Friedemann Mattern
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Computing: A Clear Trend

- One computer (mainframe) for many people
- One computer (PC) for everyone
- Many computers for everyone
“The Computer for the 21st Century”


„In the 21st century the technology revolution will move into the everyday, the small and the invisible…“
The Trends
1. Smaller, Cheaper, Faster

- Processing speed and storage capacity **double** every **18 months**
  - trend holds for about **50 years** now

- Exponential increase
  - will probably go on for the next **10 years** at same rate
Dr. Michael Beigl
Universität Karlsruhe
Institute for Telematics, Telecooperation Office

Prof. Dr. Dirk Timmermann
Universität Rostock
Institut für Angewandte Mikroelektronik und Datentechnik
2. Progress in Communication Technologies
3. New Materials
Consequences:
Smart Paper, Electronic Ink

E-Ink, 2001

Siemens, 2003
4. Better Sensors

- Miniaturized cameras, microphones, ...
- Fingerprint sensor
- Sensors for
  - temperature, humidity, acceleration, ...
5. Location

- Progress in technology
  - smaller, cheaper, more accurate

- More and more “smart” mobile objects
  - assets, devices, products, everyday objects, people

- New applications
  - e.g., never get lost, find valuable objects
Where Does All the Technological Progress Lead To?

- Wireless high-speed communication
- Better sensors
- New materials
- Item localization

Moore’s law

??
The Vision
The Vision

„In the 21st century the technology revolution will move into the everyday, the small and the invisible...“

Mark Weiser (1952 – 1999), XEROX PARC

- Small, lightweight, cheap, mobile processors and sensors
  - in almost all everyday objects („embedded computing“)
  - on your body („wearable computing“)
  - embedded in the environment („sensor networks“)
From an Internet of Computers...
To an Internet of Things?
Cooperating Smart Everyday Things?

When the **tooth brush** communicates with the **bathroom mirror**

- animated **cartoon** appears on the mirror
- brushing the teeth becomes a **computer game**, the tooth brush becomes a **joy stick**
- high-score lists, collect rewarding **points**, …

image source: Philips
How do we Interact with Disappearing Computers?
Dr. Albrecht Schmidt
Ludwig-Maximilians-Universität München
Institut für Informatik
Dr. Dr. **Norbert A. Streitz**
Fraunhofer-Institut für Integrierte Publikations- und Informationssysteme (IPSI)
Darmstadt
When the Smart Fridge Communicates with the Hall Mirror...

ANOTHER BEER, PLEASE, HAL...

I'M SORRY, DAVE. I CAN'T DO THAT. THE BATHROOM SCALE AND THE HALL MIRROR ARE REPORTING DISTURBING FLAB ANOMALIES
Prof. Dr. Lorenz M. Hilty
Eidgenössische Materialprüfungs- und Forschungsanstalt EMPA
St. Gallen
The Vision

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Wearable Computing
Prof. Dr. Gerhard Tröster
ETH Zürich
Wearable Computing Lab
Augmented Reality – Application Scenario
Prof. Dr. Alois Ferscha
Johannes Kepler Universität Linz
Institut für Pervasive Computing
The Vision

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Wireless Sensor Networks

- Embed into the physical world numerous distributed sensors
Wireless Sensor Networks

- **Embed** into the physical world numerous distributed sensors
- **Network** these sensors so that they can **coordinate** to perform higher-level tasks
Wireless Sensor Networks

- **Embed** into the physical world numerous distributed sensors
- **Network** these sensors so that they can coordinate to perform higher-level tasks
- **Monitor** the world and recognize relevant events and situations
Prof. Dr. Kurt Rothermel
Universität Stuttgart
Institut für Parallele und Verteilte Höchstleistungsrechner IPVS
Applications?
What If Everyday Objects Become Smart?

- What applications might then be possible?
- Implications on business?
Prof. Dr. Elgar Fleisch
Institut f. Technologiemanagement
Universität St. Gallen (HSG)
und
Department of Management,
Technology and Economics
ETH Zurich
Prof. Dr. Peter Welzel
Universität Augsburg
Lehrstuhl für Volkswirtschaftslehre
Prof. Dr. **Rolf Pfeifer**
Universität Zürich
Institut für Informatik
Implications?
Child Locators?

- „We'll map your child's location within feet and provide the closest street address“
- Privacy?
Endangered Societal Values?

- Freedom of expression
  - loss of privacy
- Self-determination, being in control
  - humans out of the loop in automatic procedures
- Dependability
- ...

Friedemann Mattern
F.Ma. 58
The Digital Revolution Reverses Defaults

- What was once **private** is now **public**
- What was once **hard to copy** is now **trivial to duplicate**
- What was once **forgotten** is now stored **forever**
Prof. Dr. Günter Müller
Universität Freiburg i. Brsg.
Institut für Informatik und Gesellschaft
Marc Langheinrich
ETH Zürich
Institut für Pervasive Computing
Prof. Dr. iur. Alexander Roßnagel
Universität Kassel
Institut für Wirtschaftsrecht (IWR) und
Forschungszentrum für Informationstechnik-Gestaltung (ITeG), Fachbereich Wirtschaftswissenschaften
Why Care About the Future?

“We should all be concerned about the future because we will have to spend the rest of our lives there”.

Charles F. Kettering
Why Care About the Future?

“We are always very bad at predicting how a given technology will be used and for what reasons”

Bran Ferren
A Better World?
Vlad Coroama
ETH Zürich
Institut für Pervasive Computing

Matthias Handy
Universität Rostock
Institut für Angewandte Mikroelektronik und Datentechnik
Living in a Smart Environment

- Consequences of Ubiquitous Computing
  - social, economic, privacy
  - everyday life, work, home,…

- What alternatives do we have when shaping a „smart“ world?

- Gottlieb Daimler- & Karl Benz Foundation
  - supported 7 groups (DE, CH), Jan 02 – Jan 05
  - scenarios, demonstrators, papers
  - discussions and discourses
Ladenburg Discourses
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