Integrated Care Solutions

CeHA

Center for eHealth Applications and Services

FORTH - Institute of Computer Science

The **Institute of Computer Science** is one the six institutes of the **Foundation for Research and Technology-Hellas (FORTH)** - one of the largest research centers in Greece with well-organized facilities, highly qualified personnel and a reputation as a top-level research foundation worldwide - with a mission to perform high quality basic and applied research and to contribute to the development of the Information Society at a national and international level.

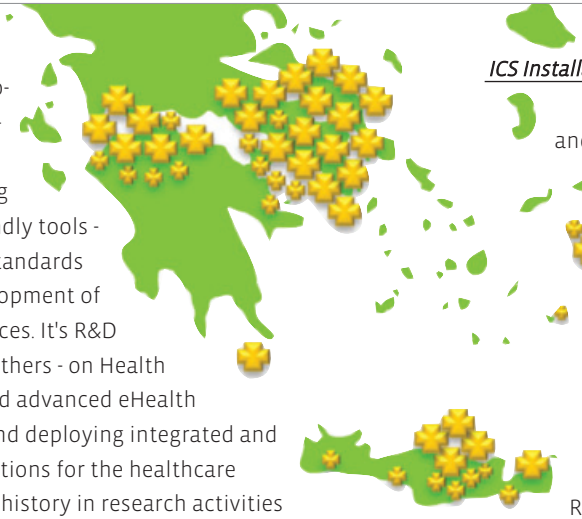
The **Center for eHealth Applications and Services (CeHA)** operates in the context of the **Computational Medicine Laboratory (CML)** of the Institute of Computer Science. As such, its mission is to develop and deploy IT software for the healthcare domain by providing qualitative tools and services and by evolving R&D results into commercial products focused on integrated care solutions in the wider context of predictive, individualized, preventive and participatory medicine.

The following pages present the main technical and operational features of the **Integrated Care Solutions applications (ICS)** software suite components.

CeHA

Center for eHealth Applications & Services

Head: Mr. Dimitrios G. Katehakis



ICS Installations in Greece since 2005

CeHA aims at developing and transferring technology and knowledge to clinical settings at the point of care, as well as building state-of-the-art, user friendly tools - following international standards and trends - for the development of sustainable eHealth services. It's R&D activities focus - among others - on Health Information Networks and advanced eHealth services, by developing and deploying integrated and qualitative tools and solutions for the healthcare domain. Through its long history in research activities and participation in many European research projects and international co-operations, the Center has developed a series of eHealth applications that are used today by various healthcare facilities.

CeHA is committed to eHealth interoperability and the consistent implementation of international standards as the only way towards high-quality, active, and pervasive EHRs that seamlessly support clinical procedures, reducing medical errors and improving integrated health care in and out of the hospital to support continuity of care. CeHA's personnel carry a long experience in the implementation of both national and European projects, and in depth knowledge of the healthcare domain. A major milestone was the implementation of HYGEIAnet which was the first Regional Health Telematics Network in Greece that involved all healthcare organizations of Crete as well as the local branch of the National Health Emergency Coordination Center (EKAB). HYGEIAnet was a finalist for the eEurope Award for eHealth in 2003 and applications developed during that period are the predecessors of today's products.

Today CeHA provides both consulting and support services to numerous clients including hospitals, medical centers, and regional health authorities.

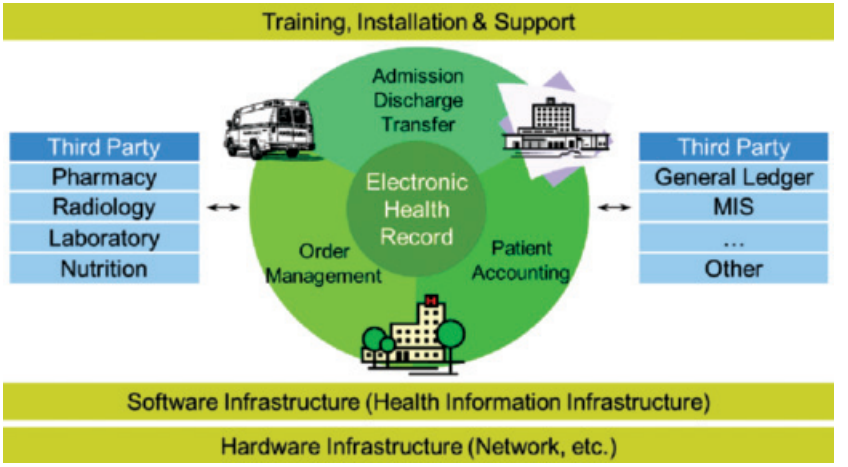
The **Integrated Care Solutions (ICS)** software suite comprises a series of IT applications and services based upon an open, scalable and evolvable architecture. It is an innovative service platform for electronic and mobile health applications and services across heterogeneous networks, focusing on patient centered, clinically driven, healthcare delivery system. ICS integrates distributed information and knowledge in a flexible manner, focusing on the timely and effective delivery of the appropriate information to all authorized users. It is built upon an underlying healthcare information infrastructure allowing scalability, modularity and robustness. The ICS suite follows high quality international trends regarding both the structure of the Electronic Health Record (EHR), as well as integration with third party systems through the use of internationally acclaimed standards and protocols (like e.g. HL7, DICOM etc). ICS through its various tools and applications contributes to clinical decision support for disease management and treatment planning.

Integrated Care Solutions ICS

General characteristics of ICS applications include the following:

- They can be installed either as stand-alone systems or in combination with other applications.
- They are subsystems of an integrated solution.
- They support automation of business processes both within and between healthcare facilities.
- They can electronically interface with third party applications and open devices, based on standards such as HL7, DICOM, XML, and web services.
- They are customizable and scalable according to the needs of each institution.
- They support role based access control.

Several applications of ICS have been installed and are operating, under service level agreement contracts, in more than 20 healthcare organizations in Greece, and most of them are part of Integrated Regional Health Information Systems, like the ones of the 1st Healthcare Region of Attica, the 2nd Healthcare Region of Piraeus and Aegean, and the 6th Healthcare Region of Peloponnesus, Ionian, Epirus & West Greece.



ICS Architectural Approach is Structured around a Citizen - Centered EHR

The software suite **Integrated Care Solutions (ICS)** is a series of IT applications structured around the electronic health record (EHR), like:

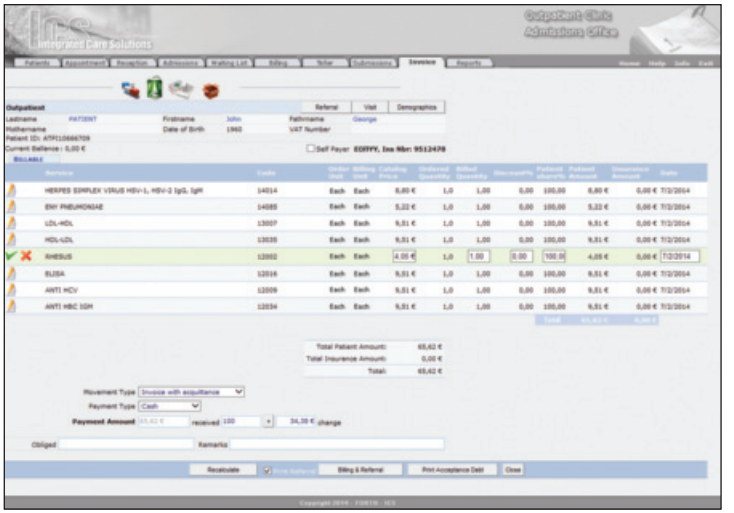
- ICS - A (**Administrative**): Integrated Care Solutions for Patient Administration
- ICS - C (**Citizen**): Integrated Care Solutions for the Citizen
- ICS - E (**Emergency Care**): Integrated Care Solutions for Pre-Hospital Emergency Care
- ICS - H (**Health Information Infrastructure**): Integrated Care Solutions for Health Information Infrastructure (HII)
- ICS - I (**Integrated Electronic Health Record**): Integrated Care Solutions for Integrated EHR (I-EHR)
- ICS - M (**Medical**): Integrated Care Solutions for Nursing and Medical Applications
- ICS - P (**Primary Care**): Integrated Care Solutions for Primary Health Care
- ICS - W (**Welfare**): Integrated Care Solutions for Welfare
- ICS - X (**PACS**): Integrated Care Solutions for Picture Archiving and Communication.

Patient Administration

ICS-A

Patient Administration (ICS-A) applications support all patient management procedures that are important for inpatients and outpatients in a healthcare facility. They support patient admission-discharge-transfer, including the radiology department, waiting lists and appointment booking, billing, payment collection and interaction with other facilities at a cross-enterprise level, allowing for the improvement of the organizational performance and cost savings.

They are based upon an open, scalable and evolvable architecture that integrates distributed information and knowledge in a flexible manner, focusing on the timely and effective delivery of the appropriate information to all authorized users. Being the outcome of applied research, they encompass both state of the art trends and real-world requirements for effective use. ICS-A is suitable for patient administration departments in healthcare facilities (e.g. hospitals).



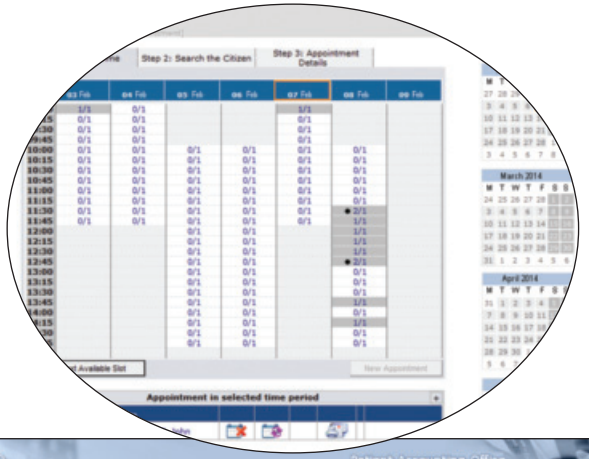
The Patient Administration family of ICS products have been designed for the automation of administrative paperwork in healthcare organizations, particularly hospitals, and are one of the core components of a hospital's IT infrastructure for:

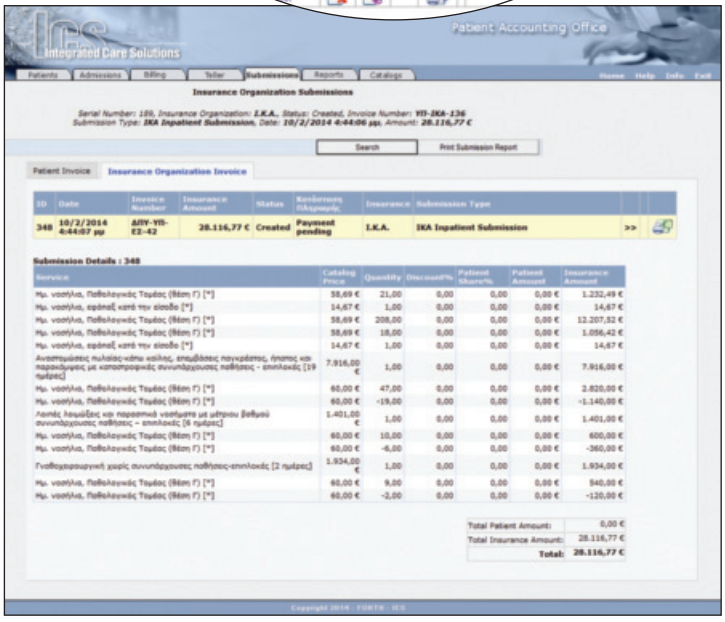
- Outpatient Clinic Admissions Office (A-OAO)
- Emergency Department Admissions Office (A-EAO)
- Outpatient Pharmacy Admissions Office (A-PAO)
- Radiology System (A-RIS)
- Inpatient Admissions Office (A-IAO)
- Information Office (A-INF)
- Patient Accounting Office (A-PAC)
- Appointment Booking System (A-ABS)
- Hospital IT Department (A-ITD)

ICS-A applications support standards based electronic communication with 3rd party systems for:

- Accounting, Materials Management, Pharmacy, Radiology, Laboratory, etc. for electronic transmission of patient and encounter data and for updating lists of services.
- RIS/ LIS for examinations ordering.
- Insurance organizations and / or government bodies in line with existing legislation.

Several ICS-A applications have been deployed at more than 20 hospitals in Greece since 2005.





Top: Appointment Booking
Bottom: Insurance Organization Invoice for Patient Hospitalization
Left: Outpatient Clinic Billing

for the Citizen

ICS-C

Citizens are actively involved in their healthcare and wellbeing through Integrated Care Solutions for Citizens (ICS-C), a platform which supports self-monitoring of health status for wellbeing as well as for self-management of chronic conditions such as diabetes, chronic obstructive pumonary disease (COPD), hypertension and cardiovascular diseases and others. The platform can be adapted and configured for different wellness or clinical domains providing citizens with all the necessary tools for being more involved in the effective management of their health and for improving their health education and literacy.

The citizen platform adapted for diabetes is **MyDiabetesAdvisor (MDA)**. **MDA** is a long-term, daily-based management system for citizens with diabetes, which comprises also the monitoring of risks of complications. The **MDA Patient** allows self-monitoring of health status by capturing vital signs, lifestyle data (activity, diet, etc.) and medication data (insulin, OADs). Educational material is an integral part of the platform to enhance self-management of diabetes. Furthermore, citizens with diabetes can fill in

MyDiabetesAdvisor Patient

MyDiabetesAdvisor

life-style and compliance questionnaires in order to provide, at the periodic reviews, a more complete picture of their health status to their general practitioner (GP).

The system also offers the possibility to connect the citizen platform to the general practitioner platform in order to allow for supervision and management. In such case, through the **MDA Doctor**, the GP can view and analyze various types of vital signs such as blood glucose, blood pressure as well as weight and oxygen saturation. Furthermore, the life-style, medication data and compliance questionnaires can also be inspected. In this way, the GP is able to check the health status of their patients at any time and offer the necessary supervision and management. The MDA can be used by citizens with diabetes as well as their informal caregivers such as family members, neighbors, close friends, and others. When supervision is required the system can also be used by hospitals, primary health centres as well as community doctors managing patients with diabetes.

The MDA was implemented with state of the art technologies (ASP.NET 4.5 MVC framework, HTML5 and CSS3). It is a multiplatform web application with optimized user interface that has undergone usability evaluations and expert evaluations. It is suitable for mobile devices, tablet PCs and smartphones, and desktop PCs allowing citizens to interact with the platform anytime, anywhere.

The MDA is currently in daily use (in its supervised version) in two primary health care centres in the island of Crete.

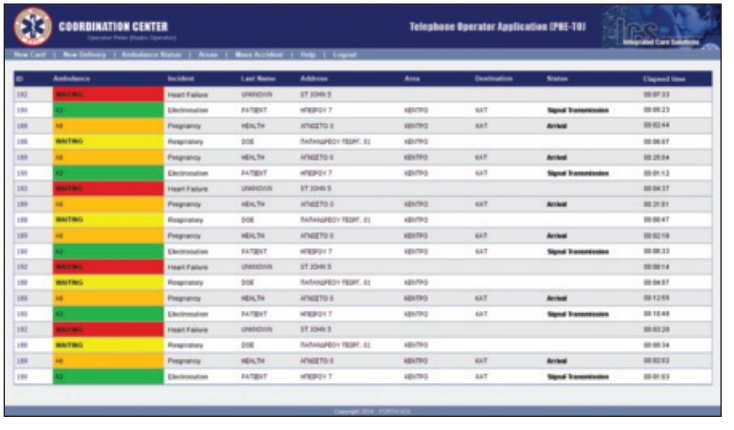
Patient View Measurements in Tabular and Graphic Formats

Pre-Hospital Emergency Care

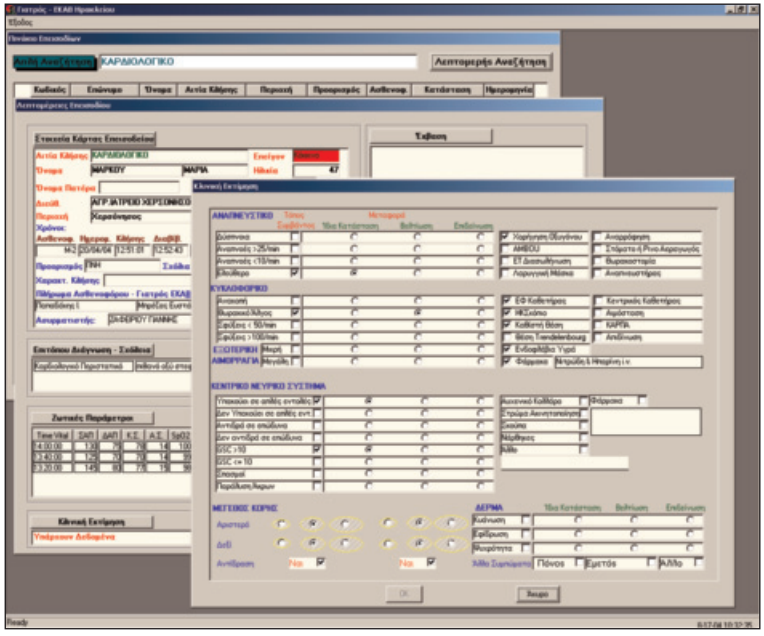
Pre-Hospital Emergency Care (ICS-E) applications feature a unique tool for prompt and accurate management of emergency incidents and of ambulatory resources. The coordination center and the ambulance service can prioritize and manage the available resources in the best possible way. In the ambulance, episode monitoring is supported through patient telemonitoring of vital signs to allow for proper arrangements at the host health center.

The Health Emergency Coordination Center Management application supports the whole process from the citizen's emergency call to the hospital. All the detailed information about the incident is recorded, and the episode is monitored from the time of dispatch until its arrival to the hospital. Among other functionalities, the use of triage protocols (special algorithms) for the operators / dispatchers is important for better estimation of the severity of the incident and the selection of the appropriate resources (e.g., ambulance, mobile unit) to be dispatched.

Left: Health Emergency Coordination Center Management Application in use
Right: Telephone Operator Screen



ICS-E



The Pre-hospital Emergency Care family of ICS products have been designed for health care professionals who provide emergency and primary health care to patients at the point of need, and also deal with transportation between hospitals and medical facilities.

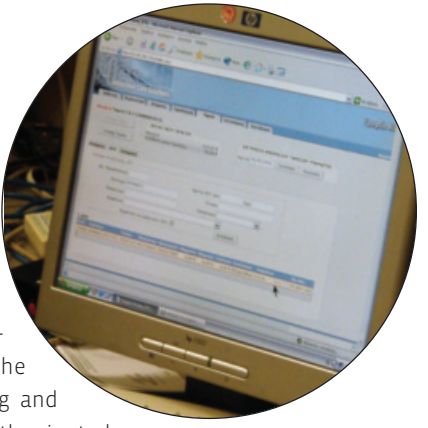
ICS-E applications include the following:

- Health Emergency Coordination Center Management (PHE-M)
- Telephone Operator Application (PHE-TO)
- Radio Dispatcher Application (PHE-RD)
- Incident Monitoring (Coordination Center part) (PHE-IM)
- Incident Monitoring (Ambulance part) (PHE-AA)
- Automated External Defibrillator Network Management (PHE-ED)
- Pre-Hospital Emergency Care Protocol Management (PHE-PM)

The significant impact of creating an emergency management system reveals demographic, topological, and qualitative issues allowing health emergency coordination centers to improve efficiency and effectiveness by reducing dispatch time, time at accident scene for metropolitan areas, and time at the emergency ward, mainly due to medical interventions on site.

ICS-E is deployed at the Pre-hospital Emergency Coordination Center (EKAB) of Crete and has already recorded more than 450.000 incidents since 1996.

Health Information Infrastructure



Health Information Infrastructure (ICS-H) includes a set of healthcare-related components to support cross-vendor and cross-enterprise integration. Its purpose is to resolve issues related e.g. to the proper identification of the subject of care, the exchange of integrated EHR indexing and health data (utilizing appropriate health oriented protocols like HL7), the facilitation of collaboration between healthcare professionals and patients/ experts, authorization for accessing healthcare related resources, and the management of common medical terminology.

ICS-H components can electronically interface with ICS and third party applications and open devices. All interfaces are based on standards such as HL7, DICOM, XML, and web services. ICS-H is suitable for the development of Integrated health information systems to support cross-enterprise cooperation.

Integrated Care Solutions can electronically interface with third party applications and open devices, based on standards such as HL7, DICOM, XML and web services

ICS-H

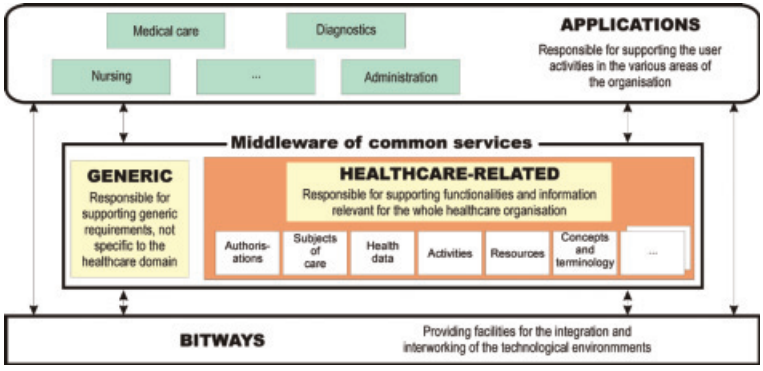
ICS-H includes two major categories of components. The first category is a series of web (middleware) services which provide services in accordance with predetermined procedures, while the second includes a series of reusable software objects which can be incorporated in other ICS applications.

Middleware Services:

- Person Identification Service (PIDS)
- Clinical Observations Access Services (COAS)
- Integrated Electronic Health Record Indexing Service (I-EHR IS)
- Common Terminology Services (CTS)
- XML Acceptor (XML-A)
- XML Creator (XML-C)
- HL7 Gate (HL7G)
- Health Resource Service (HRS)
- Barcode Printer Service (BPS)
- Collaboration Service (CS)

Reusable software objects:

- DICOM Interface Objects (IO-DICOM)
- HL7 Interface Objects (IO-HL7)
- Security Inter-face Objects (IO-S)
- Helper Inter-face Objects (IO-H)
- PIDS Interface Objects (IO-PIDS)
- HRS Interface Objects (IO-HRS)
- ECG Interface Objects (IO-ECG)



The European Committee for Standardization (CEN) Standard Architecture for Healthcare Information Systems (ENV 12967), Health Informatics Service Architecture or HISA, has been Adopted. HISA Provides Guidance and a Formal Standard for a Service Oriented Architecture, based on three co-operative Layers to Support the Creation of Flexible and Reusable Applications for the Healthcare Domain

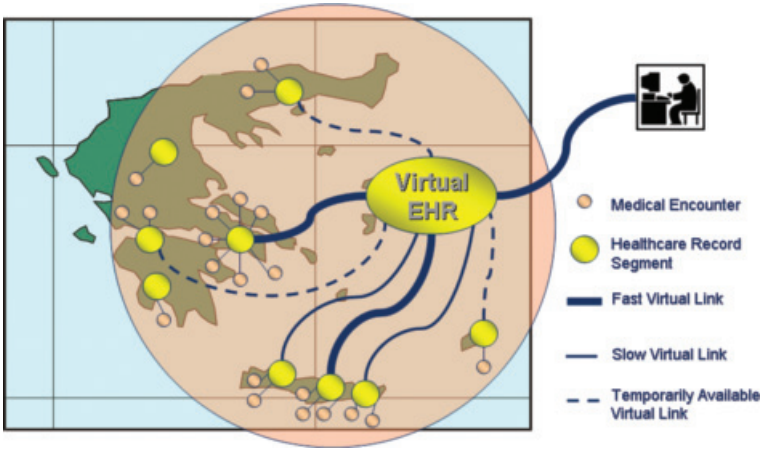
Different components of the health information infrastructure are deployed at several integrated regional health information systems in Greece since 1998.

Integrated Electronic Health Record

The **Integrated Electronic Health Record (ICS - I)** applications provide a uniform way for professionals and citizens to access patient record data that are physically located in different clinical information systems across different organizations. They provide fast, secure access to distributed patient record information from multiple disparate sources to properly authorized users. Integrated Electronic Health Record applications address key challenges, such as the provision of a framework for the integration of a diverse set of heterogeneous and distributed information sources into a seemingly uniform collection of data and knowledge, thus increasing the availability of previously inaccessible information.

ICS-I is suitable for the development of integrated health information systems to support cross-enterprise cooperation.

ICS-I



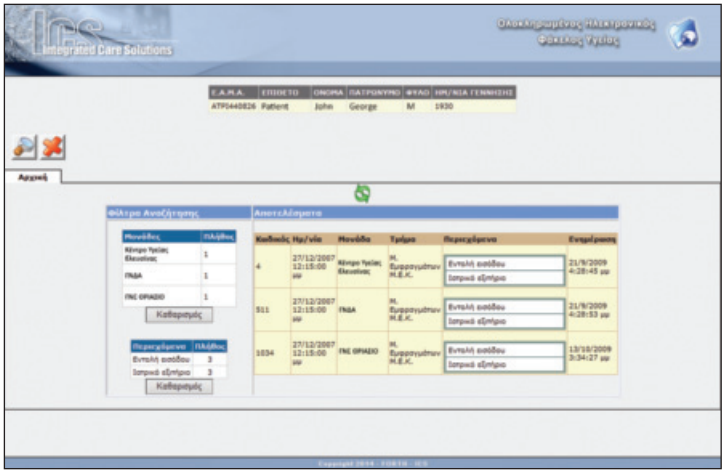
In order to support seamless and personalized information delivery, services and information must be accessible without visible organizational boundaries.

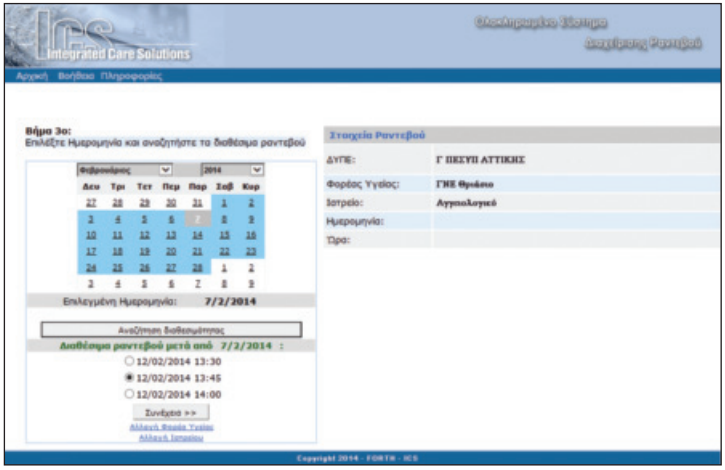
The Integrated Electronic Health Record family of ICS products have been designed for health care professionals and citizens who want to access systematic collections of electronic health information about individual patients or populations. The approach followed does not focus on the standardization of the content of the EHR, but rather tries to provide access to already existing EHR systems. As such, the federated approach selected is based on a set of already available Health Information Infrastructure components that deal with inter-enterprise integration issues, and imposes a level of common design that varies according to the actual compo-sition of the end-user requirements.

Integrated Electronic Health Record applications include the following:

- Master Patient Record Management (MPR)
- Integrated Electronic Health Record Viewer (I-EHR Viewer)
- Integrated Booking System (IBS)

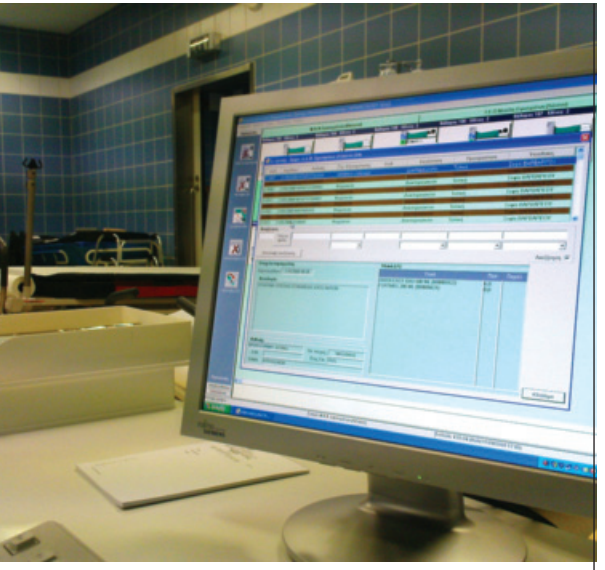
The technology has been tested under different settings in Greece since 1998.





Top: Integrated Electronic Health Record Viewer (I-EHR Viewer)
Bottom: Integrated Booking System (IBS)

Nursing and Medical Applications



EuroREC EHR Quality Seal Level 2 Certificate

Nursing and Medical Applications (ICS-M) support EHR management for nursing and medical personnel in the context of a healthcare organization environment. They support the management of medical ordering for materials, internal and external services, therapies and medical acts. They are also ideal for assisting nursing and medical personnel in their daily duties (clinical documentation). Bed management, surgery and operating rooms management are also supported. Specialized EHRs for pathology, cardiology, pediatrics, orthopedics, intensive care unit, oncology, etc. are included as well.

In 2011 CeHA's "Nursing and Medical Applications" (under the product name ICS-M), which are part of the ICS software suite, was certified with the EuroRec Seal of Quality Electronic Health Record (EHR) Level 2 by the European Institute for Health Records EuroRec (www.eurorec.org). The Seal encompasses 50 functional quality criteria, addressing various essential functions of the EHR: access and security management of the system, basic functional requirements on medication, clinical data management and the generic statements focusing on trustworthiness of the clinical data.

The Nursing and Medical Applications family of ICS products have been designed for health care professionals who require the use of software within a medical context.

ICS-M

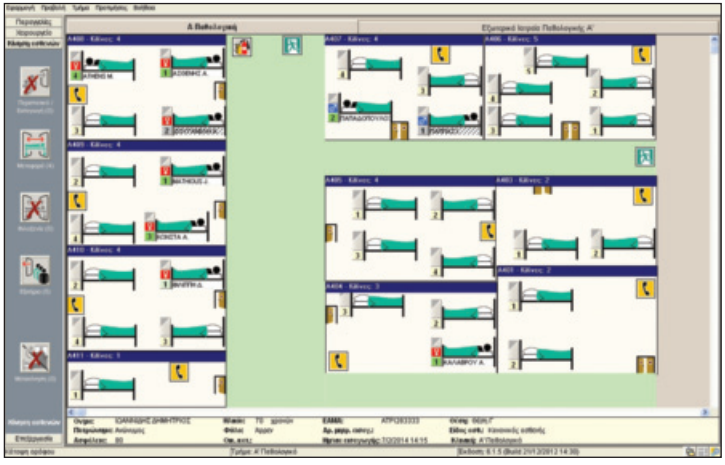
Nursing and Medical Applications include the following:

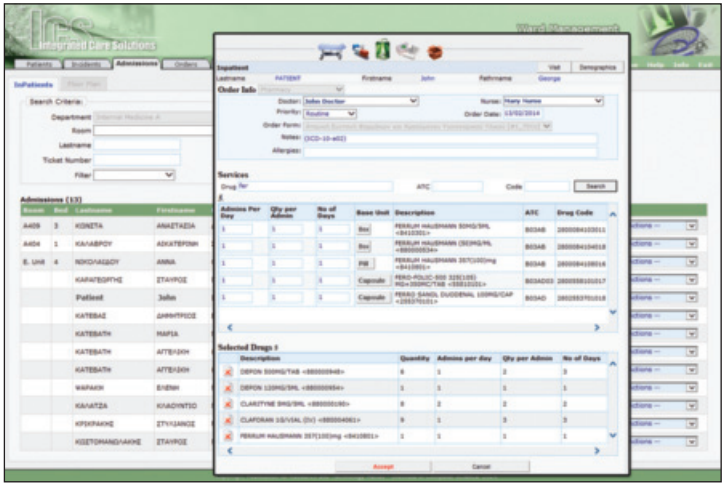
- Ward Management (WM)
- Supply Management (SM)
- Outpatient Clinic (OC)
- Emergency Department (ED)
- Radiology Information System (RIS)
- Operating Rooms Management (OR)
- Electronic Health Record (EHR)
- Hospital IT Department (M-ITD)

ICS-M is suitable for care provision departments in healthcare facilities (e.g., hospital clinics). Nursing and Medical Applications support standards based electronic communication with 3rd party systems for:

- Pharmacy Materials Management and Nutrition department for ordering, order cancellation and administration of drugs / medical supplies / diets.
- RIS/ LIS for ordering / order cancellation of examintions and viewing results.
- Business Intelligence / MIS for the electronic transmission of data for statistical analyses.

Several ICS-M applications have been deployed at more than 25 Hospitals in Greece since 1999.





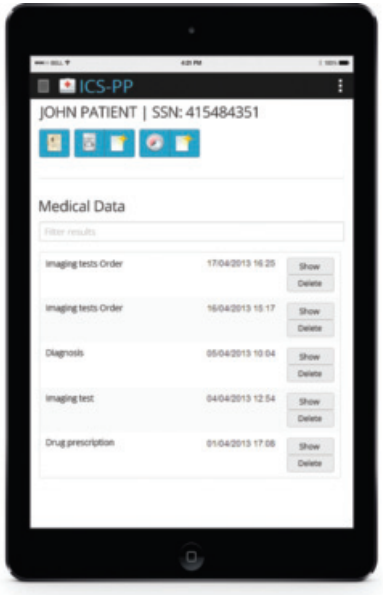
Top: Floor Plan in a Clinic
Bottom: ePrescription within a Hospital Environment
Left: Ward Management Application in use inside an Intensive Care Unit

Primary Health Care

Primary Health Care (ICS-P) applications support EHR management, appointment booking, billing of services, and supply management in the context of a primary health care provider setting. They follow high quality international trends regarding both the structure of the EHR, as well as integration with third party systems. The EHR is based upon internationally accepted models for primary care, and supports visit-oriented and problem-oriented views and process automation to support clinical decision for disease management and treatment planning

ICS-P is suitable for primary care centers and medical offices of private practitioners.

ICS-P



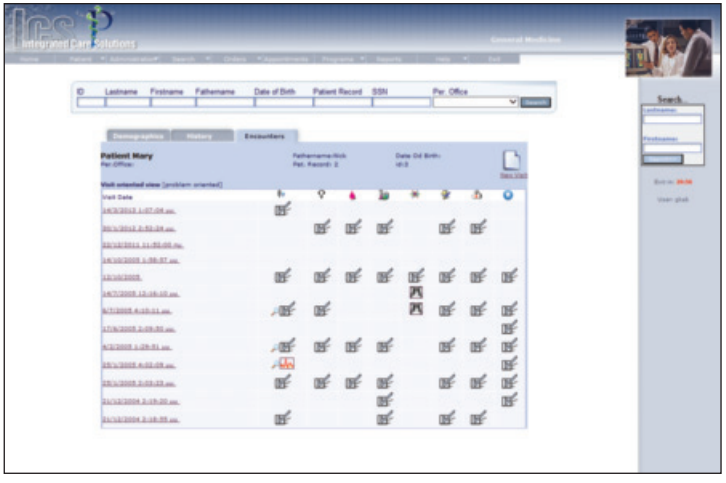
Mobile Application for Private Practitioner Electronic Health Record (PC-PP)

The Primary Health Care family of ICS products have been designed for health care professionals who act as a first point of consultation for all patients within a health care system.

Primary Health Care applications include the following:

- Primary Care Unit Reception (PC-UR).
- Primary Care Unit Electronic Health Record (PC-HR).
- Private Practitioner Electronic Health Record (PC-PP).
- Primary Care Unit Appointment Management (PC-AM).
- Primary Care Unit Supply Management (PC-SM).
- Primary Care Unit IT Department (PC-IT).

Primary Health Care applications support standards based electronic communication with 3rd party systems for:



- Accounting, Materials Management, Pharmacy, Radiology, Laboratory, etc. for electronic transmission of patient and encounter data (e.g. invoices and cash movements, orders, etc.) and for updating lists of services.
- Laboratories for ordering / order cancellation and business intelligence / management information systems for the electronic transmission of data for statistical analyses.
- Communication with 3rd parties (e.g. insurance organizations) or government bodies in line with existing legislation.

Several ICS-P applications have been deployed at more than 30 Primary Care Centers in Greece since 1998.

Patient Encounters (Visit Oriented View)

Welfare

Welfare (ICS - W) applications support appointment booking and EHR management in the context of a welfare organization setting. They are specialized in child welfare in meeting the requirements of this type of organizations, and in supporting the involved healthcare personnel such as pediatricians, social workers, occupational therapists, speech therapists, and psychologists. They support caseworkers' interactions with children, youth, and families, as well as managerial decisions. This way the organizations can enhance program efficiency and improve outcomes for the families they serve.

ICS-W applications are based upon an open, scalable and evolvable architecture that integrates distributed information and knowledge in a flexible manner, focusing on the timely and effective delivery of the appropriate information to all authorized users. Being the outcome of applied research, they encompass both state of the art trends and real-world requirements for effective use.

ICS-W is suitable for care units (e.g. for handicapped children, elderly homes, and others).

ICS-W

The Welfare family of ICS products have been designed for care professionals who provide for social well-being and support to individuals (e.g., with illness or disability, the elderly, etc.).

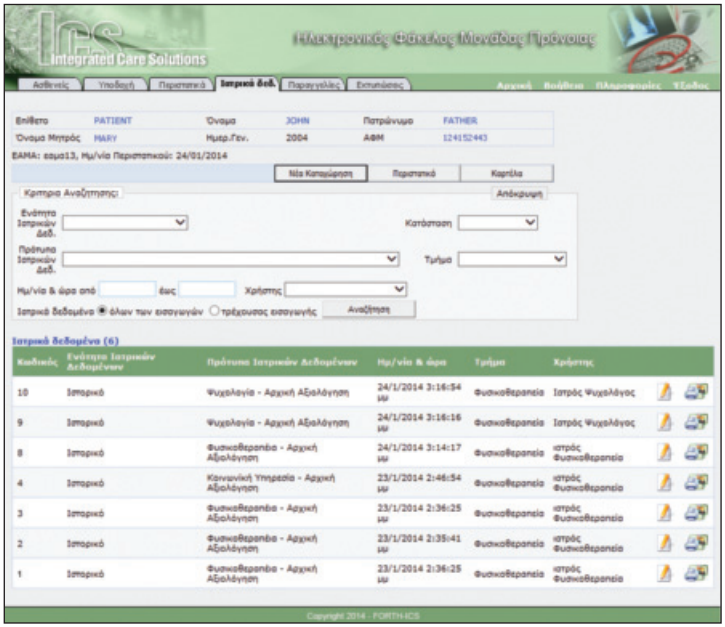
Welfare applications include the following:

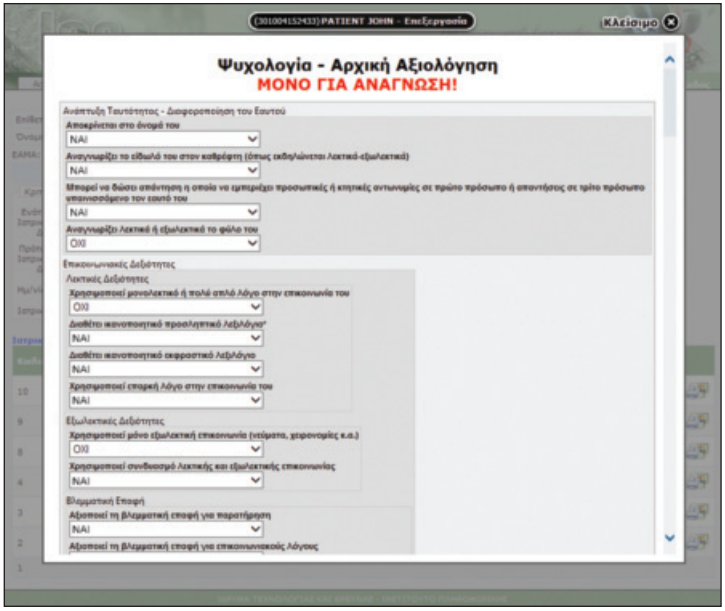
- Welfare Unit Reception (WF-UR)
- Welfare Unit Electronic Health Record (WF -HR)
- Welfare Unit Appointment Management (WF-AM)
- Welfare Unit Supply Management (WF-SM)
- Welfare Unit IT Department (WF-IT)

Welfare applications support standards based electronic communication with 3rd party systems for:

- Pharmacy, Materials Management and Nutrition department for ordering, order cancellation and administration of drugs / medical supplies / diets.
- Business Intelligence / MIS for the electronic transmission of data for statistical analyses.
- Communication with 3rd parties (e.g. insurance organizations) or government bodies in line with existing legislation.

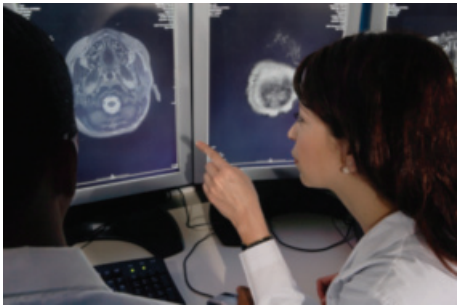
ICS-W has been deployed in Crete since 2013.





Top: Welfare Unit Electronic Health Record (WF -HR)
Bottom: EHR Template Instantiated for Welfare

Picture Archiving and Communication



Picture Archiving and Communication (ICS-X) applications feature the ability to store imaging examinations in a central repository (server), where they can be searched and reviewed by users who have similar and compatible applications. Exams come primarily from imaging equipment such as Radiography, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), or Ultrasound and are stored in the Digital Imaging and Communications in Medicine (DICOM) format. Communication with Radiology Information System (RIS) is supported.

ICS-X is suitable for the imaging department in healthcare units.

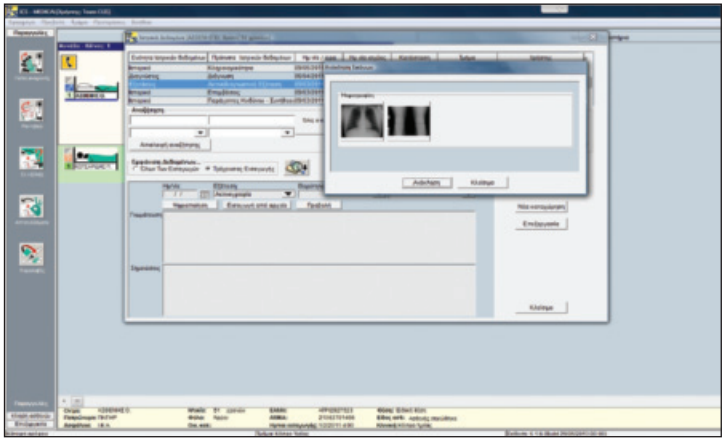
The Picture Archiving and Communications family of ICS products have been designed for health care professionals who require a medical imaging technology for economical storage and convenient access to images from multiple modalities (source machine types). They consist of a miniPACS application server, a miniPACS management console and a viewer.

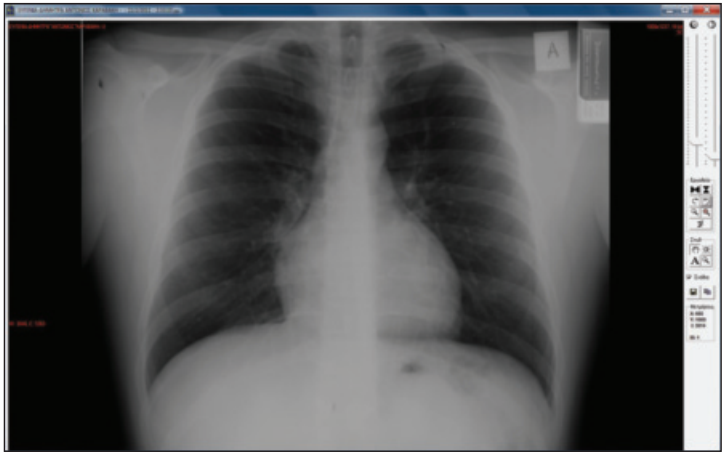
ICS-X

miniPACS

The **miniPACS** application provides a scalable and customized solution to radiology examinations archiving that adheres to IHE framework directives. It implements the basic actors and transaction of Integrating the Healthcare Enterprise (IHE) Radiology Profile that facilitate the archiving and management of radiology examinations. It is accompanied by a straightforward to use administration tool, which facilitates custom configuration and basic administration. Additionally, custom solutions, such as pre-fetching techniques, routing of examination studies to specific workstations, as well worklist adapters or any kind of RIS adapters based on IHE Radiology Profile can be easily implemented and incorporated to the existing solution. The examination studies are archived in operating system file system. This way it can be easily deployed over any scalable RAID implementation.

ICS-X has been installed and operates at the University Hospital of Patras since 2005.





Top: Access to Radiology Images Managed by the miniPACS Application
Bottom: X-ray Viewer

CeHA products and services have been certified according to: the **EuroRec Seal of Quality Electronic Health Record Level 2** and the requirements set by **ISO 9001:2008** quality management system for the design and development of complex information systems and the implementation of ICT projects in the domain of health.

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