UPGRADING HEALTH CARE INFORMATION SYSTEMS

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Abstract: The leading idea in the process of upgrading standard HCIS is make them web-oriented and integrated them together. First step is improvement of HCIS's security subsystem and ensure patient data privacy protection. After that, the next step is realization of web applications that allow patient scheduling, communication with doctors from other clinics as well as user services for scientists and researchers. Development of advanced intraclinical information system with ability of data acquisition from diagnostic and laboratory facilities is third phase. The last step of this upgrading process is stronger integration with emergency department information systems. This paper represents directions and a methodology for upgrading standard health care information systems and explains one possible scenario for doing this job.

Keywords: Health Care Information System (HCIS), Web-Oriented HCIS (WOHCIS), Modular, Security, Intraweb, Emergency Department Information System (EDIS), Upgrade.

1   Introduction

The rising cost of health care throughout the world has created an urgency to improve health care productivity and quality. It is the reason which has led to the development of new health care delivery models, broad organizational restructuring, and the redesign of health care business and clinical processes. Not only are these changes redefining the health care environment, they are also creating a demand for a new healthcare information infrastructure.

The creation of this health care information infrastructure requires the integration of existing and new architectures, application systems, and services. Realization of standard, intraweb-oriented, health care information systems made doctors' and physicians' work on clinic easier, but, nowadays there are a lot of spaces for their improvement. System, like this one, allows medical staff members at multiple and single health care centre to use facility across the organization as well as between them. Furthermore, these systems include capabilities to manage resources more efficiently and support managed care environments. Also, integration of medical information systems, together with development of medical expert systems and improving of medical instrumentation, can help further advance in healthcare, and generally in medicine [1].

2   Security and remote access solutions

Upgrading standard (intraclinical, intraweb) health care information systems (HCIS) to web oriented HCIS is useful and desirable process that has a lot of advantages. But, unfortunately the Internet has a dark side too. Just as WOHCIS provides transparent access to external resources for an organization, it can also provide a possibility, for some people who does not have good intentions, to relatively easy access to the organization's internal computers and information. The hackers are not only risk for web oriented systems. There are malware (viruses, worms, etc.), spam (unsolicited commercial email messages), denial of services (DoS) and internal attacks too.

Security solutions proposed for WOHCIS are based on realization of firewalls integrated with malware and spam protection (fig. 1). Over time information system is exposed on different forms of attack. Because, its security system must to have a variety of corresponding point security solutions [2].
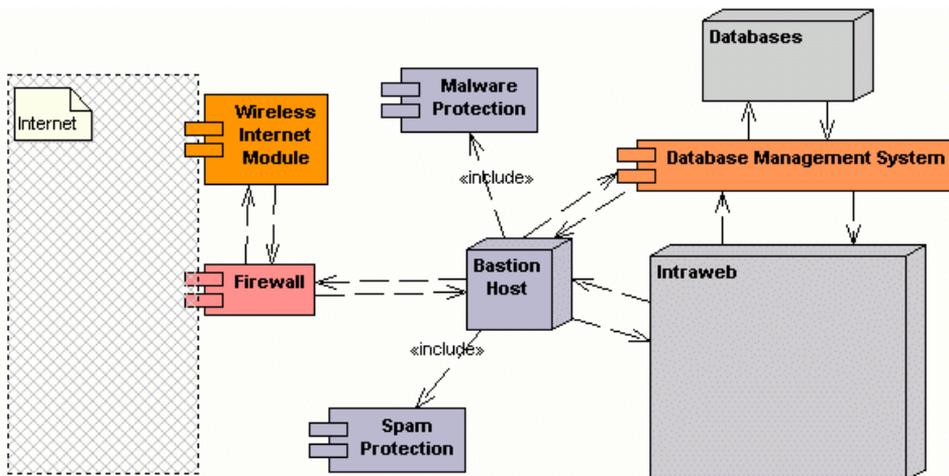

Fig. 1: Security infrastructure of HCIS

The first "member of staff" on the "line of duty" is firewall. It is placed at the point where the Internet enters a facility, and it controls network traffic for security purposes by examining all inbound and outbound traffic; and permitting only traffic meeting predetermined criteria to pass. Firewalls that incorporate application proxies can block some forms of attack disguised as legitimate traffic and perform other security and inspection functions. To minimize internal threats firewalls can also be used to segment an internal network.

Virus and spam protection are realized through computer programs that search targeted software for known or potential malware. They can be installed on every computer in the organization and scan each file received or sent from that system (host-based scanners). Also, they can be resident on a single computer that sits at the Internet's point of entry to an organization, scanning all inbound and outbound email and at-

tachments (gateway-based scanners). Ideally an organization should install both forms of protection to add an extra layer of security. However, if budgets are limited, the perimeter approach is easier to administer, more secure and more cost effective.

Wireless protection is an important layer in security structure too. Devices that are connected to HCIS, using wireless connection, provide encryption of traffic as well as authentication. This is protection against the additional hazards. Computer software residing at both ends of a remote communications connection enables the establishment of secure virtual tunnels through a shared public Internet infrastructure.

Authentication for remote access to the system will be based on smart cards, bar codes, passwords, and biometrics solutions [3]. According to keeps integrity of patient information, restricting access to individual patient records is necessary. This requires the ability to unique identify and autentificate each individual user.

Smart cards are very suitable authentication choice. Visually, they have form like credit cards with established "two-factor" identification. This type of autentification is implemented using PIN protection. One security number is stored on card, and second (PIN) is known only by user. Result of this approach constitutes one of the strongest forms of access control. But, smart cards also have the drawback of labor and cost-intensive implementation. Smart card deployment would mean providing a smart card reader for numerous workstations including patients that wish to ensure on-line privacy. Otherwise, cards with bar code are less expensive, but less secure access method. Another advantage is lower costs of bar code reader, but small data capacity is huge disadvantage.
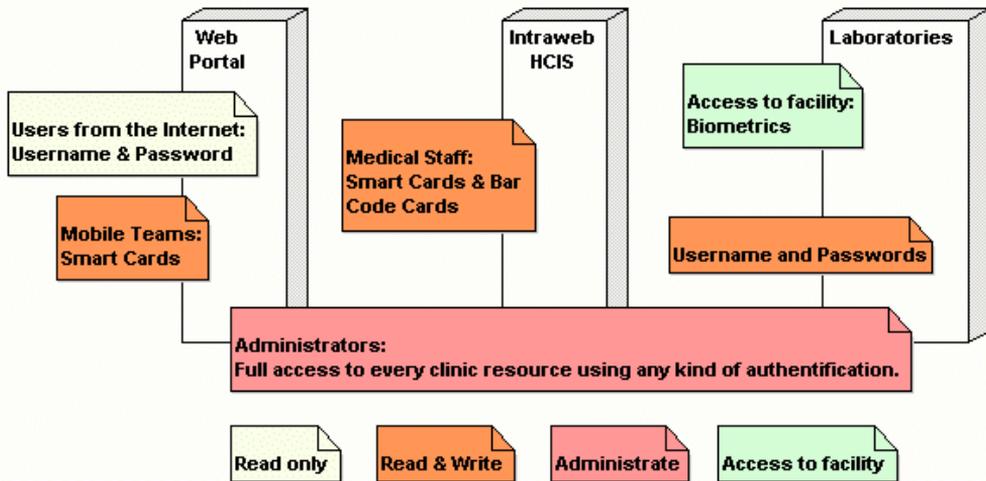

Fig. 2: Authentification methods used in HCIS

Passwords, as traditional authentification method, are easiest and cheapest to deploy. However, passwords also happen to be one of the easiest to hack. Passwords are convenient for users if they are short, but they can make a hospital more vulnerable to

unauthorized network intrusions and cause security breaches. If the hospital IT department tries to use a complex password convention, users will just end up writing them down because they are too difficult to remember.

Biometric solutions have risen in popularity because they are not only secure but also sense of "high-tech" security that encourages acceptance. But they are not without drawbacks. Their most inconvenient characteristic is high cost.

So, solution should be sublimation of all of counted authentification methods (fig. 2). Different classes of users will have different levels of protection. And, the scope of patient accessible data should not be the same for all of the users.

3   HSIC users' Internet communication system

Internet Communication System (ICS) for HCIS users is set of web applications that allow remote access to relevant data [4]. Access to these applications is realized through implementation of web portal. Realization of specific web portals, together with special web services implementation, is one of the most important processes in HCIS-WOHCIS transition. The ICS consists of standard user service and scheduling service (fig. 3). The main parts of user service are data providing module (from HCIS), report generator, forum and message board. Scheduling service allows:

- To patient: scheduling all types of diagnostic and therapeutically visits on clinic.
- To doctors: rescheduling activities and generating wait lists.
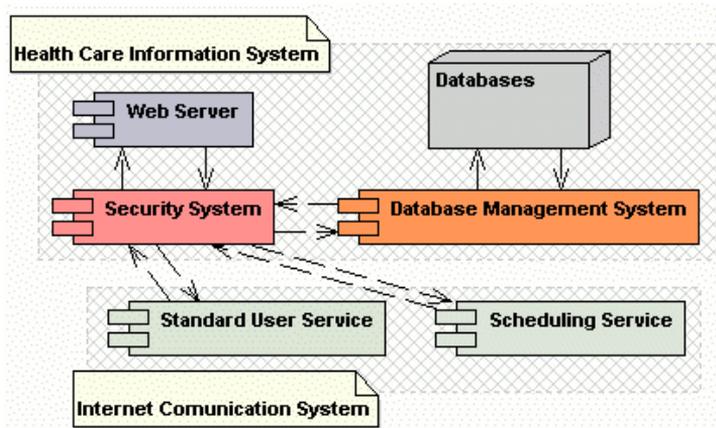- To clinic management: creating time tables for employees and control material resources' flow.

Fig. 3: ICS – the basic structure

Users access ICS through web portal using simple web browser. After authorization and verification they could use their facilities, and access to their medical information. The scope of accessible data is defined for each class of users (fig. 4). An ef-

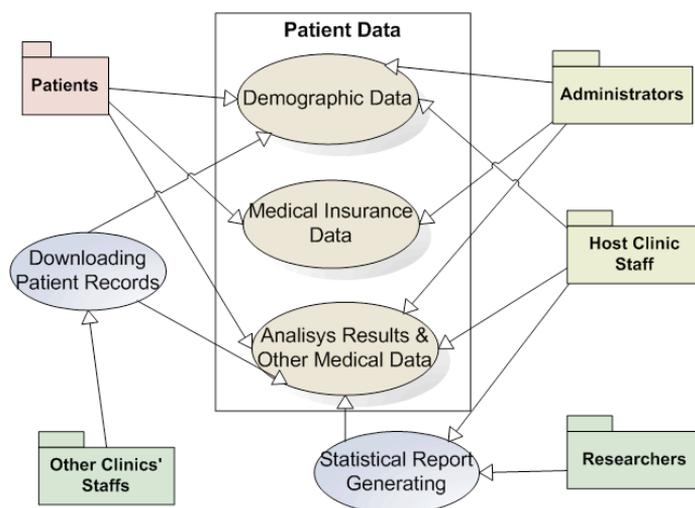fective use of ICS could indicate better management with clinic affairs as well as lower costs.

Fig. 4: Classes of users and their access privilegies according to patient data

This system is realized using PHP 4.3 technology with Apache 1.3 as web server and Interbase6 as database server. Functionality, that is realized using PHP for server-side scripting, is additionally improved with client side scripting in JavaScript [5][6]. The main advantage of mentioned software environment is platform independency. In this moment system is in phase of testing on General Paediatric Clinic in Niš.

4   Upgrades for intraclinical information system

The next step of developing intraclinical health care information systems is integration of all realized subsystem. To increase the power and versatility of old HCIS applications, they should be incorporated with other software, and built into complete system. Existing intraclinical part of HCIS consists of general patient care system and pharmacy control system. Additional parts that will be done in this phase are statistical analysis support component, laboratory information system, imaging and therapeutic services (fig. 5).

Laboratory information system improves the speed and accuracy of lab work - from requisitioning through final reporting - by eliminating time-consuming paperwork and delivering information to physicians quickly and efficiently [7]. The main characteristics of system are multisite and multifacility specimen tracking, up-to-the-minute patient data and charge information, ability to perform statistical analysis and compare test results, on-line patient inquiries, reports, and summaries, integrated inventory management and maintenance scheduling for laboratory instruments that are permanently connected to the system.
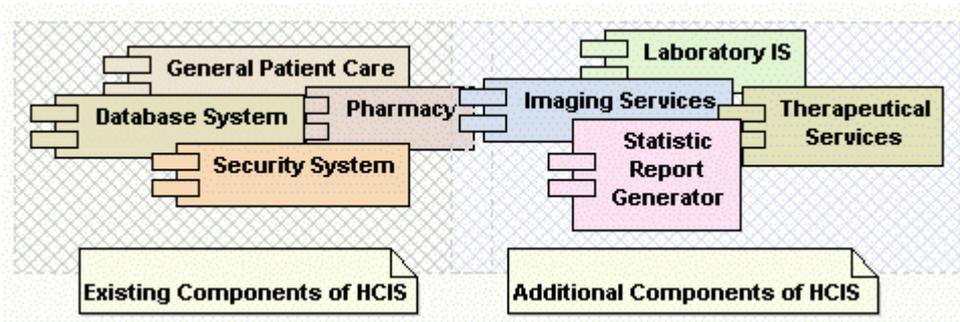
Fig. 5: Components of intraclinical information system

Staffs have the ability to enter results via workstations, on-line automated analyzers, and user-defined result entry screens. Also, laboratory information system helps streamline the result verification process and ensure the accuracy of results reporting. Laboratory personnel can perform real-time, on-line inquiries by physician, date, test, patient name, medical record number, partial name look-up, specimen number, or laboratory test. Reports, generated as results of inquire, can be automatically printed, faxed, and e-mailed.

5   Integration with emergency department information system

The integration healthcare and emergency department information systems (EDIS) is one of basic requests in the near future. So far, the emergency departments' information systems have existed like independent networks slightly connected to HCIS. The data flow between them was on unacceptable low level, and in some urgent cases, data deficiency was a huge problem. Now, the main question is not *do we have to*, but *how to* integrate them together.

There are many different ways to ensure network availability to drive data through applications. For example, a lot of international institutions use Secure Sockets Layer (SSL) virtual private networks (VPNs), Voice over IP (VoIP), and XML/SOAP Web services to access internal applications and databases [7]. Also, medical institutions need intelligent technology for corporate security architecture that will protect network traffic and provide reliable customer service.

Proposed solution includes using XML/SOAP web services and Internet protocols together to make data flow secure (fig. 6). Developing web applications based on mentioned technologies will be the main part of future integration system. Every distant and mobile part of integrated system, will access to central database using wireless connection. In the same time, system will trace all of them using GPS.
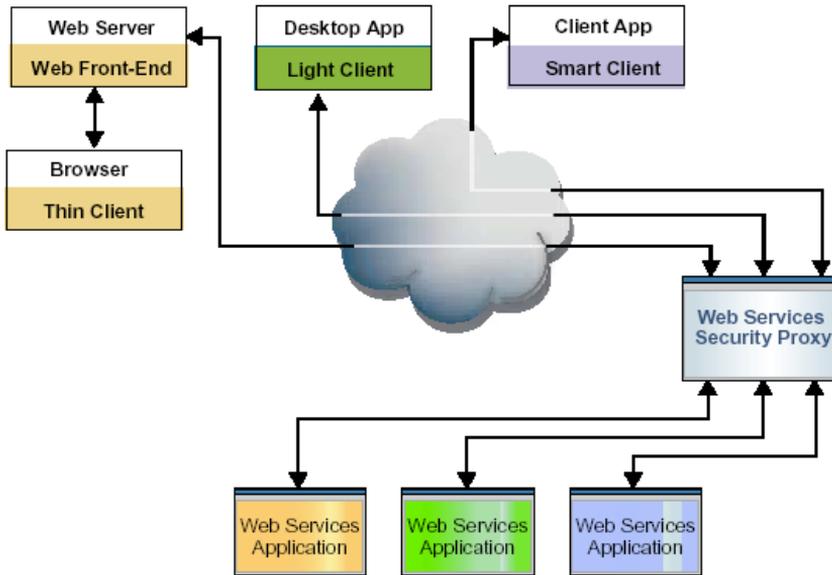
Fig. 6: Web services security proxy pre-processes all transactions with Web services applications

Another important part of join information system is the e-commerce. New information system, built on integration of EDIS and HCIS, must include user services that can be easily accessible for all of business partners in the supply chain. In the same time, integrated information system has to be able to respond on demands and connect to suppliers' customer web services.
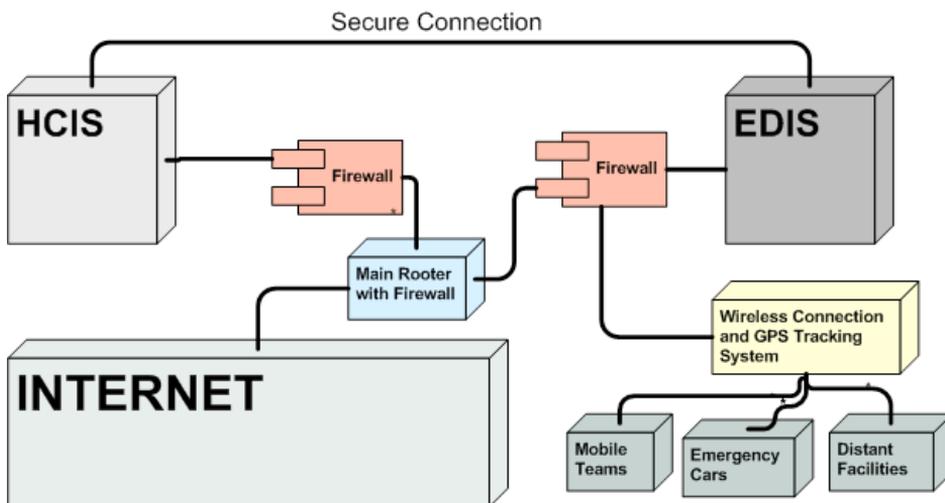

Fig. 7: Integration of EDIS and HCIS

This new, integrated information system must be able to profile appropriate traffic patterns and integrate network security with network management features to provide the highest network availability to applications. Also, ability to actively block deviant network traffic is preferred, as well as offering high performance with low additional latency to application and data access. A complete scheme of integrated system is shown on figure 7.

A strong integration between systems allows implementation of security solution with perimeter firewall filters, application gateways, and host protection software to focus on satisfying business requirements. Network integrity systems are essential to all mission-critical application environments that depend on network uptime, such are emergency services.

6   Conclusions

The development of the Internet and related services makes the communication between health care providers easier and faster. In the same time, linking physicians from other clinics, researchers, patients and other authorized individuals to hospital information systems is more effectively than ever. Nowadays, the main challenge is ensuring data security. The solution for HCIS protection, presented by this paper, is based on firewalls, intrusion detection and user authentication technologies.

The implementation of an integrated communication system based on web makes all of the health care providers closer to patient. For example, using HCIS's web portal doctors can access to lab reports, patient status updates and other important patient information. Also, the clinic can bring consultants from other institutions into the circle of care through integrated video conferencing and secure network connections.

The healthcare providers are facing with growing expectations for the quality of medical care. They have to invest significant time and material resources to improve their intraclinical information system. Otherwise, in light of shrinking government and insurance reimbursements, clinics expect every department to manage and control costs carefully. In that reason integration and improvement of health care information system is important process. The main goals of this process are further advance in medicine as well as reducing costs of healthcare.

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