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Promoting interoperability through the consistent implementation of the SCP-ECG standard in electrocardiography

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ECG Interoperability portal

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Abstract and objective

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- Electrocardiography is the most frequently applied non-invasive examination for early detection an follow-up of heart disease.
- The operation of most Electrocardiographs is based on proprietary protocols and data formats!
- What is OpenECG?
  - The OpenECG network promotes interoperability in electrocardiography through the consistent implementation of standards
  - OpenECG members are 845 individuals from 60 countries in June 2007, representing different stakeholders.
  - An online SCP-ECG (EN1064:2005, 2007) conformance testing service assists integration of electrocardiographs with eHelath systems.

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What is OpenECG?

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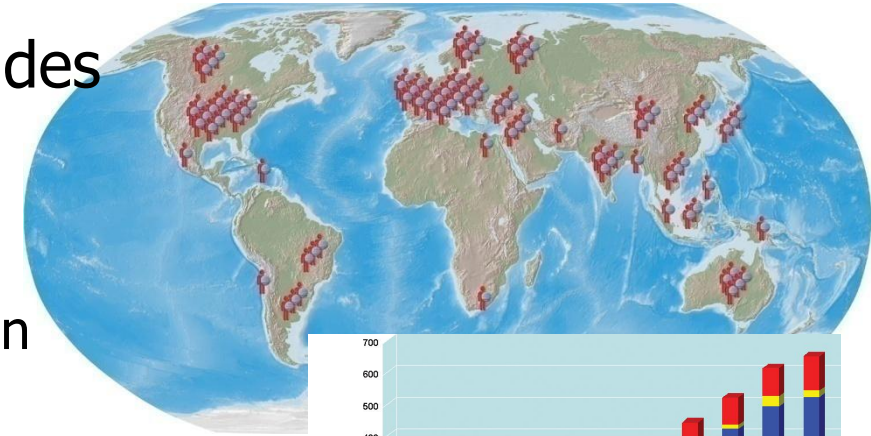
- OpenECG is a European initiative with world-wide impact that actively promotes interoperability and open standards in electrocardiography since 2002.
- 845 members from 60 countries worldwide in June'07
- all stakeholders represented, 30% manufacturers
- The OpenECG portal provides
  - world-wide experience
  - up-to-date information
  - assistance in implementation
  - open source tools
  - specifications and data sets
  - online conformance testing



	Oct-02	Feb-03	Jun-03	Oct-03	Feb-04	Jun-04	Oct-04	Feb-05	Jun-05	Oct-05	Dec-05
Refused	0	2	3	7	19	30	48	72	87	87	107
Under Evaluation	1	2	4	8	6	10	5	19	12	33	21
Members	55	66	91	121	178	235	290	352	422	493	523

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Increasing impact worldwide

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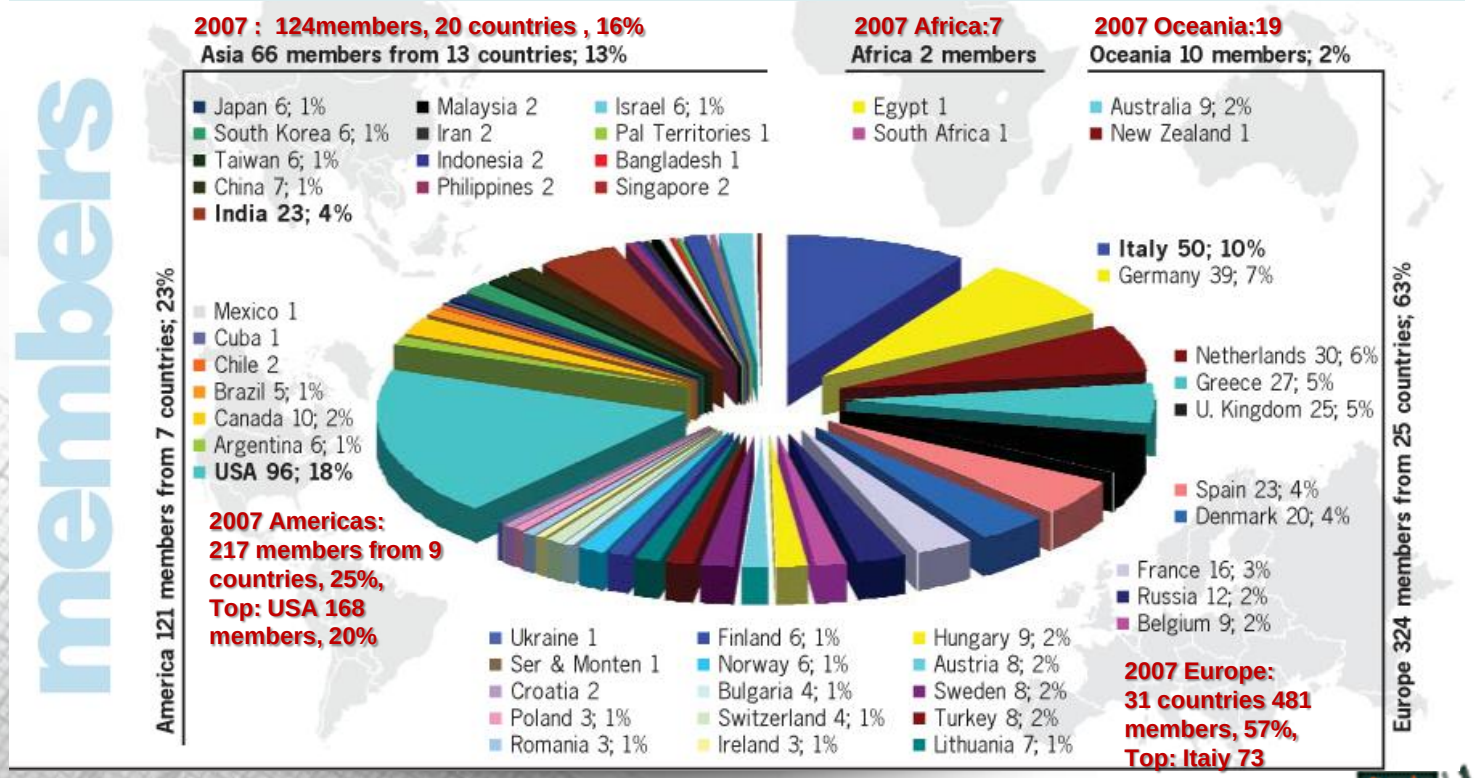
523 members from 49 countries worldwide [Jan 2006]

845 members from 60 countries worldwide [*June 2007*]



60% increase in members since January 2006!
Mostly outside Europe…

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OpenECG services

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ECG interoperability portal

- online services: specifications, data sets, tutorials, converters, SCP-parsing by email
- open source SW repository: download tools in open source, peer-reviewed by the OpenECG community
- help desk: contact helpdesk@openecg.net to receive assistance on implementing ECG interoperability standards
- mailing list: discuss developments and practical problems with ECG interoperability standards
- **interoperability testing: conformance testing of SCP-ECG records and ECG devices, SCP-ECG validation web service**
- liaison with standardization bodies: provide practical feedback from implementations
- open source programming contest: check out award winning software at the open source SW repository.

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Resting Electrocardiograph (ECG)

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- The most common frequent non-invasive examination for early detection of heart disease is the Resting ECG where the ECG in supine position is acquired with 12 leads (I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6) for a short time (usually 10 sec)
- The CSE project (1980-1990) identified some minimal requirements for diagnostic ECG
  - duration of acquisition (10 sec), sampling rate (500 Hz) and resolution (5 μV) for assuring diagnostic quality to the acquired ECG signal
- The European standard EN1064:2007 (SCP-ECG) up as an ISO NWI, specifies an interchange format to assist the integration of electrocardiographs to eHealth services & EHR systems.

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SCP-ECG structure and compliance levels (EN1064:2007)

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Status	Content
Mandatory	2 bytes- Checksum CRC - CCITT over the entire record
Mandatory	Pointers to data areas in the record [0]
Mandatory	Header Information – Patient data/ECG Acquisition data [1]
Optional	Huffman tables used in encoding of ECG data [2]
Optional	ECG lead definition [3]
Optional	QRS Locations (if reference bits are encoded) [4]
Optional	Encoded reference beat data if reference beats are stored [5]
Optional	Residual signal after reference beat subtraction or encoded rhythm data [6]
Optional	Global measurements [7]
Optional	Textual diagnosis from the "interpretive device" [8]
Optional	Manufacturer specific diagnostic and over reading data.. [9]
Optional	Lead measurement results [10]
Optional	Universal statement codes resulting from the interpretation [11]

SCP-ECG: Compliance Levels

Category	Data Sections Required	Content Description
I	**0, 1, 7, 8**	**Demographics, global measurements and interpretation**
II	**0, 1, 2, 3, 6, (7), (8)**	**Demographics and ECG rhythm data**
III	**0, 1, 2, 3, 5, (7), (8)**	**Demographics and reference beats**
IV	**0, 1, 2, 3, 4, 5, 6, (7), (8)**	**Demographics, ECG rhythm data, and reference beats**

- SCP-ECG is a European standard for 12 lead ECG interoperability
- Includes
  - Demographics
  - Rhythm data (waveforms)
  - Diagnostic report
- Option for ECG specific compression
- Quality control characteristics
- Specific for Short-term conventional "Resting" not:
  - Body surface ECG
  - Intracardiac potentials.
  - Medium and long-term ECG (exercise ECG, Holter ECG or ECG monitoring).

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METHOD: SCP-ECG compliance testing and OpenECG certification

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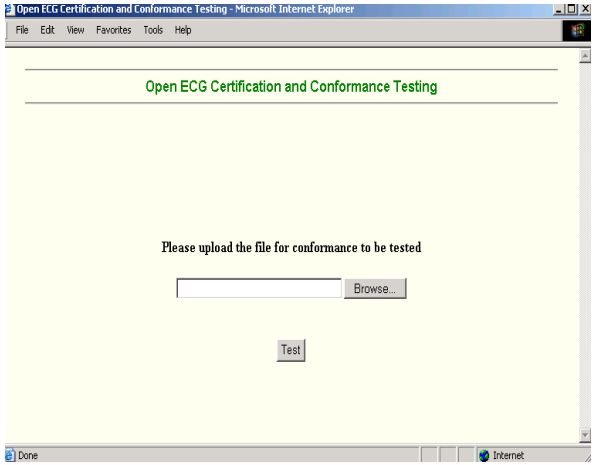

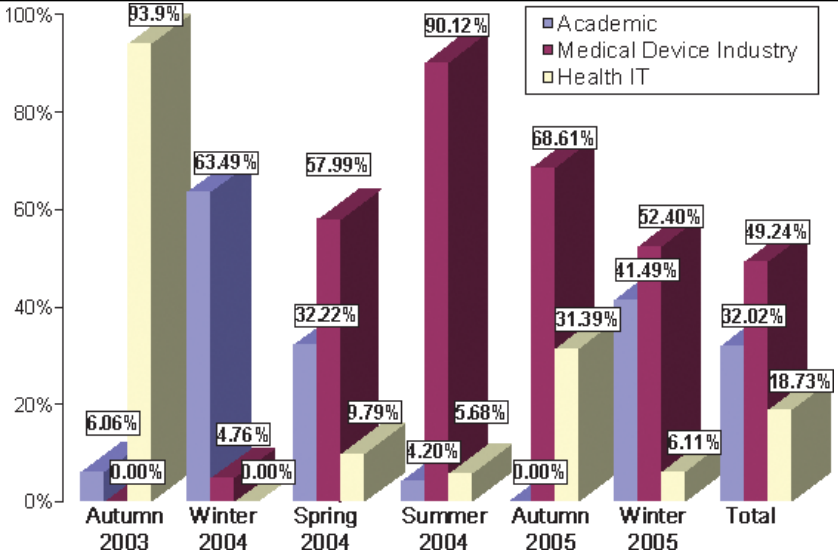

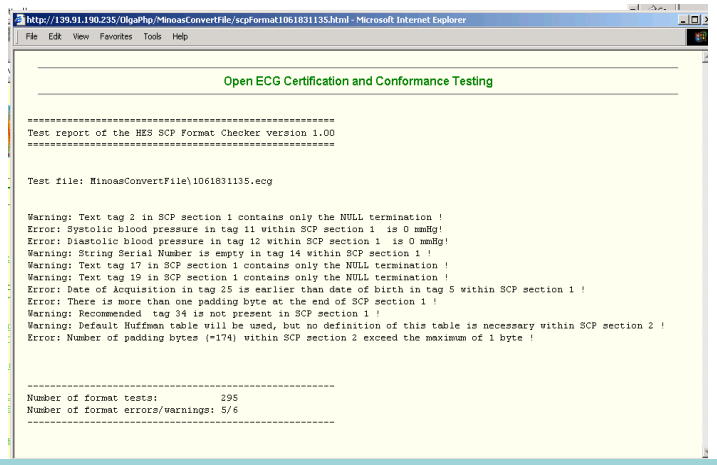

SCP-ECG testing also as a web service: a programming interface to access the SCP-ECG conformance testing service from 3rd party software

RESULTS: Who is using conformance testing?

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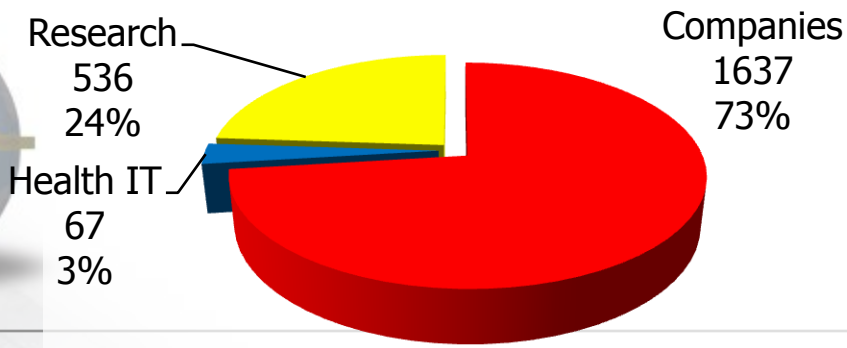
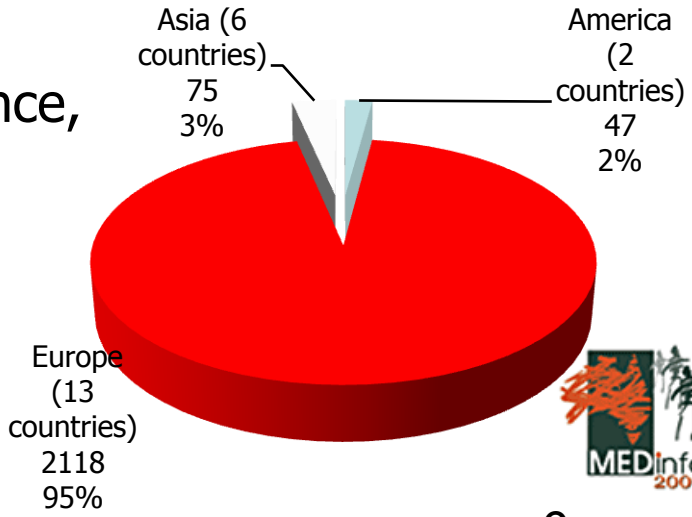
- 49 organizations, 21 countries world wide [June 07]:
  - From September 2003 to June 2007, a total of **2235 ECGs** were submitted by 64 members (8% of the community)
    - Top in Europe: Italy 12 members with (560) 22,5% ECGs
    - USA, 3 members (38 ECGs submitted)
    - Top in Asia: Japan, 2 members (21 ECGs)
  - 23 companies (italy, poland, russia, hungary, us, spain, germany, finland, france, greece, austria, netherlands, japan, china, turkey)
  - 20 research organizations, 2 freelance, 4 healthcare facilities/authorities





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FUTURE WORK: Harmonization Open ECG formats

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- SCP-ECG to HL7 aECG two-way converter
  - Using Biosig (www.biosig.sf.net)

Ref: Schloegl el al. Computers in Cardiology 2007

- MFER to SCP-ECG mapping (available from the creators of MFER)
- SCP-ECG to DICOM waveform converter (since 2004 in the openECG website)
- MIME types for ECG format

The BioSig Project

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BioSig is an open source software library for biomedical signal processing, featuring for example the analysis of biosignals such as the electroencephalogram (EEG), electrocorticogram (ECoG), electrocardiogram (ECG), electrooculogram (EOG), electromyogram (EMG), respiration, and so on. Major application areas are: Neuroinformatics, brain-computer interfaces, neurophysiology, psychology, cardiovascular systems and sleep research. The aim of the BioSig project is to foster research in biomedical signal processing by providing open source software tools for many different applications. Generally, many concerns have to be addressed in this scientific field. BioSig handles this by providing solutions for data acquisition, artifact processing, quality control, feature extraction, classification, modeling, data visualization, and so on. Everything in this project is freely available under the GNU General Public License.

BioSig consists of some (more or less) coherent parts, for more details take a look at the project page:

- BioSig for Octave and Matlab (biosig4octmat): A toolbox for Octave and Matlab with powerful data import and export filters, feature extraction algorithms, classification methods, and a powerful viewing and scoring software.
- BioSig for C/C++ (biosig4c++): A C/C++ library that provides reading and writing routines for different biosignal data formats.
- SigViewer (sigviewer): A viewing and scoring software for biosignals (especially for EEG signals) based on C++ and the platform-independent GUI toolkit Qt 4.
- rtsBCI (rtsbci): A real-time BCI system implemented in Matlab and Simulink.
- BioProFeed (bioprofeed)
- BCIx (bcix)

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The VISION: plug-n-play operation of medical devices with Personal Health Records

845 members from
60 nations world wide
In June 2007

- Billion devices connected, some managing our health: are they trusted?
- mobile and wearable "health devices"
- Smart textiles recording biosignals
- patient safety/ reduction of errors
- Intelligence, reliability, robustness
- plug-n-play operation
  - ECGs and biosignals in EHR

    Acquired, processing

    Analysis, managing alarms

- For OpenECG interoperability is:
  "A patient safety issue,
  a quality label for eHealth innovation!"

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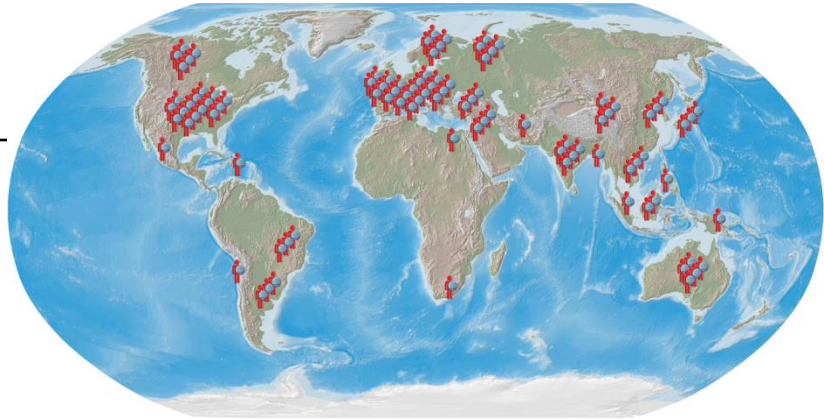
If you think it's time for

- plug-n-play ECG devices/ biosensors
- personal health monitoring
- lifelong electronic health records
- analysis of high quality health data



Be part of the effort!

join us!

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