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# A Service Layering Architecture for Inherently Real Systems

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*Abstract*

Commercial systems that are based on virtual reality tend to find very specific niche areas for commercial applications e.g. military flight simulations, entertainment. Such an approach describes the prevalent application centric approach to the design of virtual systems. An alternative approach involves the separation of the hardware implementation platform from the service applications. By doing so it would be possible to deploy a wider range of services upon the hardware platform, broadening the scope and appeal of the system. This paper describes a service layer architecture for inherently real systems, systems that are fundamentally based and coupled with the real world e.g. Augmented Reality and Telereality. Three layers of service are described, a Personal User Service, Local Area Service and Global Service Network. The Personal User Service describes user centric services that are available from personal devices they pocess e.g. mobile phone. Local Area services define the services that are available to the user from the immediate environment and Global Service Network defines the services available to the user from universal networks e.g. UMTS. An experimental system used to facilitate this service structure based on visual cells is presented and discussed.

Keywords : TeleReality, Virtual Reality, Augmented Reality, Telepresence, Visual Cell

## 1. Introduction

The most creative and successful of literary masters have managed to transport their audience into a alternative world and time by using creative writing and actors to create a visual impression in the mind of it's audience. For the last number of decades others have attempted this through the medium of Virtual Reality, Augmented Reality and TeleReality, pushing the current technology to the limits in order to provide more realistic, immersive, interactive experiences for entertainment, training and communication purposes.

Commercial applications utilising these technologies have generally found their way into niche markets like military simulation, games, security systems etc. without attaining any form of broad appeal or general usefulness in everyday life. In part, these systems are highly focused and optimised to perform their allotted tasks. To emerge from such a narrow focused approach in order to reach a wider audience, a system must have a greater amount of flexibility and potentially support a wider range services. By separating the hardware platform from the services that reside upon it, opens the possibility for the flexible deployment of additional services, hence improving the overall attractiveness of the system.

In this paper, the authors describe a Service Layering Architecture for inherently real systems (Augmented and TeleReality systems) which is been proposed under the Wireless Strategic Initiative(WSI) for 4$^{th}$ generation mobile systems. The Service Layering Architecture divided the service provision between the user, the immediate local area and the globally area network. The user is provided with a Personal User Service (PUS), that provides services only they can use without accessing any external network. The Local Area Service(LAS) provides the user with access to services that are available in the surrounding environment and the Global Service Network(GSN) provides access to global information and services like the internet and UMTS. A system to test and develop this service approach is under active construction as part of the PAULA project.

This paper is organised as follows. Section 2 briefly describes the 3 main fields of Virtual reality, Augmented Reality, TeleReality and their relationship with each other. The concept of 'Inherently Real' systems are discussed. Section 3 proposes the service layer architecture comprising of Personal User Service, Local Area Service and Global Services Network. Section 4 briefly describes the Visual Cell concept and implementation which will provide the platform for future study. Section 5 presents the conclusions of this paper.

## 2 .Relationship between 'Reality' technologies

Virtual Reality has become a catch all phase to incorporate everything involving the creating of virtual information and the associated hardware. Essentially there are 3 fields of study that originates from 'Virtual reality'

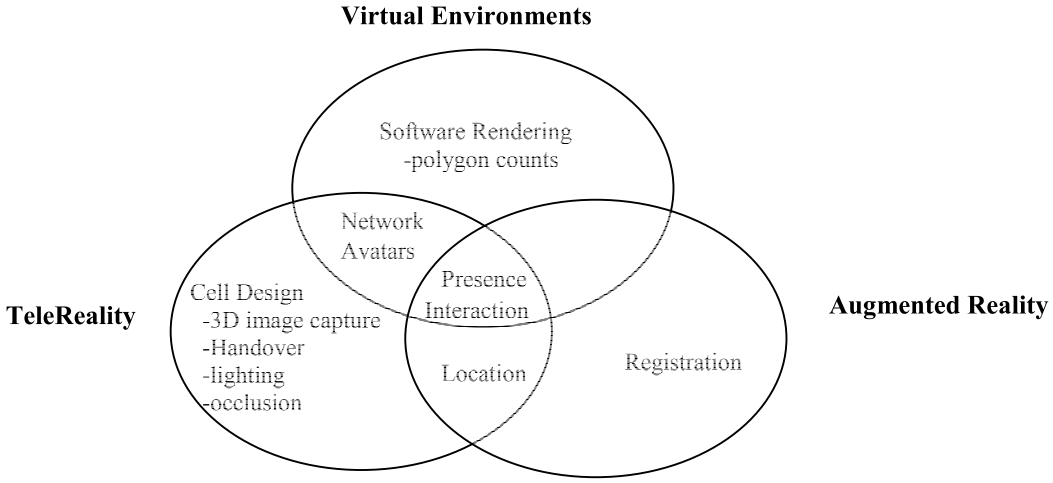


**Figure 1** Relationship demonstrating the common areas of technology between the research fields of Virtual Environments, TeleReality and Augmented Reality

*Augmented Reality* Augmented Reality systems superimpose synthetic objects on the surrounding environment to provide information about the surroundings helping with tasks like maintenance, navigation etc.[1]

*TeleReality*. Telereality extends telepresence systems by allowing greater interaction with a remote environment and enables the user to browse a remote real world in much the same manner as they could browse a virtual environment. [2]

*Virtual environments* The field most closely related to Virtual reality, it covers the creation of virtual environments [3,4].

The author prefers to use the term 'Reality engineering' to group these 3 research fields together.

**Inherently real/virtual system:** A basic distinction between the different Reality fields is the context in which they reside. Virtual Environments, while they may model a real location, provide no coupling between the real world and the virtual world. If a light is switched off in the real world, then this is not reflected in the virtual world. Hence Virtual environments are 'Inherently Virtual'. By contrast Augmented Reality and TeleReality systems are based on the real world. A change in the real environment is instantly commuted to the user. These systems are then called 'Inherently Real' systems.

The distinction between inherently real/ virtual systems has a strong impact on the technology used to realise the systems. From figure 1 it can be observed that the critical technologies, registration, location and cell construction, are all based on obtaining real world information.

**Selected critical research topics:** In Figure 1, the significant research questions which are applicable to each technology and shows the technologies that are of common interest. The choice of placement is open to debate but as a whole it is based upon their relevant importance, e.g. software rendering is important to all three systems, however it is much more significant an issue for Virtual environments .[1].

To construct a basic platform for an inherently real system, the designer must address to some degree the technological problems shown in Figure 1.

*Registration* Important for augmented reality it is necessary for the correct overlaying of synthetic objects on the real world [5].

*Cell construction* This is the process by which a Telereality system is built. The environment is captured using image capturing techniques that contain it's physical 3D layout [6], enabling remote users to navigate it in the same manner as they would navigate a virtual world. Key problems concern image capture, occlusion and lighting.

*Network*. Virtual Environments (NVE) can either be networked e.g. Massive, or standalone. Virtual Network Environments (NVE) transfer basic state data e.g. orientation, position etc. to other players in the network. TeleReality systems are entirely network dependent and the primary data transmission type is video streaming with some additional state data transfer. Hence TeleReality systems are much more limited in scale due to the higher required bandwidth than Nave's.

*Avatars* Avatars are the virtual representation for the user in VE and TR systems. In TR systems, the virtual avatar is available to the users residing at the real world location that is been visited.

*Presence* Presence determines the level of immersion a user feels in a reality system. Presence can be achieved by sensual immersion or alternatively by task performance [7].

*Location* In VE environments the world is constructed on a 3 dimensional co-ordinate system. Location for Augmented Reality systems are more complex. Location can be determined by the GPS position of the user. This does not work well for indoor environments so an additional location based system is used to determine the accurate position of a user. TeleReality for practical reasons also uses the same location based approach as AR.

*Interaction* Interaction is essential for reality systems. Interaction not only provides an additional felling of presence, but enables the users to perform tasks and access services.

## 3 Service Access Layers

Many Reality systems described in literature tend to focus on specific scenarios or applications for which their system is constructed. Virtual Environments are constructed for the purposes of gaming, situational training etc. Augmented Reality systems are constructed for navigation [8]and TeleReality systems are used for meetings [9]. To broaden the scope and appeal of inherently real systems, significant effort should be devoted to the deployment of an open service platform that can provide different services and is capable of deploying new services when available.

This section will discuss such a service model for inherently real systems. Inherently real systems already provide an important bounds to the research problem, the real world. The real world is a concept easily understood by developers, essentially concentrating their efforts on the real world needs of the user rather than some arbitrary virtual world concept.

**Service Layering Architecture:** The service architecture model that is proposed is in the form of Service layering and is shown in Figure 2. In this model the services are divided between the user, the local area and the global area. The local area is subdivided into cells and a macro layer. These layers and their scope are described as follows.

**Personal User Service:** The Personal User Services are a number of personal services that only the user has access to. The user effectively owns these services .These services are carried by the user and reside on a personal area network e.g. Bluetooth based. The supporting devices can be carried (mobile phone), sewn into clothes, sophisticated HMD type glasses etc. Examples of possible services include a watch, notepad, mobile phone, mobile internet access terminal etc. Some services can be instructed to interact with other services layers to make voice calls, access printing services etc.

**Local Area Services :** Area services are specific services that are offered in a geographical location that the user is in (AR) or visiting (TR). The local area services are divided into macro layer services and cell layer services. The macro layer provides services to everyone within the area e.g. a office building. Cell layer services provide services for specific sub areas e.g. a checkout counter.

**Global Services Network:** The Global Service Networks are services that are available from more universal systems like UMTS the internet. These services can be accessed through the PUS or LAS (e.g. a virtual payphone).

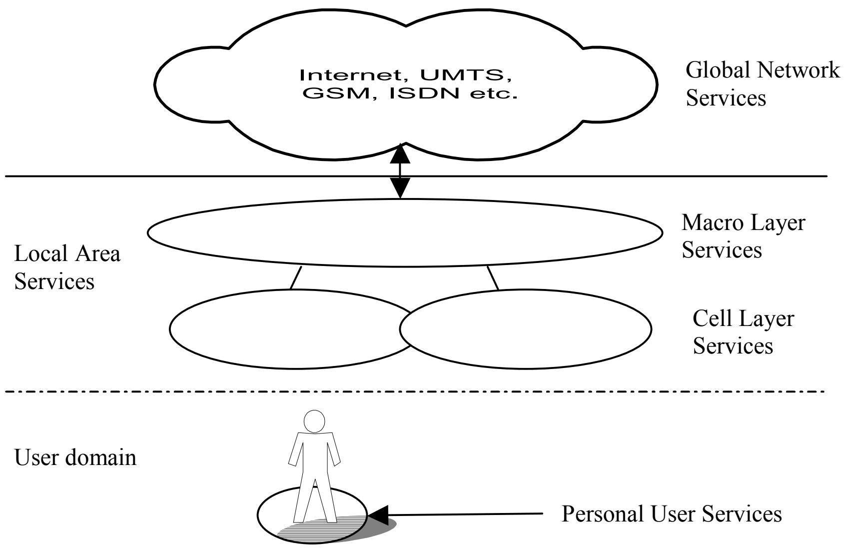


**Figure 2** Service layering architecture for TeleReality and Augmented Reality systems

The advantage of this service layer structure is that it divides services according to the area and needs of the user. With personal services, the user has total control to customise their settings to match their own needs. Area services provide additional user information e.g. company announcements, shop advertising etc. Global services can be accessed at anytime anywhere.

The service layers outlined are not without some problems and disadvantages. Two main concerns involve service information overload and security concerns. Service information overload can be caused by the user been swamped with information that is either unwanted or is excessive enough that the user has difficulty in selecting the required service, hence a method must be examined that will enable the user to filter out useful services. Secondly, there is always the risk of a big brother feeling or that people may get access to services that they are not entitled to e.g. restricted Aries. Hence some services could be placed on different levels of security access.

**Service Object types**

So far we have discussed the different service layers for an inherently real system. Service objects manage the access and provision of a service. The service object has a Service Object Interface(SOI) and the Service Manager.

The Service Object Interface is the element that is presented to the user of the system. It contains information relevant to it's location on the world, orientation, shape and texture representation. It contains all of the interface requirements necessary for the service behaviour it is attached to.

The Service manager contains the service behaviour. It determines if it can fulfil the requested service, can act as a facilitator to an additional service e.g. a payphone service would connect to the global network.

The Service Object can be static, dynamic or migrating. A static service object resides in the system permanently. A dynamic service object is a temporary service created when a user visits a areas e.g. virtual shopping basket. A migrating service object travels with the user from cell to cell, e.g. a virtual tour guide.

## 4 Visual Cells System.

The preferred method for implementing a TeleReality system at present is to arrange a large number of visual cells in a matrix to create a much larger space. A visual cell is defined as

> *'A limited space containing an image capturing device, where the space contains interactive real/virtual objects. Visual cells can be combined in a matrix to form one space which can be navigated and interacted with'*

An important element of this approach was to incorporate interactive objects which would allow a visitor to interact with the immediate surroundings. It soon became apparent however that when the user resided at the same location he was accessing, they were essentially receiving the same type of services as a Augmented Reality user. As a augmented reality system also uses a similar cell like structure to determine registration and location information, it was logical to group the service provision for both systems under the same service provision cell like structure.

At the University of Oulu we have we have constructed the first version of an experimental Visual cell system containing 2 cells. The system contains 2 visual cell, each providing a constant video feed. Each cell contains 1-2 interactive objects, used to 'teleport' from cell to cell. It is also possible to move from cell to cell using a keyboard keys.

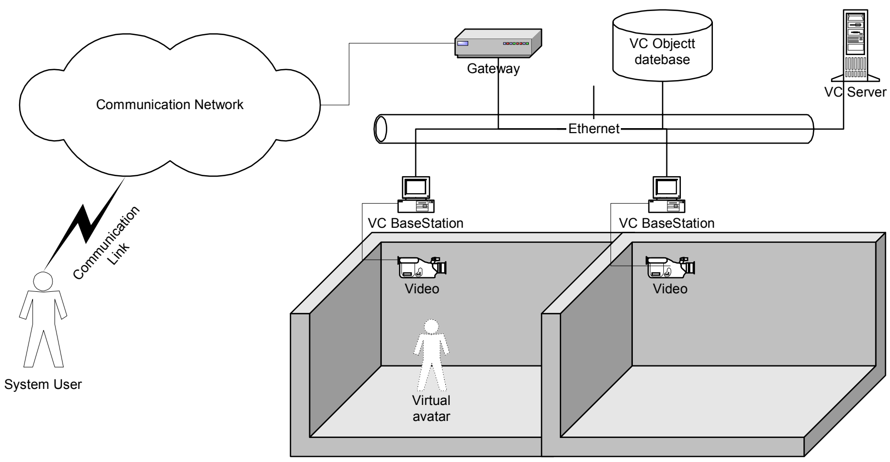


**Figure 3** Experimental Visual cell architectue

Figure 3 shows the current setup for the system. Each visual cell is equivalent to a Local Area Cell while the Local Area Macro layer resides in the VC Server. Access to the GSN is available by TCP/IP, although no services use this feature yet. The database stores the visual cell object information, which is accessed at start up. In future iterations of the system, it is planned to store dynamic objects and migrating objects in a 'visiting' database

The Visual cell system provides a good starting point for further research and conceptual testing

## 5 Conclusion

This paper has set out to present a service layer structure for use with inherently real technologies like Augmented Reality and Telereality. The service layer composes of 3 different core layers, the personal service layer, Area layer and global Layer. The Area layer is de composes into cells which provide services to at specified locations while the over layer provides universal services for the whole area. Additionally the concepts of resident static and dynamic services objects and migrating service objects were also introduced. In addition, an experimental platform system using visual cells was introduced. The visual cells concept was described and the architecture of the system was discussed.

Considerable work is still required to fully develop the system. Future work will primarily focus on and implementing migrating objects, proxy objects plus the addition of shortwave radio to allow a augmented reality user access to the system

## 6 Acknowledgements

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