

Software-Infrastructures for Ambient Intelligence

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German Abstract

»Ambient Intelligence« ist die Vision von einer Welt, in der wir von intelligenten, intuitiv bedienbaren Geräten umgeben sind. Diese unterstützen uns bei der Gestaltung, Organisation und Durchführung unseres täglichen Lebens. Der Begriff »Ambient Intelligence« bezeichnet ein neues Paradigma der Interaktion zwischen dem Menschen und seiner Alltagsumgebung: »Ambient Intelligence« versetzt diese Umwelt in die Lage, sich des in ihr handelnden Menschen, seiner Ziele und Bedürfnisse bewusst zu sein (Awareness) und den Menschen aktiv beim Durchführen seiner Tätigkeiten und beim Erreichen seiner Ziele zu assistieren (Proactivity). Im Rahmen des BMBF-Leitprojektes »EMBASSI« wurde am Fraunhofer IGD eine neuartige Agenten-Middleware für selbstorganisierende Multimedia-Appliances entwickelt, die den einfachen Aufbau von Ambient-Intelligence-Anwendungen ermöglicht. Im Mittelpunkt steht die Unterstützung von technischen Infrastrukturen des täglichen Lebens. Vor allem Anwendungen im Bereich der Unterhaltungselektronik und der Heimsteuerung lassen sich so leicht umsetzen. So das der Nutzer Komponenten verschiedener Hersteller freizügig miteinander verbinden kann.

»Ambient intelligence« is the vision of a world in which we are surrounded by smart, intuitively operated devices that help us organize, structure, and master our everyday life. The »ambient intelligence« notion characterizes a new paradigm for the interaction between a person and his or her everyday environment – »ambient intelligence« enables this environment to be aware of the user's goals and needs as he interacts with it. Thus, the person is proactively assisted in his activities and in reaching his goals.

A simple example for an aware, proactive environment: My car stereo tunes into exactly the station I recently listened to at the breakfast table or my mobile phone redirects calls automatically to my voice mail when I am in a meeting. Another example would be the bathroom mirror that reminds me to take my medication.

So far, the user has had to manage his personal environment himself. He needs to operate and control the various appliances and devices available for his support. However, more technology and more options mean a greater challenge to master our everyday environment, i.e. the challenge not to get lost in an abundance of possibilities. Failing to address this challenge adequately simply results in inoperable and therefore effectively useless technology. »Ambient intelligence« allows the environment to control these options and to manage appliances on behalf of the user. Thus, the environment's full assistive potential can be mobilized for the user and tailored to his individual goals and needs.

»Ambient intelligence« is technically based on ubiquitous resp. pervasive computing which involves the diffusion of information technology into all

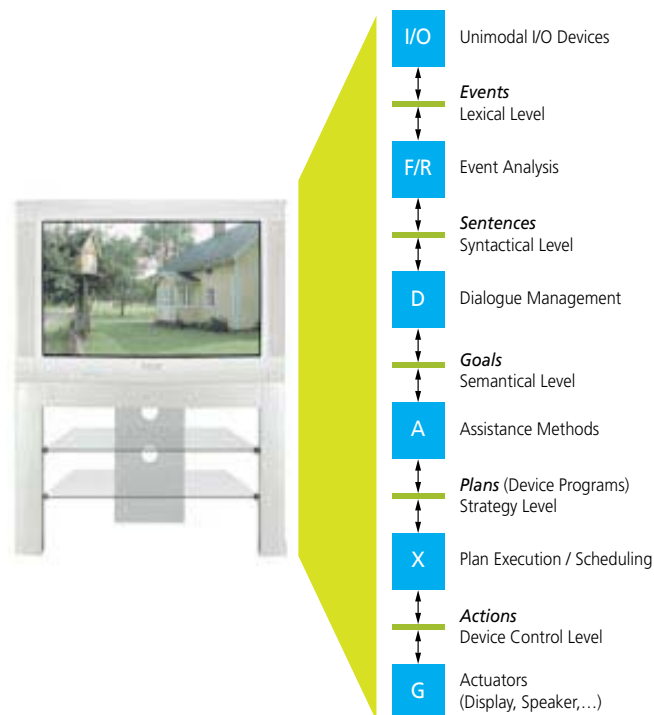


Figure 1:
An appliance and its
internal component
structure

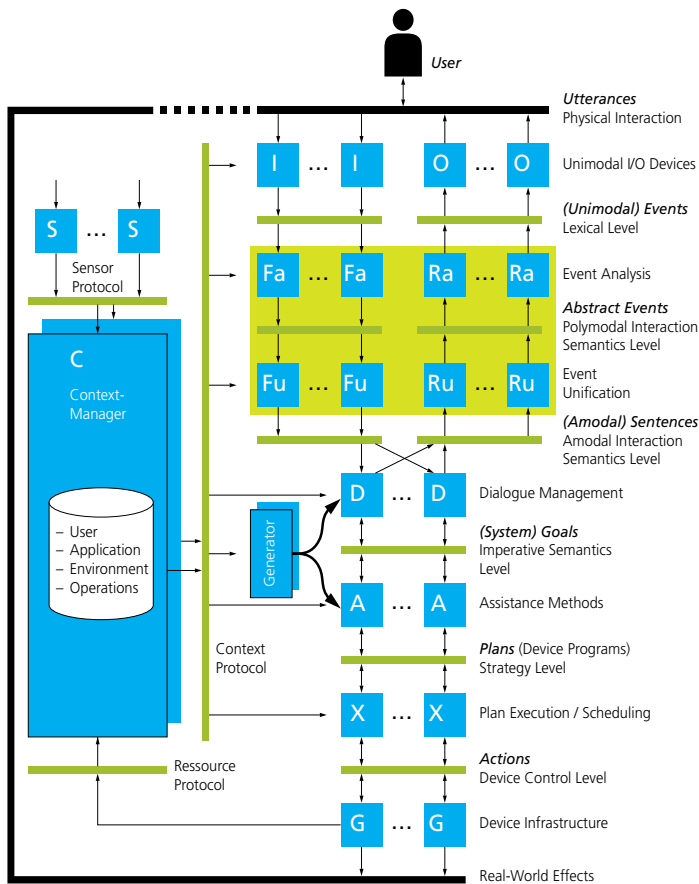


Figure 2:
The sodaPop
standard topology

Middleware supporting the interoperability between appliances in such settings will:

- Ensure independence of components,
- Allow dynamic extensibility of the appliance by adding new components,
- Avoid central components (single point of failures, bottlenecks),
- Support a scalable distributed implementation,
- Allow flexible re-use of components,
- Enable exchangeability of components, and, specifically,
- Provide the basic strategies for handling multi-modal interaction within the ensemble.

These characteristics are met by the SodaPop middleware. SodaPop is based on a two-level approach to self-organization that supports the spontaneous integration of multiple appliances into a coherent ensemble. On the data-flow-level, SodaPop establishes the typical processing stages within the appliances and the communication interfaces between the individual stages (cf. figure 2) – the data flow topology. On the cooperation level, SodaPop spreads a processing stage across the corresponding components of several appliances, using conflict-resolving publish / subscribe mechanisms (cf. figure 3). Appliances can now be added to or removed from a SodaPop ensemble at any time. The integration of the appliance into the ensemble is managed completely autonomously by SodaPop.

Application areas for SodaPop and its underlying models are smart environments for professional and consumer applications when an easy implementation is required – ranging from smart offices and conference / multimedia presentation environments to home theatre and home control.

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appliances and objects of everyday life, made possible by miniaturized and low cost hardware. In the near future, a multitude of »information appliances« and »smart artifacts« will characterize everyone's personal environment. To make the vision of »ambient intelligence« come true, coherent teamwork among the environment's appliances needs to be established, enabling a co-operative, proactive support of the user. Wireless ad-hoc networking and embedded sensors provide the basis for coherent and coordinated action of an appliance ensemble with respect to the user's current situation. By enabling multi-modal interaction such as speech and gestures, intuitive interaction is made possible. Additionally, new strategies for the self-organization of appliance ensembles are required to allow an adaptation to the user's needs and desires.

Middleware for Self-Organizing Systems

Within the scope of the BMBF focus project »EMBASSI« (Electronic Multimedia Operating and Service Assistance), we have developed a prototype agent middleware for self-organizing appliances ensembles, named »SodaPop« (Self-Organizing Data-flow Architectures supporting Ontology-based problem decomposition). The SodaPop middleware simplifies the development of ambient intelligence applications for appliance infrastructures of everyday life that are created and extended by the end user in an ad-hoc fashion. This kind of infrastructures is common, in the area of home entertainment, for instance, where the user may deliberately combine components built by different manufacturers. A similar situation applies for typical office environments.