image data, also non-radiological images

The required service and object pair (SOP) classes are defined for the following image types (at minimum): computed tomography, magnetic resonance imaging, computed radiography, angiographic (secondary capture and Dicom X-ray angiographic), ultrasound, nuclear medicine and X-ray images as well as digitalised X-ray films and non-radiological images such as photographs, ophthalmologic and cardiologic images.

Routing and pre-fetching

Modality-specific examinations are routed to desired workstations, web servers and local RAID memory. Pre-fetching is based on anatomical regions specified in radiological referrals, time period and the number of examinations. The RIS interface utilises HL7 standard.

Distribution of images to the whole community: interfacing with the link directory

The ASP archive is interfaced to the link directory via an HL7/clinical data architecture interface. The link directory is a global repository containing links to image information that is stored in different organisational databases. The link directory is like glue between regional PACS installations. In order to view images from another organisation's database, the patient's informed consent is required.

Response times

The vendor guarantees a response time less than 30 s for archive searches regardless of the age of the examination. These response times are checked on a half-year basis or at request, if the function seems to have slowed down. The performance has to be maintained with the continuous growth of the archive.

Redundancy

The usability of the system should be near 100%. The maintenance, control and management of the system cover 24 h per day, 7 days per week.

Data privacy and security

Each user has a unique username and password. Image queries are restricted by organisational codes and the roles of the professionals. Images belonging to different organisations are archived to logically separate entities. With the patient's informed consent, it is possible to view images over organisational boundaries through the link directory.

The use of public key infrastructure technology including smart cards for professionals and third-party lightweight directory access protocol directories for users and their roles is possible. All user activities including image transfer and browsing as well as searching criteria are logged. When transferring data outside the hospital district, they are also strongly encrypted.

Storage and integrity of information

The vendor guarantees storage of data for the legally determined 20 years and assures confidentiality and integrity both in storage and data transfer. There is a conversion plan from one storage media to another to guarantee viewing during the whole storage time. The vendor is also committed for destroying the data when the legally determined storage time has passed.

Comparison of the costs for the in-house and ASP solution

Unofficial queries were sent to three potential ASP vendors, which all replied. One of the replies was based on stored Mbytes instead of per examination; it was converted to correspond to the others. The specifications were (1) 1 million examinations stored annually, (2) pricing per stored examination, (3) no extra charge for fetching of images, (4) storage of images for 20 years and (5) maintenance and control on daily working hours excluding the weekends. Networking and the hiring of the off-site data centre were excluded.

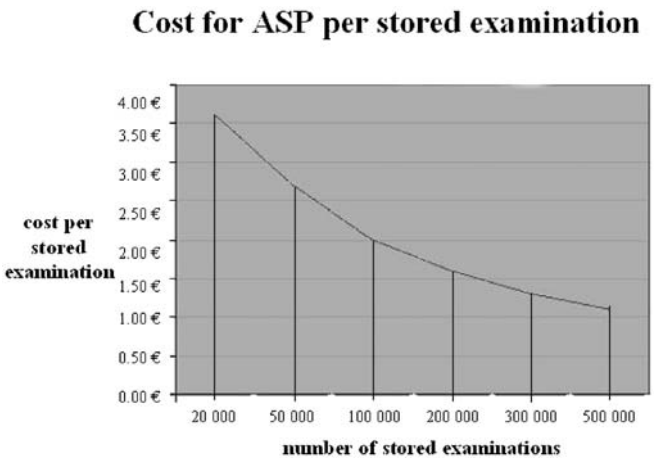

Fig. 2 Costs for ASP per stored examination as a function of the amount of stored examinations per year

The unofficial offers ranged from 0.85 to 1.83 euros per examination. To include maintenance and control every day 24 h per day raised the figures to 1.0–2.25 euros.

In order to compare the ASP prices with the in-house solution the following calculation was carried out using the PACS components of the most economical ASP vendor. The capital costs of the PACS components to be outsourced, the archival media, the software and hardware upgrades, installation, testing and maintenance service contracts were summed up and divided by the annual number of examinations. The maintenance service contract in this calculation covered only normal working hours excluding the weekends. The fee per stored examination in the in-house long-term archiving was 78 cents per examination.

ASP costs for local PACS vs regional PACS

PACS as an ASP service is not economically profitable with small annual examination numbers (see Fig. 2: costs for ASP per stored examination as a function of the amount of stored examinations per year; based on information from Agfa Gevaert with the assumption of the present HUSpacs ASP service level and the network solution, but differing numbers of examinations). The large-scale of the HUSpacs installation—1 million examinations per year—makes the ASP solution economically cost effective. It would have been at least four times more expensive to arrange long-term archiving separately hospital by hospital in the HUS region (annual examination numbers range from 20,000 to 130,000 per hospital).

Discussion

To our knowledge extensive turn-key ASP versions covering the whole PACS do not exist today. ASP programs still require an impressive list of conventional PACS components located in-house: only a few of the applications, such as long-term archiving or the total archiving operation, are provided remotely as an ASP service. In some cases also the web servers are included. In other words, it is the server sub-system of the PACS that may easily be under ASP (database servers, image data servers, archive servers, work-flow servers, web servers, etc.). The service usually covers archiving of the images for the legally determined period, back-ups and maintenance and management services. Diagnostic workstations, modality interfaces and local short-term archiving are still commonly bought in-house [8].

There are only a few ASP PACS installations in Europe [2, 3]. ASP is more popular in Scandinavia than in the rest of Europe: in Scandinavia networks have traditionally been broad-bandwidth solutions, which accelerates the introduction of off-site archives. Along with the implementation of national data networks, regional PACS installations and interoperable security platforms the ASP PACS concept will become more common in Europe. The understanding of the specifications for the ASP service from the customer's side and the development of the service products of vendors that have traditionally sold hardware and software are still major issues.

The fee of the ASP service is usually based on the number of examinations stored per year or the Mbytes used per year. In the former case the payment does not regard the variations in file sizes or examination types. Images can be fetched without extra charge. If web servers are included in the ASP model, there can be a fee per general web access to an examination stored or a fee per transaction. The general fee in the USA typically includes network expenses, installation, training, application support and upgrades [8]. In the publication by Grey it is stated that the fee per examination for off-site archiving is from 3 to 10 US dollars and for the web server access from 50 US cents to 2 US dollars. The fees are, however, deeply dependent on the service content. The number of examinations as well as the redundancy, quality of service and bandwidth of the network also affect the prices. The ASP prices in the HUS region are lower than those stated above: the number of examinations is high and the network with full redundancy and guaranteed bandwidth is utilised.

Working hours of the in-house service personnel and the costs for the replacement of old technology during the legally determined storage period of 20 years were not taken into account in our calculation. The economical aspect is, however, one of the criteria when considering whether to go into the ASP solution. The benefits of

ASP PACS have been discussed a lot recently [1–4, 8–12]. One of the most common arguments to choose ASP is that archiving is not the core business of health care delivery entities. The ASP solution also removes or diminishes the risk of choosing wrong archiving media or technology. Other benefits include the fact that costs are shifted from investment to the operational budget, easy prediction of archiving costs, utilisation of off-site IT expertise, easy upgrading and deployment of new technology, scalability according to the need and shifting of operational headaches to the ASP vendor. If the core PACS vendor is not the same as the ASP vendor, on-site technical support is still needed and the advantages of ASP are smaller.

Possible drawbacks or features that make the ASP solution less attractive include the smaller control over the image data that is not physically on-site. There can also be doubts about the ownership of the patient data and stability of the vendor behind the ASP solution; what happens if the vendor goes bankrupt? If the information management process fails—in terms of confidentiality, integrity or availability of information—it may be hard to find the responsible partner.

To provide an ASP service, the vendor needs quite an infrastructure and capital investment to start with. It is profitable only if you have a lot of customers or a few big customers. The ASP solution would be a very attractive solution to smaller sites that cannot afford the initial investments in PACS or the service and support personnel in-house. In Finland today, the ASP archives are not shared by several customers (except the customers for the prime contractor such as primary health care centres). The ASP concept is not affordable for smaller sites therefore and has led to "ASP over ASP" concepts, where large health care delivery entities offer archiving services to minor ones. Archiving may thus become eBusiness: primary health care centres, private clinics and small hospitals, maybe even patients, can buy archiving space from the common ASP storage centre. Also, non-radiological images from other specialities can be archived and charged for. Instead of health care delivery entities, in the future, patients may sign the archiving contracts with vendors and empower professionals to view the data when needed; clinical data will be retrieved from the clinical information systems to be stored in personal archives provided by third-party ASP vendors.

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