From Awareness to Adaptation

Large Scale Recognition and Opportunistic Configuration

Alois Ferscha

AWARENESS Workshop
Faculty of Engineering of the University of Bologna
viale Risorgimento 2, 40136 Bologna

January 23, 2012

(supported by the EC under the FP7 FET grant AWARENESS)

Univ. Prof. Dr. Alois Ferscha
Universität Linz, Institut für Pervasive Computing
Altenberger Straße 69, A-4040 Linz
ferscha@soft.uni-linz.ac.at
Connectedness: Late 90s – Early 2000s

Connecting literally every-“thing” to every-“thing”

driven by the availability of “technology to connect” >> Networks of ICT systems (Internet, Mobile Data, Wireless Communications)

- clouds of communicating, miniaturized, cheap, fast, powerful, wirelessly connected, “always on” systems (omnipresent / total connectivity)
- enabled by the massive availability of miniaturized computing, storage, communication, and embedded systems technologies
- sensors collect data, passive interaction with environment; actuators control devices, can modify environment
- sensor-actuator systems invert role of interaction from human to machine (implicit interaction)
- special purpose computing and information appliances, spontaneously communicating
- organism like capabilities (self-configuration, self-healing, self-optimizing, self-protecting)
Aware interaction among every-“thing”s

driven by upcoming context recognition and knowledge processing technologies

>> Ecologies of ICT systems

- situation aware, self-aware, context-aware, energy-aware, etc.
- reframing autonomy to be based on “knowledge”, extracted from low level sensor data captured in a particular situation or over long periods of time
- “autonomic elements” able to capture, interpret, predict, context (from sensors)
- to build up, represent, carry and share knowledge
- to self-describe, -manage, and –organize with respect to the environment
- behaviour >> “knowledge based” monitoring, analyzing, planning and executing
- interaction in spontaneous spatial/temporal contexts, based on proximity, priority, privileges, capabilities, interests, offerings, environmental conditions, etc.


“Meaningful” interaction of every-“thing”s within a complex system

build upon connectedness and awareness, but give meaning to situations / actions

>> “Smartness”

• use technical sensors (aligned with 5 human senses) for vision, audition, gustation, olfaction, tactition to give meaning to situations

• computational perception > to extract meaning ...

• understanding patterns (activity, mobility, „life style“) > to extract meaning ...

• formalization of human cognitive capabilities: attention, intent, emotions, experience, ...

• relate meaning to building up belief, acting, expectation, memorizing, learning, developing behaviour, building up knowledge


Pervasive Adaptation Research Agenda (www.perada.eu)

Request a Printed Copy: http://www.pervasive.jku.at/rab/order/
See fet'11 Presentation Videos: http://www.pervasive.jku.at/fet11
Highly complex, orchestrated, cooperative and coordinated systems

- “Ensembles of Digital Artefacts” (FP7 FET), “the power of crowds”
- Rephrased in Weiser-words: “Pervasive ICT will be weaving social and technological phenomena into the ‘fabric of everyday life of societies.’”

- “… dynamic network of many … acting in parallel …”
  “… constantly acting and reacting to what the other are doing …”
  “… where the control tends to be highly dispersed and decentralized …”
  “… if there is to be any coherent behavior, it has to arise from competition / cooperation.
  “… overall behavior of the system is the result of a huge number of decisions made every moment by many individuals …” (Castellani, B., Haerty, F.W., 2009).

- deployment of pervasive computing systems at massive scale poses challenges both in the technological as well as in the societal dimension!

  $10^{12}-10^{13}$ “things” or “goods” traded in markets
  $10^8$ humans; $10^9$ nodes on the internet, mobile phones, cars, digital cameras, etc. on planet
  $10^7$ citizens in megacities, $10^8$ users on Facebook, $10^8$ videos on YouTube, $10^7$ titles on last.fm, ...

A Critique on “Non-Social” ICT

“working in the small”, severe deficiencies “in the large”
A Critique on “Non-Social” ICT

“working in the small”, severe deficiencies “in the large”

Personal Communication (email, social network software, ...) >> ??
Personal ICT (smartphones, appliances, gadgets, ...) >> ??
Individual Mobility (automotive vehicles, airplanes, public transp., ...) >> ??
Logistics (transportation of goods, energy, ...) >> ??
Mass Media (print, TV, e-paper, digital video, ...) >> ??

Common: None has been designed on “Social Grounds”!
What is Socially „Capable“ ICT?

What are the Social Capabilities of your Car?

Espresso Machine ?

Shoes ?
What is Socially „Capable“ ICT?

“We need to understand that traffic is not just a line of cars: It is a web of connections. A real solution will look at relationships across the entire road network and all the other systems that are touched by it: our supply chains, our environment, our companies, the way people and communities live and work…”

IBM Global Commuter Pain Study, 2010

“The possibility is quite high, that if a lot of people power off all lights at the same time and back on 5 minutes later, pumped hydro storage wont be enough to satisfy the enormous spike, resulting in substations taking their last breath.”


Mass Panic
Jan 2006, Mekka
Sep 2005, Bagdad
May 2001, Accra
Apr 2001, Johannesburg
Jun 2000, Roskilde
Dec 1999, Innsbruck
Jul 1990, Mekka
Apr 1989, Sheffield
Duisburg Loveparade, 2010
### Socio-Inspired ICT

<table>
<thead>
<tr>
<th>Context Aware ICT</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“… is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves.” [1]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Socially Aware ICT</th>
<th>Social Context</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“… is the additional non-verbal information (e.g. signals from the body language, facial expression, and tone of voice, etc.) transmitted among communicating people, and which is the main determinant of a successful social interaction and engagement.” [2]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Socially Interactive ICT</th>
<th>Socially Aware Computing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“… all social relations, social interactions and social situations which are directly related to or confined to small time-intervals and space-regions around the present time or present location of a person”. [3]</td>
</tr>
</tbody>
</table>

Socio-Inspired ICT

**Understanding** the hidden laws and processes of society

**Inspire** the development of a new wave of robust, trustworthy and adaptive ICT based on the principles of social interactions.
Sensor/Tactor Seat: Supporting Lane Change Safety by Extending the Perception Range

Perception range for early lane changes

M30 Motorway Traffic Patterns

Example Socio-Inspired ICT :: Social Sense App (SOCIONICAL)
Example Socio-Inspired ICT :: Social Displays (SAPERE)

Both public and private displays are SAPERE nodes that advertise their presence by pumping a computational field throughout the ecosystem. This fields are used by the steering service for path computation.

Alois Ferscha
Socio-Inspired ICT Research Challenges

Social Values:
- Ethics
- Moral Norm
- Social Awareness
- Social Behaviour
- Social Interaction
- Cognitive Capabilities

Value Based Design
(Respect, Dignity, Trust)

ICT with Social Capabilities
(Needs Fundamental Research)
- Social Adaptiveness, Self-Organization
- Cooperation, Competition
- Conflict Resolution
- Negotiation, Decision Making
- Reputation
- Collective Awareness
- Attraction/Repulsion
- Flocking/Foraging
- Morphogenesis/Chemotaxis

ICT w. Cognitive Capabilities
(Needs Fundamental Research)
- Attention, Perception, Meaning
- Belief, Trust
- Experience, Expectation
- Empathy
- Narration
- Goal Oriented Behavior

Socio-Inspired ICT

Novel ICT:
- Microelectronics
- Sensors / Effectors
- Smart Material
- Social Media
- Participatory Platforms
- Big Data
- Reality Mining
- Recommender Systems

Alois Ferscha
Socio-Inspired ICT Vision

(1) New ICT could contribute to gather direct, accurate and intelligible information on how an individual experiences social relations

>> foundational character of a “Social Sense”

(2) New ICT could be designed to gain from “socially inspired” system architectures and operation principles

>> foundational character of “Socially Capable/Adaptive ICT”