DICOEMS

IST-2002-507760

A DIAGNOSIS COLLABORATIVE ENVIRONMENT for MEDICAL relevant SITUATIONS

Summary :

- Project Objectives and Results
- DICOEMS Usage Scenario
- System Architecture

Project Consortium

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DICOEMS vision

- An eHealth platform that **acquires and transfers critical information** from the place where a medical emergency occurs to remotely located health structures.

- A **portable collaboration environment** that brings together the on-the-spot care provider and a network of experts.

DICOEMS outcomes (1/2)

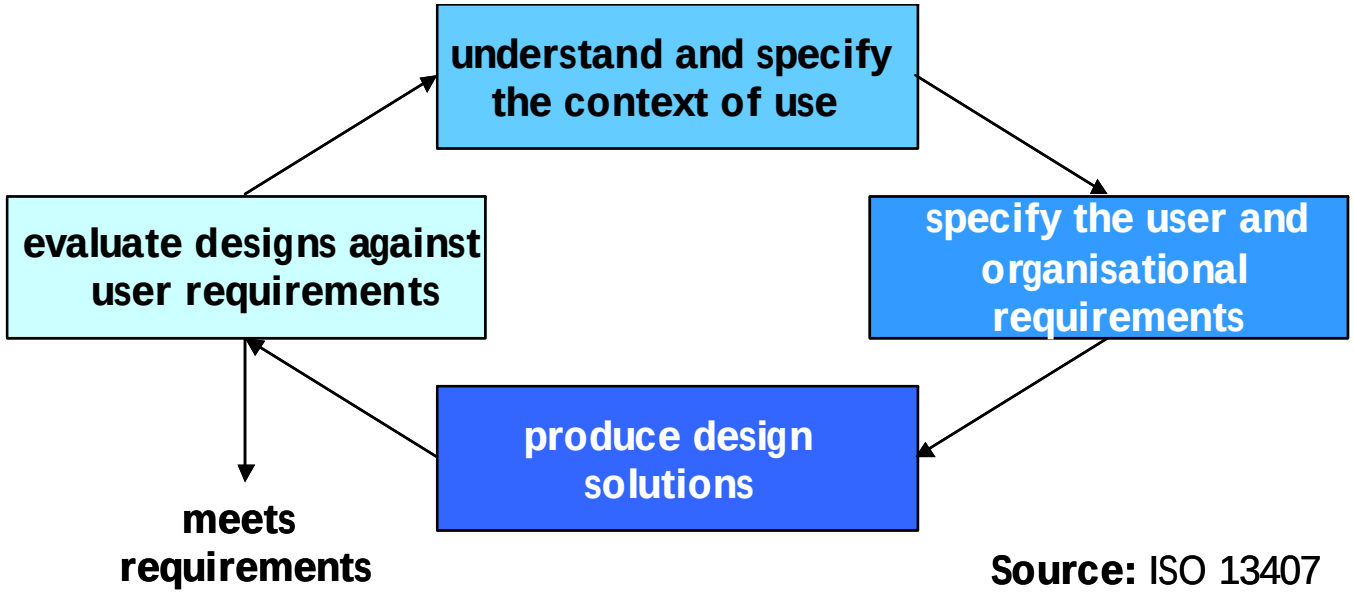
- Improved immediate assistance, through collaboration network
- More effective decision support, enhanced diagnostic and treatment capabilities
- Drastic increase of patient salvation chances

DICOEMS outcomes (2/2)

- Enhanced risk management in primary diagnosis, pre-transfer arrangements and treatment of critical situations,

- Raise of timely health care delivery processes thanks to enhanced data sets available on the patient at the receiving structure.

User Requirement analysis



Source: ISO 13407

Users & Operational Goals

Ambulance staff /Paramedics

DICOEMS added value
• Improve support to ambulance staff and paramedics in caring for A&E patients and minimize possibility of inappropriate intervention. • Navigate easily to an incident site and locate the most suitable structure for patient delivery • Follow protocols from hand held computers; and record basic patient information and send it to emergency department; • Send images of incident sites and patients condition to hospital trauma specialists and to Central emergencies switchboards • Send patient vital signs to Emergency departments

Users & Operational Goals

Hospital Emergency staff

DICOEMS added value
• Improve support in caring for A&E patients and minimize possibility of inappropriate treatment to patients. • Early identification of patients and the retrieval of (Electronic Patient Record) EPR to assist in providing appropriate treatment. • Receive from ambulance enhanced patient information (images of incident sites and patients condition, vital signs before the ambulance reach the ED) • Receive a patient's recent medical history before the patient reach the ED mainly through CPR investigation and in some cases through General Practitioner remote involvement. • Identify the patient through a sophisticated and innovative DNA analysis procedure.

Users & Operational Goals

Hospital Specialist Medical experts

DICOEMS added value
•Early identification of patients and the retrieval of EPR to assist in providing appropriate treatment. •Hosting a collaboration session between the involved peers, transparent sharing human or material resources and knowledge •monitor the patient remotely in real time (on line). •Access via a web browser over the internet in a secure way •Multychannel DICOEMS collaboration environment (PDA/smart phone)

Users & Operational Goals

Molecular Genetics Laboratories

DICOEMS added value
• Improvement of quality of laboratory services • Remote DNA analysis techniques, applied research improvement

DICOEMS functions:

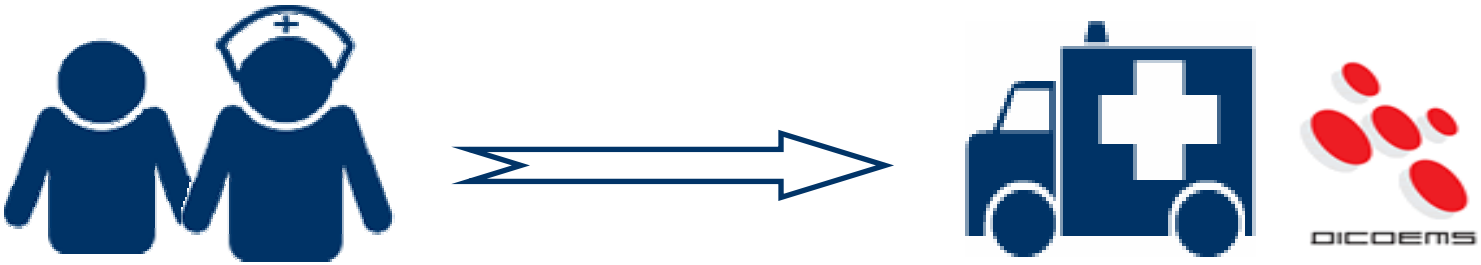
- Customised user interface for all actors
- Medical measurements wirelessly transmitted to the CES/A&E
- Real time data update
- Collaborative environment, enabling knowledge sharing and transfer via a multimedia-based collaborative session.
- GPS functionality for emergency location (ambulance) and the resources (hospitals, other medical facilities) geographic location, supported by a GIS application
- Messaging and alerting mechanism (patient identification, hospital availability check, notifications on the patient's transfer.

DICOEMS functions:

- Free-text search mechanism used by the expert located at CES/A&E to find suitable experts and hospitals. The Medical Ontology for DICOEMS system will cover Cardiovascular dysfunction's terminology.
- Interoperability infrastructure implementation among heterogeneous and geographically dispersed clinical databases for patients' EPR retrieval.
- Efficient network management configuration.
- GRID system applied to the communication and EPR matching (resource management , data transfer, patient ID)
- Patient Identification through remote DNA analysis

DICOEMS usage scenario

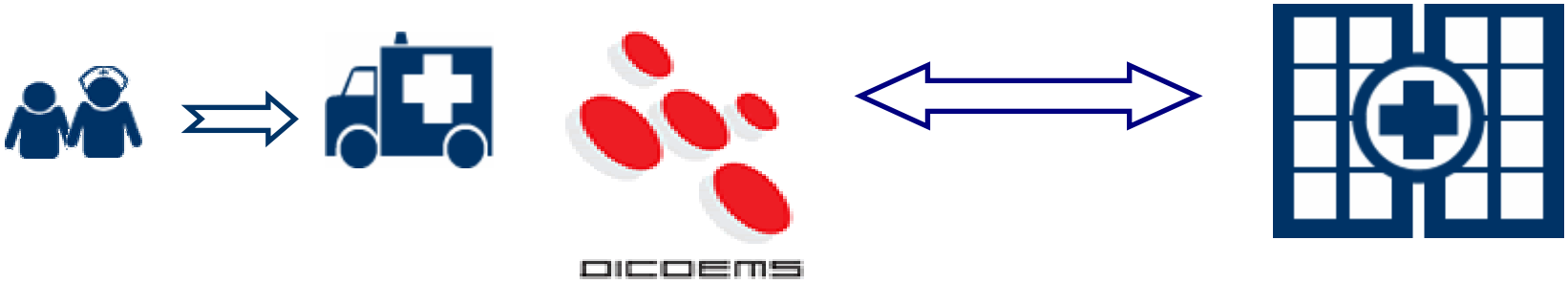
with conscious patient (1/4)



- The paramedics transfer the injured person to the ambulance
- Attach the sensors of the medical devices to the patient and record vital sign values

DICOEMS usage scenario

with conscious patient (2/4)

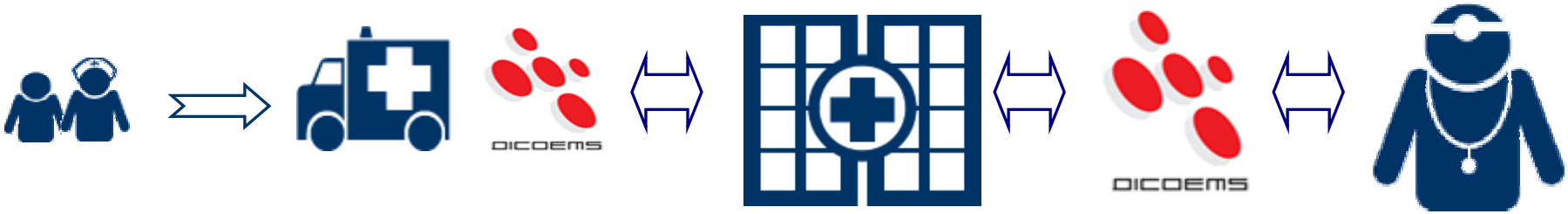


Through DICOEMS system paramedics invite the CES/A&E to start the acquisition of:

- Vital signs from the medical devices attached to the patient
- Video stream from inside and/or roadside the ambulance
- Manually inputted data (patient report form) for the patient's condition and treatment that may be necessary

DICOEMS usage scenario

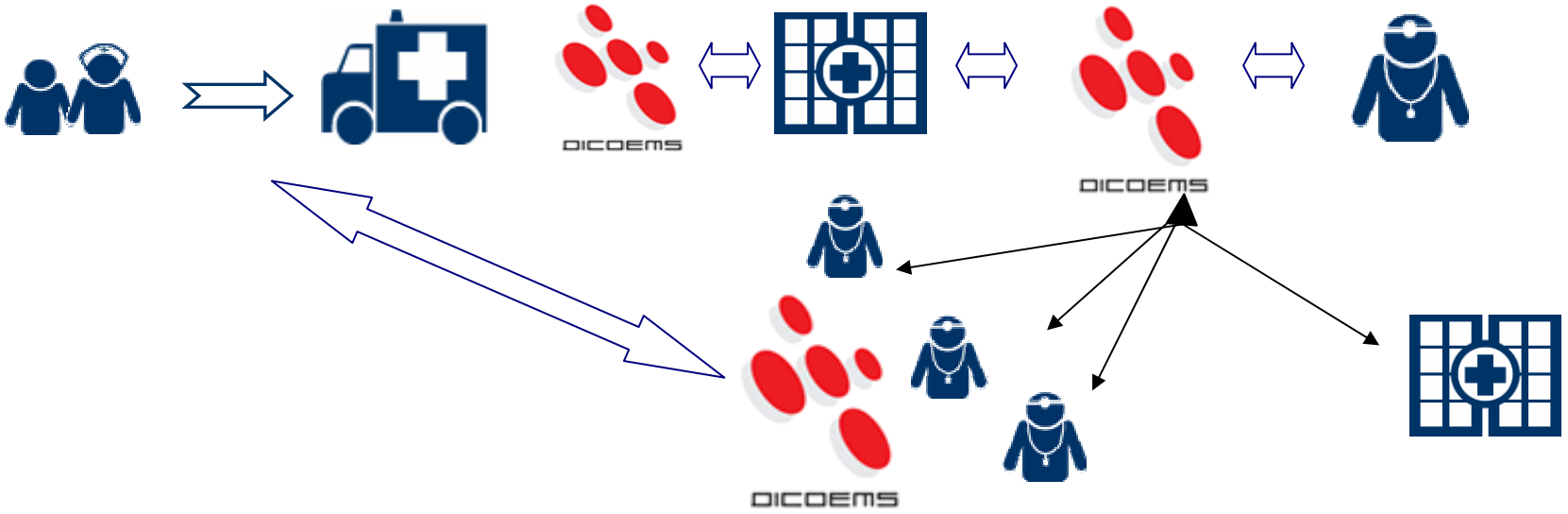
with conscious patient (3/4)



- In the CES/A&E unit, the Doctors are informed about the current patient's condition by receiving all data transmitted from the ambulance.
- The data is updated in near real time so that any change to the patient's condition might be handled by the expert instantly
- Clinical identification of the patient, EPR retrieval process (showed at CES/A&E premises)

DICOEMS usage scenario

with conscious patient (4/4)



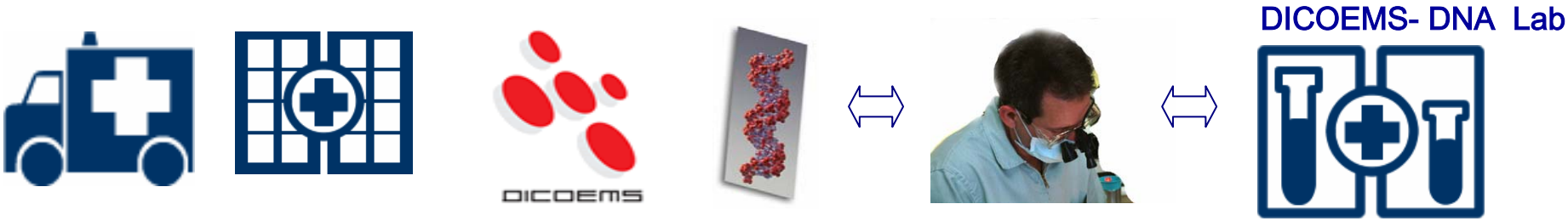
- Paramedic input + Medical measurements monitoring process allow the CES expert performs a **search for the most suitable hospitals** (geographical location/resources) **and experts** (specialty/expertise).

- The experts participate in a **collaboration session** providing their advice during the DICOEMS session.

- In parallel, the CES expert monitors the locations of hospitals and ambulance route to the GIS subsystem and provides **advice on the paramedics**

DICOEMS usage scenario

unconscious patient



The paramedic:

- Takes blood sample in the ambulance
- Puts some DNA in pre-prepared tubes
- Inserts the tubes into a portable **PCR machine and set the amplification of DNA.**

The amplified DNA is given to the DNA lab of the hospital for analysis:

The results are used in the DICOEMS DNA lab to match patient among DNA identification profile bank (specifically constructed for DICOEMS).

- DNA matching results (patient ID) are communicated to the DICOEMS system initiating requests for the clinical record (EPR) of the patient
- Process supported by GRID

Selection of most suitable DNA fragment analysis system

DICOEMS will utilize the ABI sequencer :

- 92% of the worldwide market, top technology in the DNA amplification and analysis of samples quickly, accurately and safely.

- The selected DNA identification kit have the higher accuracy (according to the data collected from the bibliography) because it gives an almost unique profile of a patient.

DNA Analysis Steps

NUMBER	DESCRIPTION OF STEP	INFORMATION
1	Blood sample	Informed consent document, medical history, demographics
2	DNA extraction	
3	PCR amplification of multiple STR markers	
4	Separation and detection of PCR products in the ABI Sequencer (STR alleles)	
5	Sample Genotype Determination (DNA profile)	1st DNA graph/xls file
6	Generation of probability of random match of the specific sample tested.	Probability Accuracy of result
7	Storage of DNA genotype data	1st DNA graph/xls file in the DICOEMS base linked to the name of the patient
8	DNA graph from DICOEMS	2nd DNA graph/xls file
9	Comparison of the 2nd DNA graph/xls with the graphs stored in the base	Match with the 1st graph/xls-Identification of the patient

DICOEMS Trials

- Selected and collected 50 blood samples anonymously and DNA has been extracted and stored for further use. Each sample has been given a code number.

- Connection between medical records and the Excel files exported after DNA analysis from the ABI are currently investigated.

- An informed consent document (in Greek,English).

Collaboration session

Hosting a collaboration session between the involved peers, transparent sharing human or material resources and knowledge

- Multiple concurrent accesses to DICOEMS to monitor the patient remotely in real time (on line).
- Access via a web browser over the internet in a secure way should be available
- DICOEMS should be able to support collaboration with PDA/smart phone devices.

Global Positioning System (GPS):

GPS functionality enriches the collaboration grid with precise geographic information about the incident location and the location of distributed resources

- Digital maps to show hospitals, incident and ambulance location.
- GPS route planning and guidance (conveniently displayed and located for the driver)

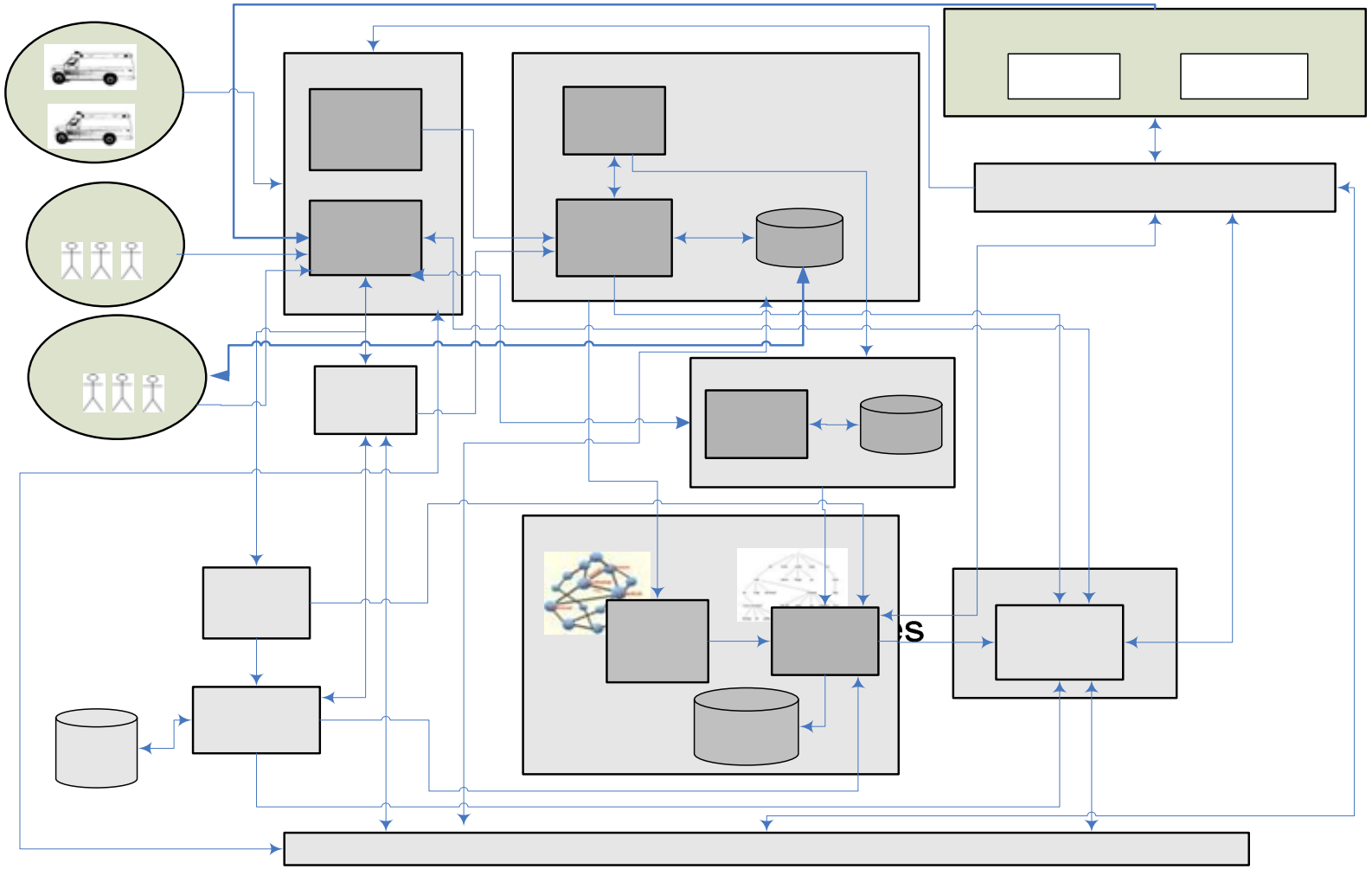
Available devices to be integrated:

Emergencies Data Surveys		Methods and tools	Medical equipment Technical details
	ECG		Defibrillator Lifepack 500 www.specialityoxygen.co.uk
	Pulse oximeter		www.nellcor.com
	Respiration and Oxygen Monitoring		http://www.welchallyn.com/
	Temperature Monitoring		http://www.welchallyn.com/

DICOEMS main modules

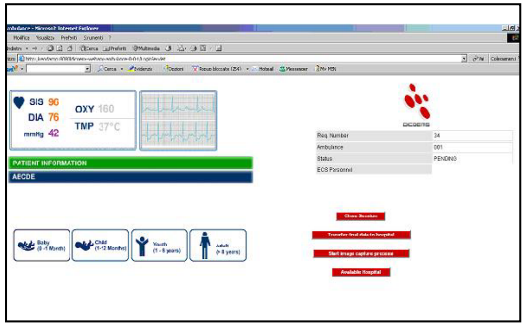
1. Medical data input
2. User presentation
3. Ambulance connection
4. GPS
5. Medical Emergency Ontology Search
6. Resources mapping and administration
7. GIS
8. Profiling and users authentication
9. Interoperability
10. Network management
11. Security

DICOEMS workflow



User Interactio

Medical data input module



- **collects all the data** (derived from medical devices)in a central unit

-**store data sets** in a local memory for the reconstruction and visualisation of the complete emergency session when the ambulance will be back to the A&E

-assemble **heterogeneous data sets** , to be sent to the transmission module

Medical data input module

Image Capture Module

DICOEMS has the all functionalities of motion detection, streaming, local recording, events schedulator

DICOEMS uses the transmission model it has at disposal

(UMTS-ADSL-GPRS-GSM...etc)

Manual Medical Data

-ABCDE input, the result of the first survey on patient (such as respiratory frequence, heart-beat frequence, suspect fractures, …)

- MSB (Territorial Basic Rescue Means of transport form)

User presentation module

HC personnel

•Informed on status of devices transmission ,patient, ambulance routing

•Input data manually

•In non critical situation, to input MSB Data

Central Emergency Switchboard

Complete emergency data available

Identification of the most suitable hospitals and experts

Receive notifications and alerts

External experts

•Wireless access to the DICOEMS system

• collaboration and alerting functionality

• collaboration session with the paramedics at the ambulance and the CES/A&E

• download and upload data from the ambulance to the Hospital or other structures

Ambulance data transmitting/receiving

Ambulance Connection module allows the transfer of data from the ambulance central unit to the external environment utilising :

- Wide_Mobile connection module (GSM/GPRS technologies)
- Nearby_Mobile connection module (wireless local area connection, WiFi)

  Data transferring standard (Bluetooth, Wi-Fi, GPRS, GSM, UMTS)
- Videoconferencing standard (Mpeg4, 3GPP)

GPS module allows to transmit the ambulance spatial position and it uses this information as input for other functionality **(GIS Module)**

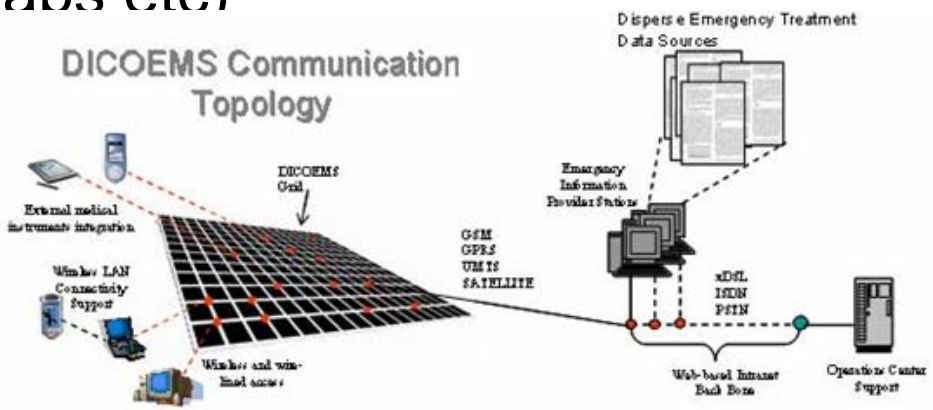
Network Module

This module permits the communication and transmission data into the DICOEMS platform between the several involved actors

GRID computing in DICOEMS

DICOEMS project has to cope with the following problems:

- Difficulties to search information
- The workload is better not to be concentrated
- The execution of the serialized search
- Parallel search process to speed up the data matching (DNA and EPR retrieval process)
- Provide the results to the several actors (general experts, A&E, labs etc)



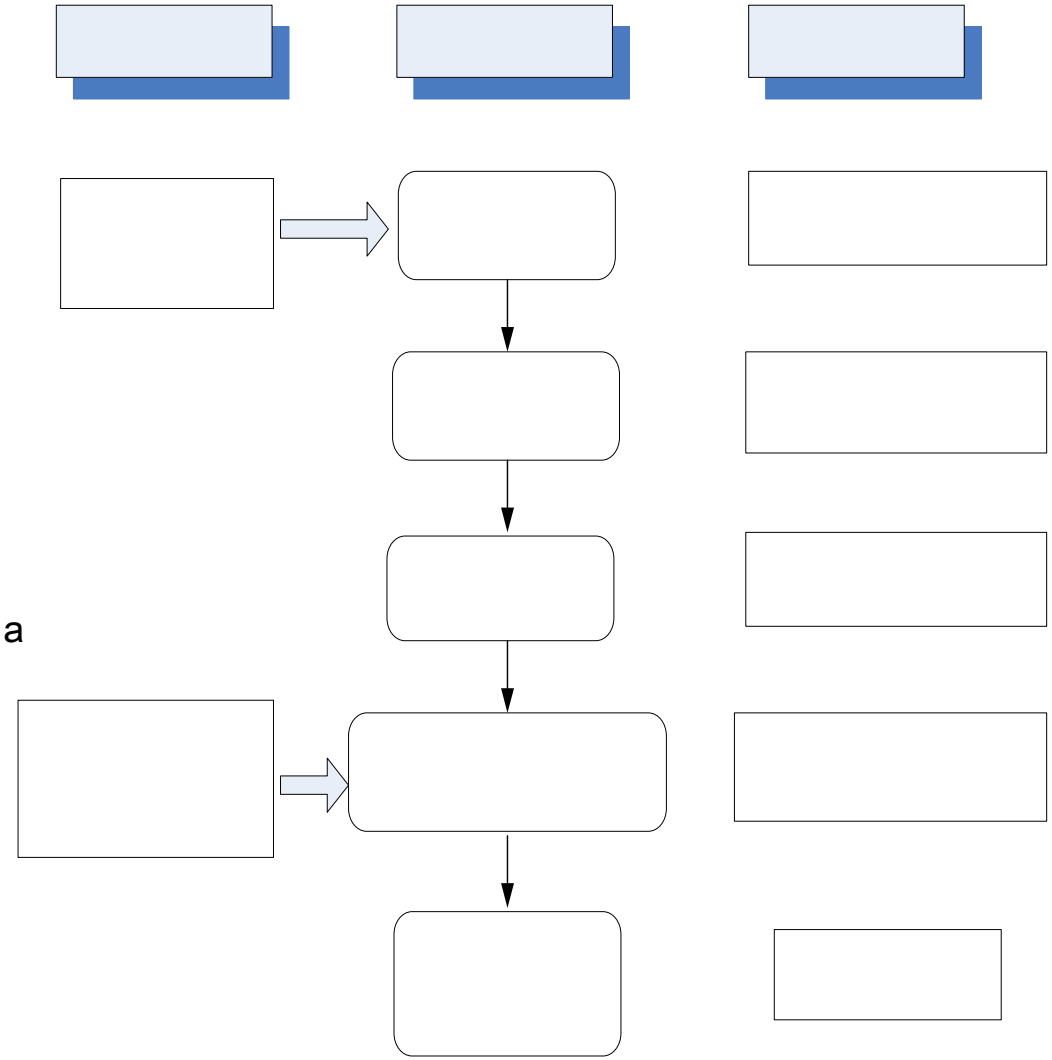
Knowledge Management

- Medical Emergency Ontology Search module
  - Provides the appropriate parameters for the identification of suitable resources (hospitals, experts)
  - These parameters are the output of a searching process within a Medical Emergency ontology

- Resources Mapping and Administration module
  - Identifies the list of experts and the appropriate hospitals for a specific emergency case
  - Provides the administrative functionality of the system

Medical Emergency Ontology Search

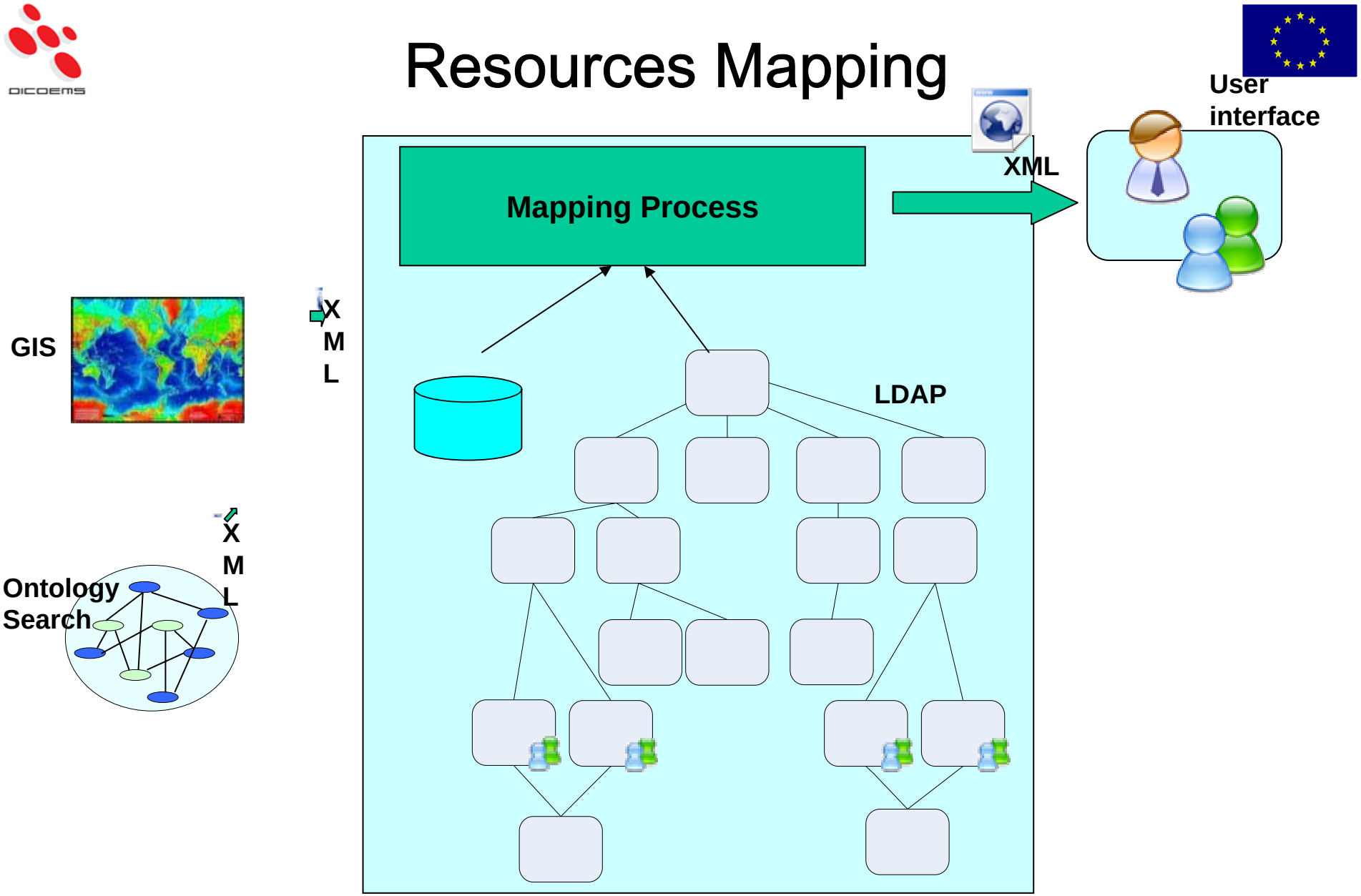
- Functionality
  - *Input*
    - the free-text query that the CES expert provides
  - *Process*
    - Free-text query processing
      - Retrieval of lexical parts (nouns only and their synonyms) and stop words removal
    - Parsed content of previous step input to the ontology schema
    - Search functions for concept retrieval
    - Ontology hierarchy tree relates to a terminology of cardiovascular diseases and emergency cases
  - *Output*
    - a list of possible diseases
- Implementation
  - *Web services (WordNet, Protégé, Apache Axis)*



Resources Mapping

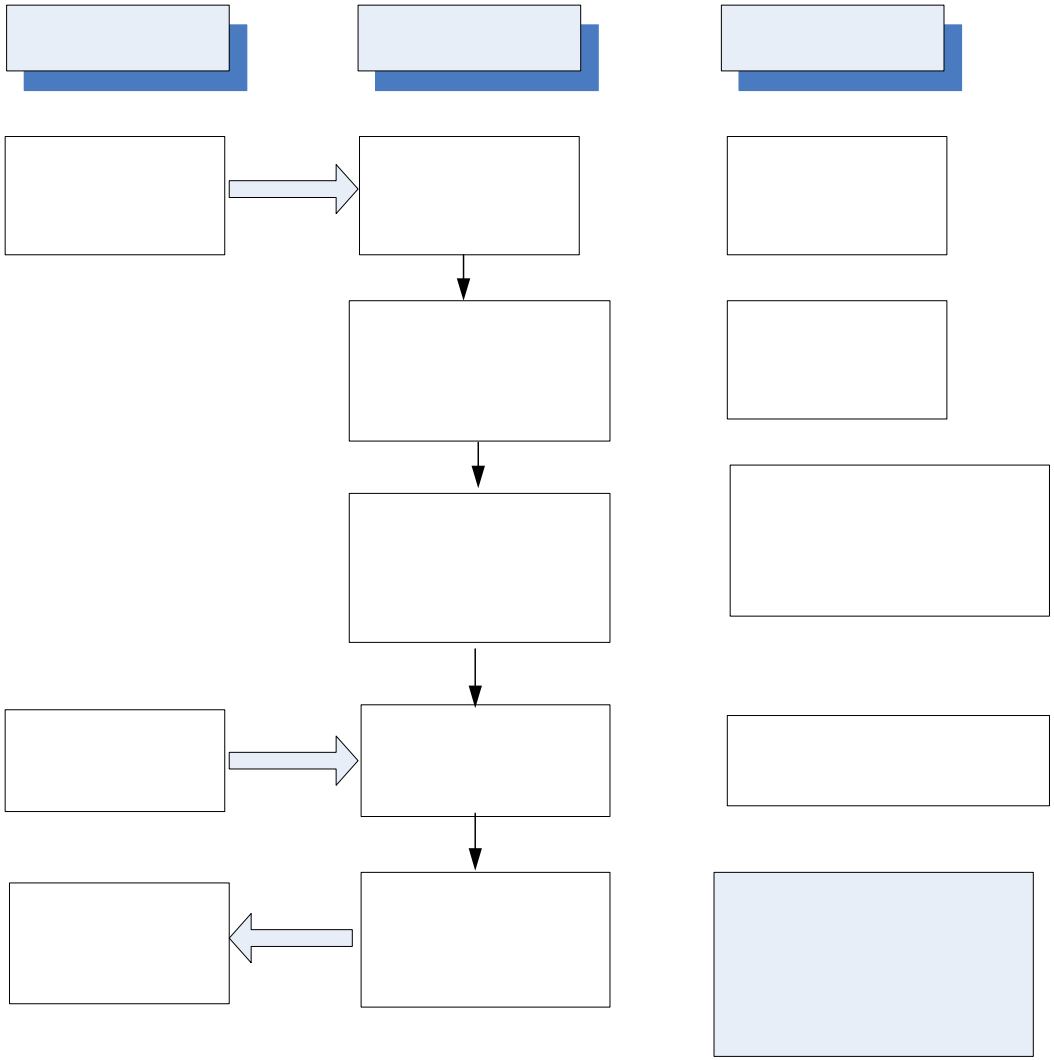
- Functionality
  - *Input*
    - Ontology Search XML and GIS XML (ambulance and pilot-related hospitals' positional data)
  - *Process*
    - Temporary storage of input data for synchronization purposes
    - Mapping is the allocation of the suitable hospital(s) in terms of geographical reference and clinical resources availability
      - *Geographical reference*: the nearest to the ambulance hospital(s)
      - *Clinical resources availability*: resources that can handle the emergency case
  - *Output*
    - XML structure with suitable resources (hospitals/experts)
- Implementation
  - LDAP schema holds resources information
  - SQL server database holds all input to the module data
  - Web services

Resources Mapping



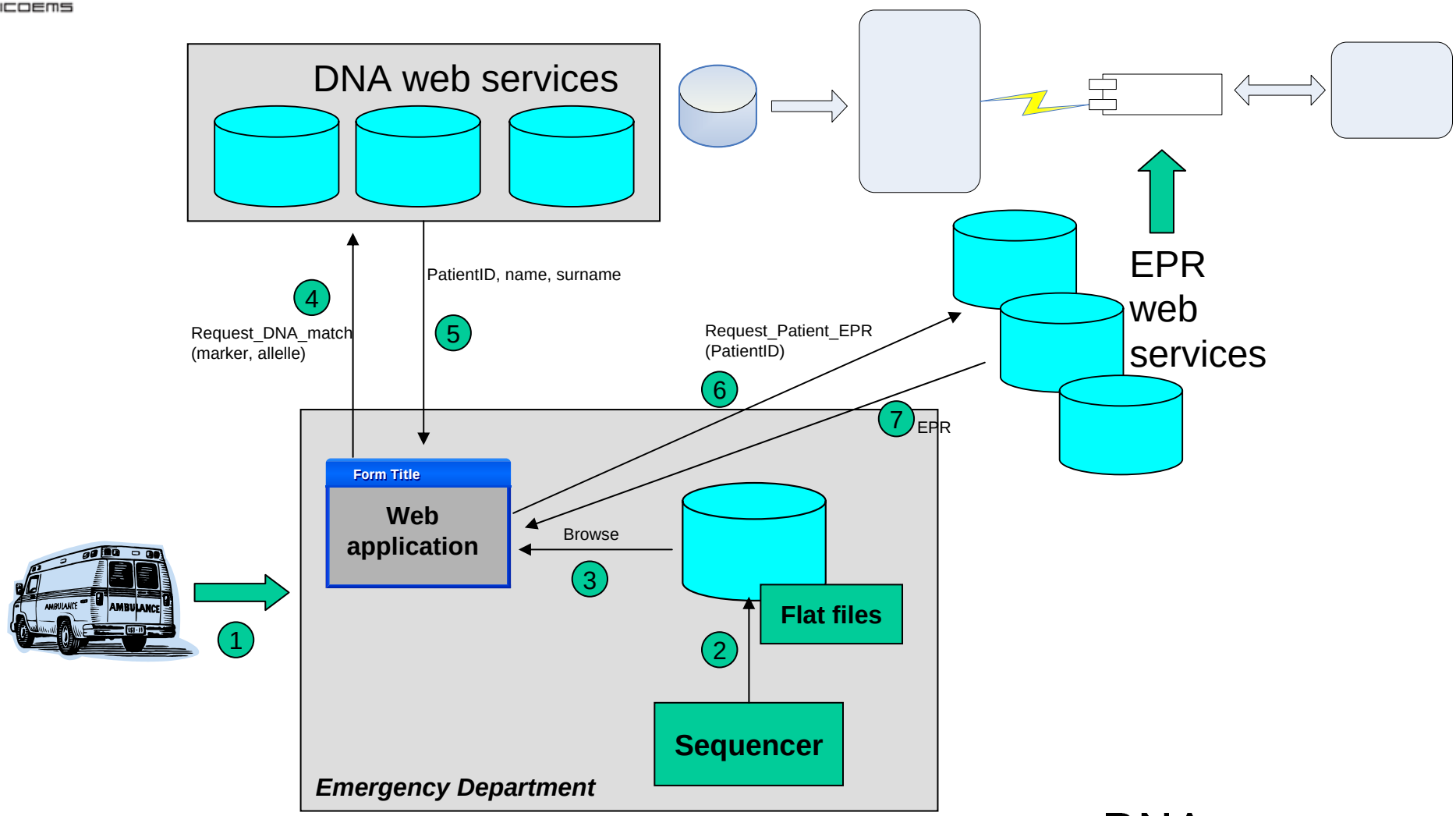
Interoperability

- Functionality
  - interoperability framework among dispersed clinical databases
  - Acts as a proxy layer between DICOEMS and hospital repositories/DNA databanks
  - Retrieves patient's EPR and maps EPR different structures to internal DICOEMS XML structure



- Implementation
  - Legacy integration and external interfaces
  - Web services for EPR invocation
    - BizTalk Server 2004
    - HL7 accelerator for BizTalk

Interoperability scenario for DNA data



DNA repository

DN repos

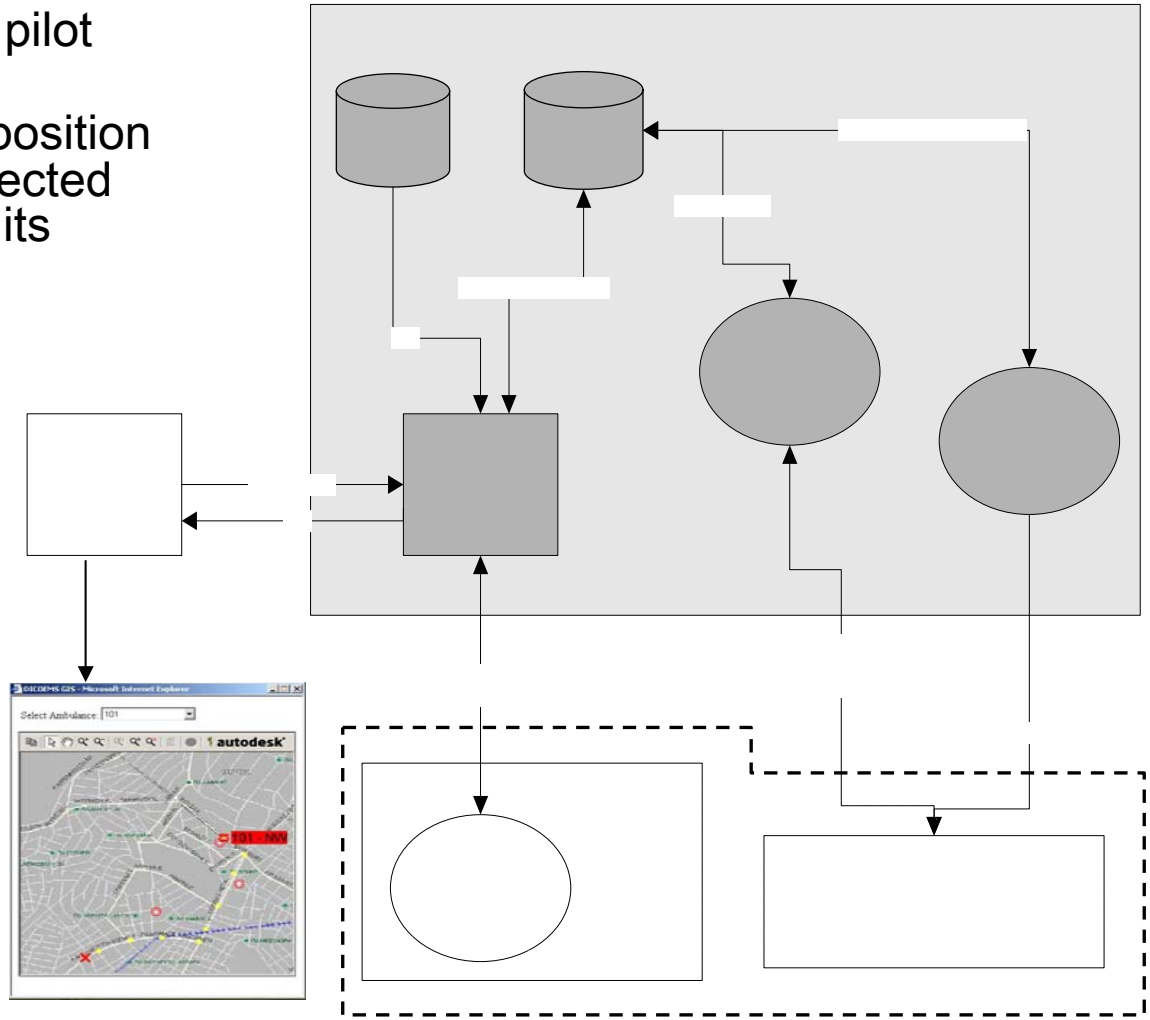
GIS

Functionality

- Map representation of the pilot area
- Depicts the geographical position of the hospitals, the selected ambulance's route and its current location
- Zoom in/out functionality
- Resources information

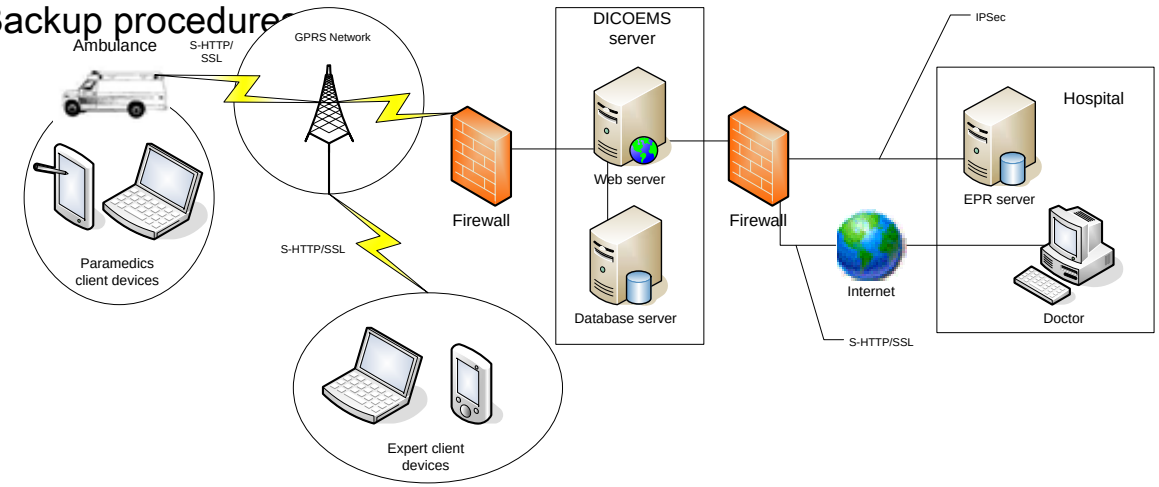
Implementation

- . NET VB web application
- Autodesk MapServer, MapAuthor
- SQL server Topology DB
- .NET VB Web Services



Security framework

- **Security module** will provide the mechanisms for ensuring security
  - *User security*
    - User authentication (username, password)
    - Services correspondence to user types
  - *Communication security*
    - Data encryption (SSL digital certificates)
    - Web services security framework (WS-security, SOAP secure transmission)
    - Certified protocols for usage of medical devices
  - *Web security*
    - Firewall protection
  - *Data security*
    - No EPR information is stored by DICOEMS
    - DBMS security
    - Backup procedures



Project Progress

Project Duration 30 months

Project Progress 16th month

Completed activities:

- User Requirement Analysis
- Complete System design

Running Activity:

- System modules development

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