

ADVANCED PERVASIVE COMPUTING

Lecture 1: Introduction to Pervasive Computing

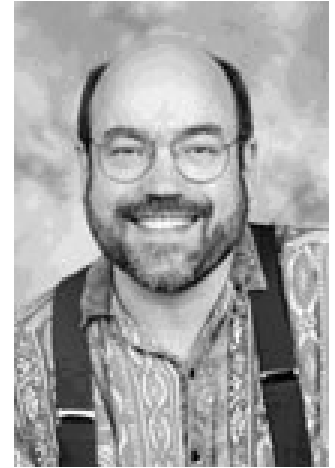
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AGENDA

- › Introduction to the course
- › Introduction to pervasive computing
- › Course agenda
- › Exercise: Video with debate

HISTORICAL BACKGROUND

- › **70's and 80's:**
- › focus on PC and GUI development
- › **Xerox PARC research into alternatives**
- › (Xerox PARC invented the PC and GUI/Windows)
- › **80's Mark Weiser introduces new paradigm**
- › Ubiquitous Computing (Weiser)
- › The Invisible Computer (Norman)
- › Next Generation replaces "Office Metaphor" / PC
- › Implosion: computers getting smaller
- › Explosion: interactive rooms, augmented reality
- › **"computere i alting" or "ting der tænker"**
- › **Today: also known as pervasive computing**



Mark Weiser (1952-1999)

COURSE INTRODUCTION

› **Builds on Applied Pervasive Computing (STAPC)**

- › STAPC topics include: novel interaction devices, basic context sensors, wireless sensor nodes
- › STAPC alternatives: smart phone programming, context aware computing

› **Advanced Pervasive Computing Topics**

- › Distributed Context Awareness
- › Intelligent Environments and Smart Spaces
- › Ubicomp User Interfaces
- › Probabilistic & statistical modeling & estimation methods, positioning of persons and autonomous entities
- › Multi sensor fusion, e.g. for reducing the amount of data while preserving the inherent information

› **Project Work**

- › Group size: 2-4
- › A range of weekly exercises

› **Exam**

- › Oral examination 7-scale external examiner

MARK WEISER DEFINITION

› Mark Weiser envisioned:

Ubiquitous computing is just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of *calm technology*, when technology recedes into the background of our lives.

Mark Weiser is the father of ubiquitous computing (1991).

[Mark Weiser, "[The Computer for the Twenty-First Century](#)", *Scientific American*, pp. 94-10, Sept. 1991]

What Ubiquitous Computing Isn't

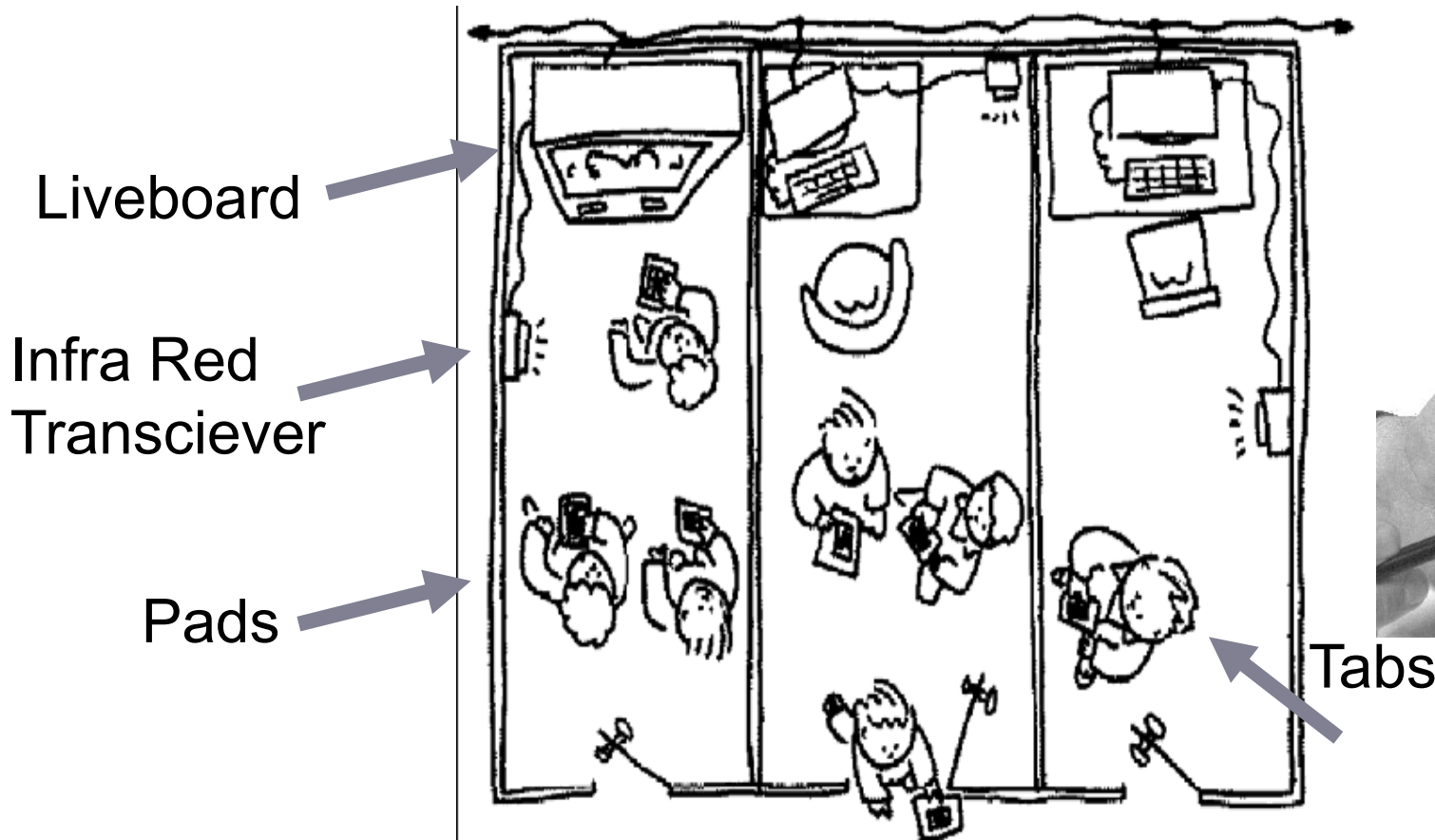
Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people. Virtual reality is primarily a horse power problem; ubiquitous computing is a very difficult integration of human factors, computer science, engineering, and social sciences.

Ubiquitous:

Being or seeming to be everywhere at the same time; omnipresent (DK: allestedsnærværende)

UBICOMP AT XEROX PARC

› At Xerox PARC – UbiComp was Implemented



UBICOMP AT XEROX PARC

- › **Tabs, Pads and Boards for interaction**
- › More natural interaction within context of work, rather than PC
- › **Wireless infrastructure, PAN / LAN / WAN**
- › Enabled data access “anywhere, anytime”
- › **Context awareness (Olivetti Research: Active Badge)**
- › Auto redirect phone calls and find people,
- › Auto “push” relevant data and application within new context
- › **Interaction Substrates (alternative interaction devices)**
- › Alternatives to mouse and keyboard: speech, hand typewriting

OTHER PROJECTS

- › **iLand**
 - › RoomWare, DynaWall, CommChair, InteracTable
- › **MIT Media Lab**
 - › Wearable computing
- › **Georgia Tech**
 - › Aware home and class room 2000
- › **Olivetti Research**
 - › Active Badges
- › **University of Karlsruhe**
 - › Smart-its
- › **HP**
 - › Cooltown
- › **Proces Data**
 - › The Intelligent Building



Steve Mann's "wearable computer" and "reality mediator" inventions of the 1970s have evolved into what looks like ordinary eyeglasses.



(a)
1980



(b)
Mid 1980s



(c)
Early 1990s



(d)
Mid 1990s



(e)
Late 1990s

PERVASIVE COMPUTING

- › **Term more frequently used today than Ubiquitous**
- › **IBM - Pervasive computing defined :**
- › “Pervasive computing describes access to information using new communications or networking technology. The technology implies computing power, freed from the desktop, extended to wireless handheld devices, automobile telematics systems, home appliances, and commercial tools-of-the-trade.”
- › **Important aspects:**
- › Mobile Computing / Embedded / Distributed Computing
- › Sentient Computing / Sensor Networks / Context Awareness
- › Implicit HCI / AI / Agent Technologies / Calm technology

Pervasive:

pervasive (spreading or spread throughout), **pervade** (spread or diffuse through), DK: gennemsyrende

RELATED TERMS

› **Tangible Computing**

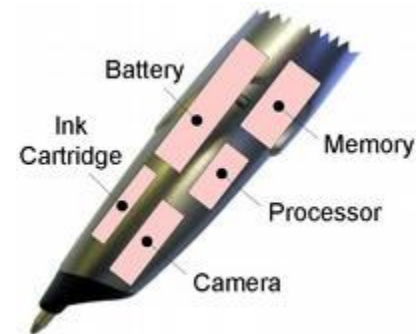
- › Interacting with the digital world through physical objects

› **Embodied Virtuality**

- › Same as Ubiquitous / Pervasive computing
- › Opposed to Virtual Reality

› **Augmented Reality**

- › Enhancing the "real world"
- › See-through displays with overlay graphics
- › Projecting digital images on surfaces
- › Digital Pen / Digital Paper



PERVASIVE COMPUTING TOPICS

The main pervasive computing topics today is:

1. Location awareness (pervasive positioning)
2. Context awareness
3. Activity recognition
4. Smart objects (Internet-of-Things and intelligent devices)
5. Automated capture and access
6. Natural interfaces / continuous interaction / everyday computing / invisible computing / calm technology
7. Smart spaces / Intelligent Environments



ENABLING TECHNOLOGIES

- › **Mobile**
- › **Distributed**
- › **Sentient / Context-aware / Ambient = Sensors**
- › **Embedded**
- › **Novel interaction types**
- › intelligent environments, smart spaces

MOBILE COMPUTING

- › **Key element of concurrent Pervasive Computing discourse**
- › **One of the most mature ubicomp technologies**
- › **Using tablets, smart phones to access the “overall information space” anytime / anywhere**
- › **Relies on Distributed Computing for infrastructure**
- › PAN / LAN / WAN technologies
- › IrDa, ZigBee, Zwave, WiBree, Bluetooth, WiFi, GSM/GPRS/UMTS/LTE
- › Middleware: CORBA, Web services, Java RMI, .NET Remoting
- › **Challenges:**
- › Range and coverage, Battery life, Bandwidth, Security,
- › Limited user interface, limited processing power,
- › COTS availability, cost

SENTIENT COMPUTING

› **Related concepts:**

› Sensor Networks & Context/Location Awareness

› **Using sensors to make devices aware of the current context**

› Hospital bed “senses” which patient is in the bed

› Mobile device can “sense” a patient

› **Enabling Technologies**

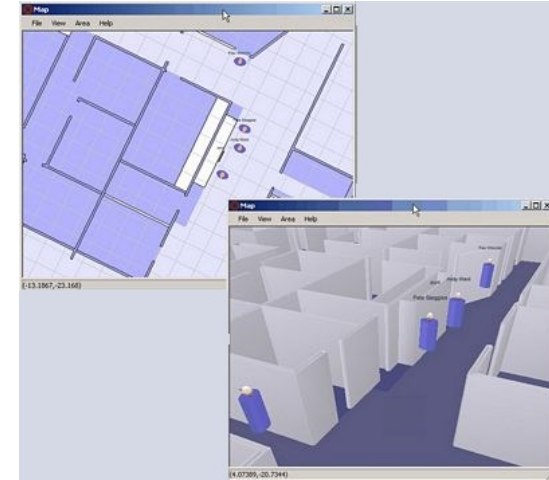
› Sensors collecting data, movement, temperature, blood pressure,

› RFID / NFC / SemaCodes / Barcodes for identification,

› Bluetooth, WiFi, (UWB) for local positioning,

› GPS, GSM triangulation, for global positioning

› JCAF: Java Context Awareness Framework



CONTEXT AWARENESS

- › Equipping the embedded devices with intelligence
 - › Modeling and reasoning of data using filtering and classification methods
 - › Kalman filtering, Monte Carlo Markov, Bayes classifiers, Hidden Markov Models, Neural Networks ...
- › Devices understand what is expected of them and reacts
 - › Devices must be able to differentiate what is expected of them
- › Sensor fusion
 - › More than one sensor needed. GPS + accelerometer + gyrometer + magnetometer

UBICOMP USER INTERFACES

- › Present day user interfaces inadequate
 - › - fixed computers with keyboards and mouse
 - › - phones and tablets also have their limitations
- › Do you always carry your phone or tablet?
 - › - in the shower? ... or to the toilet?
 - › - in the kitchen while cooking? To the pig pen?
 - › - while driving, eating, training, sleeping, relaxing?
- › New class of alternative UI devices needed
 - › - smart watches, voice recognition, intelligent surfaces (walls, doors, tables)
 - › - face/eye tracking, hand gestures
 - › - implicit interaction (getting up from the couch or the bed will turn on the light), intelligent floor, movement sensors



INTELLIGENT ENVIRONMENTS



UBICOMP SYSTEMS ENGINEERING

› **Often extremely complicated**

- › Novel usage models and interaction paradigms
- › Difficult to design, implement, and evaluate
- › Uncharted territory and cutting edge technology

› **Systems of systems engineering**

- › Consists of many different sub-systems and communication interfaces
- › Many heterogeneous technologies must be able to integrate
- › Sensor nodes, infrastructures, distribution middleware, gateway computers
- › Requires the use of standards as well as the use of efficient and open communication middleware

› **Pervasive Systems Engineering**

- › Novel field to consider, new methodology needed
- › Proof-of-concept prototyping

PERVASIVE SYSTEMS ENGINEERING

- › Main topics and challenges in UbiComp & Pervasive Systems
 - › 1) Resource constrained devices
 - › 2) Volatile execution environments
 - › 3) Heterogeneous execution environments
 - › 4) Fluctuating usage environments
 - › 5) Invisible computing
 - › 6) Security and privacy

PERVASIVE HEALTHCARE

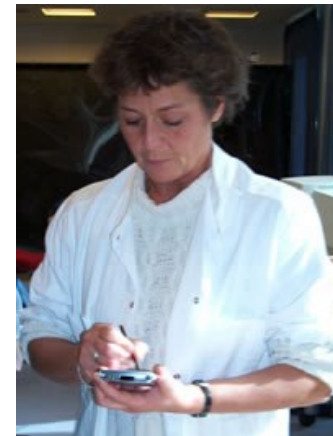
› Emerging Discipline

› Elements from

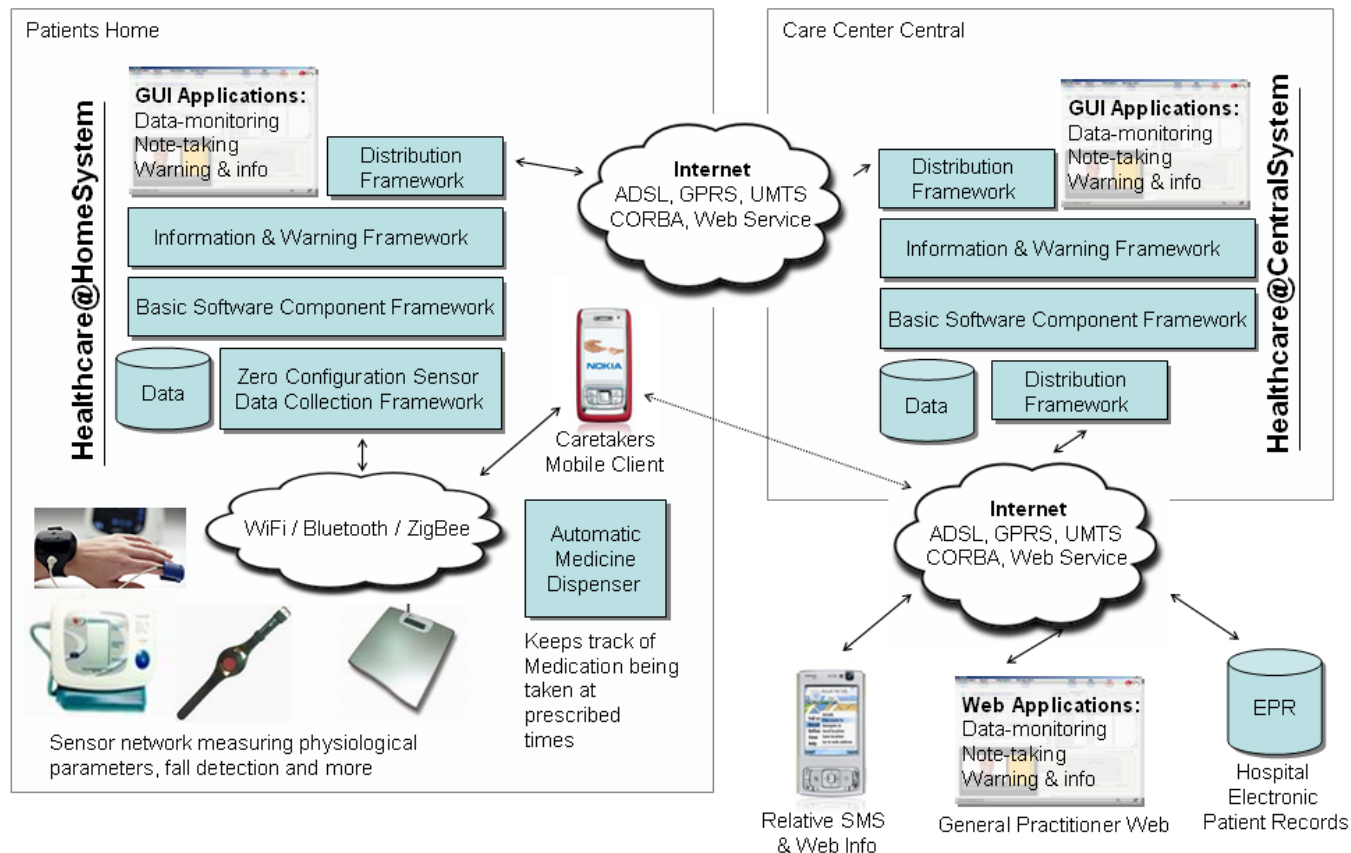
- › Pervasive Computing
- › Telemedicine
- › Bio Medical Engineering
- › Medical Informatics

› Pervasive Healthcare

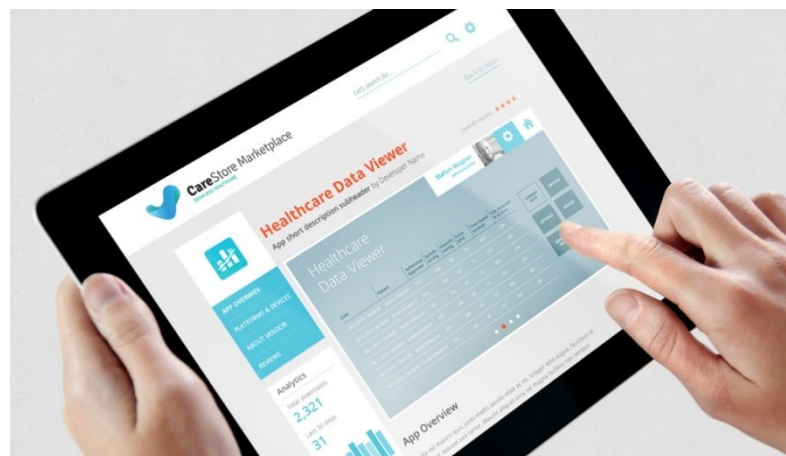
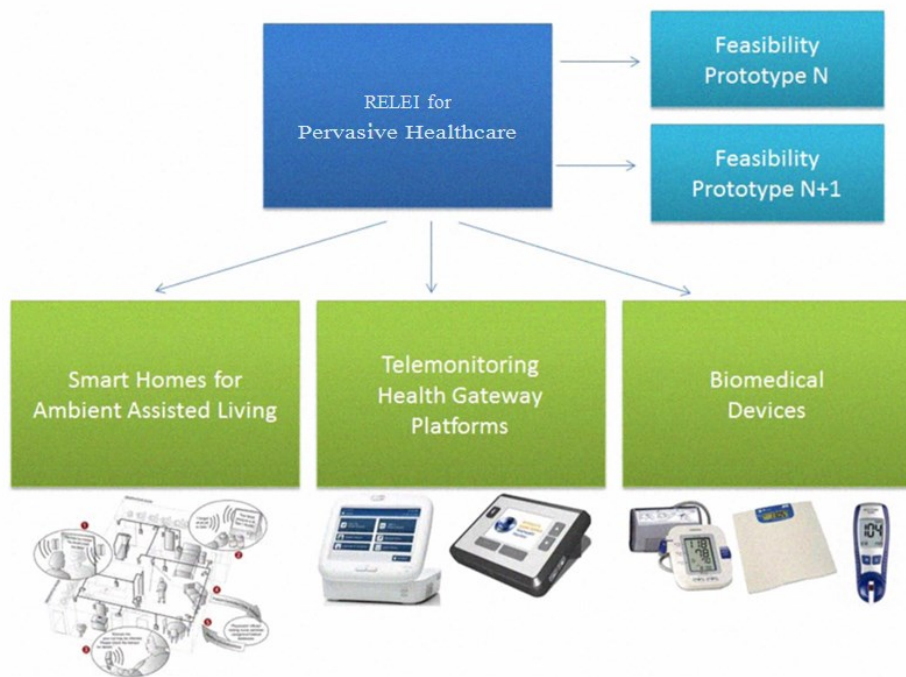
- › Home setting
- › Clinical setting



PERVASIVE HEALTHCARE AT HOME



OPENCARE – CARESTORE - RELEI



OPENCARE - VALIDAID

- › Record blood pressure of pregnant women at week 12 scanning
- › Context-aware user interface
- › Tagging of context data
- › Use of Artificial Neural Network classifiers for recognizing speech
- › Use of first order logic for rest and posture of patient



CARESTORE



Stefan Wagner
Administrator



09:39 :57 torsdag

23 januar 2014

Login success! Welcome to your CareStore Dashboard



HealthDataViewer App



Manual Data Input App



Marketplace

CARESTORE

Healthcare Data Viewer

Stefan Wagner

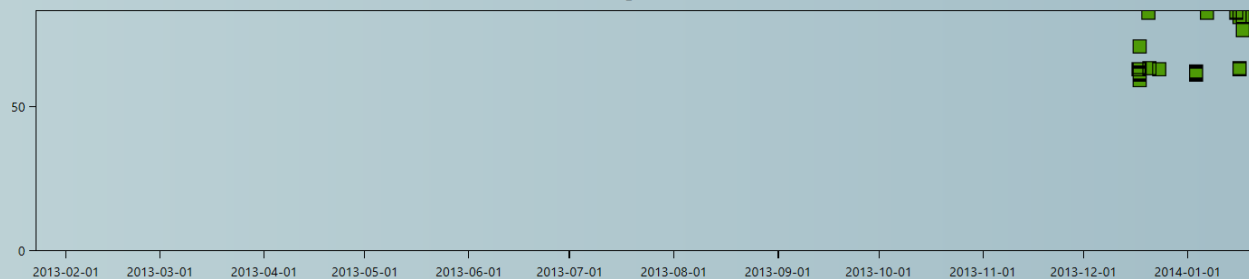
Administrator



Weight

Time	Weight
16-01-2014 12:45:37	62,9kg
16-01-2014 12:45:27	62,8kg
16-01-2014 12:45:17	63,2kg
16-01-2014 12:45:07	63,2kg
16-01-2014 12:44:57	63,2kg
16-01-2014 12:44:47	63,2kg
16-01-2014 12:44:37	63,2kg
15-01-2014 13:40:20	83kg

Weight Chart



Weight

Blood Pressure

Glucose

Saturation

Year

Month

Week



COLUMN CLINICAL LOGISTICS



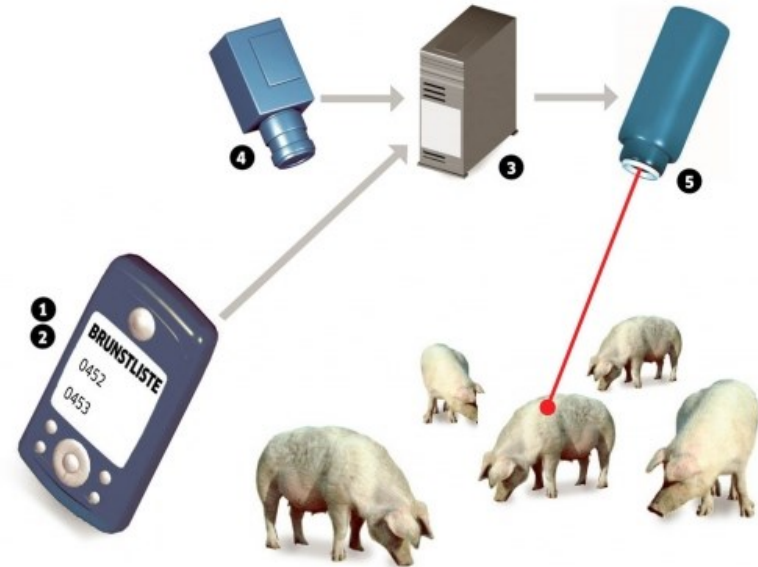
PERVASIVE AGRICULTURE

- › **IIOSS Project**
- › **2013 EU Requirement**
- › **Help needed:**
 - › Identification
 - › Pin-pointing
- › **Additional:**
 - › Behavioral tracking
 - › Weight measurement
 - › Disease and wound identification
- › **The barn as an intelligent environment**



IIOSS TECHNOLOGIES

- › RFID (active and passive)
- › Camera / Signal processing
- › Laser / projector
- › PDA, cell phone,
- › Speech, Gesture, Laser
- › Infrastructure: LAN, WiFi, Bluetooth, GPRS
- › TinyOS Sensor Nodes
- › 802.15.4
- › Accelerometer
- › Temperature



PERVASIVE FIREFIGHTER

› Enhanced communication with smoke divers during operation:

- › Arm wrist based tablet
- › Radio communication

› Positioning:

- › GPS
- › Dead reckoning
- › Intelligent maps

› Physiological

- › Heart rate, respiration, and temperature sensors

› Status and location transmitted

› Data shown real time

- › arm computer
- › fire truck computer
- › recorded for future use



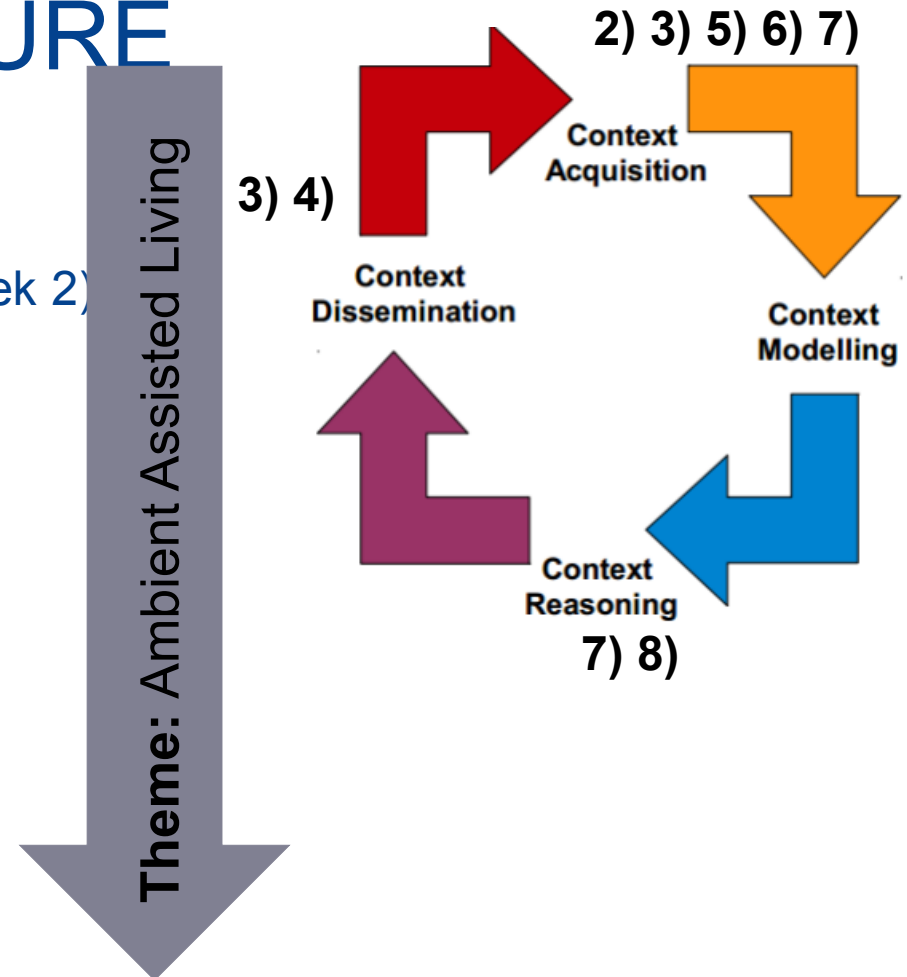
COURSE STRUCTURE

› Topics

- › 1) Introduction (week 1)
- › 2) Distributed Context Awareness (week 2)
- › 3) Intelligent Environments (week 3)
- › 4) Ubicomp User Interfaces (week 3)
- › 5) Activity Classification (week 3)
- › 6) Zero Configuration (week 4)
- › 7) Localization (week 4-5)
- › 8) Multi sensor fusion (week 6-7)

Oral Exam

time
↓



EXERCISE

- › **Watch the following videos**
- › **Note which technologies are used**
- › **Discuss in groups of 3-4:**
 - › Which elements in the videos uses pervasive technologies and concepts?
 - › How can we use these technologies to build intelligent homes?
 - › Use your findings to complete mandatory Exercise 1 on Campusnet

VISION VIDEOS

› **Microsoft:**

› <http://www.youtube.com/watch?v=os7myNIZRUA>

› **Continua Alliance:**

› http://www.continuaalliance.org/about-the-alliance/continua_vision_video

› **Intel Health guide video:**

› <http://www.youtube.com/watch?v=6u-bhsXd0OA>

› **Phillips Medication**

› <http://www.youtube.com/watch?v=j8Y4ukdNM60>

› **CareStore Project Vision**

› <http://vimeo.com/66053988>

› **Shimmer module:**

› <http://www.youtube.com/watch?v=Earu8WP-bM4&feature=channel>

EXERCISE 1

- › Write a half a page essay on the topics: a) what is pervasive computing?
b) which "enabling" technologies does it involve? c) what is your personal experience with pervasive computing projects and technologies? Hand-in via assignments on Campusnet as a personal essay.