



Integrating Medical Sensor Systems into Electronic Medical Records: The ITALH and TRUST EMR Projects

Mike Eklund

University of California, Berkeley

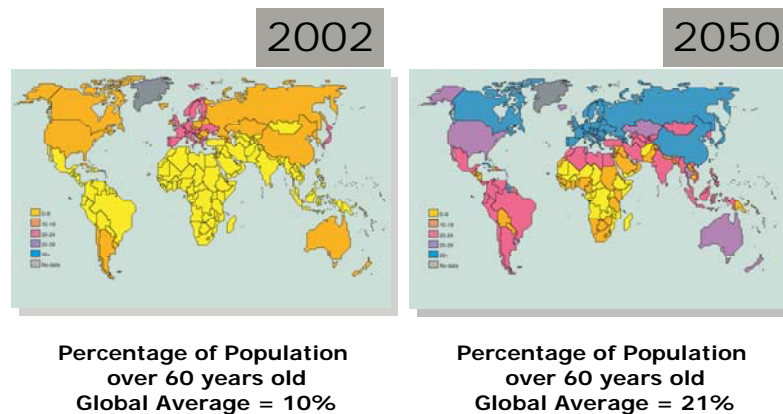
CITRIS in Europe June 20, 2006

The issue: Rising Healthcare Costs

- According to the National Coalition on Health Care, total health care expenditures in 2003:
 - Increased by 7.7 % -- four times the rate of inflation
 - To \$1.7 trillion – projected at \$2.1 trillion in 2006 and \$3.8 trillion in 2015
 - Which was 15.3 % of GDP – a projected to reach 19.0 % by 2015.

Where are these increases coming from?

- Many causes, one of which is the aging population
- Group care facilities are very expensive
 - Monetary cost to the individual and their family and/or the social welfare system
 - Health/happiness cost: Leaving ones home is often difficult or even traumatic.



SOURCE: United Nations • "Population Aging • 2002"

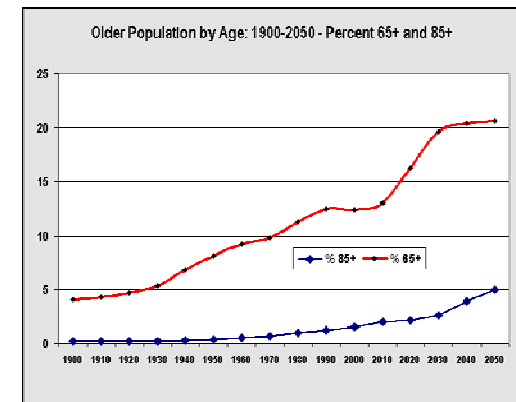


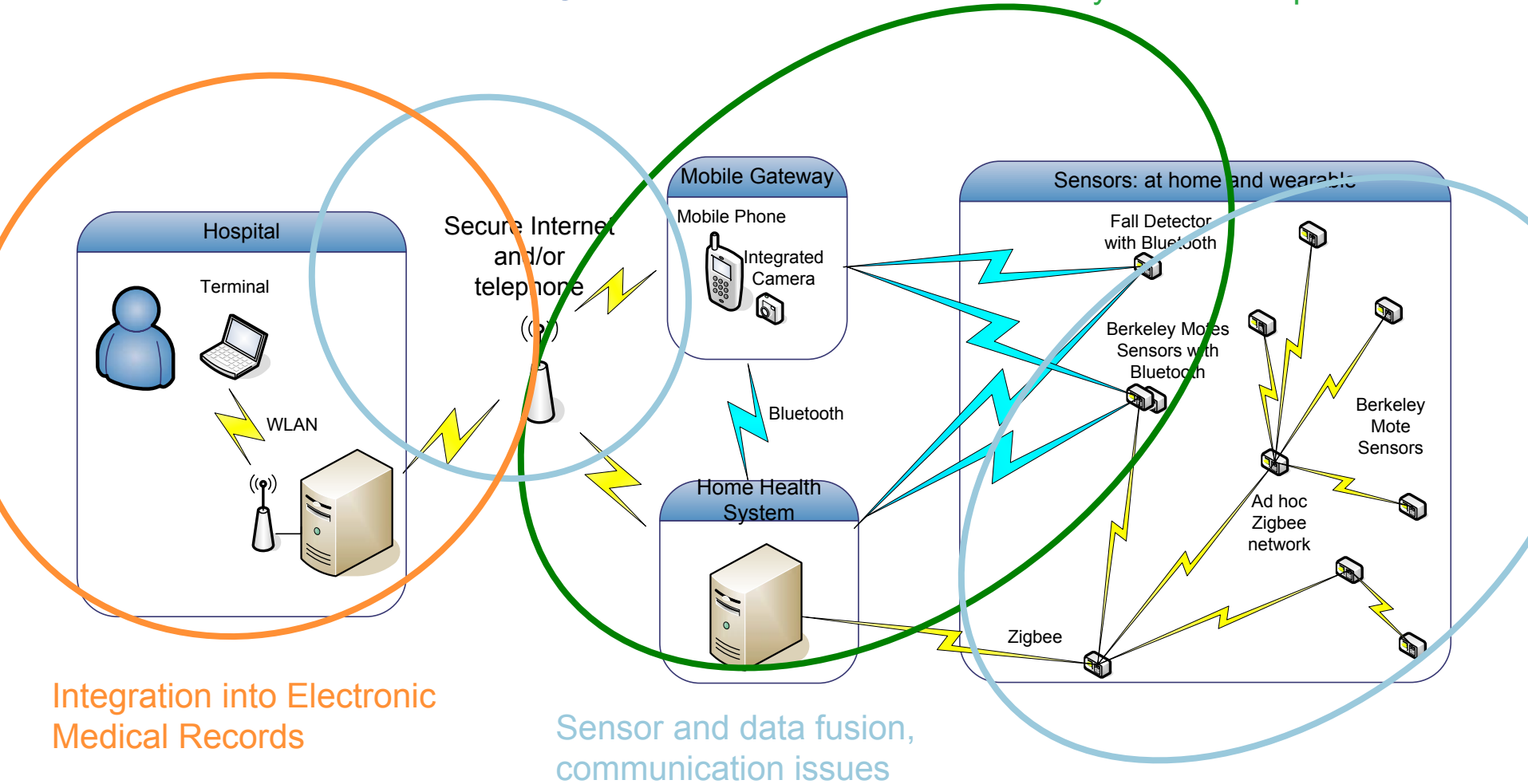
Table compiled by the U.S. Administration on Aging based on data from the U.S. Census Bureau.

How will Health Information Technology impact this trend

- David Brailer, National Coordinator for Health IT (US), speaking at CITRIS/TRUST EMR Workshop, April 28 2006, Berkeley CA.
 - [...] from a technology perspective – that’s when it gets really interesting, because it is not about a doctor using a keyboard – it is about [...] a streaming set of information that is flowing from a patients home, body, etc to allow people to be empowered and autonomous at home and not in a nursing home.”

The ITALH System

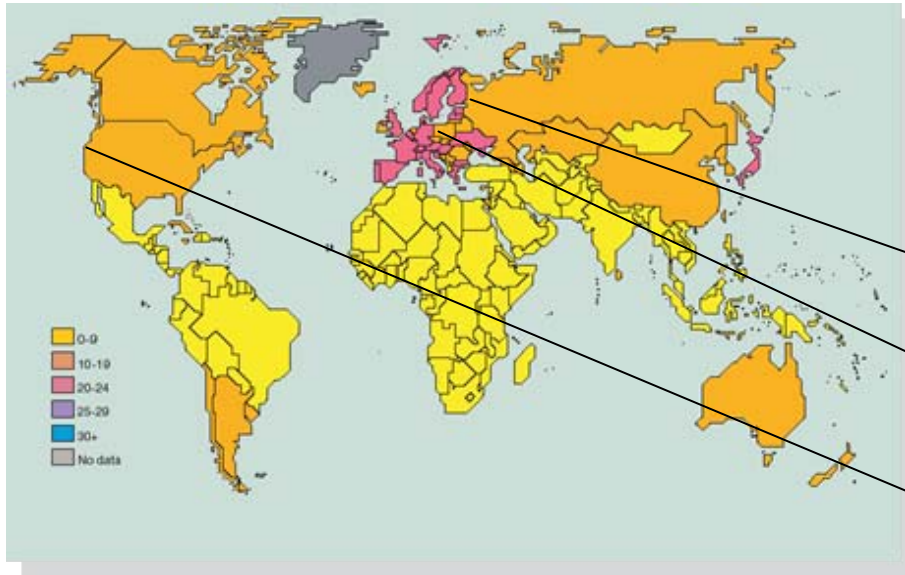
Individual sensor system development



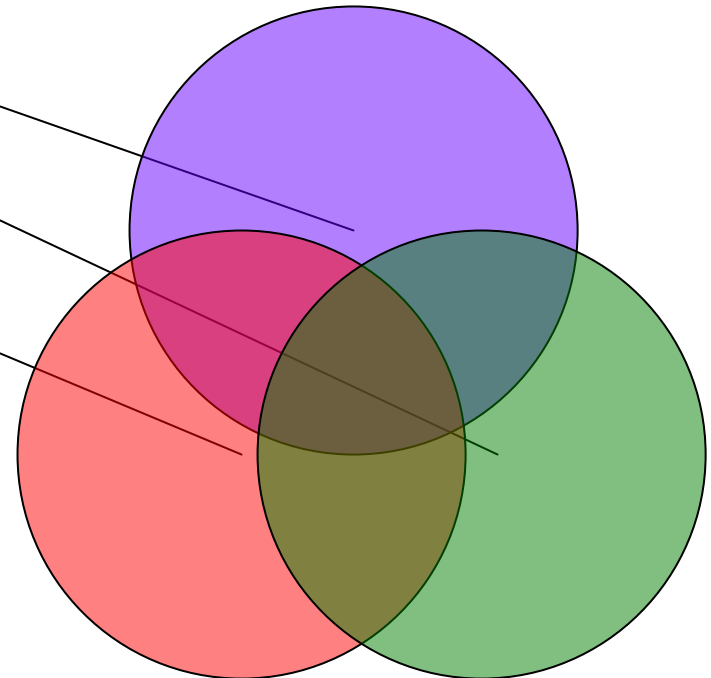
Integration into Electronic Medical Records

Sensor and data fusion, communication issues

The ITALH team



Finland (Tekes, TUT, HUT)



An international collaboration with mutual interests in technology and applications in HIT.

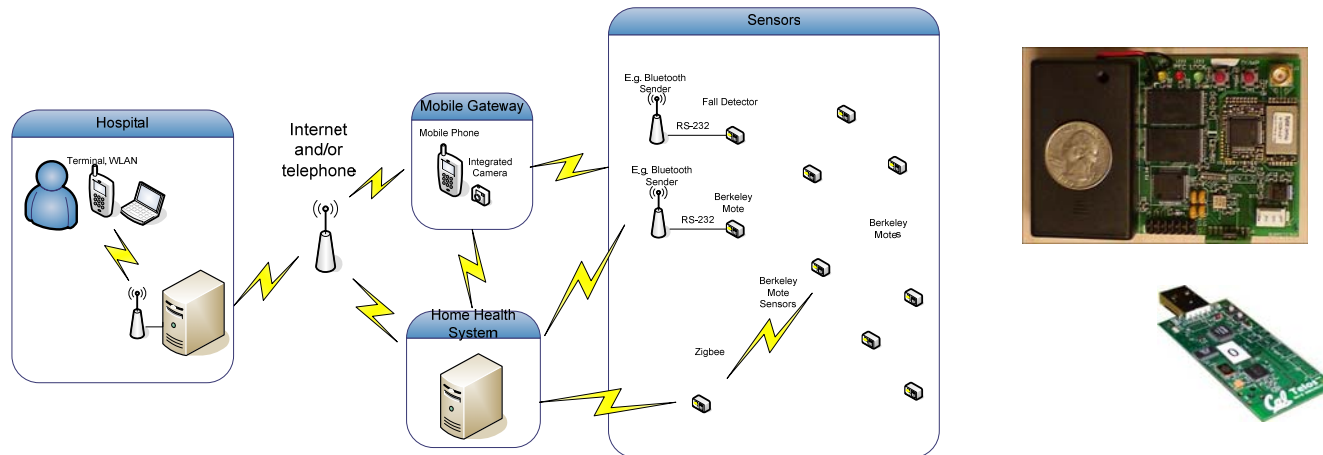
USA (Berkeley, TRUST)

Denmark (Aarhus)

Telecom Italia

Integration of sensor systems to EMRs

- Part of the Team for Research in Ubiquitous Secure Technology (TRUST) EMR Project
- Using ITALH as a testbed
- Biomedical sensor systems
 - Can monitor for acute and chronic conditions and emergency events
 - Is it necessary to store the data in an EMR?
 - Is it useful to do so? Would it provide medical benefit?

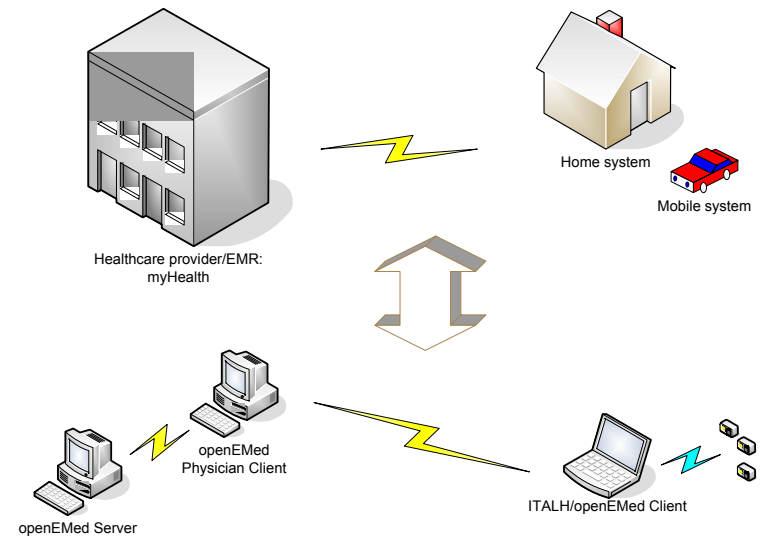


What are the possible benefits of including this data in an EMR?

- Currently entry requires manual intervention by health care provider
- Most data is not used nor stored for analysis
- Could provide significant diagnostic ability, and improved care
 - E.g. for osteoporosis, where a clear negative correlation has been shown between activity level and bone density loss
 - E.g., currently, pre- and post-operative evaluations are at best snap-shots of the patients conditions

ITALH/EMR Development

- Protocols and policies must be established for the inclusion of automated data collection
 - This will be integrated with the Vanderbilt myHealth system following initial development
 - A test system is being developed to integrate the ITALH testbed with an open source EMR system
 - Using volunteers in Berkeley and Sonoma

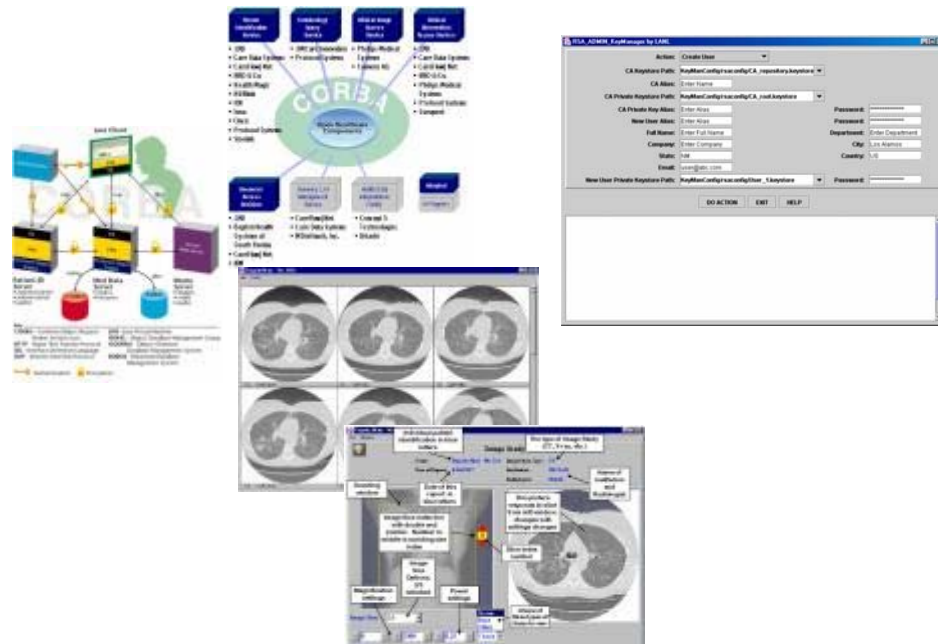


Current Work: ITALH and SUPERB

- Summer Undergraduate Program for Engineering Research at Berkeley (SUPERB)
 - Local EMR - OpenEMed
 - Camera-based motion sensors and tracking system
 - I/R motion sensor system
- Ongoing ITALH work
 - TUT biometric sensors
 - HUT/Elsi Technology Oy for tracking and biometrics
 - UCB IVY Fall Sensor

OpenEMed

- An open source EMR system
 - It has been used a live systems
- It will provide the local testbed

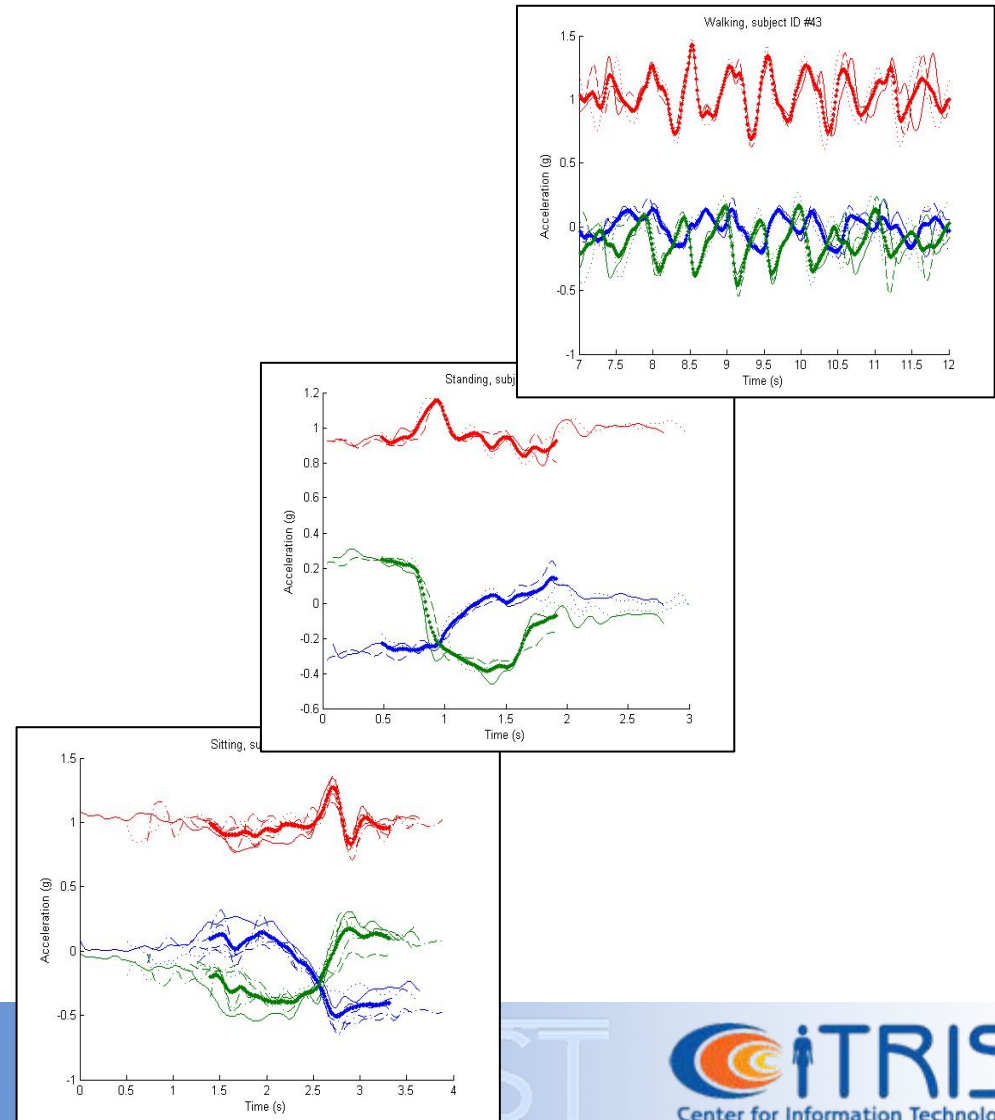


ITALH initial and secondary results

- Initial focus of sensor development: Fall Detection
 - Falls are the leading cause of fatal and nonfatal injuries to older people in the U.S.
 - Each year, more than 11 million people over 65 fall – one of every three senior citizens
 - Treatment of the injuries and complications associated with these falls costs the U.S. over 20 billion annually
- Secondary information that has resulted:
 - The devices reveal additional information about the user
 - This provides significant opportunities for health monitoring
 - It also creates a potential threat to the users privacy

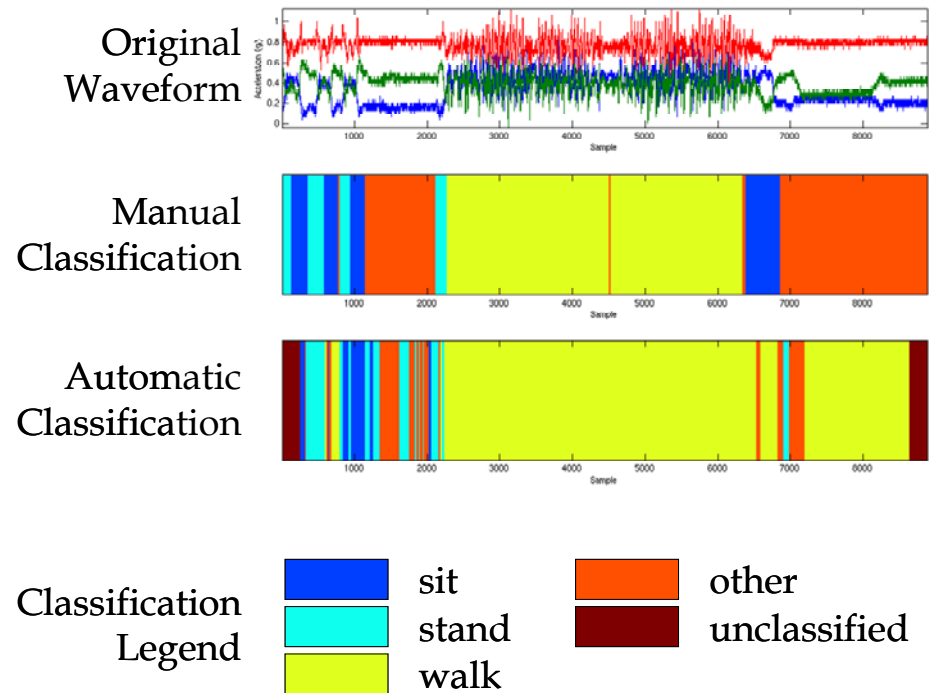
Identification of Activities of Daily Living

- Activity of Daily Living, e.g.
 - Standing
 - Sitting
 - Walking
- Being able to measure and analyze a patient's activity, enables:
 - Rapid and automated response to critical and emergency situations
 - Potential for improved diagnosis and treatment:
 - Diabetes, for example



Support Vector Machine Classifiers of ADL

- Boosted SVMs combined with HMM for classification of sit, stand, walk
- Good results, but we will use other sensors for redundancy and better accuracy



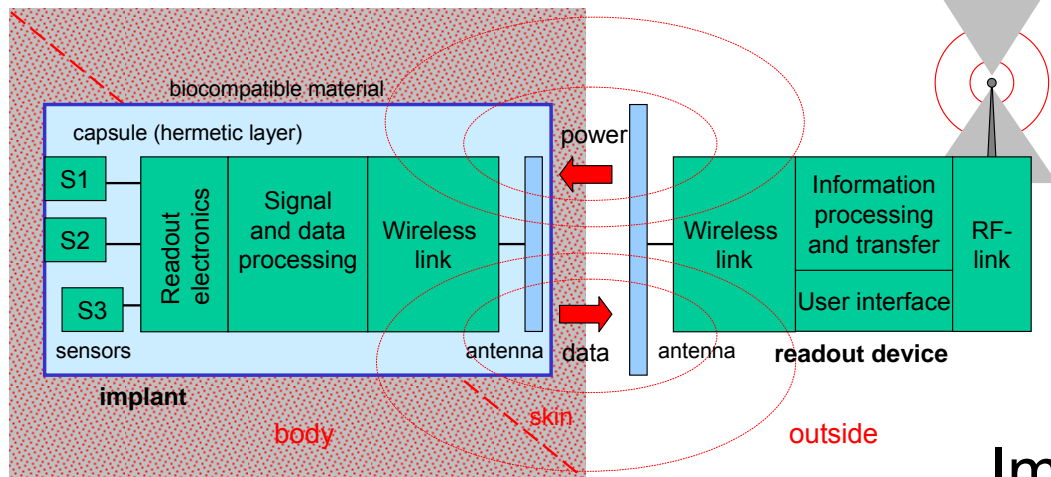
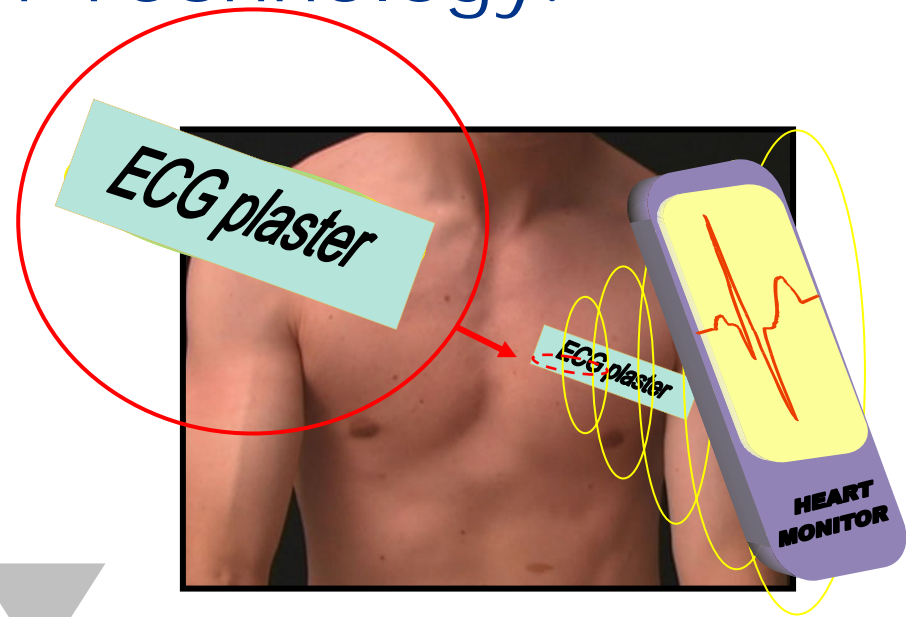
(Todd Templeton, UCB)

Implications

- This potential can only be realized on a societal scale if they are integrated in the EMR systems, so that:
 - Data acquisition is at least semi-autonomous
 - The data can be guaranteed to be accurate
 - The system is secure
- What does Security mean?
 - We must be able to assure the user of their privacy
 - Not limited to medical information
 - We must be able to assure data integrity
 - Other considerations: what if they withhold or provide false information?

Tampere University of Technology: Biometric sensors

Surface mounted

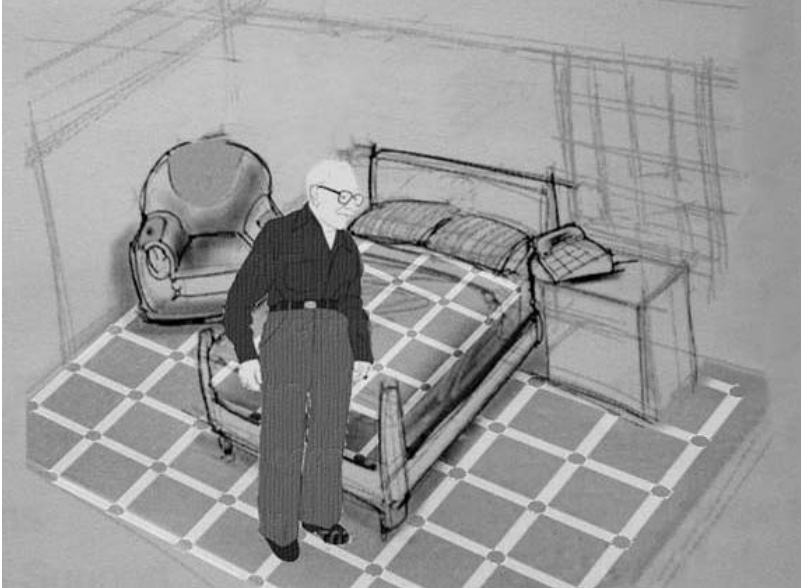


Implanted

(Jari Hyttinen,
Jukka Leikkala,
TUT)

Elsi Technologies Oy

Wireless service system for elderly people

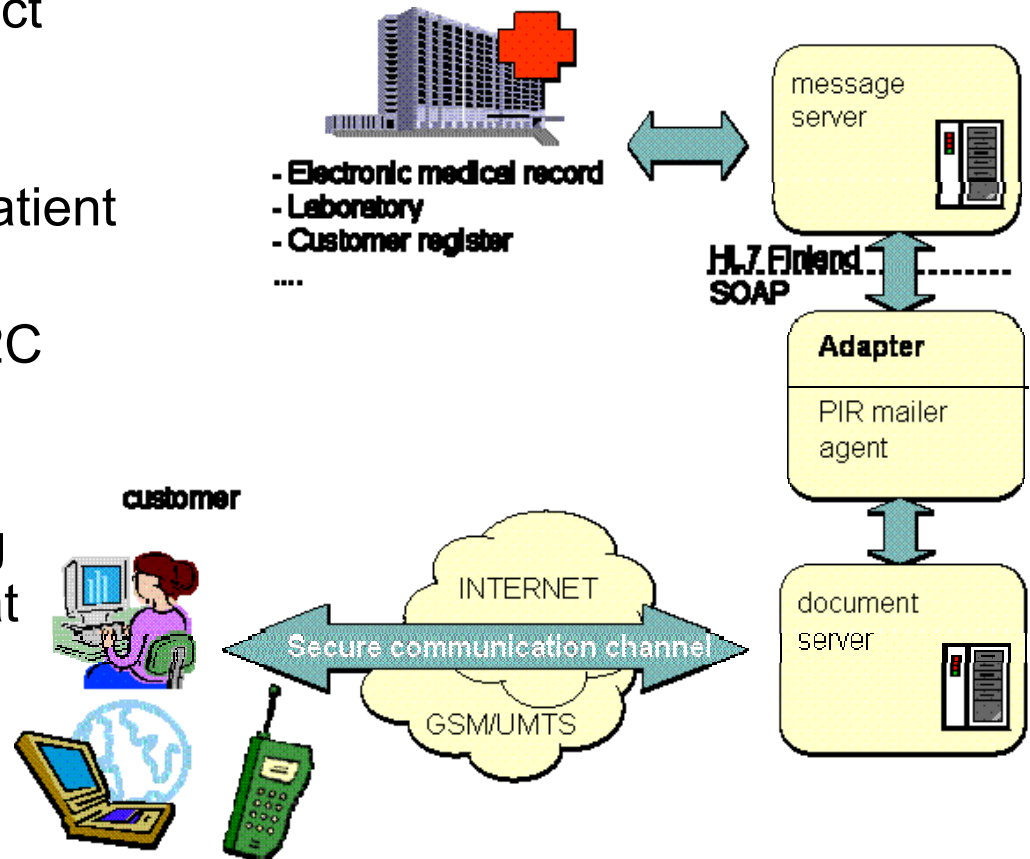


(Raimo Sepponen,
Vesa Kämäräinen,
Antti Alho,
HUT/Elsi Tech)

- New scalable service platform for monitoring and control
- Consists of transducer sensor elements (installation under the floor covering), sensor controller electronics, a system unit and monitoring software
- A system to which many different service packages can be linked:
 - Location detection, Movement detection, Vital function (breathing and pulse) monitoring, Different alarms, House automation, Rescue plans etc.

VTT B2C Health Project

- The objectives of the project are:
 - Provide a customer document service for patient information systems
 - Develop a model for B2C health information
 - Provide easy-to-use concepts for performing health measurements at home



Conclusions

- TRUST EMR Project
 - Developing a testbed and protocols for directly including sensor data in EMRs
- The goal is to enable live, automated medical record entry from sensor systems
 - Home-based at first, clinical applications later
- This is an issue of international importance, and interest

CITRIS in Europe Workshop Session Two: Information Technology in Health Care

June 21, 2006: 9:15am - noon

Contact: [Mike Eklund](#)

We welcome you to participate in the Workshop on Information Technology in Health Care on day two of the CITRIS in Europe meeting (June 21, 2006).

The workshop will be chaired by Thomas Rundall of the Center for Health Research at UC Berkeley and Esko Alasaarela of the University of Oulu and will focus on bringing together CITRIS and European researchers, health care providers and companies by identifying areas of mutual interest in the area of IT for health care.

Following an introduction by Thomas Rundall there will be presentations by John Hsu of Kaiser Permanente, Esko Alasaarela, Karita Ilvonen of Stanford University and Helsinki University of Technology, Mike Eklund of UC Berkeley, and Kevin Dawson of UC Davis

The main part of the workshop will be round table discussions with all the participants.

We welcome all interested attendees to actively participate in this workshop, and also to send us a one page position statement in the form of a Power Point slide that will be made available to all the attendees in a take home package and assembled into posters to be shown at the event. We ask that you use the provided template [\[here\]](#) and send it to the organizers [\[eklund@eecs.berkeley.edu\]](mailto:eklund@eecs.berkeley.edu) on or before June 14th NOTE: Please feel free to send it after this date, we will try to accomodate if we can.

Questions?