

Ambient Intelligence and Embedding Components: Application Viewpoints

Session # 1: Introduction to Ambient Intelligence

Dr. Kieran Delaney

Tutorial

Ambient Intelligence

Proactive interfaces supported by Ubiquitous computing & networking.

"Ubiquitous Computing is 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." - Mark Weiser

...everyday objects and places become 'infused' and 'augmented'...

... enrich everyday life simply and naturally...

the disappearing
COMPUTER

Concepts Infer Huge Sensor/Actuator Infrastructures for Full Realisation.

The Disappearing Computer Initiative



**Research Disciplines Are Converging To Make The
Vision Of Ambient Intelligence A Reality**

The Goal:

- To enhance everyday life through the implementation of global, electronics systems and *intelligent environments*.
- To provide proactive support to society through an interaction which is intuitive (cognitively invisible) to the user(s).
- To Provide Personalisation, Security, Privacy, and Continuity to each user through the implementation of appropriate *personal area networks*.
- To develop an intelligent electronics ecosystem which evolves dynamically in accordance with the changing needs of society.

Ambient Intelligence

Primarily Software and
Concept Oriented.

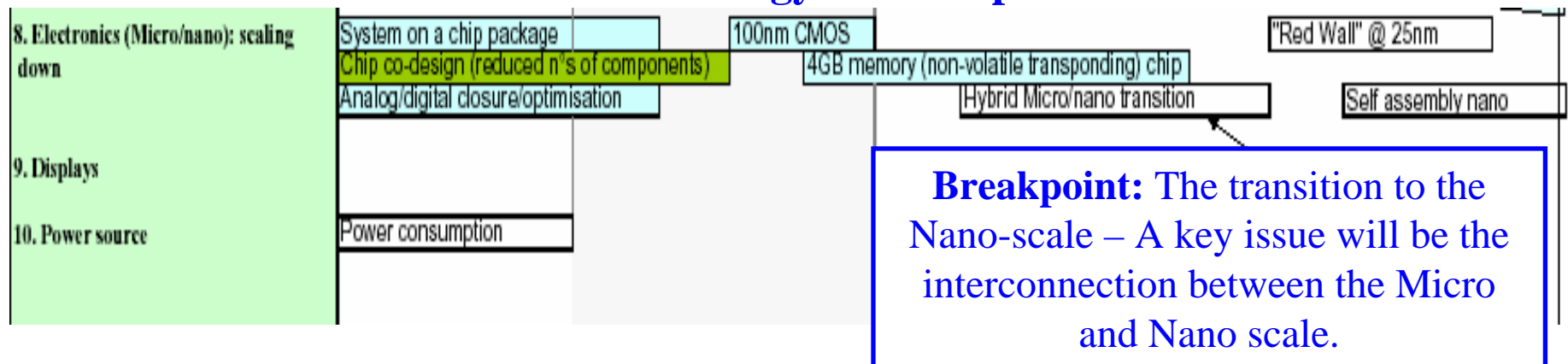
- Autonomic Computing (IBM)
- Amorphous Computing (MIT)

- Disappearing Computer
- Distributed Systems

- Smart Matter (PARC)
- Smart Dust (UC Berkeley)

It infers huge sensor and actuator infrastructures for full realisation of the concepts. Object-oriented thinking is predominant. (i.e. clothing, household items, cars, etc)

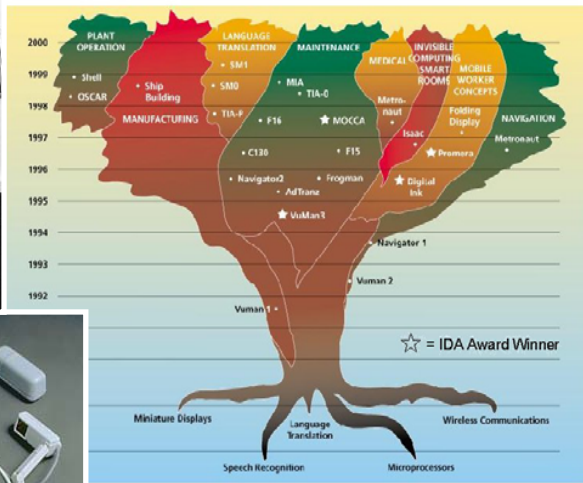
Technology Roadmap



Ambient Electronics

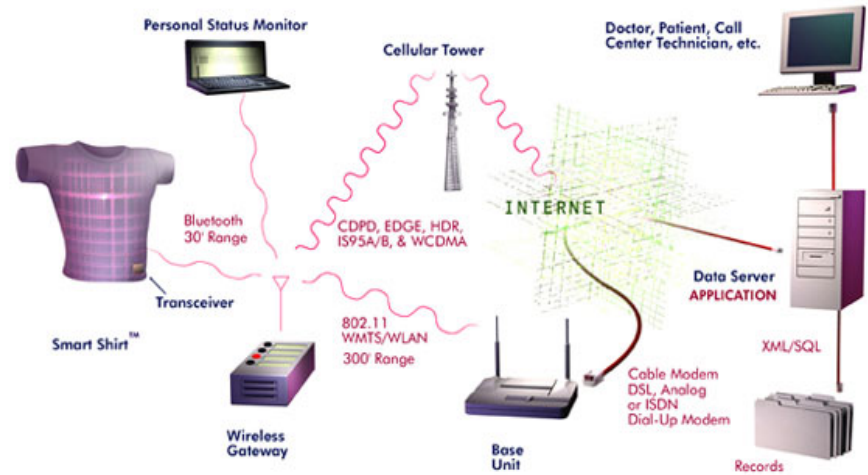


Family Tree of CMU Wearable Computers (by Operational Delivery Dates and Application Areas)

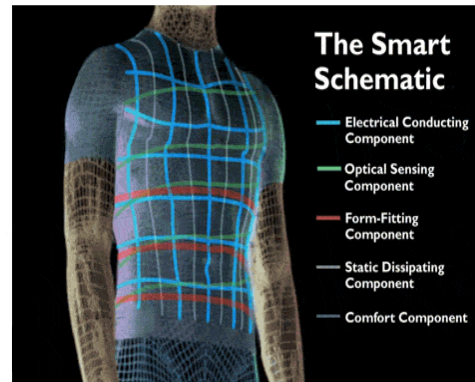


CMU: Vu-Man 1

Platform Implementation Combined Small Area & Wide Area Wireless Monitoring Application



MIT Media Lab



**Georgia Tech
(Sensatex)**

Philips



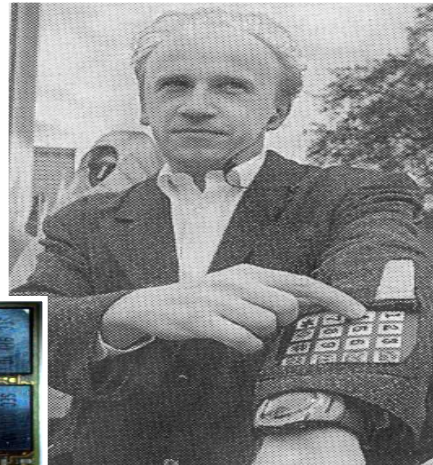
Circuits On Fabric



Philips / Levis:
"First Wearable"

ETH Zurich

**Steilman / ETH
Communications
Jacket
(AVANTEX 2000)**

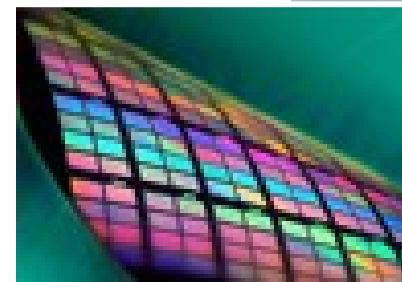


µblocks AG

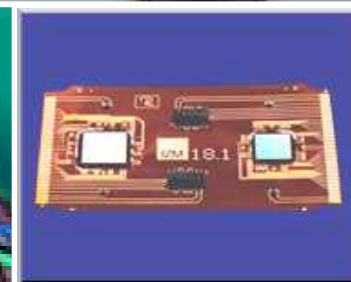


Fraunhofer IZM

**Wrist
Transmitter**

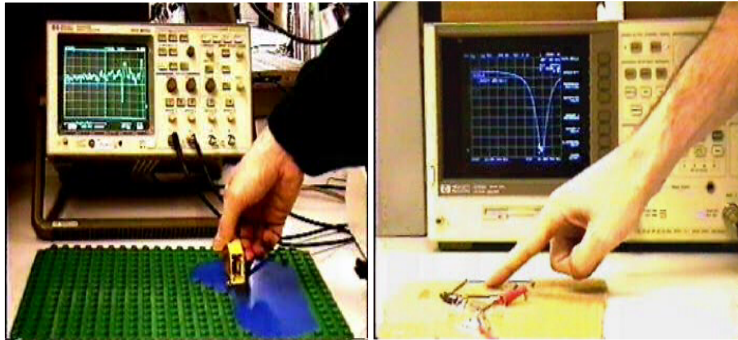


Wafer Thinning

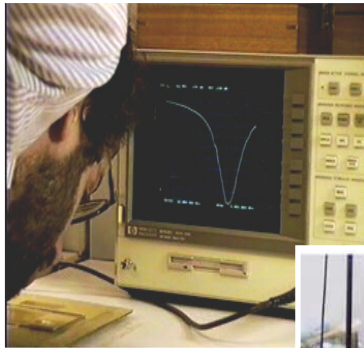


Flex

MIT-Medialab



**Pressure,
Orientation,
Temperature
Sensors
(Anti-clockwise)**



Sensor Necklace and Bed (Resp.)

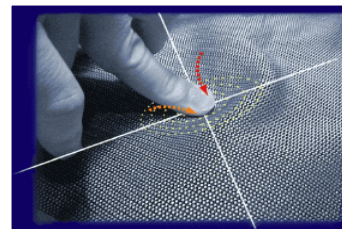
STARLAB



Charmed Inc.



ElekTex

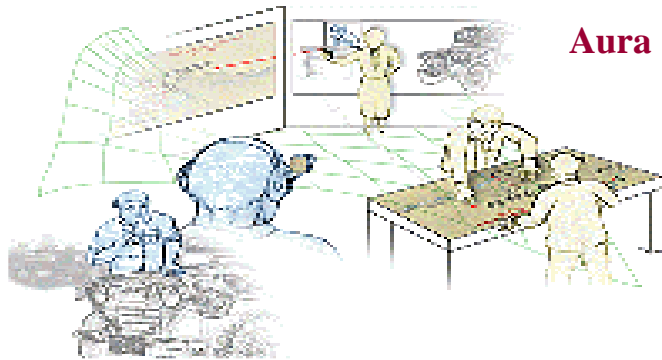


SONY



DataTiles: Modular Platform for Mixed Physical and Graphical Interactions

Carnegie Mellon University



Aura

Distraction-free Ubiquitous Computing

Georgia Tech



Future Computing Environments

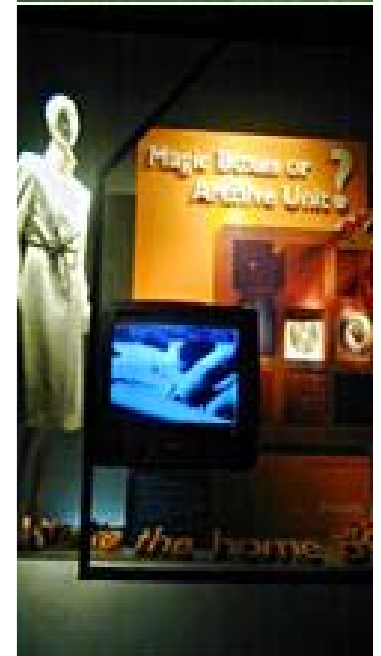
“Awareness Room”



MIT



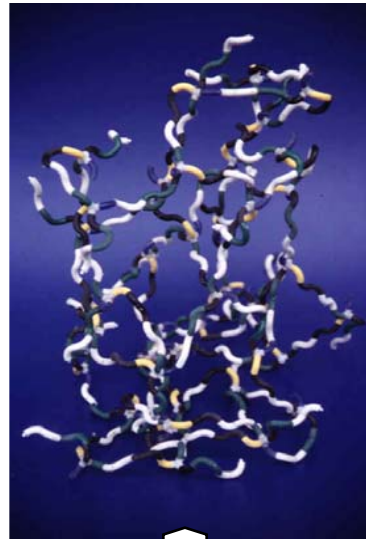
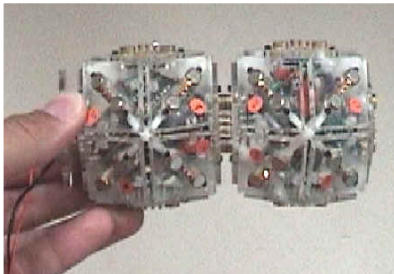
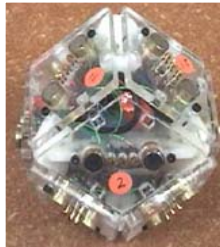
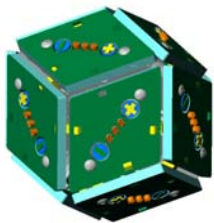
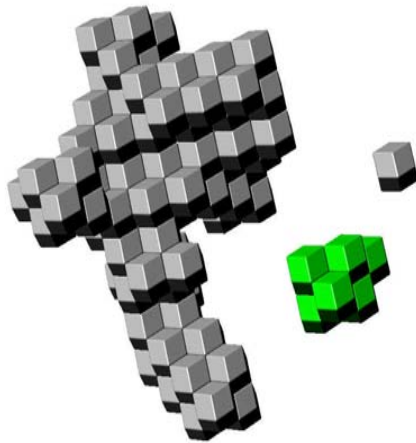
Philips



“The House of the Near Future”

Xerox Palo Alto Research Centre

Digital Clay

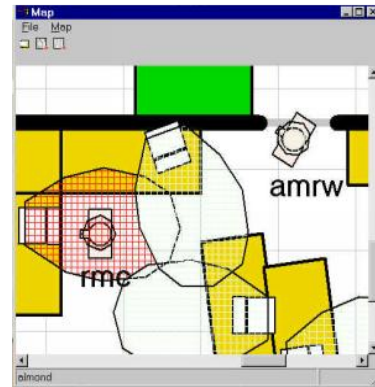
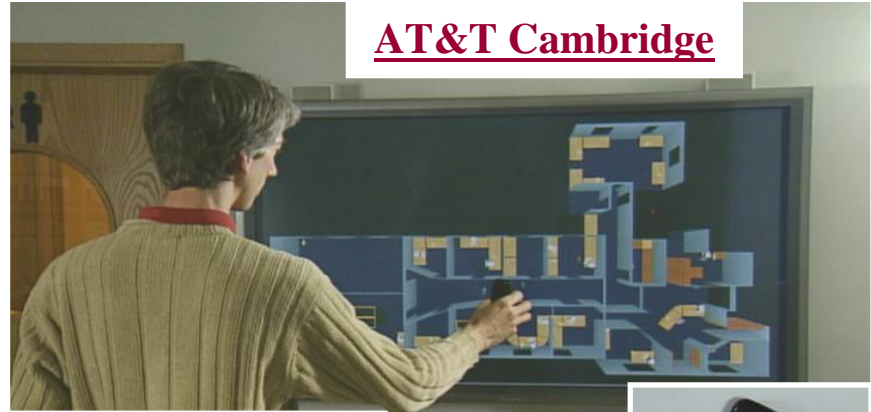


(Hard) Connection of Modules.

Assembly of Modules

Micro-Robots

AT&T Cambridge



Visualisation Controller



Deja Vu
+ smaller files, multi-page
- slower, needs plug-in

FEEDER
document is placed in the sheet feeder

GLASS
document is placed on the scanner glass

SCANNING COLOUR
LOW
+ quicker scan
- less detail
HIGH
+ more detail
- slower scan

SCANNING RESOLUTION
SCAN to hopper
SCAN to email
SAVE my selection





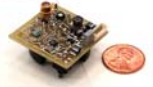

To use the sheet feeder push the document in face up with the lever in position A, then pull the lever to position B to secure the document.

To use the scanner glass place the document face down at the top right of the glass surface.

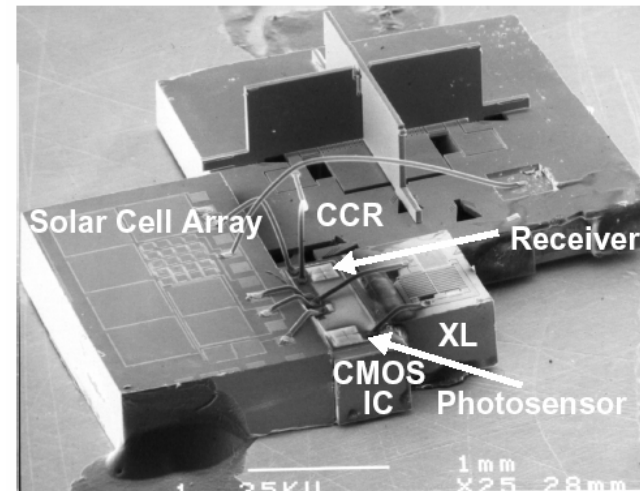
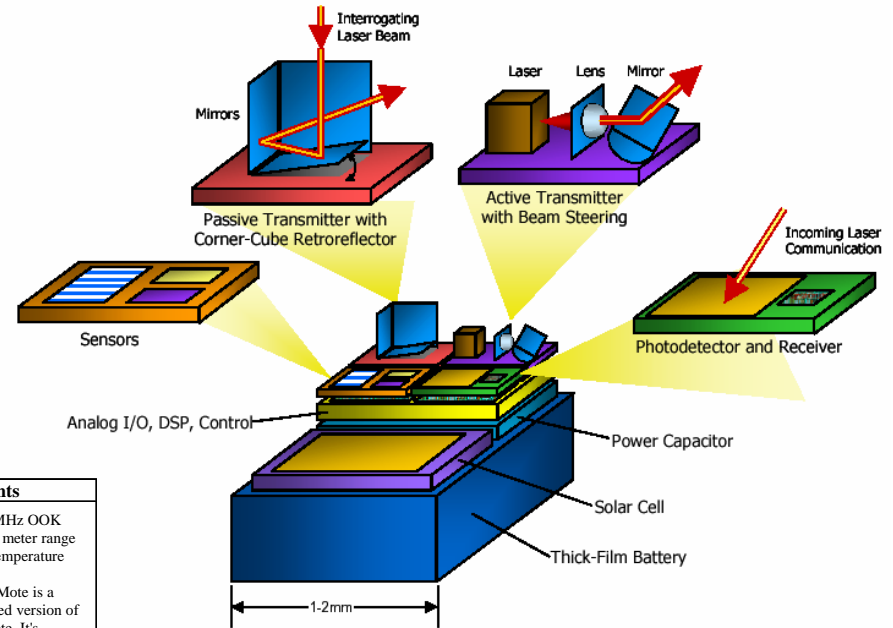
SMART DUST Program

K Pister (Berkeley Sensor and Actuator Centre)

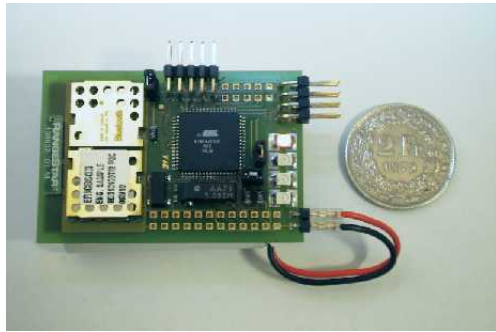
Platforms: Motes, Tiny OS, Tiny DB

Name	Picture	Comments	Name	Picture	Comments
RF Mote		RF 916.5MHz OOK 5kbps 20 meter range Sensors: 2 axis magnetometers, 2 axis accelerometers, light, temperature, pressure The RF motes' final design was finished in the early part of 1999.	Mini-mote		RF 916.5MHz OOK 10kbps 20 meter range Sensors: temperature The Mini Mote is a miniaturized version of the RF Mote. It's smaller size and simpler circuit design makes it both cheaper and easier to handle
Laser Mote		Laser Module: 3 mW optical transmission 150 mW electrical power. 10's of km range. Sensors: temperature, light, pressure, humidity	weC		RF 916.5 MHz OOK 10kbps 20 meter range Sensors: light, temperature
CCR Mote		Corner Cube Reflector/Light Receiver Communication. Range is function of the intensity of the laser. Sensors: temperature	IrDa		IrDA communication Sensors: temperature

Autonomous 16mm³ Solar Powered Node (June 2002)



Lancaster University, UK: Hans Gellersen



SMART-ITS

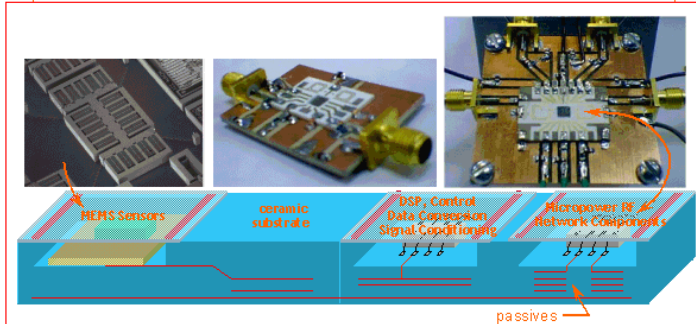


TEA (Technology Enabling Awareness)

The WINS Project at the UCLA *Wireless Integrated Sensor Networks*

LWIM LTCC Integration

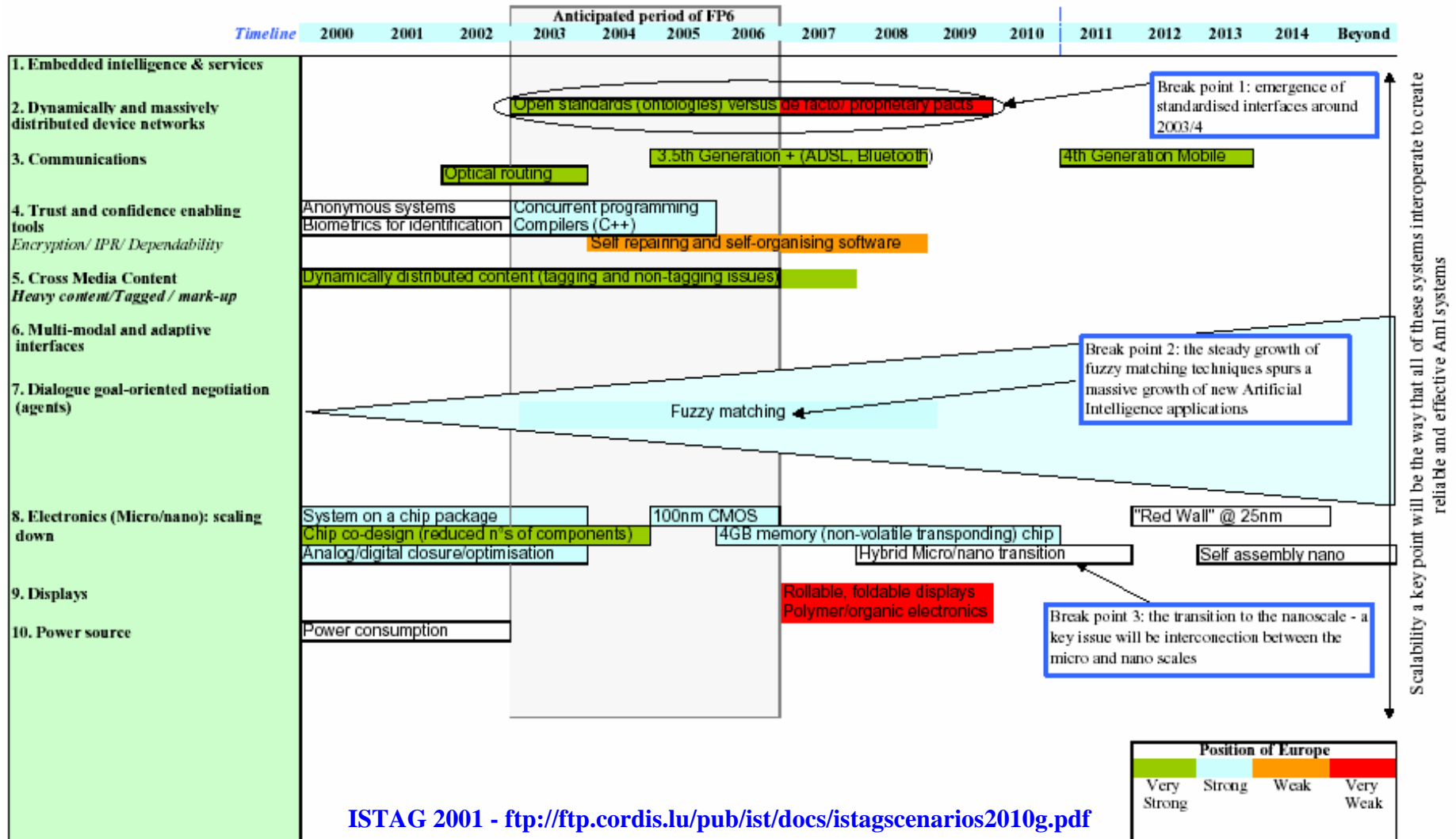
- LTCC: Low Temperature Co-fired Ceramic
 - low loss substrate
 - high quality RF passives
 - microsensor integration



MIT Media Lab

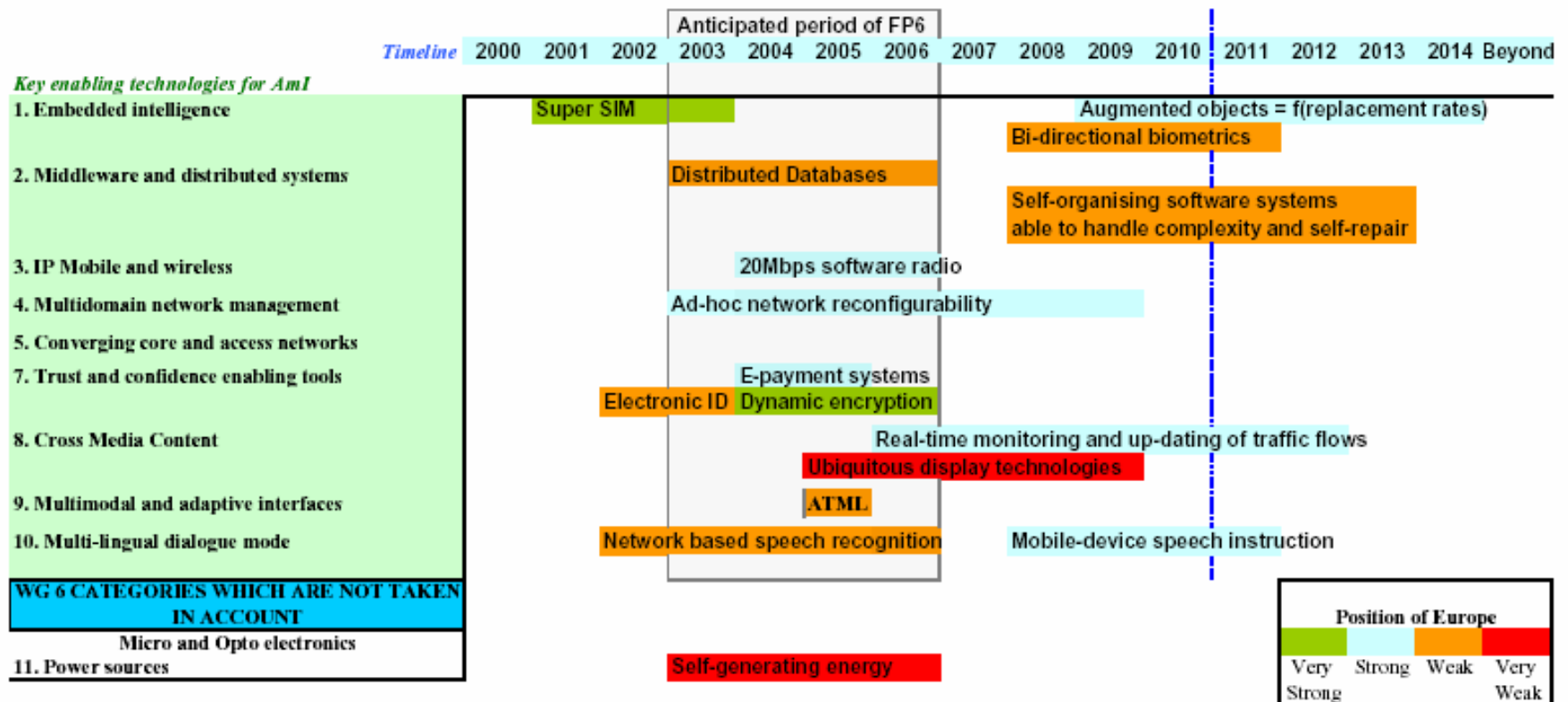
Amorphous computing:
randomly distribute a great number
of similar computing elements on
a surface or throughout a volume.

Generic Aml Techno line



Ambient Electronics

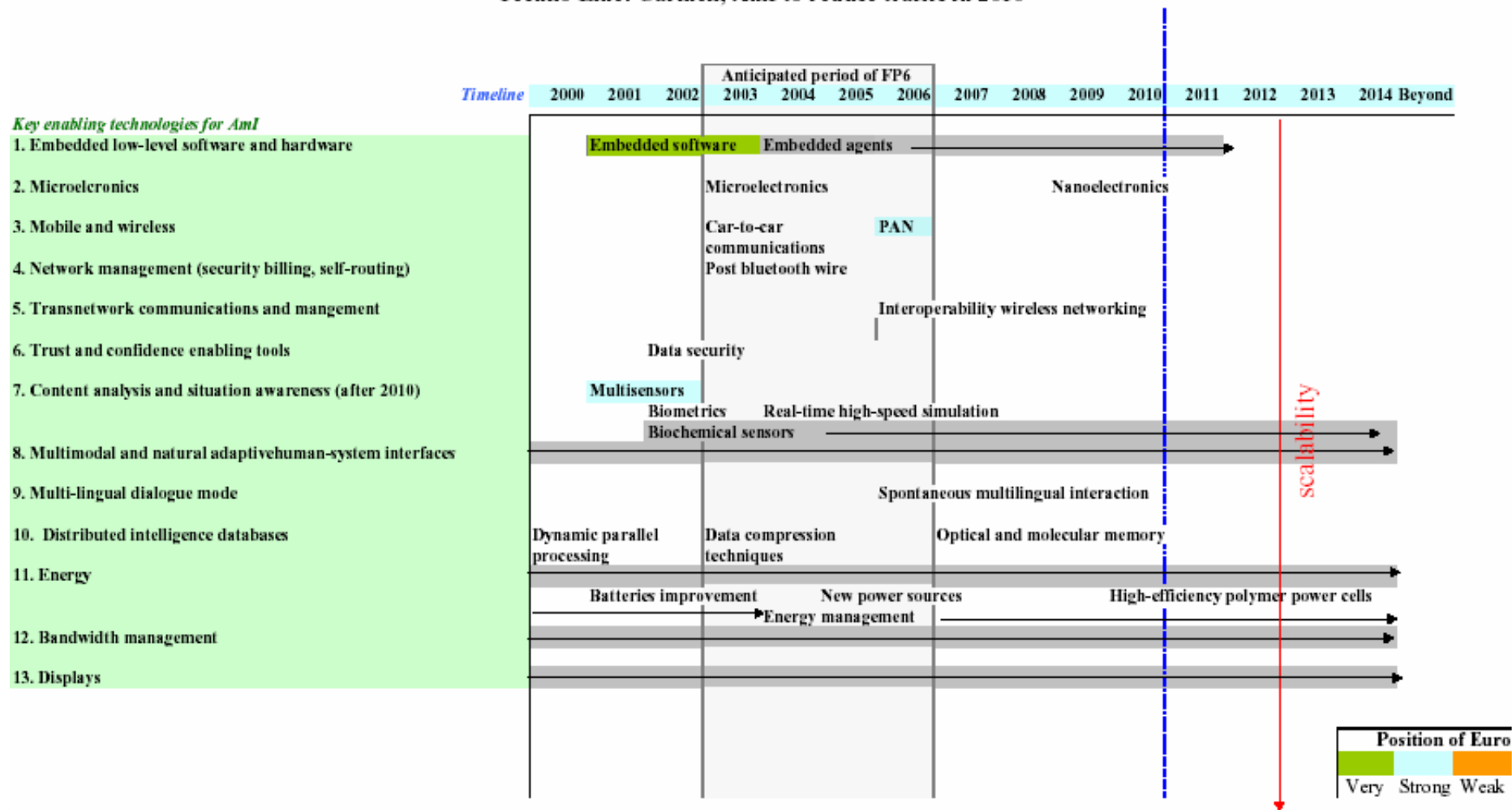
Techno Line: Maria, Road warrior in 2010



ISTAG 2001 - <ftp://ftp.cordis.lu/pub/ist/docs/istagscenarios2010g.pdf>

Ambient Electronics

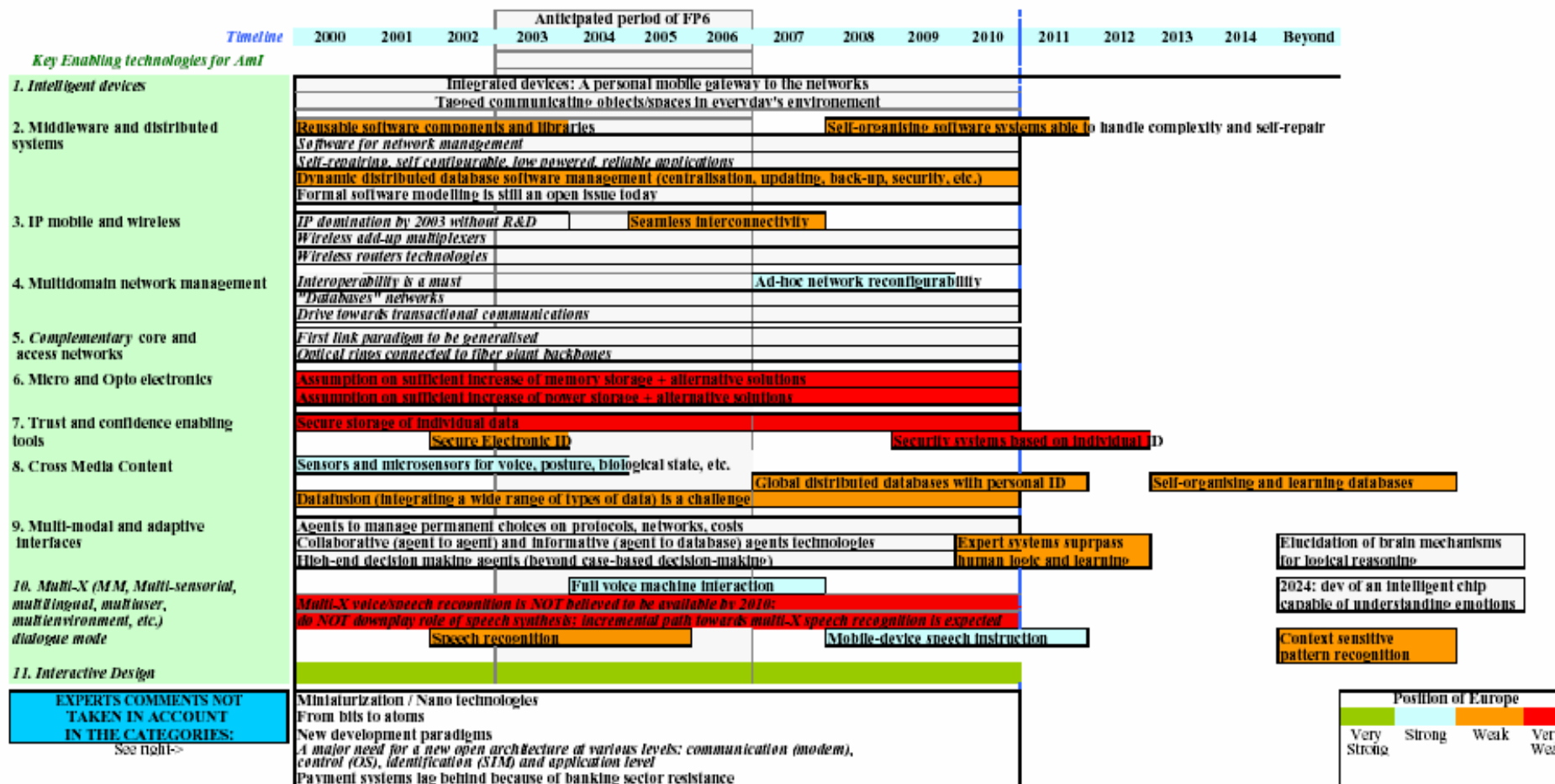
Techno Line: Carmen, AMI to reduce traffic in 2010



ISTAG 2001 - <ftp://ftp.cordis.lu/pub/ist/docs/istagscenarios2010g.pdf>

Ambient Electronics

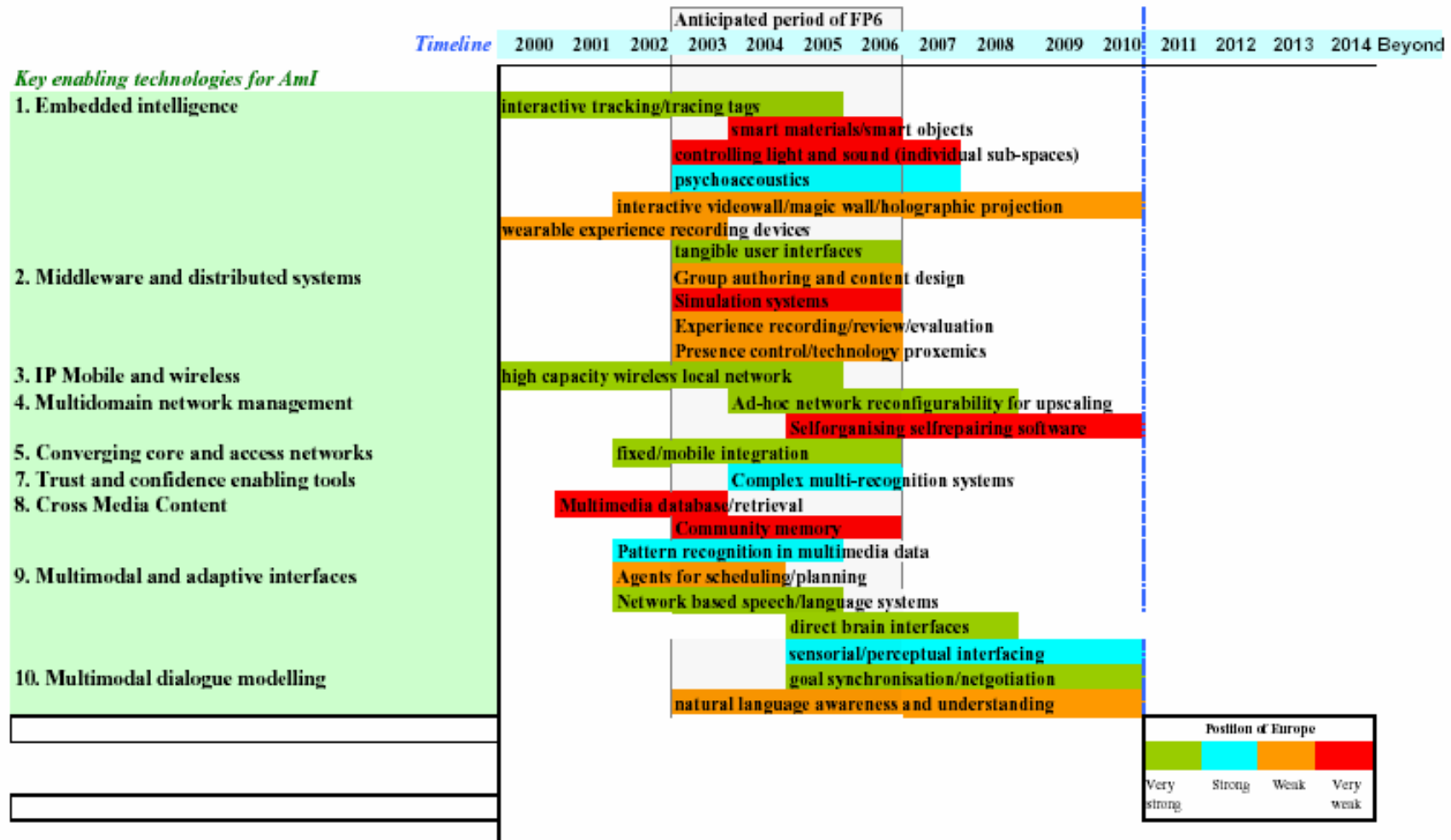
Techno line: Digital Me in 2010 (in italic are the elements derived from the December WS)



ISTAG 2001 - <ftp://ftp.cordis.lu/pub/ist/docs/istagscenarios2010g.pdf>

Ambient Electronics

Techno Line: Ambient for Social Learning



ISTAG 2001 - <ftp://ftp.cordis.lu/pub/ist/docs/istagscenarios2010g.pdf>

Ambient Electronics

The Ambient Intelligence Landscape

From a technological perspective, the concrete requirements for Ambient Intelligence are:

- Very Unobtrusive Hardware*
- Seamless Mobile/Fixed Communications Infrastructure*
- Dynamic and Massively Distributed Device Networks*
- Natural Feeling Human Interfaces*
- Dependability and Security*

The requirements for unobtrusive hardware contains a number of specific challenges, including:

- Self-generating power and micro-power.*
- Smart Surface, and New I/O Displays*
- Active Sensors and Actuators*
- Interfaces for User/environment perception and interaction*
- Smart materials that can change their characteristics.*
- Nano-electronics: nano-micro devices.*

Technology Challenges for Implementing Ambient Intelligence

Short-term Technology Issues (2005-2007)

Micro-sized software radio transceiver

Personal ID “key of keys”

Radio Bandwidth 20Mbps.

Wireless protocol interoperability

Flexible User interfaces

Modular Design of Agents

Augmented Objects (IP Address and User Interfaces)

Multifunctional personal identifier (biometry, or chip implants)

Stand-alone micro-sized devices with data capture capacity and ad-hoc wireless communication.

Behavioural / emotional pattern recognition – information into “knowledge”.

Intercommunicating Active (lights, doors) and Passive (labelling, bio-sensors) Devices

Intelligent Agents that learn, infer, and negotiate.

Transition from object to quasi-subject.

ISTAG 2001 - <ftp://ftp.cordis.lu/pub/ist/docs/istagscenarios2010g.pdf>

Ambient Electronics

Technology Challenges for Implementing Ambient Intelligence

Middle-terms Technology Issues (2008-2010)

Personal Area Networks - Low Power Sources, Wireless, Bandwidth, bio-sensors, scalability, miniaturisation.

Autonomous power supplies

Pico-radio technology – “short hop” wireless

Smart materials embedded both in vehicles, and wearable communicators.

Advanced tagging systems and devices. (RF ID tags the size of a rice grain)

Long-term Technology Issues (2010-)

Tangible/tactile and sensorial interfaces

Miniaturisation and nano-technologies: very small cameras, sensors and actuators.

Miniaturisation and nano-technologies: combined with smart materials

End-of-life management of augmented objects

Many Institutes and Companies Investigating Technologies which are Applicable to Intelligent Environments Research

Academic Research

MIT Media Lab
Carnegie Mellon University

Australian Institute of Marine Science
Columbia University
Lancaster University, UK

TeCO at the University of Karlsruhe
University of Nottingham
Interactive Institute

Royal Institute of Technology, Sweden
University of Birmingham, UK
University of North Carolina at Wilmington
University of Oregon
University of Essex, UK
University of Minho, Italy.
Stanford University Wearables Lab
VTT Electronics
Rutgers University
Brunel University
Centre National de la Recherche Scientifique

Academic Research (contd.)

Computer Technology Institute

Georgia Institute of Technology

SINTEF, Norway

University of Washington

Fraunhofer IZM

CURE-Vienna
University of California Berkeley
University of California
University of South Australia
University of Toronto

Industrial Research

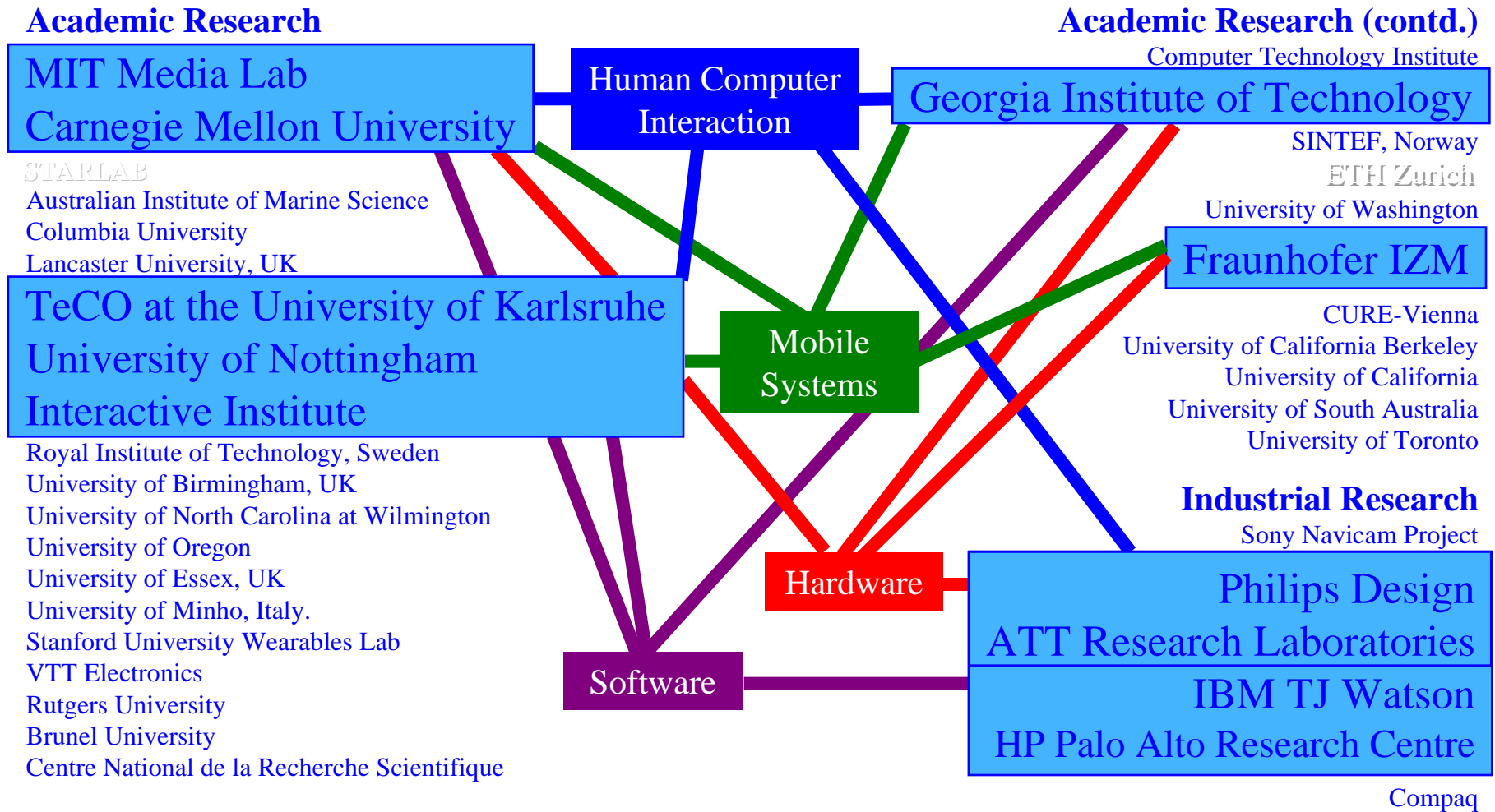
Sony Navicam Project

Philips Design
ATT Research Laboratories

IBM TJ Watson
HP Palo Alto Research Centre

Compaq

The More Noteworthy are Performing Cross Disciplinary Research driven by Applications and/or Scenarios.



Ambient Electronics

CHALLENGES

Challenge: Develop seamless intelligent environment, which any user can personalise and utilise in real-time and freely adapt through his/her chosen mobile interface to perform any desired task.

***Problem:** The system is inherently limited to the designer's vision of what it is expected to do. How does it handle different users?*

Solution: Add artificial intelligence, allow “learning”, “emergent behaviour”.

***Problem:** How to collect the correct contextual information for the system to learn?*

CHALLENGES

Challenge: Develop a System which senses the required information at the appropriate moment in time.

Problem: How many sensors do we use and where do we put them? How do we account for changes in the functionality of the intelligent spaces?

Solution: Integrate very many sensors into the system(s). Utilise specific sets of sensor formats which may be processed to provide the appropriate contextual information. Allow forms of hardware and software re-configurability.

Problem: Information processing requires significant computational power. Centralised System formats will struggle.

CHALLENGES

Challenge: Develop a modularised system with distributed computational power, facilitate intercommunication, and provide artificial intelligence in the modules.

***Problem:** Module design now becomes a limiting factor in the development of systems with proactive response. How much processing power is enough, and how do we integrate the format into the everyday environment?*

Solution: Develop a “plug and play” format that can be readily upgraded. Utilise advanced high density interconnect (HDI) formats to miniaturise the modules.

***Problem:** Standard HDI platforms do not provide enough miniaturisation or flexibility.*

CHALLENGES

Challenge: Develop a distributed system (micro-environments) containing potentially unlimited numbers of modules in everyday objects using adaptable/upgradable formats.

***Problem:** Scaling issues now become highly significant, and a trade-off exists between scale, granularity, and functionality.*

Solution: Develop reconfigurable software, and communicate (filtered) information in large systems using, for example, diffusion techniques.

***Problem:** The system will need to be reliable and robust in its response to faults and failures (and upgrades) in parts of the system.*

CHALLENGES

Challenge: Build a reliable, dynamic and context-aware distributed system that provides for reliable performance through reconfigurable software AND hardware components.

Problem: How do we realise practical solutions for hardware reconfigurability?

Solution: Implement mobile agents based upon versions of micro-robot technologies which will be developed to merge with distributed systems.

Problem: The system will need to be miniaturised to a level significantly below human cognition for this to be effective (i.e. micron-scale robots).

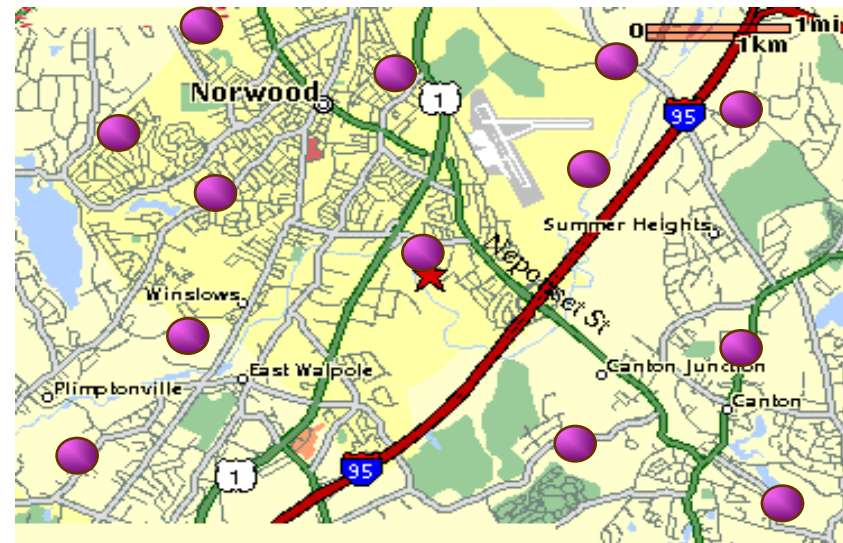
Solution: Develop suitable technology platforms based upon a determined relationship between scale, granularity, self-organisation, and functionality (incl. reliability).

THE GENERIC PLATFORM

Embed numerous distributed devices to monitor and interact with physical world: in work-spaces, hospitals, homes, vehicles, and “the environment” (water, soil, air...)

Network these devices so that they can coordinate to perform higher-level tasks.

Requires robust distributed systems of tens of thousands of devices.



Disaster Response

THE GENERIC PLATFORM

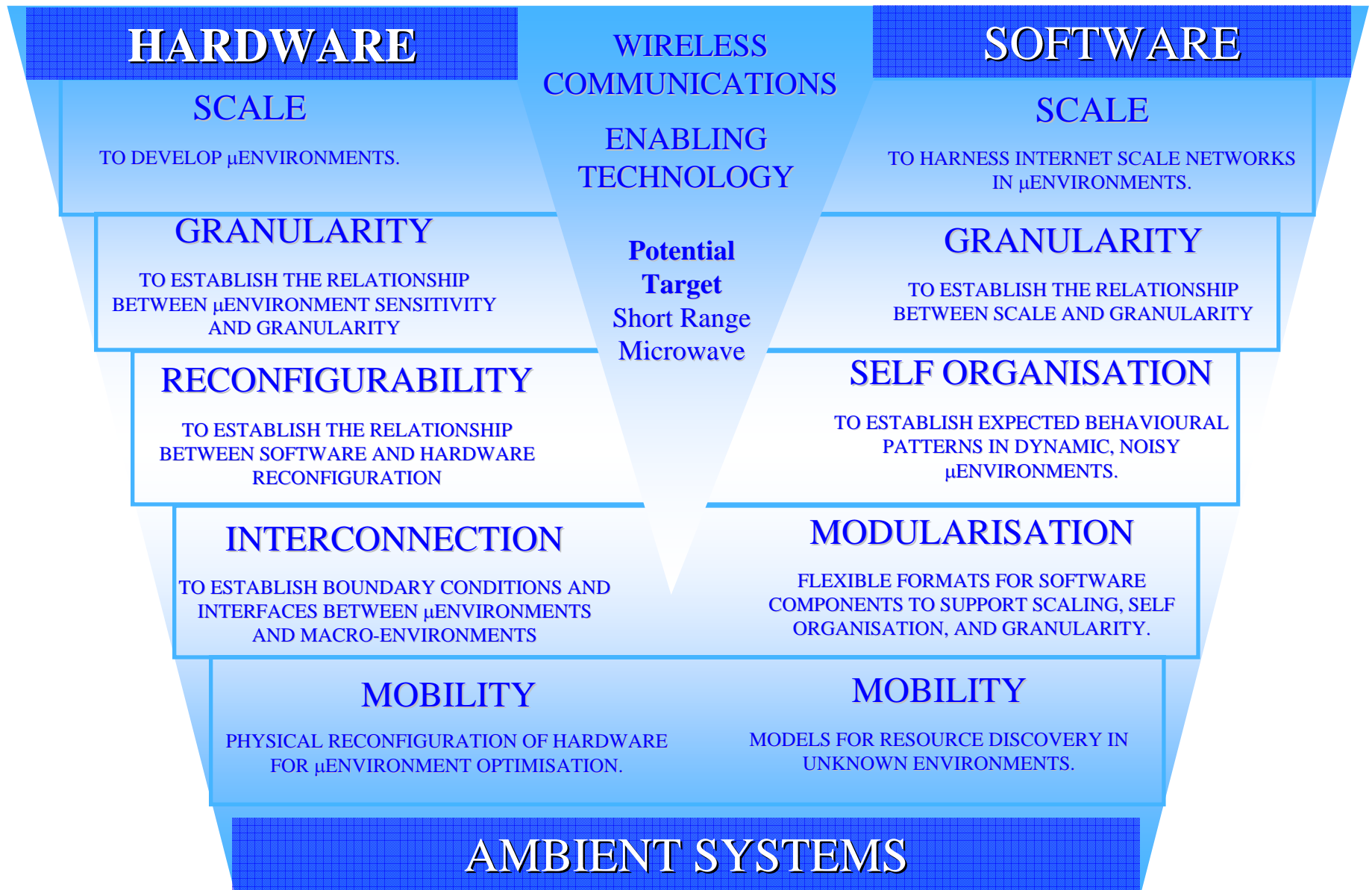
Research is Strongly Oriented Towards Scenarios and Iterative Experimentation.

Purpose: Match the Systems' Performance to the Expectations of the User, and Make the Interaction Intuitive.

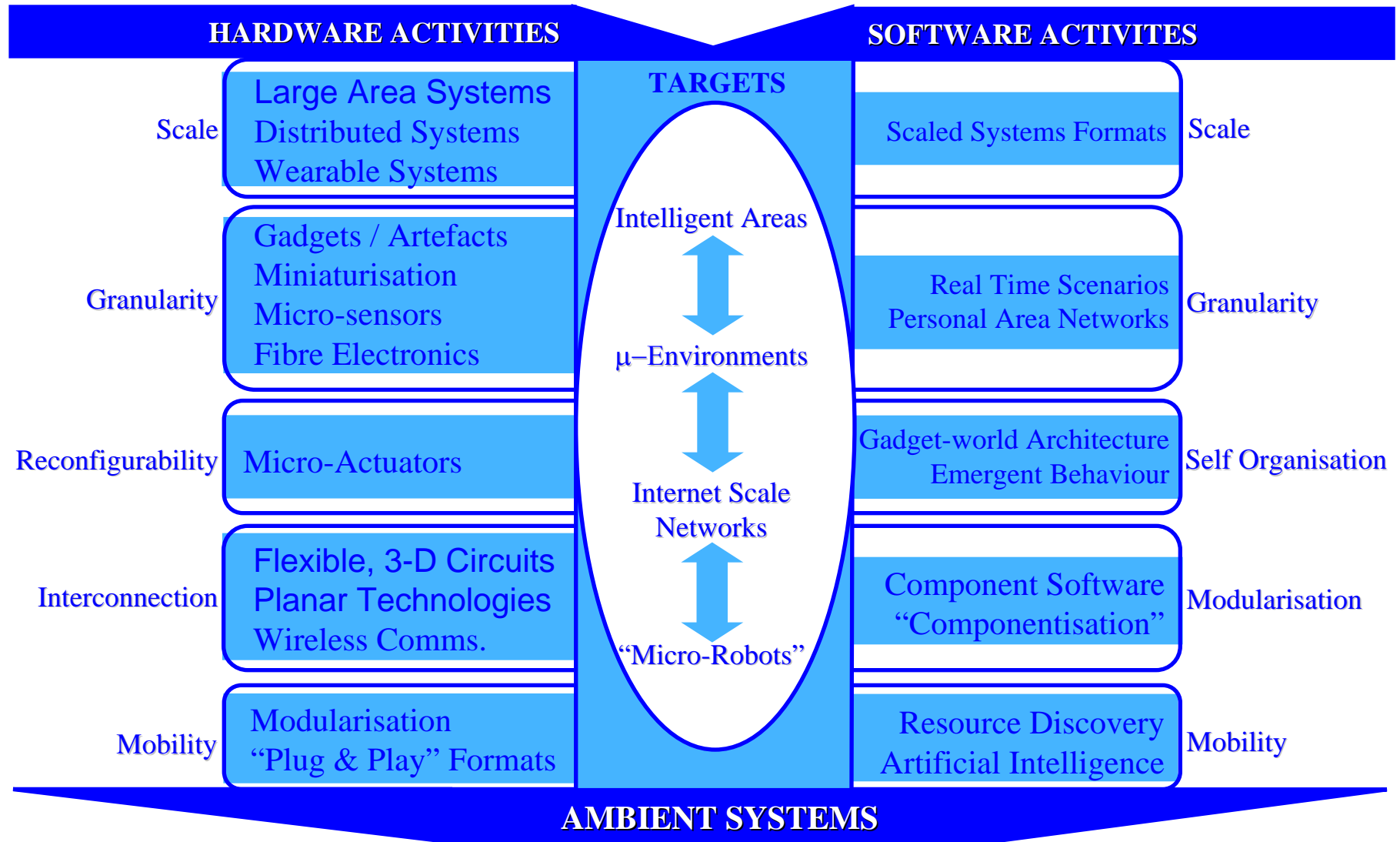
Hardware: Largely Based Upon Traditional Surface-mount Techniques.

Software: Based Upon Open System Architectures.

Communication: Primarily Uses Wireless RF.

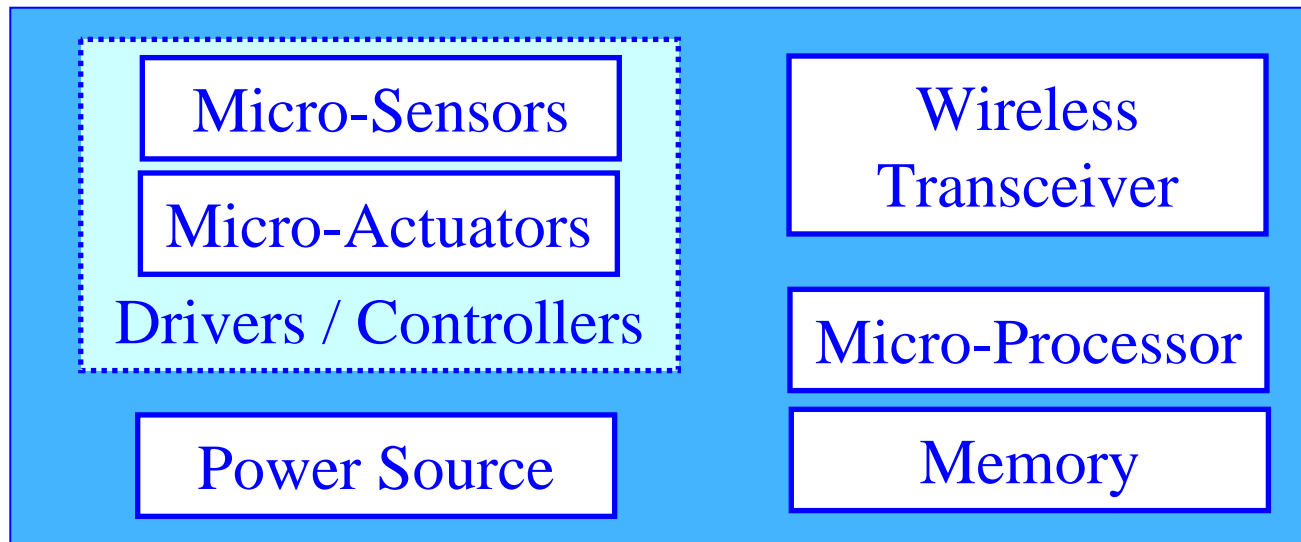


IMPLEMENTATION OF VISION

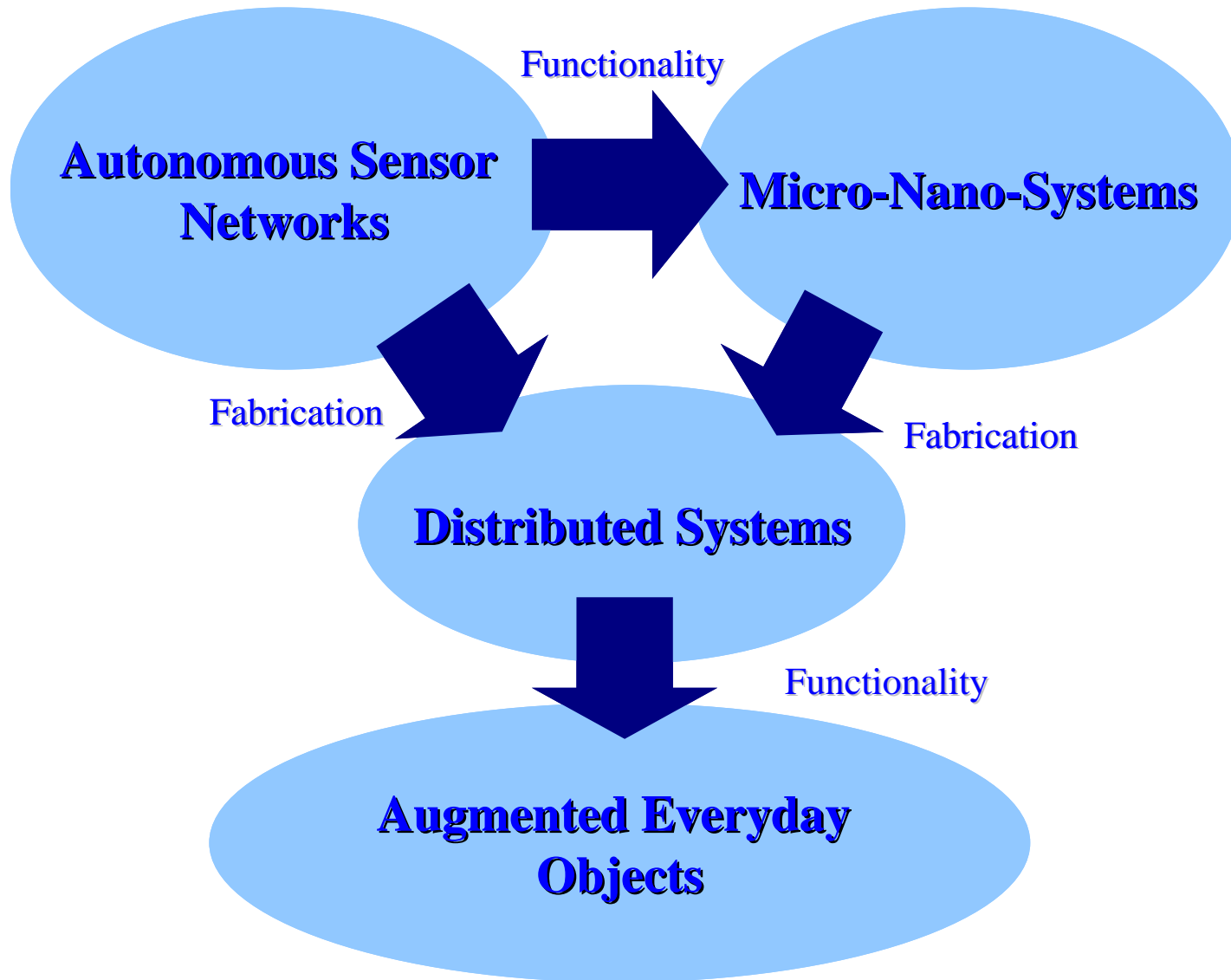


Ambient Electronics

Design / Development of Basic Wireless Module



- Building Blocks for the Development of Distributed Systems.
- Provides for Drop-In Adjustments for Application-Specific Requirements, Upgrade, and Replacement.
- Module/Agent Embedded Physically into Artefacts.
- Module Format is Flexible => Progression to Micro-Environments.



Ambient Electronics