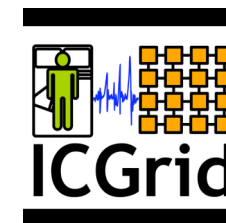


# ICGrid: Enabling Intensive Care Medical Research on the EGEE Grid



*Harald Gjermundrød, Marios D. Dikaiakos,  
Demetrios Zeinalipour-Yazti*  
**University of Cyprus**

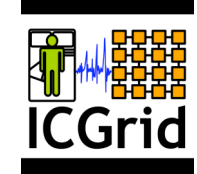


*George Panayi, Theodoros Kyprianou*  
**Nicosia General Hospital**

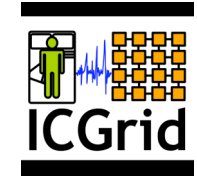


# Overview

- Introduction
- Motivation
- Architecture
- Grid services
- Implementation details
- Conclusion

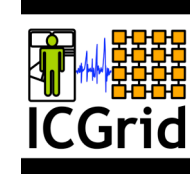


# Introduction



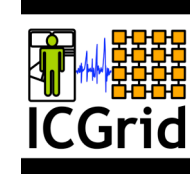
- ICGrid, a Grid application that enables:
  - the retrieval of data from patient-attached medical sensors found in modern Intensive Care Units
  - the filtering and annotation of these data by ICU medical staff
  - the storage and replication of annotated data-sets on the EGEE infrastructure
  - the distributed searching of stored metadata annotations and the retrieval of data-sets

# Motivation



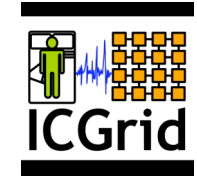
- *Intensive Care Units (ICUs)* monitor patients that are in a critical (**life-threatening**) physiological state
- Patients are connected to a very large number of monitoring devices that continuously acquire the state of the respective patient
- Clinically Interesting Episodes (CIE), can contain multiple incidents
  - $(temp > X \text{ and } press > Y) \Rightarrow \text{cerebral emergency } 95\%$
- Currently physicians can only **reactively** respond to such incidents
- Proactively finding such CIE in the acquired signals is of critical importance

# Why use the Grid



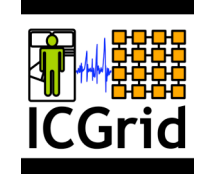
- ICUs lack the required high performance and dedicated storage resources for long-term collection of medical data, and the computational power to perform advanced processing and data-mining on these data
- Most ICUs lack the qualified information technology personnel that can undertake the complex task of running in-house computations
- The sharing and collaborative processing of medical data collected by different ICUs raises important privacy, anonymity, information integrity challenges that cannot be addressed by existing commercial ICU information systems

# Goal



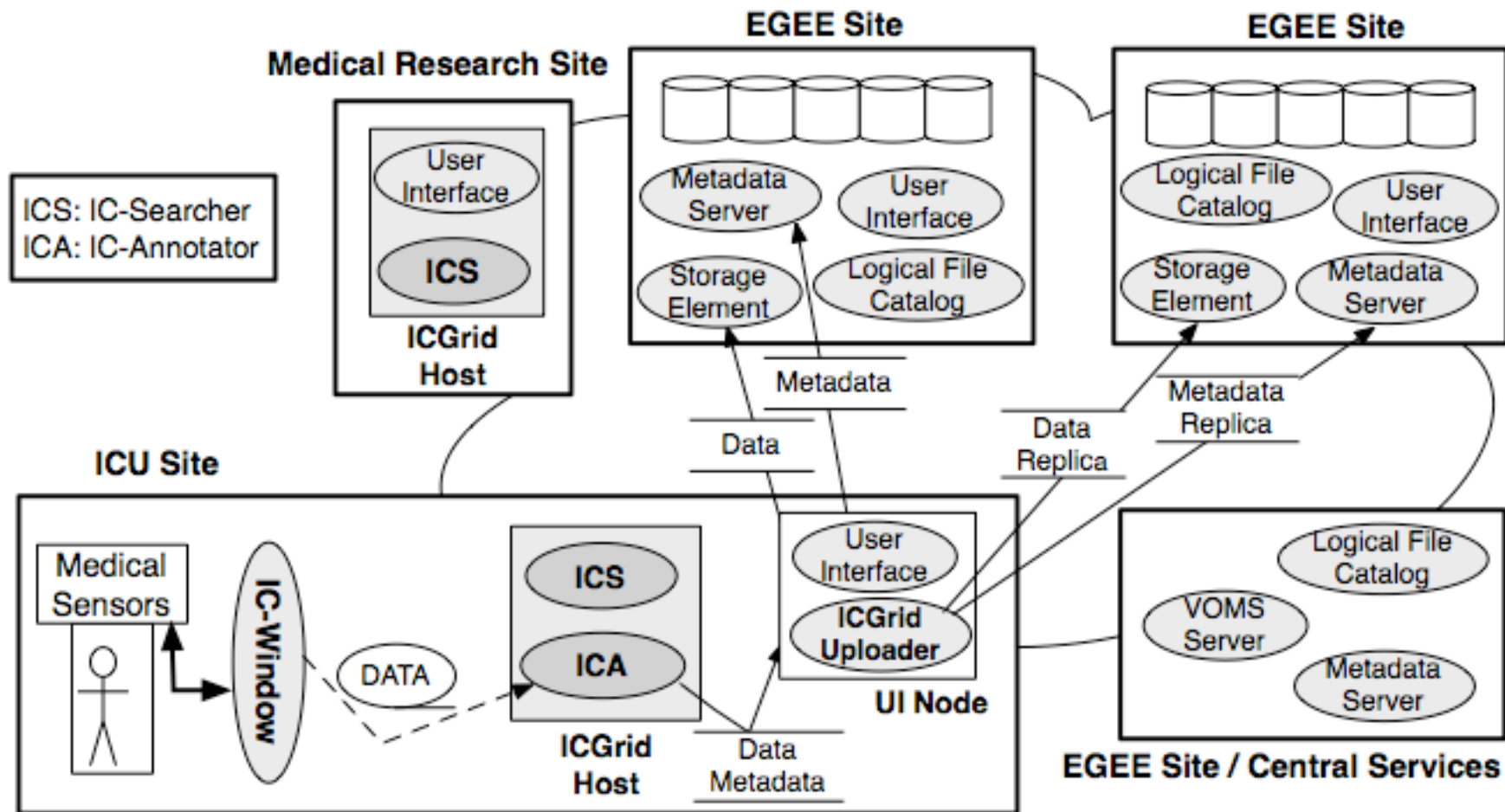
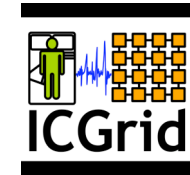
*Create a (distributed) tool  
that enables the seamless  
**integration, correlation and  
retrieval** of clinically  
interesting episodes across  
Intensive Care Units*

# Design Criteria



- Make the use of the Grid infrastructure completely transparent to the end-user
  - Therefore we developed a collection of user friendly interfaces which allow physicians to get access to the EGEE resources without any prior knowledge of Grid technologies
- Provide for platform independence
  - Two out of the three tools are built using Java
- Security
  - The collected information is anonymized
  - Physical separation between the collection tool and the Grid tools

# Architecture

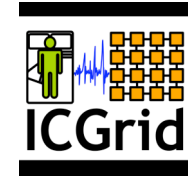


# gLite Middleware Services

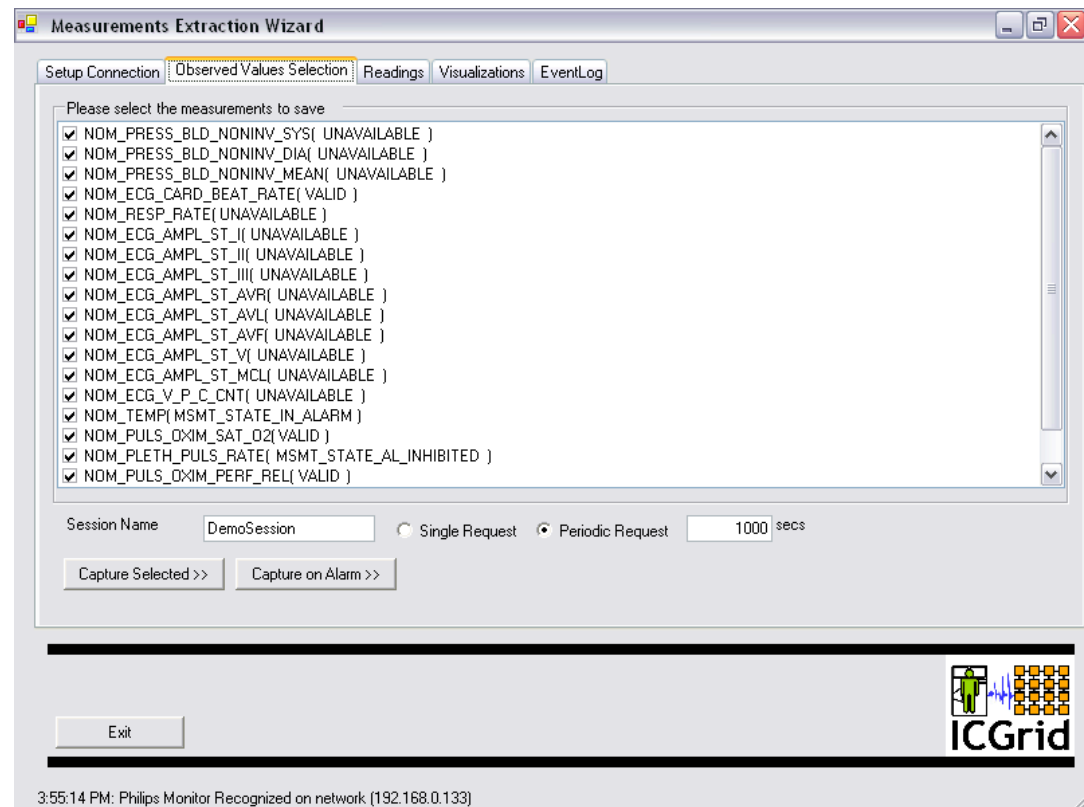


- User Interface
  - Entry point to the Grid
  - Used to generate X509 proxies and access the other services
- Storage Element
  - Used to store the collected data
- AMGA (Metadata Service)
  - Used to store the collected meta-data
- Logical File Catalog
  - Used as the file catalog for the collected data stored

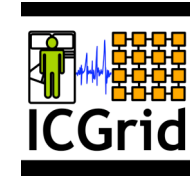
# Intensive Care Window



- Provide open implementations to the various proprietary and closed protocol of medical monitoring devices
- Current status: implemented a full-fledged interface to access the Phillips IntelliVue MP70 medical monitor



# Intensive Care Annotator



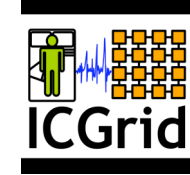
- Assists the end-user with annotating the collected sensor data
- Following information is provided:
  - Institution
  - Physician
  - Patient (anonymized)
  - Medical devices
  - Clinically Interesting Incidents
- Then upload the info to the grid

The screenshot shows the ICGrid Annotator application window. It is divided into several sections for data entry:

- Collected Information:** Includes a 'Load Data Dir' field with the path '/Users/harald/source/test', and fields for 'Meta-Data File' and 'Data Archive'.
- Institution Information:** Fields for 'Country' (CY), 'Institution' (lgh), and 'Unit' (icu\_e).
- Physician Information:** Fields for 'First Name' (Theodoros), 'Last Name' (Kyprianou), 'Birth Year' (1958), 'Experience' (5), and 'Exp. ICU' (2).
- Patient Information:** Fields for 'Sex' (female), 'Age' (40), 'Weight' (70 kg), and 'Height' (160 cm).
- Instrument Information:** Fields for 'Manufacturer' (Philips), 'Model' (Intellivue), and 'Sensor' (NOM\_ECG\_AMI). A list of sensors is visible, including NOM\_ECG\_CARD\_BEAT\_RATE, NOM\_ECG\_AMPL\_ST\_MCL, NOM\_ECG\_AMPL\_ST\_II, and NOM\_ECG\_AMPL\_ST\_AVF.
- Incident Information:** Fields for 'Start Time' and 'End Time' (both set to 1 Jan 2006 12:30:00), and a 'Description of incident' text area.

At the bottom, there are buttons for 'Save To Archive', 'Upload To Grid', 'Clear All', and 'Exit'.

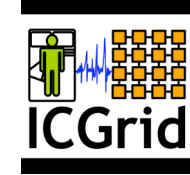
# Intensive Care Searcher



- Simple and intuitive GUI to search in the uploaded information
- Future direction
  - Automatic identification of similar episodes
  - Data mining techniques, such as predicting the future value of a signal and clustering similar inpatient states
- Current status:  
can perform searches within the metadata

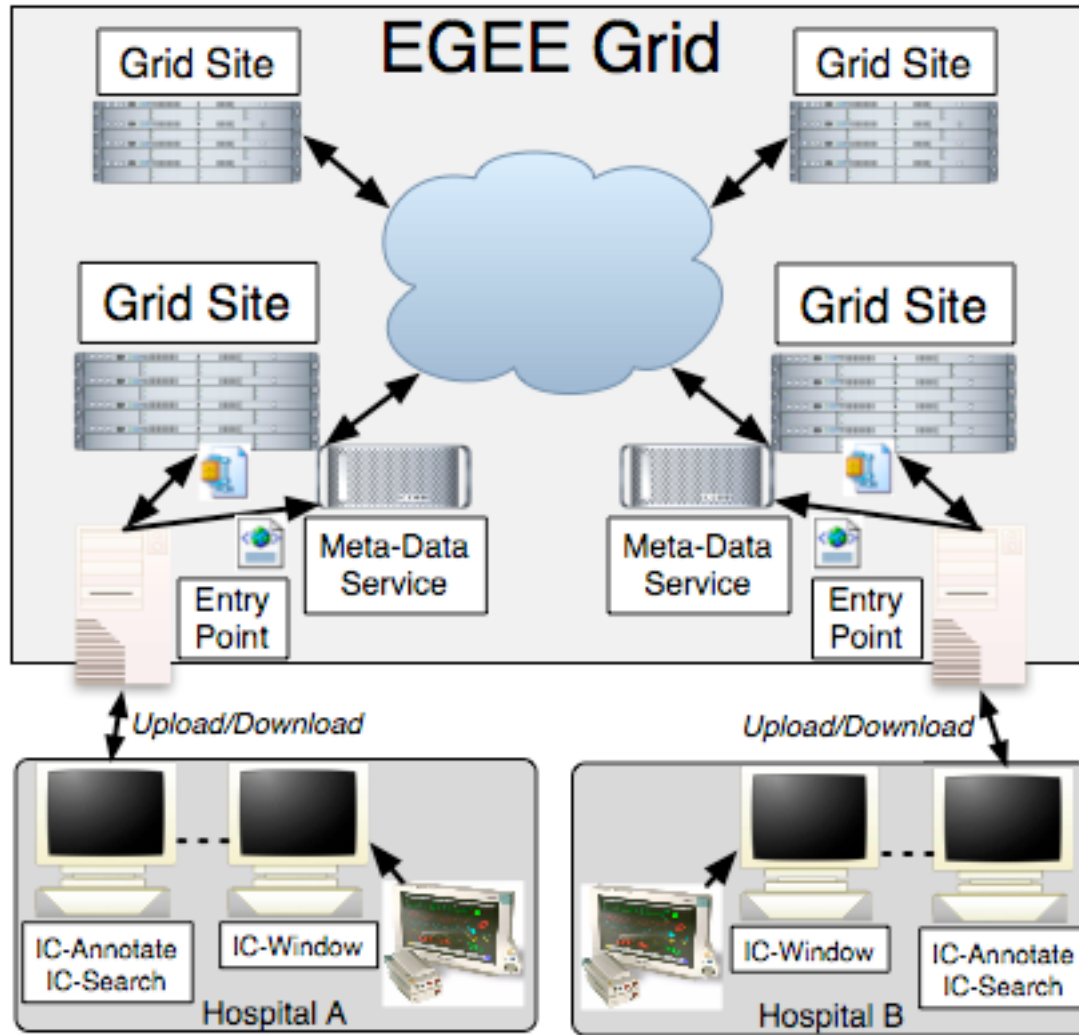
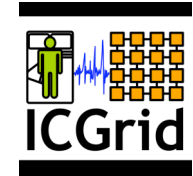


# Data Organization

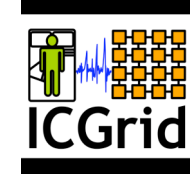


- Collected data
  - The sensor data are stored in tab separated text files, one file per sensor.
    - Each line in the file contains timestamp, the recorded physical parameter and the state of parameter
  - An episode consists a set of these files that are collected from an inpatient.
  - A data archive are created of all the sensor data files along with the metadata file
- Annotated data
  - The metadata is encoded as an XML-document defined by an application-tailored schema

# Deployment

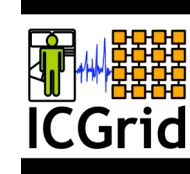


# Use case scenarios



- Teaching/training:
  - Replay of rare incidents for trainees or students
  - Observe the inpatients reaction to different treatment or drugs during the stay
- Research:
  - Searching/comparing the shared datasets for medical research
  - Perform signal processing, data-mining, etc..
- Pro active treatment/suggestions:
  - Search for similar incidents for what is currently being observed in from the inpatient
- Stand alone:
  - IC-Window open implementation to gather and display the inpatient data sensor data

# Conclusion



- ICGrid, a framework that paves the way for Intensive Care Medical Research on the EGEE Grid
- ICGrid is based on a hybrid architecture that combines:
  - A heterogeneous set of monitors that sense the inpatients
  - Grid technology that enables the storage, processing and information sharing task between Intensive Care Units
- The framework is in the process of being deployed at the Nicosia General Hospital



**Thank you for your attention**