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USER-FOCUSED REFERENCE MODELLING FOR 3G AND BEYOND MOBILE AND WIRELESS APPLICATIONS*

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Abstract. In the wireless world human perspectives play an important role in understanding and developing 3G and beyond mobile and wireless applications. For this we need to develop some reference models in order to best describe the requirements in developing and deploying future generation multimedia mobile and wireless applications. In this paper it first comes up with an introduction of a reference model which forms the basis in Wireless Strategic Initiative (WSI) research project. A user-focused model is then developed which describes the users' wants and needs in mobile and wireless applications. The CyPhone system is then presented and it is followed by both static and dynamic reference modelling, which are drawn from CyPhone mobile navigation scenarios. This paper contributes to the understanding of the generic reference models and static and dynamic reference modelling in the wireless world. This paper ends up with a conclusion and future work is outlined.

Keywords: Reference, model, mobile, wireless, Cyberworld, CyPhone

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1 INTRODUCTION

The Wireless World Research Forum (WWRF) is a premier forum for mobile and wireless research. WWRF covers mobile and wireless research from both human (user) and technical perspectives. While much of the wireless research concentrates on physical and technical aspects, there is a growing interest on the user and application layer in mobile and wireless communication systems. The latest work on generic reference model of the wireless world is reflected by Wireless Strategic Initiative (WSI) reference model [1, 8]. This model is based on WWRF service architecture for the wireless world which can be found in WWRF Book of Visions 2001 [7]. The WSI reference model (Figure 1) consists of four basic building blocks, namely *Cyberworld*, *Open Service Platform*, *Interconnectivity* and *Access*. It covers all aspects of the wireless world from business models and user issues down to radio interfaces. The reference model describes the grand building blocks of the wireless world and how they interact at reference points. The reference model accommodates user scenarios and different views. The combined definition of business models and reference points enables the early definition of roles and business relationships as well as assumptions on business topology and market value chains and value networks.

Following the reference model the communication element (CE) for the wireless world is defined which can be understood as the representation of a certain device or node in the wireless world as visualized in Figure 2 [2, 3]. The functionalities integrated in the communication element are provided by different building blocks. The assumption is that the reference model should separate Content Processing, Control, and Management functions into the own end-to-end planes and subsystems. The architecture should not allow mixture of these three functions in specification.

The Building Blocks, which form communication elements, are connected by reference points. The early identification and specification of these reference points will enable more flexible communication systems than we will have with 3G systems. There are "vertical" and "horizontal" reference points. The vertical reference points are defined interfaces between the building blocks of the communication elements. A connection can also take place between communication elements which reside in different spheres using "horizontal" reference points. The reference points between the building blocks are crucial elements for the precise technological description of the model. The functionalities which the different blocks have to provide at these reference points will have to be well-defined, complete, and generic in order to assure the proper functioning of the model and to allow treating the building blocks as "Black Boxes" from the viewpoint of the adjacent blocks. The reference points can be divided into two categories:

- those which provide an interface between different building blocks in one communication element;
- those which "virtually" link equal building blocks of different CEs, thereby possibly spanning one or more spheres.

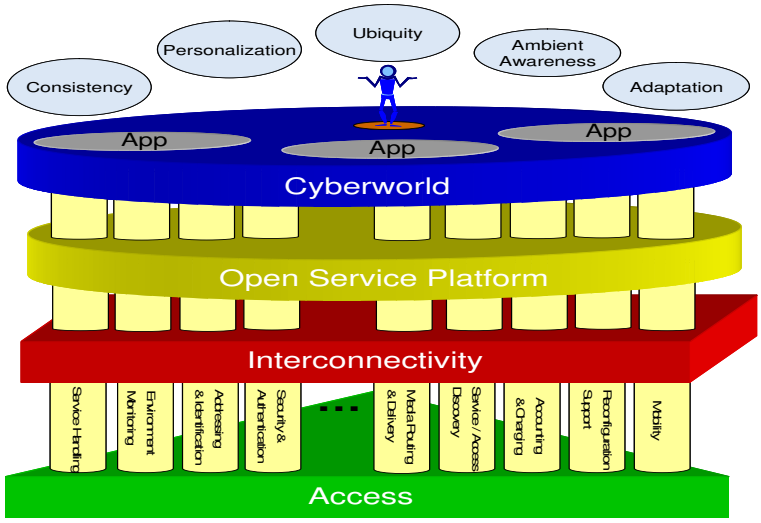


Fig. 1. WSI reference model for the wireless world

The reference points represent well-specified points of contacts between the building blocks. This specification will cover so called *generic vertical functions* that have to be provided by all reference points. Vertical functions provide certain functionality through all the building blocks by addressing the dedicated problems and technologies of each building block.

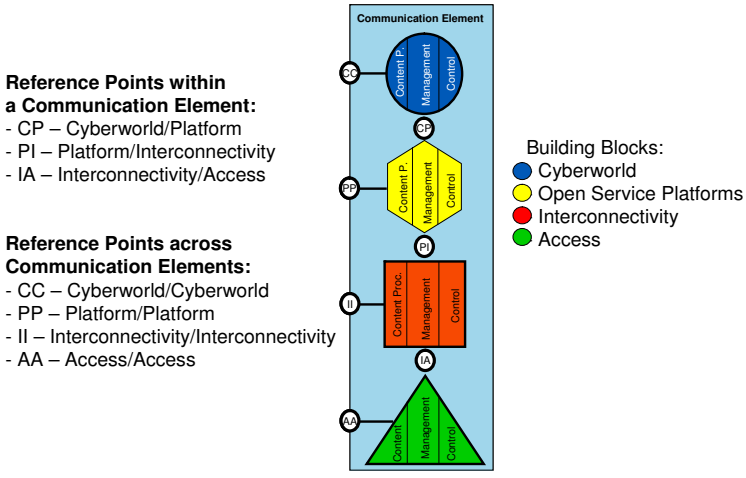


Fig. 2. Structure of communication element for the wireless world

2 SPHERES OF THE WIRELESS WORLD

The sphere concept adds another fundamental dimension to the wireless world reference model. The spheres represent the backdrop in which rich communication services may be described. The human being is in the centre of the concentric set of spheres, demonstrating the user-centric approach generally adopted in the work on the wireless world. The spheres of the reference model stand for different communication contexts. Driven by the horizontalisation introduced by 3G's mobile Internet, future vertical applications and services will draw together a multitude of wireless technologies in an ad-hoc manner. Those elements will be around us like a number of spheres in which we live. CEs do not "exist" in a certain sphere but have to be placed there logically depending on the nature of the communication they are involved in (e.g. the location of the communicating entities). For example, communication between two CEs in a global sphere can include "local sphere communication" to become possible. The communication between elements in non-adjacent spheres is assumed to always take place via one or more elements of an intermediate sphere. The final sphere structure will be a representation of the prevailing business model. Below we introduce the spheres used in WSI project and they are *Personal Sphere*, *Local Sphere* and *Global Sphere* (Figure 3).

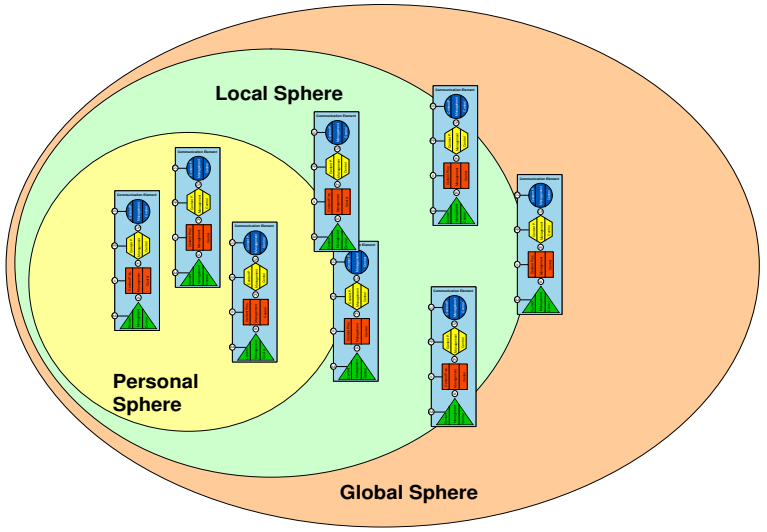


Fig. 3. Spheres definition for the wireless world

3 THE USER NEEDS REFERENCE MODEL

In Figure 4 the user needs reference model represents users' wants and needs for 3G and beyond mobile and wireless applications. This reference model describes the

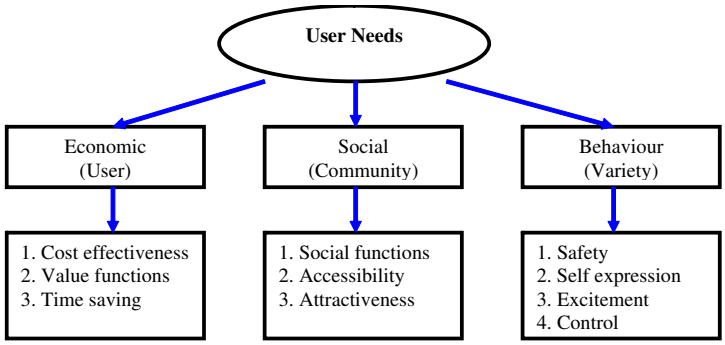


Fig. 4. The user needs reference model

essential requirements for developing killer applications. The user needs for mobile and wireless applications can be categorized as *economic*, *social* and *behaviour* needs. Each of them can be further divided into more detailed user needs. For example in *Behaviour* category the *Excitement* means that new capabilities of services or applications or unspoken needs that will cause user excitement. However, this is a general classification to indicate user needs in mobile services and applications. It is expected to alter these needs a little bit to fit various services and applications (for example electronic banking and virtual telepresence) and different user groups (for example students and business men).

4 THE CYBERWORLD REFERENCE MODEL

The Cyberworld reference model describes the key requirements at the user and application layer in mobile and wireless applications. There are a number of values or requirements demanded by end users for example *self-actualisation*, *privacy*, *safety*, *belonging*, *control*, and *human capability augmentation*. Developers of mobile and wireless applications may also express some technical requirements which are described in the "capabilities" category: *consistency*, *personalization*, *ubiquity*, *natural interaction*, *ambient awareness*, *adaptation*. Users will need to go through a number of processes for having the applications. *Presence* process is ambient awareness of the users. *Identification* process is then required for authorization purpose. It then comes with the *Interaction* process with applications which are rooted on the *Cyberhost*.

5 REFERENCE MODELLING FOR CYPHONE MOBILE NAVIGATION

In order to illustrate the reference modelling procedure of mobile scenarios in the wireless world the CyPhone mobile navigation case is used here. The CyPhone

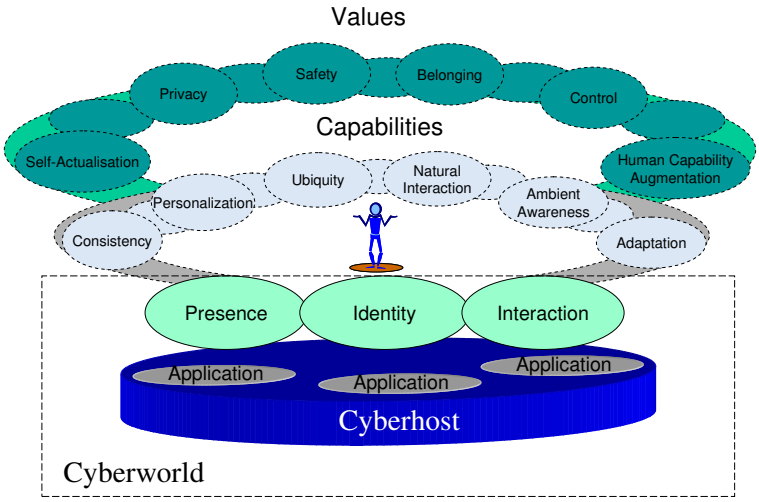
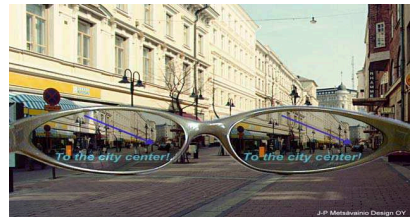


Fig. 5. The Cyberworld reference model

is a small sized combination of a digital stereo camera, a notepad computer and a cellular phone [5]. The CyPhone network is backboned by the picocellular technologies allowing transmission of high bandwidth of data. The CyPhone framework can be used as a platform for some promising mobile services that can be classified as annotation services, telepresence services and monitoring and maintenance etc. (Figure 6).

CyPhone with the support of
Head Mounted Display can offer
excellent Augmented Reality services.



An example of using Cyphone AR ability
for guidance and navigation service.
A major challenge is synchronization of
real and virtual worlds.

Fig. 6. Introduction of CyPhone services

The proposed reference modelling procedure is demonstrated in Figure 7. It models the CyPhone indoor and outdoor navigation scenarios which are drawn from the CyPhone project [6]. It starts from the initial informal model, followed by the sphere model drawn on the informal model. Communication elements with linkages

are then added into the sphere model. After this the informal model is removed which results in a clear reference model with only 3 spheres, communication elements and linkages. A trial has been made to look into the communication element and reference points details with this CyPhone example. Internal dynamic modelling and peer to peer (P2P) dynamic modelling are two different examples to give a micro and macro perspective respectively in modelling user scenarios.

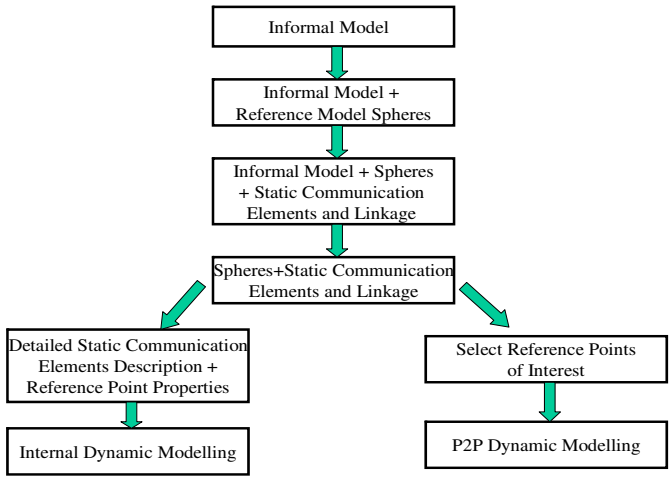


Fig. 7. Reference modelling procedure for user scenarios in the wireless world

Figure 8 is the initial CyPhone navigation layout model which identifies a number of essential scenario components including navigation service elements and enabling technologies. In this example there are two navigation scenarios: indoor navigation for a printer and outdoor navigation for a hotel. Then we further classify these scenario components into the three spheres. The *Personal Sphere* includes the user and the printer. The *Local Sphere* consists of the indoor navigation elements and enabling technologies and in our example they are *wireless LAN*, *VRE-server*, *indoor orientation and positioning system*, *bluetooth technology* etc. The most out sphere is *Global Sphere* and the outdoor navigation elements and enabling technologies reside in this sphere. These include the *hotel*, *GPS system*, *base stations*, *UMTS technology*, *geographical information system*, etc. By using the three spheres different navigation communication contexts are clearly described with the user in the centre of spheres, demonstrating the user-focused approach in the wireless world research.

Then the *Communication Elements* are added into the sphere model. Each of the scenario components is represented by a communication element beside it. Within every communication element there are four building blocks, i.e. *Cyberworld*, *Open Service Platform*, *Interconnectivity* and *Access*, which represent four different functionalities. A scenario component primarily offers one of the four func-

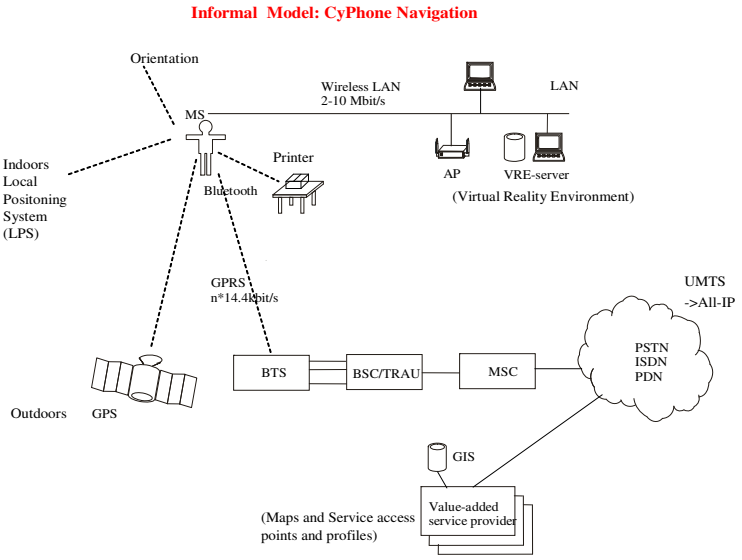


Fig. 8. Informal model of CyPhone navigation

tionalities, thus the corresponding communication element is connected to another one through its functionality building block. All of the scenario component communications are indicated through proper linkages among communication elements. In order to clearly show the navigation communication picture all of scenario components are removed with only spheres, communication elements and their linkages left (see Figure 9). The resulted model emphasizes the functionality of every scenario component in the wireless world, which is reflected through linkages to and from its communication element's functionality building block.

Figure 10 deals with the reference points in and between communication elements. Figure 10 is an example to look into reference points associated with *Cyberworld* building block. *CC* means the *Cyberworld-Cyberworld* reference point between two communication elements. *CP* means the *Cyberworld-Open Service Platform* reference point within a communication element. In Figure 10 a number of functionality properties for reference points *CC*, *CP* and *Cyberworld* building block are listed which are drawn from CyPhone navigation scenarios. These properties may vary in different wireless communication cases.

Figure 11 is an example of internal dynamic modelling between two building blocks *Cyberworld* and *Open Service Platform*. It describes the dynamic communications between the two building blocks for service discovery. In Figure 11 services reside in *Open Service Platform* in the form of various service objects. Lookup servers act as the reference points between the two building blocks. The services first join the Lookup servers and pass their service objects and additional informa-

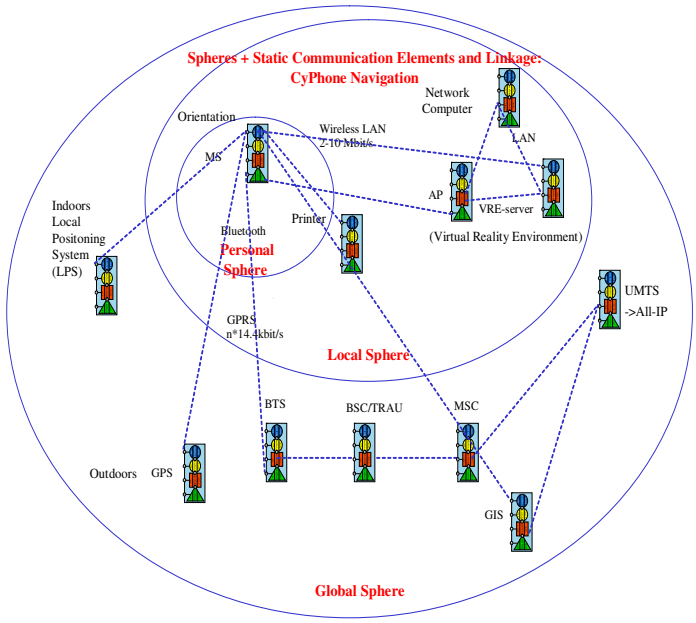


Fig. 9. Spheres + static communication elements and linkage: CyPhone navigation

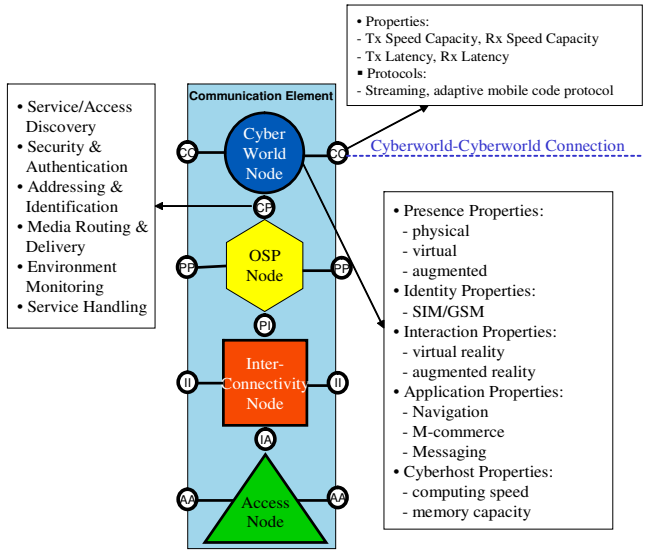
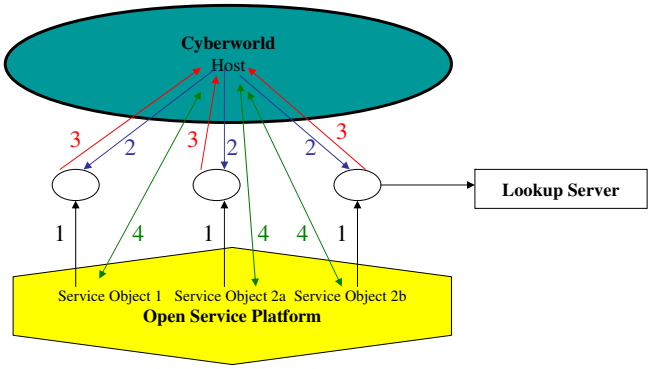


Fig. 10. Static communication element description with reference point properties

tion onto Lookup servers. Then the *Cyberworld* client commits the service discovery procedure to find out what kind of services are on offer. After communication with Lookup servers the *Cyberworld* client gets the reference to the desired service objects and then retrieves the service objects and starts using them. The internal dynamic model gives a micro dynamic view within a communication element for wireless services and applications.



1 The services join the Lookup server and pass their service objects and additional information on to it.
2 The Cyberworld client commits the discovery procedure to find out what kind of services are on offer.
3 The Cyberworld client gets the reference to the desired service object.
4 The Cyberworld client retrieves the service object and starts using it.

Fig. 11. Internal dynamic model of cyberworld and open service platform

Figures 12 and 13 illustrate the peer to peer (P2P) dynamic modelling procedure. It starts with selecting the reference points of interest for modelling. In Figure 12 six reference points are identified for indoor and outdoor navigation modelling, namely User (CyPhone), Local Positioning System (LPS), Global Positioning System (GPS), Virtual Reality Environment (VRE) server, Geographical Information System (GIS) server, and the Printer.

In Figure 13 we use Message Sequence Chart which is an efficient method to model dynamic real time systems [4]. Figure 13 is the final model of peer to peer dynamic modelling of CyPhone indoor navigation for the printer and outdoor navigation for the hotel. Reading the model is easy. The user first powers on the CyPhone and it will automatically establish global positions by activating the global GPS. The local positioning system is then launched for specific mobile services. The local positioning data are displayed through the CyPhone. Now the CyPhone system is ready for navigation services. Following the command "guide to printer", the CyPhone system will enable VRE capability. A request is sent to the VRE server for direction to the printer and the feedback is displayed through CyPhone Augmented Reality (AR)

system. This request and feedback process is carried out regularly at a predefined rate. When the user is close enough to the printer the document data are sent to the printer for printing. When the user finally reaches the printer the demanded documents are ready for pick up. The outdoor navigation for the hotel has the similar dynamic communication process by using the GIS system. The peer to peer dynamic model gives a system perspective of reference modelling; hence, it is helpful in analyzing and understanding wireless and mobile communications at a system level.

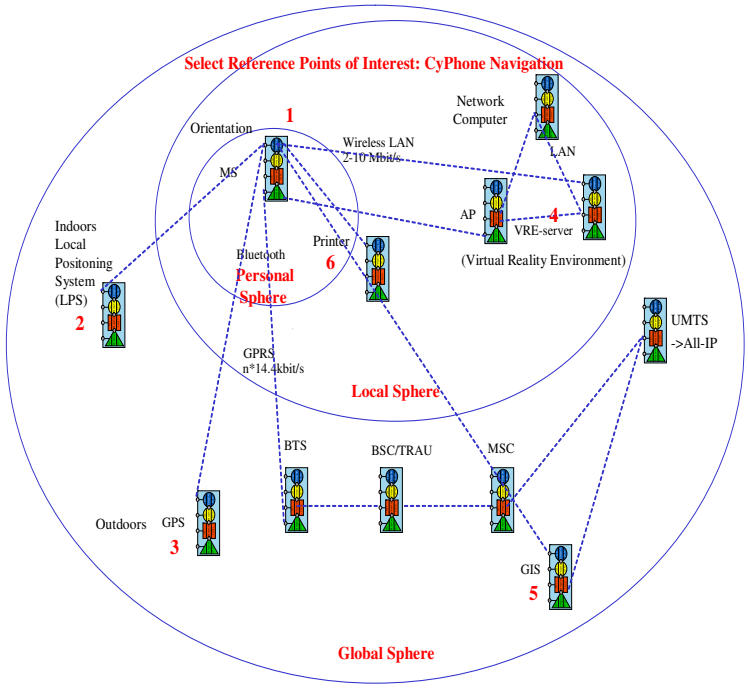


Fig. 12. Selected reference points of interest: CyPhone navigation

6 CONCLUSION

In this paper we present several reference models for 3G and beyond mobile and wireless applications. In the case study the challenging task for reference modelling of the CyPhone mobile navigation scenarios has been achieved successfully. The static reference model as well as the dynamic internal model and dynamic peer to peer model have been established. The dynamic reference models expressively describe the interaction among communicating entities over time. Static and dynamic models are complementary in a way that could be used to give a comprehensive

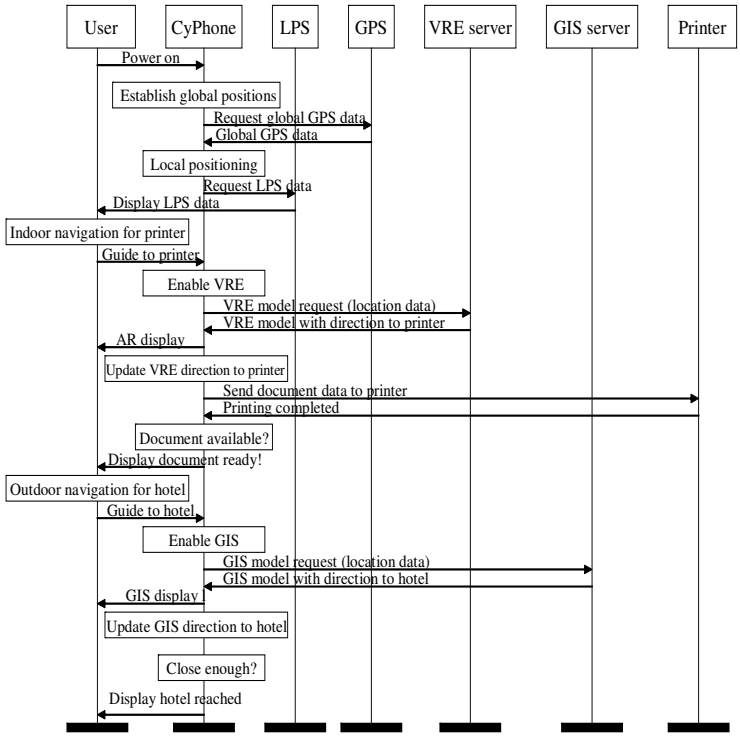


Fig. 13. Peer-to-peer dynamic modelling: CyPhone navigation

view of mobile scenarios for development and deployment purpose. The dynamic reference modelling approach is being increasingly used in research in diverse areas. The unique characteristic of this approach is its ability to represent the real dynamic world, thus justifying its role in modelling community.

7 FUTURE WORK

In the near future a well-defined generic reference model is expected to specify the basic components and their interrelationships in the wireless world. This model should be concise while expressive in defining the future wireless systems. A number of key issues in reference modelling need to be addressed:

- a formal description of the semantics of the reference points
- methodologies to define communications via the reference points
- refinement/sub modelling of the grand building blocks of the reference model

- methodologies to dynamically model key applications for systems beyond 3G in the wireless world
- more details of possible business models.

The established reference model is targeted to provide a basis for mobile scenario modelling, analysis and development in the wireless world. The reference models will be applied on modelling some 3G and beyond mobile scenarios to demonstrate and get a better understanding of killer applications in the wireless world.

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