

The Human Communication Space

Towards I-centric Communications

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Abstract

In the last years, a variety of concepts for service integration and corresponding systems have gained momentum. On the one hand, they aim for the interworking and integration of classical telecommunications and data communications services. On the other hand, they are focusing on universal service access from a variety of end user systems. Many of the technical problems, resulting from the service integration, and service personalization have been solved during the last years. However, all these systems are driven by the concept of providing several technologies to users by keeping the peculiarity of each service.

Looking at humans' communication behavior and its communication space, it is obvious, that human beings interact with habitually in a set of contexts in their environment. The individual information preferences and needs, persons to interact with, and the set of devices to control by each individual, defines his personal communication space. Following this view, a new approach is to build communication systems not on the basis of specific technologies, but on the analysis of the individual communication spaces. The result is a communication system adapted to the individual demands of each individual specifically (I-centric). The communication system will act on behalf of users demands, reflecting recent actions to enable profiling and self-adaptation to contexts and situations.

In this paper, we introduce I-centric Communication Systems, an approach to design communication systems, which adapt to the individual communication space and individual environment and situation. In this context "I" means I, or individual, "Centric" means adaptable to I requirements and a certain user environment. The architecture proposed is derived from numerous development projects in the areas of: unified messaging systems, object and person tracking, mobile guides, smart homes and cars which have been implemented with industrial partners by our group in the last four years.

1 I-centric Communications

In the former days, the communication space of human beings has been limited to the actual surrounding physical environment (like a home or a village) in general based on the geographical reachability of human senses. With the introduction of telephony, the spatial dimension of this space has been expanded. Now, it became possible to talk with people regardless of their actual location. With upcoming asynchronous services like email and fax, the dimension of time has been expanded. People can send emails and need not to care, if the addressee is ready to receive the message or not. That is, technology has eliminated distances in time and space or at least made these boundaries almost invisible.

I-centric means to take a bottomless look at human behavior and to adapt the activities of communication systems to it. Human beings communicate with their environment in different ways. They meet

with other people to talk, to celebrate, they read and travel, they are listening to news or to music, they make decisions, just to give a small range of examples. People interact with several ‘things of interest’ to solve the problems of daily life: money and bank accounts need to be managed, food has to be bought and to be prepared for eating, movies can be watched for entertainment, places are visited and news are consumed to improve the education, other people are met for discussions. All these contexts and the related objects define the communication space of a human being. A context represents a certain “universe of discourse” in an individual communication space. In general, human beings communicate with ‘objects’ in their environment in a certain context. Note that same objects may pertain to different contexts. Objects pertaining to a certain context can be active or passive at certain moment in time depending on the situation the user is into. They can be activated or deactivated by the user or environmental condition. They can be directly addressable or represent a set of physical entities performing a certain service as a whole.

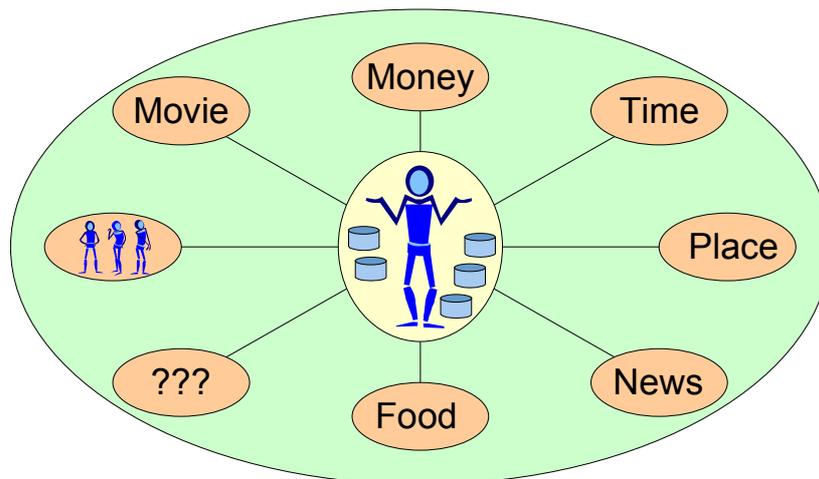


Figure 1: Communication Space of Human Beings

A user might have different preferences under different situations. Sitting alone in a silent room might indicate that the user is willing to receive incoming phone calls. However, the same user can understand this as a disturbance being involved in a conversation with other people. To be I-centric requires knowledge of the actual situation of a user. An active context defines a certain relationship of a human being to a particular number of objects of its communication space at a fixed moment in time. I-centric communication systems have to be aware of the context a user is in and have to adapt their service provisioning to that very context in a certain temporal situation

The multitude of devices, wearables, different telecommunication technologies, services in the, positioning and sensing systems, location-aware or context-aware applications etc can be seen as enabling technologies for I-centric communications. Universal information access (including service interworking, media conversion), flexible control of equipment at facilities (e.g. smart homes), and personal communications (supporting personal mobility and terminal mobility) form the fundamentals of such systems.

Three main topics for I-centric communications can be identified:

I-centric Services describe the ability to define and to manage contexts that are tailored to the preferences of single users, in its individual way to interact with the communication system. Based on the evaluation of ‘profiles’ that describe user preferences, service capabilities, and on sensing information about its actual environment, the user can be provided with individualized services for his actual demands. Self-learning capabilities are used to profile the behavior of users, numerous services or several features of different services are combined on-demand, and appropriate terminals and conversion strategies are evaluated.

Interaction with Smart Environments comprises the functionality that is required in a certain context to sense the environment in order to be able to adapt to it. Temporal and spatial characteristics are

only two examples of information, which may affect the context and adapt the communication system to a certain situation. Temperature, noise level, light intensity, presence of other people and objects in the vicinity, are additional parameters which may help to adapt the I-centric application to the user needs and profiles. Note that a certain environment can restrict the functionality provided by a certain context. Interacting in a TV context while driving a car may reduce the functionality to "record movie XYZ for later viewing". Sensing the environment provide the information necessary for the choice from several types of equipment which have to be controlled (presentation terminals, handhelds, microelectronic controlled devices), their quality of service (volume, brightness etc) that are connected via heterogeneous access networks (Infranets, Intranets, Internet, Extranets, telecommunication networks) to create an I virtual private network.

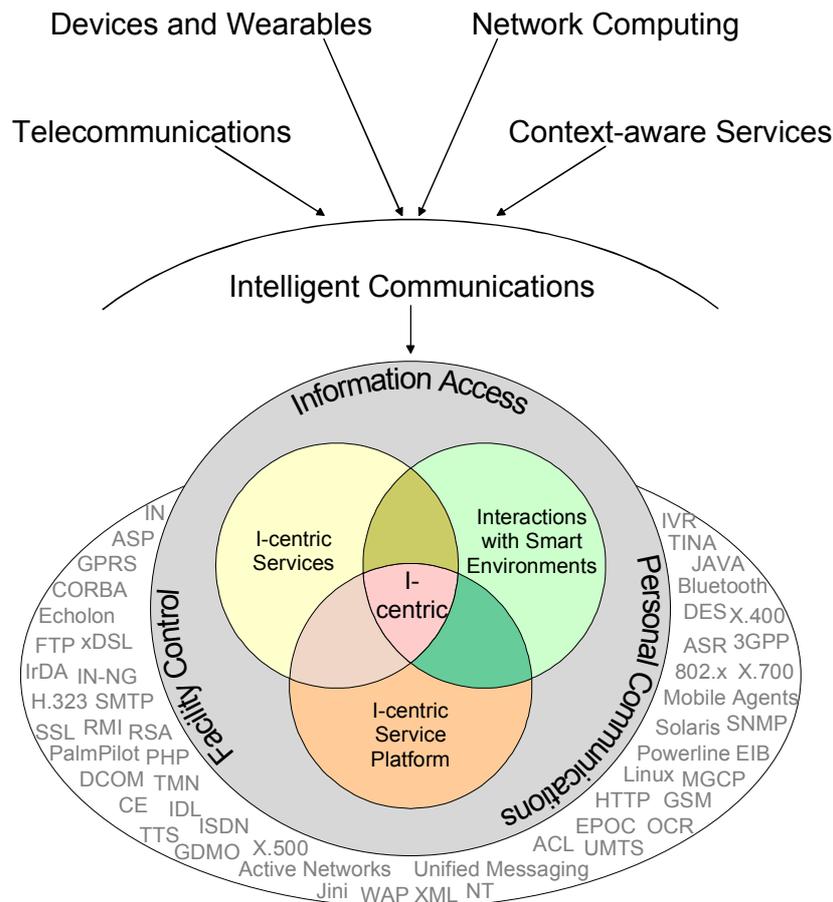


Figure 2: Trends in Intelligent Communications

I-centric Service Platform is responsible for shaping of the communication system, based on the contexts identified and the actual sensed environment information. It activates the objects involved in the context, identifies causalities between them based on sensed environmental data, controls the services offered by these objects, and converts data structures and operations for interworking between (possibly unrelated) services. The equipment is configured dynamically, its state is profiled, distributed objects are controlled, service creation and deployment is supervised, and the interworking among domains is enabled by the platform.

The aim of I-centric Communications architecture is to devise a framework that models the entire communication behavior of human beings. This has to lead to an expandable system that is almost invisible to the user, that requires no time-consuming configuration, and provides customized interfaces to each single user based on its own preferences and situations in time. Combining off-the-shelf developments for the area of microelectronic controlled devices, handhelds, wearables, Infranets, the Internet and the World Wide Web, 3rd generation mobile telecommunication networks, E-Commerce,

and context-awareness, complex and intelligent services can be provided to human beings in an easy, for them understandable and therefore acceptable way.

2 A Framework for I-centric Communication Systems

The framework shown in **Figure 3** comprises the functional components that are responsible for the mapping of abstract information about the user's communication space up to specific device instructions. The user himself employs I-centric Services and interacts with Smart Environments.

I-centric Services and components, able to sense the environment, are settled on top of the *Service Platform*. I-centric services process their tasks supported by the *Context Handler*, which determines what *Objects* (things of interest) have to be considered in a certain context (1). The user can benefit from I-centric services via the interaction with his environment. That interaction can be a dialog with an interactive user interface (touch-screen application, telephone, microphone/audio speaker combination) or a daily action, which is sensed by the Smart Environment automatically (e.g. the user enters a room and is located instantly). The knowledge about the interaction is transmitted via the *Service Platform* to the *Objects* (2), where the *Context Handler* can recognise the updated information for a certain context. The component *User Profiles* contains information about user preferences as well as information about recent service usage. Probably, this component has to be updated, for instance when habitual behaviour is monitored (3). Furthermore, the *Context Handler* deals with the problem of interpreting/converting any kind of user input, sensed information, and occurred events. It maps resulting information or user instruction into information the I-centric service can 'understand'. Finally, the *I-centric Service* interacts with the determined *Objects*, facing *User Profiles*. The results in a formal description of the requested service, the configuration of involved *Objects*, and information needed to perform the I-centric services.

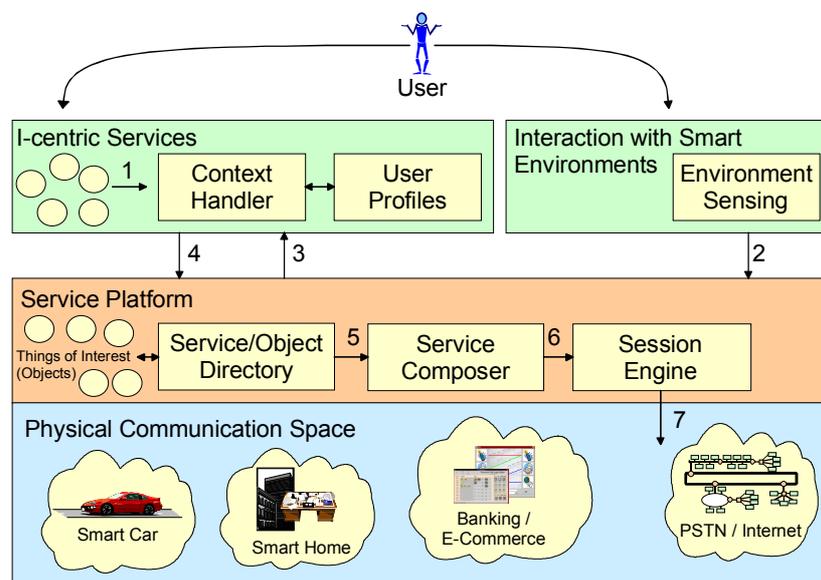


Figure 3: Architectural Framework for an I-centric Communication System

The *Service Platform* has two main objectives, the conversion and exchange of information between all components of the framework, and the mapping of causalities of *Objects* to causalities of legacy services. Each 'thing of interest' is realised as an *Object* inside the platform and can be managed by an *I-centric Service* and updated by '*Interaction with Smart Environments*'. The *Service Composer* receives the request from the *Objects*. The *Service & Object Directory* contains necessary information about services, service features, service building blocks, and policies for the mapping of causalities. The *Service Composer* can combine legacy services to fulfil the request or it can create new services on-demand out of a pool of service building blocks (5). Additionally, it selects appropriate terminals,

devices, and/or applications (6). The *Session Engine* represents the final component in the processing of a service request (7). It controls legacy services and configures selected hardware and software.

3 Service Example

In the following, the realization of an I-centric service based on the introduced framework is described. The example realises an I-centric service that controls the light and the temperature in the bathroom of a user. The user's preferences for that service are stored in *User Profiles* ('I want it warm and bright when I am in the bathroom, where bright means 500 lux and warm means 23°C).

When the service is invoked, the temperature and the light condition of the user's bathroom are sensed. If the user enters his bathroom, the information about the actual state of the sensed information is forwarded to the *Context Handler* that updates the *User Profile*. Hereby, the *Context Handler* has to translate this information into an I-centric representation (e.g. Room 6008 → bathroom; 2 lux → dark; 20°C → could) to assemble this information to a context description the I-centric service can interpret ('the user is in his bathroom, it's dark and cold there'). If temperature and/or light conditions do not reflect the user's preferences, the *Objects* for temperature and light in the bathroom are manipulated. This manipulation triggers *Service Composer* to select the appropriate legacy services (in our example facility control services) and the appropriate devices (light switch and heater in the bathroom). The *Session Engine* uses this information to configure the respected devices.

With the described framework, the user can employ several variations of the described scenario:

- the use of a telephone, e.g. to warm up the bathroom in advance while on the way home;
- to receive information about the temperature and light conditions of the bathroom while on vacation;
- personal configuration of the temperature and light conditions for each member of the family;
- automatic notification of the fire department when temperature reaches a pre-defined value.

4 Conclusion

This paper has introduced the vision of I-centric communication and architecture for the realisation of I-centric services. The three main ideas in this context are *I-centric services*, *I-centric Service Platform*, and *Interactions with Smart Environments*. The illustrated framework has shown how these ideas can be assembled to set up an environment where services are possible that face on one hand how users interact with their environment and on the other hand how user can be supported with self-adaptive services to fulfil their individual demands. The proposed framework is already used to integrate different I-centric services in a user specific communication space.

References

- [Abo99] Abowd, G. D.; Dey, A. K. et. al.: Towards a Better Understanding of context and Context-Awareness. First International Symposium on Handheld and Ubiquitous Computing, HUC'99, Karlsruhe, Germany, 27-29 Sept., 1999
- [Arb99] Arbanowski, St.; van der Meer, S.: Service Personalization for Unified Messaging Systems. Proc. of the fourth IEEE Symposium on Computers and Communications, ISCC'99, Red Sea, Egypt, July 6-8, 1999

- [Eck96] Eckardt, T.; Magedanz, T.; Ulbricht, C.; Popescu-Zeletin, R.: Generic Personal Communications Support for Open Service Environments. Proc. IFIP World Conference on Mobile Communications, Canberra, Australia, Sep. 1996
- [HINE] Eurescom Project P915-F: Heterogeneous In-House Networking Environment. <http://www.eurescom.de/public/projects/P900-series/P915/p915.htm>
- [FIPAA] FIPA Draft 2-1999: Agent Communication Language. FIPA, 199, <http://www.fipa.org/spec/index.html>
- [FIPAB] FIPA Draft 18-1999: Content Languages. FIPA 1999, <http://www.fipa.org/spec/index.html>
- [Pen99] Pentland, A.: Perceptual Intelligence. First International Symposium on Handheld and Ubiquitous Computing, HUC'99, Karlsruhe, Germany, 27-29 Sept., 1999
- [Siemens] http://www.hausgeraet.de/deutsch/produkteloesungen/produktuebersicht_frame.html
- [TINA-SA] TINA-C: Baseline. Service Architecture. Version 5.0 – June 1997
- [UIML] User Interface Markup Language. <http://www.uiml.org>
- [UMTS] ETSI Techn. specification TS 22.01v.3.1.0: Universal Mobile Telecommunication Systems (UMTS). Aspects, Principles. - Sophia Antapolis, France, 1997
- [VHE] ETSI Draft 22.70v.0.0.3: Virtual Home Environments. - Sophia Antapolis, France, 1997
- [Vdm99a] van der Meer, S.; Arbanowski, St.: An Approach for a 4th Generation Messaging System. Proc. of the 4th International Symposium on Autonomous Decentralized Systems, ISADS'99, Tokyo, Japan, 1999
- [Vdm99b] van der Meer, S.; Arbanowski, St.; Popescu-Zeletin, R.: A Platform for Environment-Aware Applications. Proc. of the First International Symposium on Handheld and Ubiquitous Computing, HUC'99, Karlsruhe, Germany, 27-29 Sept., 1999
- [XML] <http://www.w3.org/TR/1998/REC-xml-19980210>
- [Zel98] Popescu-Zeletin, R.; Pfeifer, T.; Magedanz, T.: Applying Location-Aware Computing for Electronic Commerce: Mobile Guide. Proc. of the 5th Conference on Computer Communications, AFRICOM-CCDC'98, Tunis, October 20-22-1998