Transnational integration of clinical and hospital information systems

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Topics

- Objectives and obstacles in integrating hospital information systems
- IT standards for (exchanging) medical data
- Mainstream in developing HIS
- Web based access to medical data
- Computer networking infrastructural changes
- Transparent access to medical data worldwide
- Integrating other services

Objectives in integrating hospital information systems

- Saving money
- Eliminating unnecessary examinations
- Improving healthcare (more data)
- Telemedicine
- Spreading best practices throughout the world
- Introducing standards worldwide – open competition

IT standards for exchanging medical data

- Widely adopted standards in ICT (HTML, XML, UML, Multimedia standards – images, video, sound, …)
- Medical data exchange formats
- Patient ADT (Admission, Discharge, Transfer), scheduling, clinical reports and results
- Patient medical record architecture
- Reference Information Model - static view of the information needs of HL7 V3 standard

Widely adopted Medical standards

- DICOM (Digital Imaging and Communications in Medicine) – standards for images, waveforms, structured reports primarily in radiology
- Health Level 7 – Level 7 in OSI model, 1987 - covering clinical and clinical/ administrative issues and integration
  - Clinical – laboratory, pharmacy, radiology, patient care, public health, dietary, reports
  - Clinical/administrative – patient registration, admission, patient accounts, document life cycle, …

DICOM (1)

- From proprietary medical devices that need proprietary software for acquiring medical data to a standard
- Widely accepted – precondition for survival of suppliers
- Precondition for wide adoption of RIS
- Worldwide exchange format

DICOM (2)

- Imaging products, PACS, diagnostic workstations, archives, RIS (results and reporting and partially ADT)
- Areas : radiology (all modalities), cardiac and vascular information, nuclear medicine, radiotherapy, ophtamology, ultrasound, MRI, 3D, dermatology, …
- Mature standard for integrating diagnostic devices and PACS, only partially covering RIS

HL7 - basic

- Health Level 7- Initially viewed as an application level (layer) standard of the OSI model for communication in health – telecommunications view – 1989 V2
- Was a classical text messaging view without attention for multimedia information
- Data models were not defined – only message structures that indirectly define the data models

Coverage of HL7 and DICOM

- Only partially overlapping
- Practical problems proved that the two basic standards are not enough
- Missing guidelines and many missing parts for the whole system. Evolving to incorporate:
  - PKI
  - Role based security evolution
  - Emerging standards in IT

Extending the HL7 to data modeling

- Hierarchical system of document architectures – Patient record architecture
- Defines semantic and structural constraints for management and data interchange
- Extended Mark-Up Language (XML) definition for interchange of structured clinical documents
- Flexible standardization and XML checking
- Not plug and play

Example in Serbia of XML in the pharmacies and Healthcare fund

- XML format checkers for invoices of pharmacies covering the whole country
- All legacy pharmacy information systems have a XML module
- Easy upgrade of the standards
- Flexible interface between all pharmacy IS and all levels of hierarchy in the Healthcare Fund of Serbia

HL7 Reference Information Model (RIM)

- Object oriented data model
- Consistent view of data
- Data relationship model
- Data exchange model
- Guideline for building the HIS object model

HL7 CCOW (Clinical Context Object Workgroup)

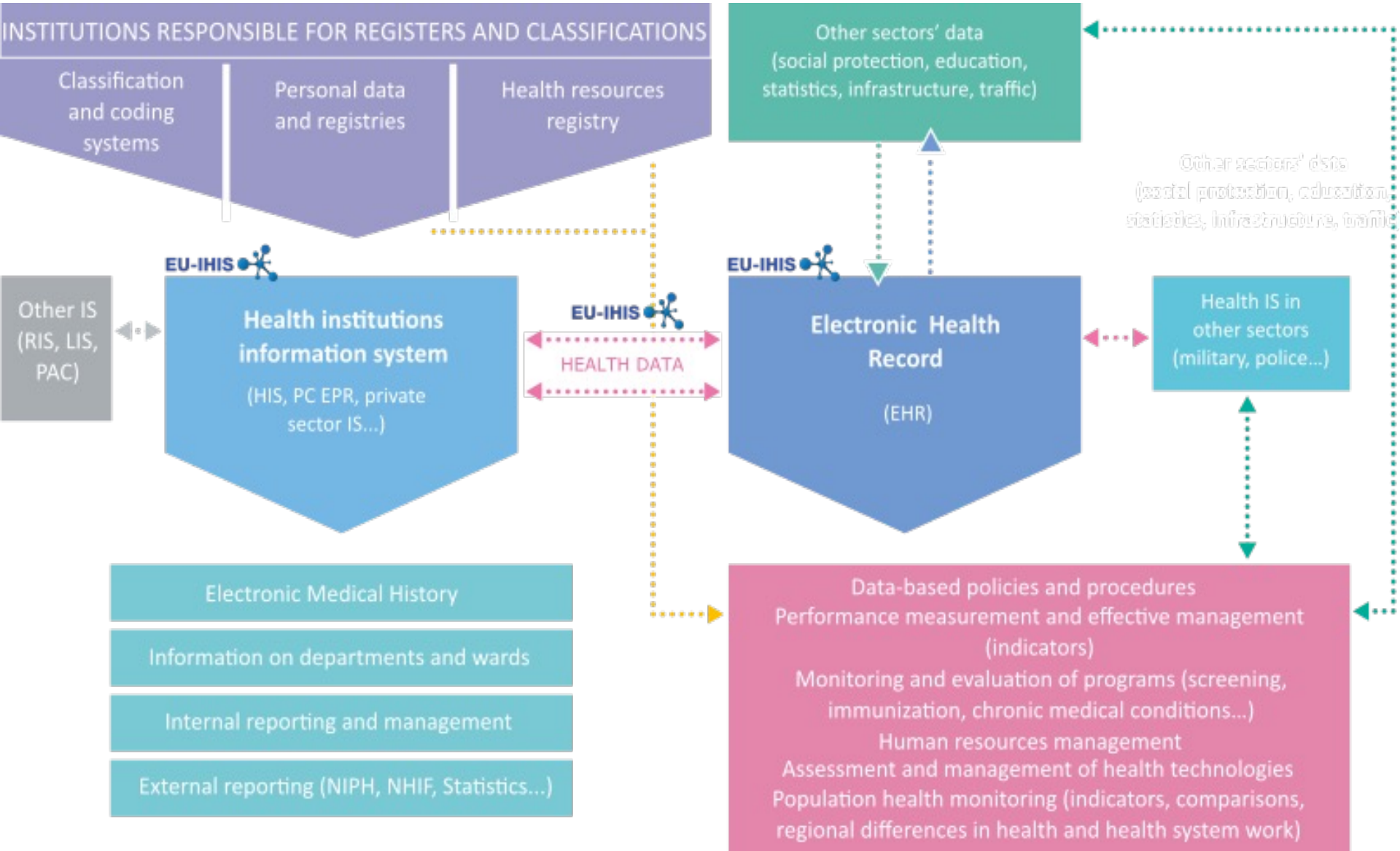
- Collaboration among Visual applications on workstations
- Synchronization on the same patient
- Enables distributed collaboration on distributed medical data of different applications
- IMSIG – Image managment SIG integrating HL7 and DICOM renamed to IISIG

CDA

- Clinical Document Architecture (CDA) is a popular, flexible markup standard developed by HL 7
- Allows health IT systems to process documents and users easily interact with them on Web browsers and mobile devices.
- If implemented, patient records can be created and read by any software system

Data flow in an Integrated Health Information System

EU-IHIS
Integrisani zdravstveni informacioni sistem



Results Achieved

- EHR conceptually rounded up and developed in compliance with the existing regulations (along with suggestions for improvement), work processes and systems for coding and classification
- Applied recommended and recognized standards and specifications in the field of eHealth
- Developed framework for interoperability, exchange and storing digital documents
  - HL7 CDA Encounter Summary and Hospitalisation Report
  - HL7 CDA **eReferral** and **patient eConsent** specification
  - Support to National Cancer Screening Office in defining the informational content of the **screening documents** in HL7 CDA forms
- HIS-EHR integration tested in 12 hospitals
  - Possibility to integrate the EHR with HIS introduced in other hospitals
  - Possibility to integrate the EHR with other systems (primary care…)

£11bn IT system HL7 2011

A plan to create the world's largest single civilian computer system linking all parts of the National Health Service is to be abandoned by the Government after running up billions of pounds in bills. Ministers are expected to announce next month that they are scrapping a central part of the much-delayed and hugely controversial 10-year National Programme for IT.

Mainstream in developing HIS

- Implementing multi-tier technologies
- Web browser as the basic and only component at the workstation level - Clinical Document Architecture becomes crucial
- Multimedia interface developed for the Web, low cost maintenance, easy sharing of data worldwide even on mobile devices
- Security solutions for Web based systems can easily be extended to healthcare (example e-Banking)

Presentation tier

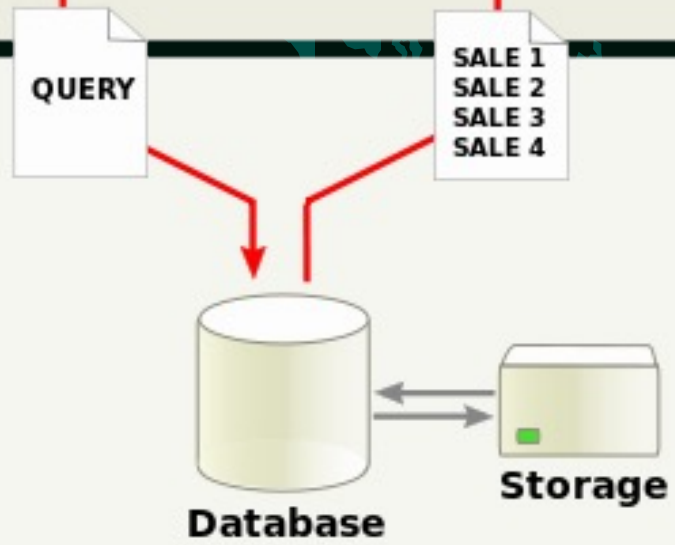
The top-most level of the application is the user interface. The main function of the interface is to translate tasks and results to something the user can understand.

Logic tier

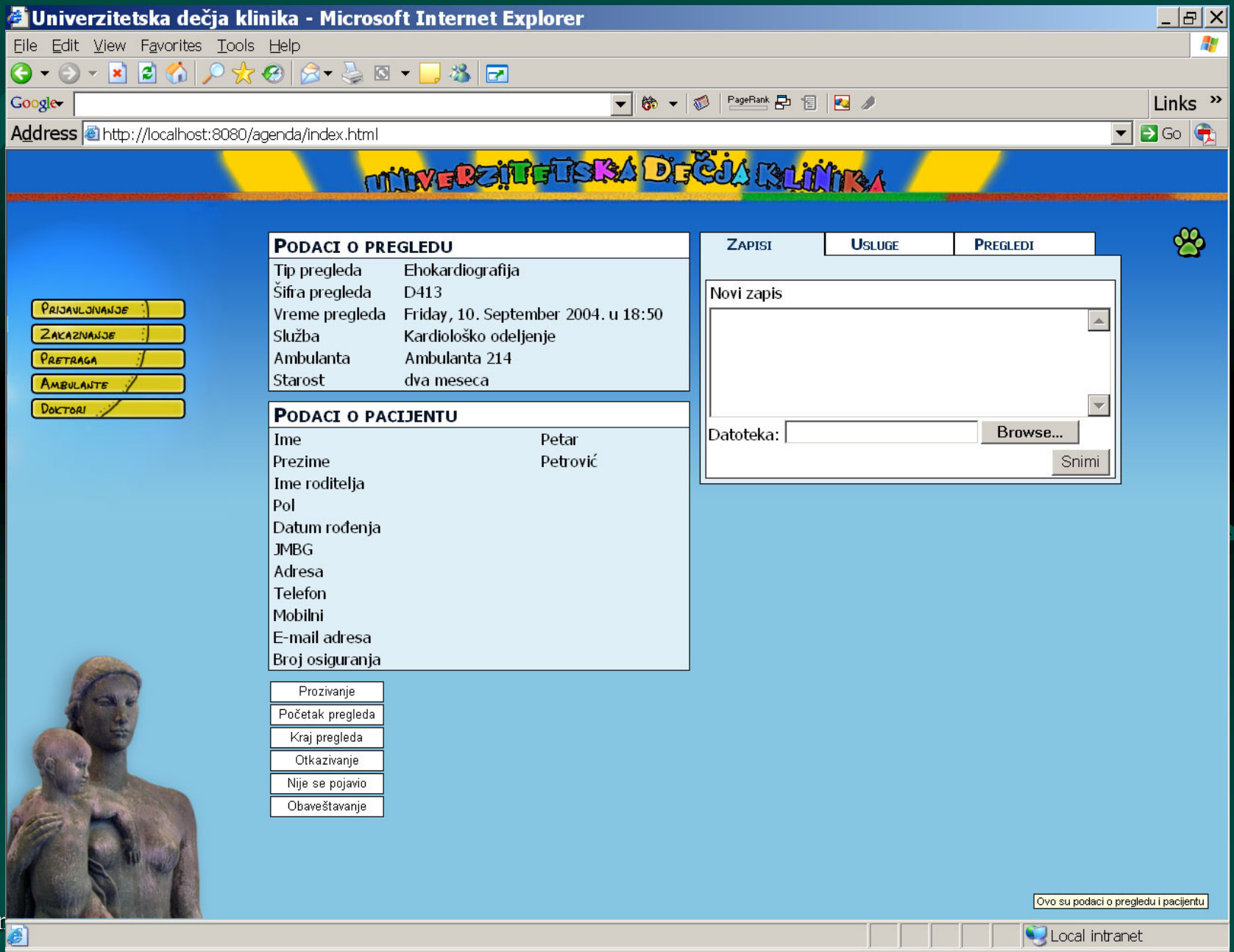
This layer coordinates the application, processes commands, makes logical decisions and evaluations, and performs calculations. It also moves and processes data between the two surrounding layers.

Data tier

Here information is stored and retrieved from a database or file system. The information is then passed back to the logic tier for processing, and then eventually back to the user.



Presentation tier for EPR

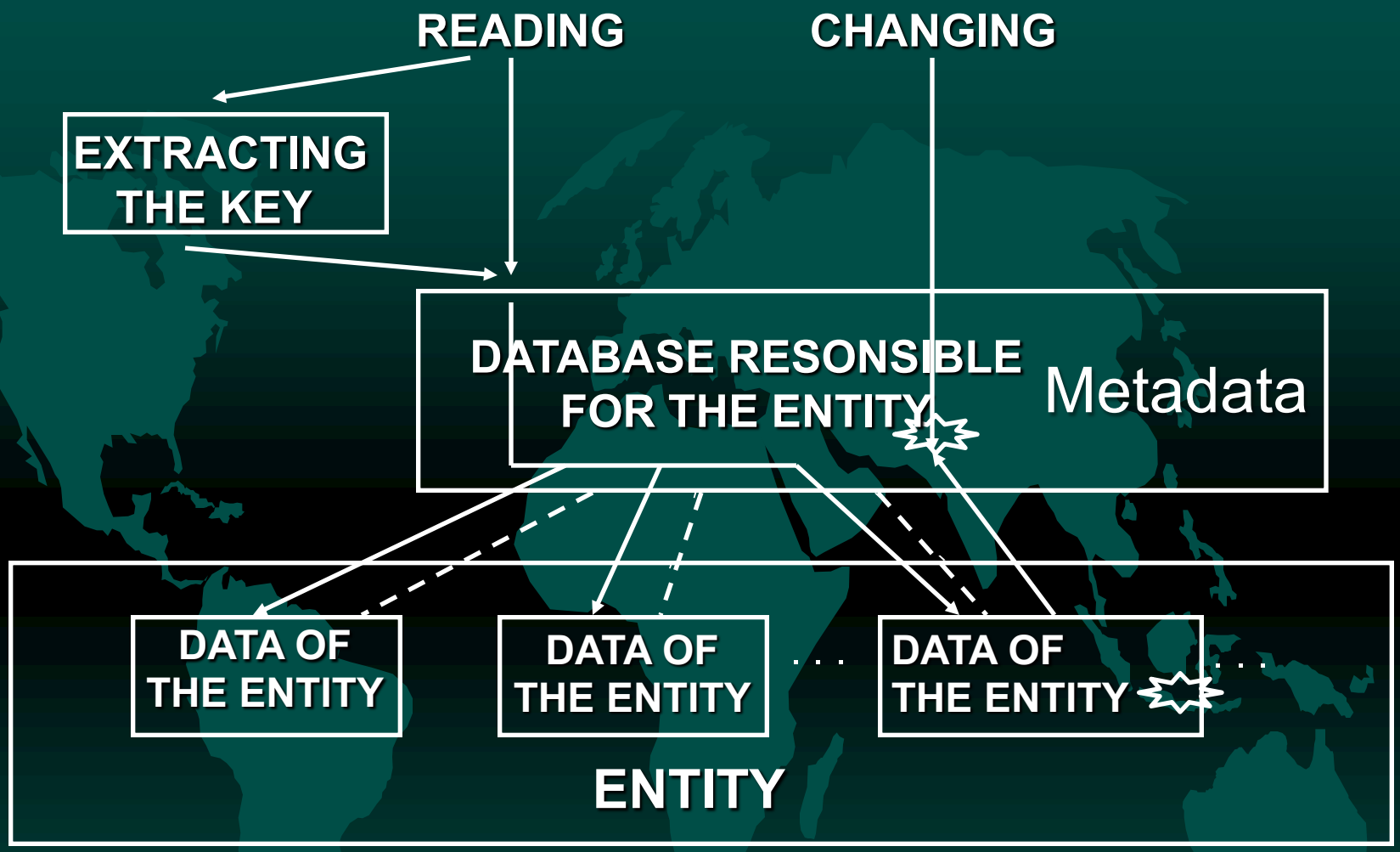


Infrastructural changes

- WAN, MAN, LAN difference in capacity – is it true?
- Extremely low price 1 Gbps and 10 Gbps interfaces on routers
- Networking worldwide is not any more the limiting issue – it seeks applications
- Free capacity of the international link is typically larger than the speed of your interface
- University hospitals on the GEANT network

Transparent access to medical data worldwide – fiction or possible?

- HL7 is NOT plug and play
- Patient digital identification worldwide
- Worldwide hierarchy of PKI certificate authorities (not self signed) for Healthcare
- Services for allowing easy access to data
- Regulatory issues



READING AND CHANGING DATA IN DISTRIBUTED GLOBAL DATABASES

Transparent access to medical data – fiction or possible?

GRAPHICAL USER INTERFACE

- Standard needed to reach data –Web browser in multitier systems
- Global level database for patients medical resources – metadata regarding all institutions where he/she has electronic medical records
- Dynamically building pages by using the metadata templates

MEDICAL GLOBAL DATABASES

- Key – somehow get approval for reaching medical data in different institutions – service providers
- Databases (Personal Resource Data - PRD) - data stored where generated
- PRDD database - standards for each field of medicine defined by MD
- Personal Resource Locator Database (PRLD) responsible for the entity

File Edit View Go Communicator Help

Bookmarks Location: http://black:8080/PMRD/Method.shtml?method=1.1.1.2.1&examination=62

Examination Data Entry

DIMEDAS/DS Alpha2

Data
Diagnosis
Therapy

Method search

- Examination methods
  - Heart examination methods
    - Echocardiography

Standard echocardiography

No submethods found

Method findings

- **Heart findings**
  - Cardiac situs and position

- **Veno-atrial segment**
  - Sistemic veins (SV) morphology and function
    - Congenital SV anomalies
  - Pulmonary veins (PV) morphology and function
    - Congenital PV anomalies
  - Left atrial (LA) morphology and function

Document: Done

Security and privacy

- Only the patient can approve the MD to reach his medical data
- Health insurance card with the possibility to make digital signatures is crucial
- HIS - identity management for the staff
- During examination MDs create a request to all needed personal resource data sites signed by the patient

Identity federations and single sign on

- Hierarchy of identity federations - Pan-European Web Single Sign On (Web SSO)
- Authentication and Authorization Infrastructures AAI for collaborations
- Security Assertion Markup Language **SAML**, open standard for exchanging authentication and authorization data between identity and service provider.

Who is the identity provider?

- Each hospital keeps data of personnel and only confirms identity and role (including MD licence certificate) – actually identity provider through HIS
- Federation of medical identity providers for medical area at country level is needed
- If the hospital HIS has users and the user – MD is already logged in, he must be already authenticated

Double authentication

- For the patient – the healthcare card provider ensures authentication
- Any medical data resource provider must be able to verify the signature
- In the signed data, the patient must define any restrictions – in attributes of SAML messages
- The medical data resource provider is the one offering the service in SAML context

Transparent access

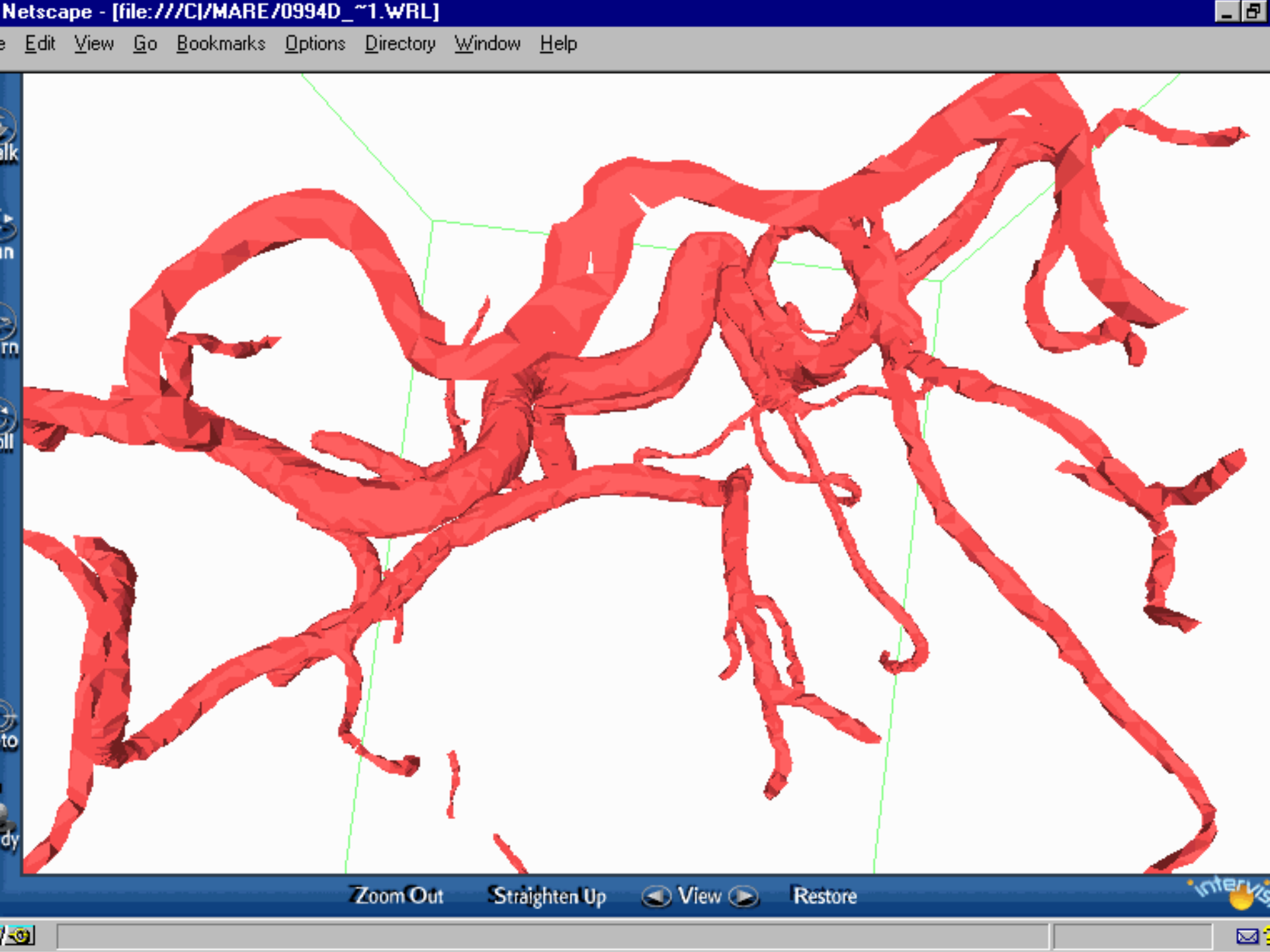
- At each country level, federations of identity providers should be formed for medical staff
- Local HIS to be used for transparent access to remote medical data
- Basically – Yes he/she is our employee and he/she normally has access to medical data

Firewalls and remote HIS security

- After receiving the request, the medical data resource provider needs to open the firewall for a session from the defined source address
- Role based security part of the HIS of the remote hospital opens a new user that can access data related only to that single patient that digitally signed the request

Three Dimensional Examination and VRML

- 3D Voxel set extracted from 3D diagnostic devices
- Creating 3D surfaces through segmentation algorithms: marching cubes, region growing
- Conversion into VRML or 3D Java to enable access through Internet
- How to present 3D data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Edit View Go Bookmarks Options Directory Window Help
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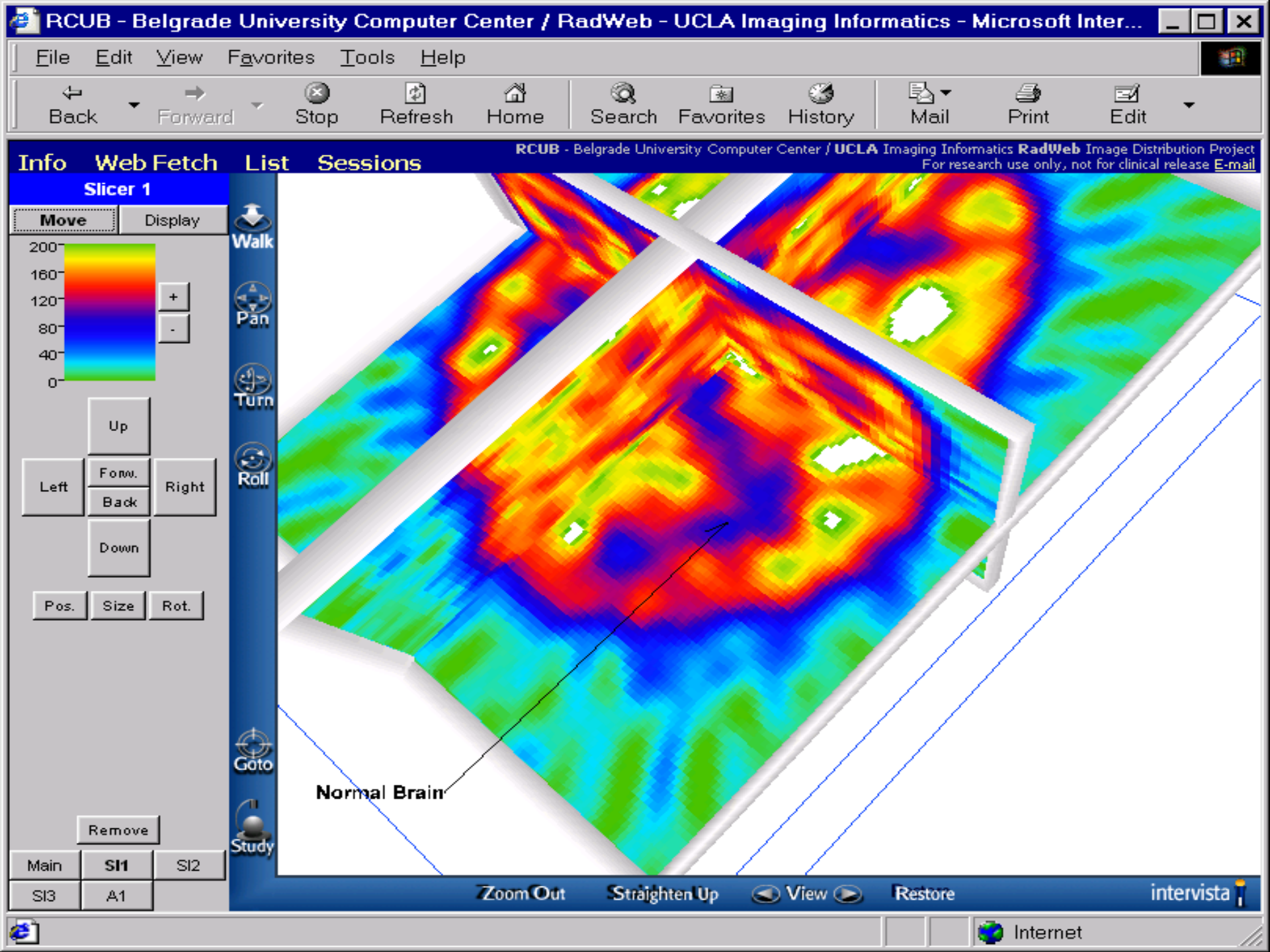
3D manipulation with a Web browser

- Java based tools for manipulating 3D objects
- Data is not exchanged – only manipulation and presentation data is traveling across the network during virtual examination
- Is there a network bottleneck – NO!!!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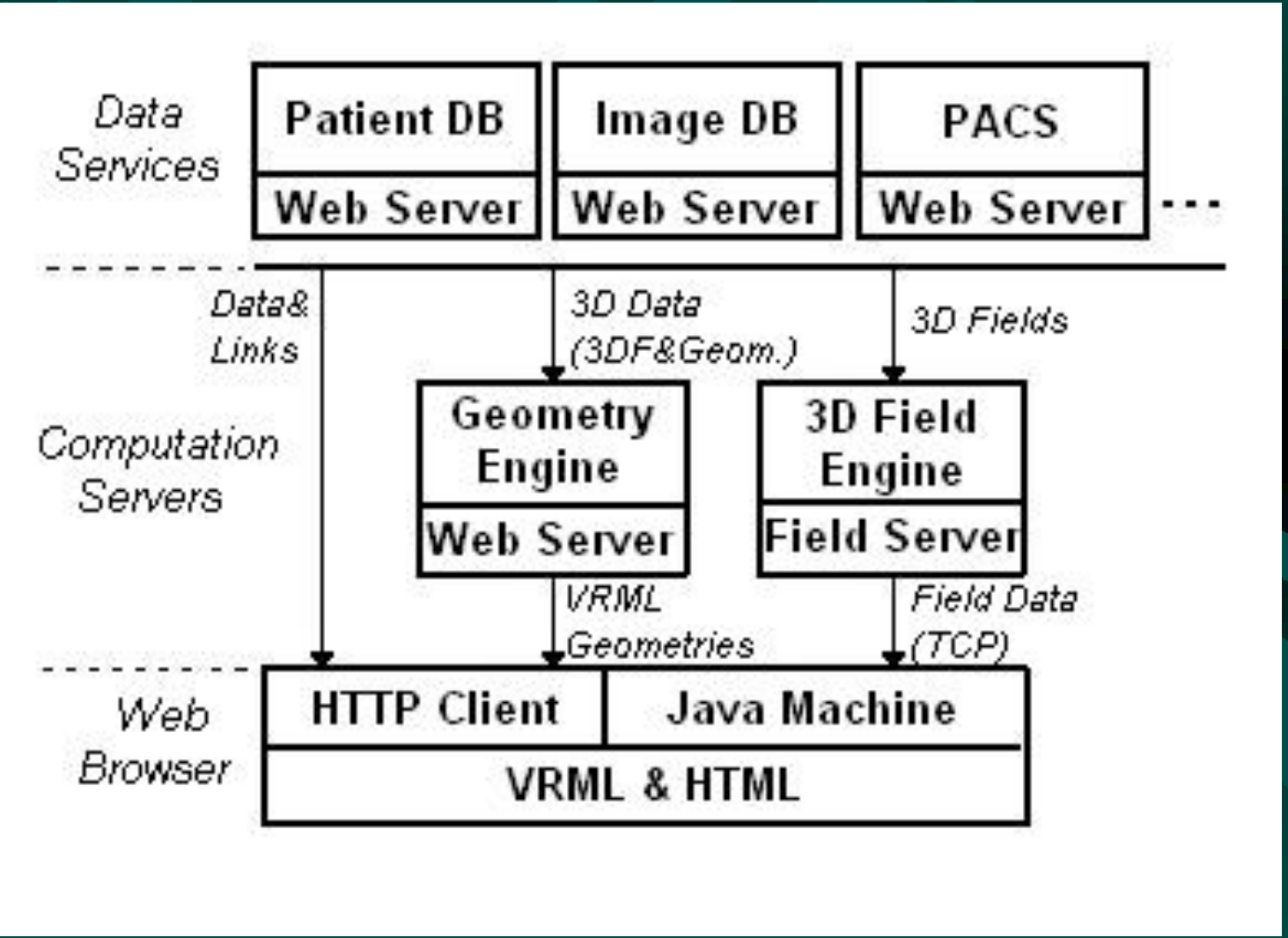
3D Visualization Components



Integrating other services

- What can become a part of the patient medical record?
- Murmurs (sounds)
- Video (surgical intervention videos)
- ECG or EEG medical data in electronic form
- For each of them a Java viewer?

Conclusion

- The Web based approach to integrating Healthcare reached maturity
- Technical problems are less important than the legal and economic issues
- The right of the patient to own his data is crucial to avoid legal obstacles