

A Context-Aware Multi-Agent System for Aml Environments

PhD thesis proposal

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- Scenarios
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A Context-Aware Multi-Agent System for Aml Environments

overview



Ubiquitous electronic environment that supports people in their daily tasks, in a proactive, but "invisible" and non-intrusive manner

[Ramos et al., 2008, Weiser, 1993]

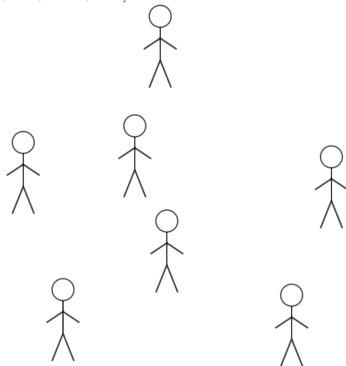
■ What is Aml?

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People

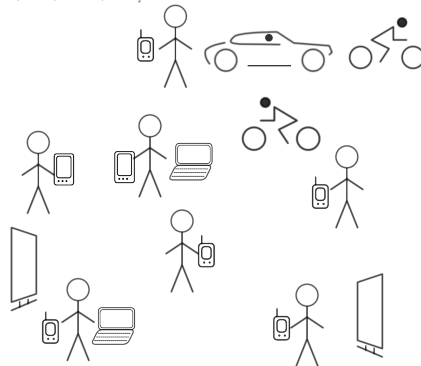
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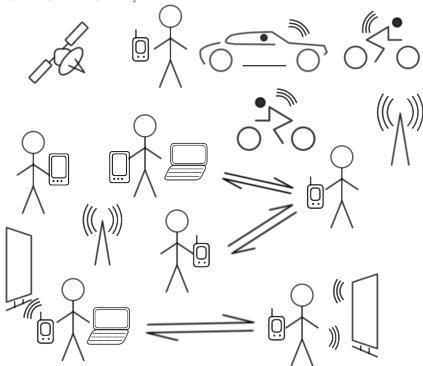
People · Devices

What is Aml?

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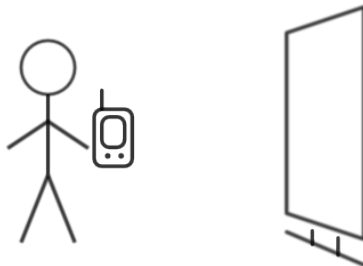


People · Devices · Communication

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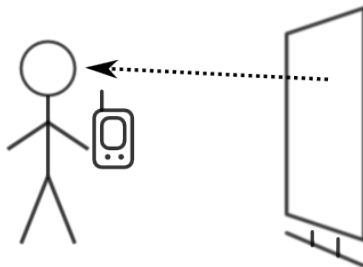
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The large screen can be used to display context-aware advertisements...

- ▶ context-awareness

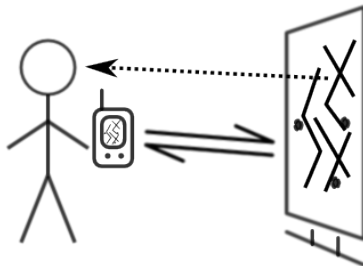
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...or to draw attention of the user...

- ▶ context-awareness
- ▶ proactivity

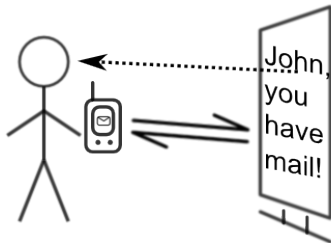
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...to show an interactive map for which the mobile phone is too small [Canut et al., 2009]...

- ▶ context-awareness
- ▶ proactivity
- ▶ flexibility
- ▶ interactivity

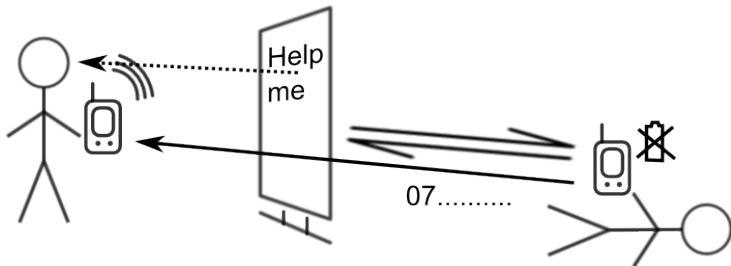
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...to draw attention towards important events, if the phone cannot...

- ▶ context-awareness
- ▶ interoperability
- ▶ proactivity
- ▶ flexibility
- ▶ interactivity

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...or take part in a more complex scenario in which it facilitates the communication with another user in distress.

- ▶ context-awareness
- ▶ interoperability
- ▶ proactivity
- ▶ flexible privacy
- ▶ flexibility
- ▶ interactivity

■ Introduction

■ Aml scenarios

■ Technologies

- pop concert, small earthquake strikes.

■ Layers

- everybody panics

■ Challenges

- mobile network is down due to heavy traffic

■ Development

- but Bluetooth still functions and 20% of the phones can be contacted

■ Middleware

- send context-aware information on how to reach the nearest exit.

■ Agents

■ Self-organization

■ Context

- ▶ context-awareness

- ▶ interoperability

■ Approach

- ▶ proactivity

- ▶ flexible privacy

■ Thesis

- ▶ flexibility

- ▶ flexibility in communication

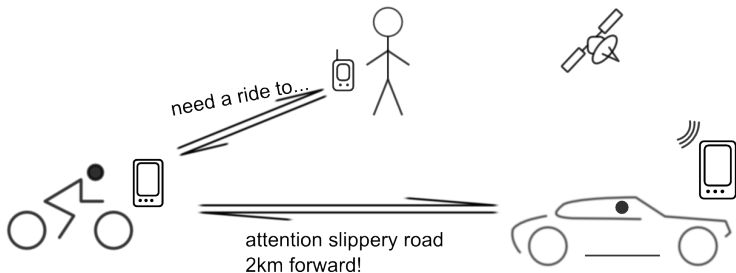
■ References

- ▶ interactivity

- ▶ information diffusion



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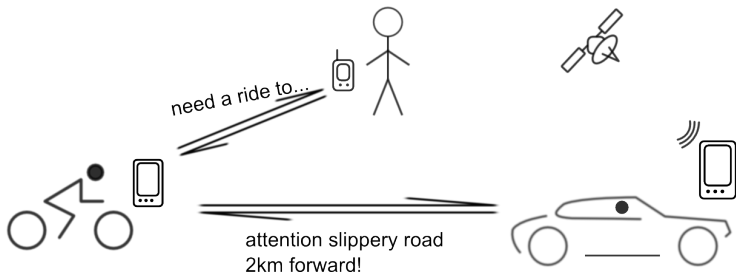


· use the same device to receive information about road conditions and to receive a proposal to pick somebody up

[Ducatel et al., 2001, Seghrouchni, 2008].

- ▶ context-awareness
- ▶ interoperability
- ▶ proactivity
- ▶ flexible privacy
- ▶ flexibility
- ▶ flexibility in communication
- ▶ interactivity
- ▶ information diffusion

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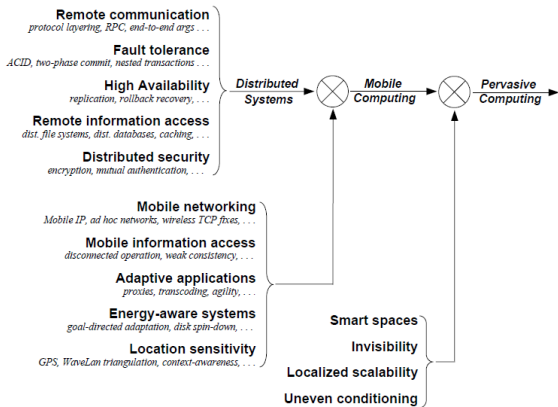
[Ducatel et al., 2001, Seghrouchni, 2008].

- ▶ context-awareness
- ▶ interoperability
- ▶ proactivity
- ▶ flexible privacy
- ▶ flexibility
- ▶ flexibility in communication
- ▶ interactivity
- ▶ information diffusion

· All these (and more) for **every** person and **every** device.



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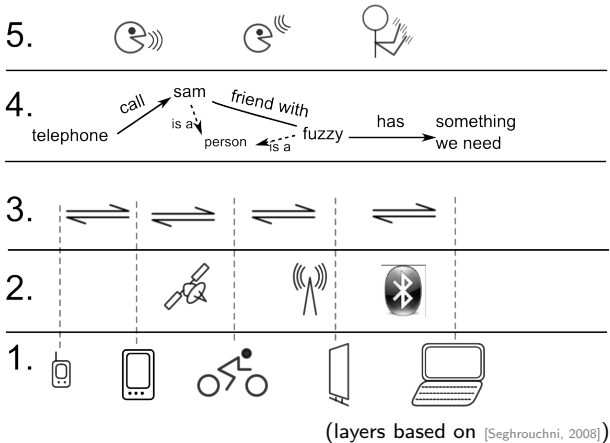


[Satyanarayanan, 2001]

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■ A layered perspective

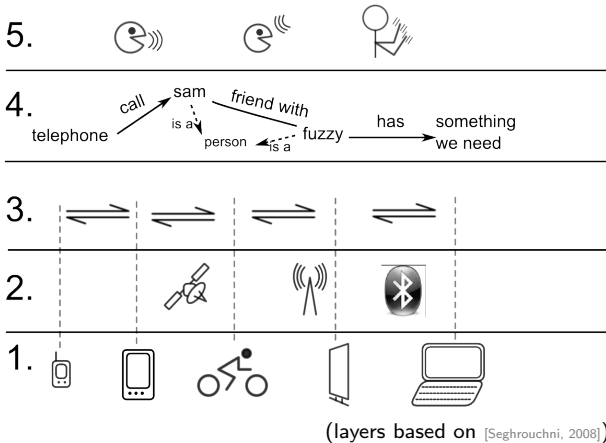
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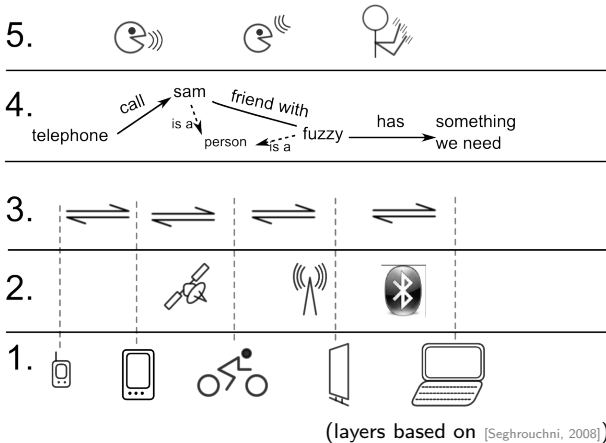


1. **Hardware:** integrated in traditional computer-like devices (laptops, mobile phones, PDAs), in appliances and even in materials. Assures different functionalities and different types of connectivity

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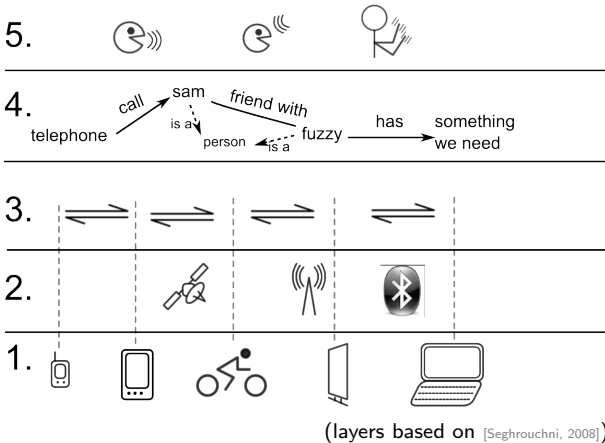
■ A layered perspective

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2. Network: ubiquitous, offers different types of connectivity. Not always secure, and connection quality varies.

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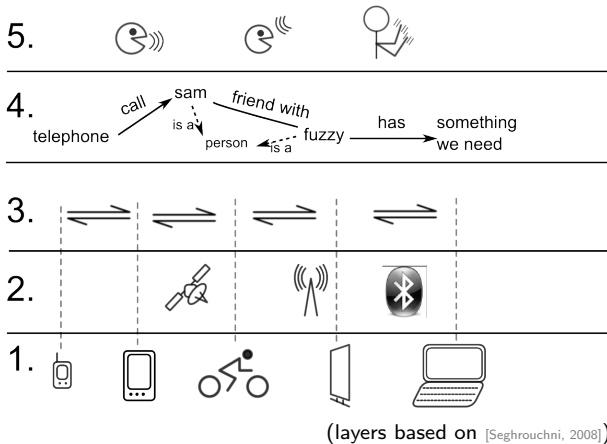


3. **Software connectivity and low-level programs:** assures interoperability of heterogeneous devices as well as basic services.

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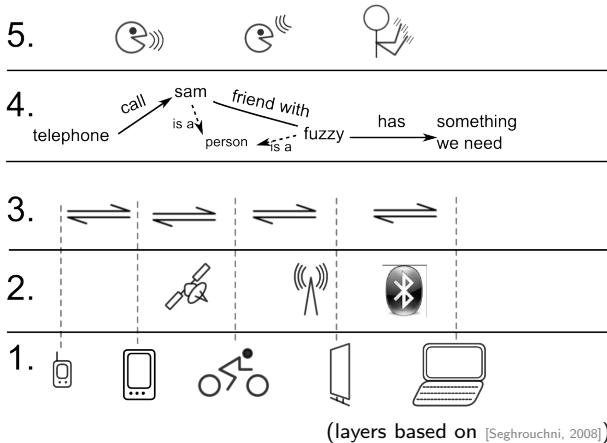
(layers based on [Seghrouchni, 2008])

4. Aml collaborative architecture: works at a semantic level, offering context-aware composed services, handles information exchange, aggregation and abstraction, has power of decision – offers most of Aml's 'intelligent' features.

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■ A layered perspective

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5. **Intelligent user interface:** multi-modal, accessible and natural interface to the users of the system: voice, speech recognition, gestures, etc.

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Challenges:

- ubiquity and scalability
- transparency and invisibility
- mobility
- robustness
- non-intrusiveness / non-distracting
- proactivity and anticipation
- adaptiveness



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Challenges:

- ubiquity and scalability
- transparency and invisibility
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- robustness
- non-intrusiveness / non-distracting
- proactivity and anticipation
- adaptiveness

Concerns:

- privacy and security
- manageability and dependability
- predictability
- ethics



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- intelligent, multimodal interfaces
- sensor networks and user tracking
- personal assistance
- personalization of user experience, anticipation of user behaviour
- context modeling
- device interoperability
- middleware for information processing and exchange

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- ▶ orientation towards personal assistance; centralized knowledge databases, ontologies and services:
 - **iDorm** [Hagras et al., 2004] – learning user behaviour
 - **MyCampus** [Sadeh et al., 2005] – privacy management
 - **ASK-IT** [Spanoudakis and Moraitis, 2006] – assistance of elderly
- ▶ orientation towards distribution, information and connection management:
 - **SpatialAgent** [Satoh, 2004] – mobile agents
 - **LAICA project** [Cabri et al., 2005] – distributed data exchange and processing
 - **AmbieAgents** [Lech and Wienhofen, 2005] – context management agents
 - **CAMPUS framework** [Seghrouchni et al., 2008] – scalable, layered architecture for context sensing and ambient services
 - **SodaPop model** [Hellenschmidt, 2005] – device interoperation and fully distributed control



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■ Software agents

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- Agents satisfy the needs of Aml in terms of:
 - reactivity
 - proactivity
 - autonomy
 - anticipation
 - reasoning



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· Agents satisfy the needs of Aml in terms of:

- reactivity
- proactivity
- autonomy
- anticipation
- reasoning

■ Software agents

- Self-organization Agents also offer beliefs, goals, intentions and easier implementation of a human-inspired behaviour.
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Both Aml and self-organizing systems characterized by:

- large number of individuals / devices
- distributed system
- heavy interaction
- unreliability of individual devices and connections

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■ Aml and self-organizing systems

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Both Aml and self-organizing systems characterized by:

- large number of individuals / devices
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Self-organization brings:

- robustness
- resilience
- fault tolerance
- decentralization
- implicit coordination

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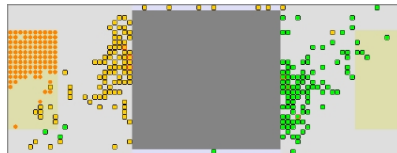
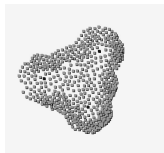


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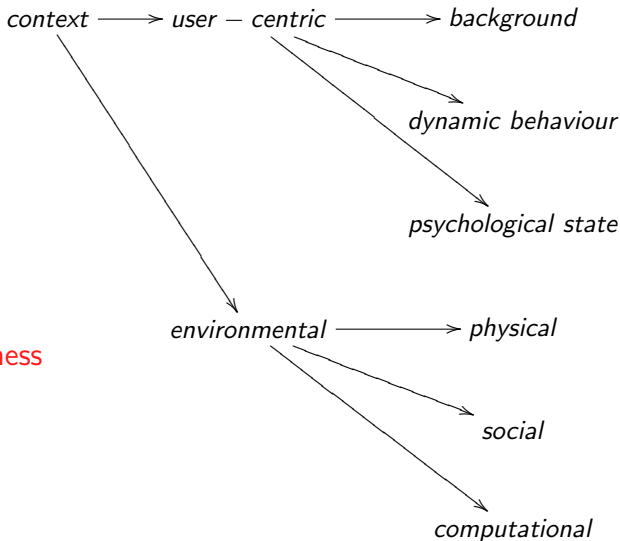
Self-organization brings:

- robustness
- resilience
- fault tolerance
- decentralization
- implicit coordination



[Zambonelli et al., 2004, Picard, 2005]

· context-awareness: the ability to **autonomously adapt** to the current context, in order to provide a better response and experience for the user [Viterbo et al., 2008]



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· address the **application layer** – above hardware, network and interoperability, below intelligent user interfaces.

■ Introduction

· this is where most of the challenges and most features that make Aml "intelligent".

■ Scenarios

■ Technologies

· *answer some of these challenges, by providing a model for an Aml system's application layer.*

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▶ multi-agent system

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■ Research approach

Agents provide proactivity, reasoning, have beliefs and goals represented semantically; one or more agents per device; flexible structure in function of device capabilities; coordination and collaboration.

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- ▶ multi-agent system

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- ▶ system distribution

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- **Research approach**

Distribute the system entirely, using centralized databases or ontologies as little as possible.

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▶ self-organization

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■ **Research approach**

Provide organization without centralized control, leading to robustness and flexibility.

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· address the **application layer** – above hardware, network and interoperability, below intelligent user interfaces.

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■ Self-organization

▶ context-awareness

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■ **Research approach**

Make behaviour, communication and information processing context-aware.

■ Thesis

■ References



The title of my PhD thesis is:

A Context-Aware Multi-Agent
System for Aml Environments

A Context-Aware Multi-Agent System for Aml Environments

The goals of my thesis research are the following:

- ▶ to develop a **multi-agent system based model** for Ambient Intelligence that features self-organization, context-awareness and anticipation;
- ▶ to develop several **scenarios** that emphasize the **requirements** of real-scale Ambient Intelligence environments;
- ▶ to develop a **simulation testbed** that implements the elements of the said scenarios, to serve for experiments with Aml platforms;
- ▶ to implement and **experiment** with the developed model, using the simulation testbed, in order to prove the model's validity as a component of an Ambient Intelligence environment.

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Thank you!

Any Questions?

