Large Scale Mobile and Pervasive Augmented Reality Games

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Abstract — **Ubiquitous or pervasive computing is a new kind of computing, where specialized elements of hardware and software will have such high level of deployment that their use will be fully integrated with the environment.**

Augmented reality extends reality with virtual elements but tries to place the computer in a relatively unobtrusive, assistive role.

To our knowledge, there is no specialized network middleware solution for large-scale mobile and pervasive augmented reality games.

We present here work that focus on the creation of such network middleware for mobile and pervasive entertainment, applied to the area of large scale augmented reality games. In, this context, mechanisms are being studied, proposed and evaluated to deal with issues such as scalability, multimedia data heterogeneity, data distribution and replication, consistency, security, geospatial location and orientation, mobility, quality of service, management of networks and services, discovery, ad-hoc networking and dynamic configuration

Keywords — Pervasive networking, augmented reality, middleware, entertainment, gaming.

I. Introduction

MARK Weiser [1] theorized about a new kind of computing, called ubiquitous or pervasive computing, where specialized elements of hardware and software would be so ubiquitous no one would notice their presence. According to Mark Weiser [1] the technology required for ubiquitous computing would come in three parts: cheap, low power computers including equally convenient displays, software for ubiquitous applications and a network that ties them all together.

In the current decade we will see the merger of telecommunications and IT worlds [2]. The Internet Protocol (IP) is the network layer protocol in the 3GPP specifications, and the current trend in developing new telecommunications networks is to utilize internet protocols. So, the network that ties all things together is now possible. But there are many issues under study in the internet community. These are mobility, quality of service, security, management of networks and services, discovery, ad - hoc networking and dynamic configuration, and geospatial location.

Cheap, low power computers including equally convenient displays are also coming closer to reality. In fact, we can consider the latest PDA's and mobile phones an early version of Weiser's ubiquitous computers.

A significant requirement of pervasive applications is fast service development and deployment [2], which implies the introduction of various service and application frameworks and platforms. For this, middleware is a common solution. The benefits of middleware utilization are the improved programming model, and the hiding of many implementation details, which make middleware based application development much faster.

It is now becoming quite clear that entertainment, and more specifically mobile gaming, will be one of the killer applications of future wireless networks [3], however, mobile gaming applications face issues that are different from fixed network applications. These issues include fluctuating connectivity, quality of service and host mobility. Another issue is how to manage game state consistency with a dynamic mobile networked environment in which devices may be physically close but topologically distant. Further yet, there is the issue of how to manage multiple wireless network connections such as, for example, GPRS and IEEE 802.11 at the same time.

Augmented reality extends reality with virtual elements while keeping the computer in a assistive, unobtrusive role [4]. It is possible to create games that place the user in the physical world through geographically aware applications. The latest mobile phones are being equipped with GPS receivers and there are software and hardware tendencies from the largest manufacturers to equip mobile phones with more advanced context - aware technology. All the latest mobile phones are equipped with cameras and some of the latest ones are coming with some form of 3D rendering technology [5][6]. Bluetooth technology and increasing miniaturization makes possible, in the near future, specialized pervasive equipment for augmented reality. The opportunity for some cheap augmented reality is here.

To our knowledge, there is no specialized network middleware solution for large-scale mobile and pervasive augmented reality games.

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II. OBJECTIVES

The main objective of this work is the creation of a network middleware for mobile communications that will enable integrated large-scale augmented reality applications to be built around it.

The middleware that will be created will evolve from previous work from the candidate in the area of interactive distributed multimedia, more specifically in state transmission for a collaborative virtual environment middleware platform, the Status Transmission Framework (STF)[7][8]. This platform extended ARMS - Augmented Reliable corba Multicast System[9] -with capabilities for the handling of state transmission for distributed collaborative virtual environments.

In this context mechanisms are being studied, proposed and evaluated to deal with issues such as::

a) Mobility, such as fluctuating connectivity, host mobility and handling of multiple simultaneous network connections;

b) quality of Service (QoS), such as minimizing delay and jitter ,and reliability;

c) security, such as authentication and prevention of cheating;

d) management of Networks and Services;

e) discovery;

f) ad-hoc networking and dynamic configuration;

g) geospatial location and orientation

h) scalability;

i) consistency

j) multimedia data heterogeneity

k) data distribution and replication

III. DETAILED DESCRIPTION

This work focus on the creation of network middleware for mobile and pervasive entertainment, applied to the area of large scale augmented reality games. There is a tremendous opportunity for research and development in the area of massive multiplayer games applied to augmented reality, from the point of view of multimedia and communications. The installed infrastructure of mobile operators makes it possible to install distributed solutions directly linked to geographical locations bounded by its transmission cells. Solutions extending the work envisioned in [10] and applying map subdivision like in [11] may be useful. The need for killer applications to justify the overwhelming investments made is another important factor to consider. But the difficulties exist, because of the current characteristics of the mobile networks [12]. Bandwidth on mobile networks, though increasing, is a scarce resource when compared to fixed networks. Adding to this, both transient and persistent storage spaces on the mobile host are very limited. There are also the problems of mobility handling and disconnected operation.

The middleware that will be created will incorporate experiences and results obtained from previous work from the candidate in the area of interactive distributed multimedia, more specifically in state transmission for a collaborative virtual environment middleware platform, the Status Transmission Framework (STF) [7][8]. This platform extended another platform, called ARMS – Augmented Reliable CORBA Multicast System [9], for event distribution. Knowledge will be used from areas as diversified as peer–to-peer computing, mobile and wireless networks, pervasive computing, embedded systems, multimedia protocols and systems, interactive distributed multimedia, and network gaming theory and protocols.

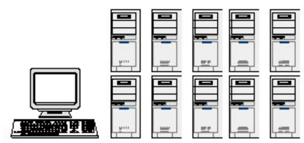

Fig. 1 - Central level of the system

We may consider that distributed collaborative virtual environments have network requirements that will in its majority be common to augmented reality environments. The fundamental problem for collaborative virtual environments is how to maintain a consistent shared state of the virtual reality world [7][8]. Another research topic is, from a quality of service point of view, how to efficiently transmit update messages so as to provide scalability, minimized delay, consistency and reliability. Collaborative virtual environments also have the requirement of being able to handle multiple types of data, which may be multimedia data, state update and control data.

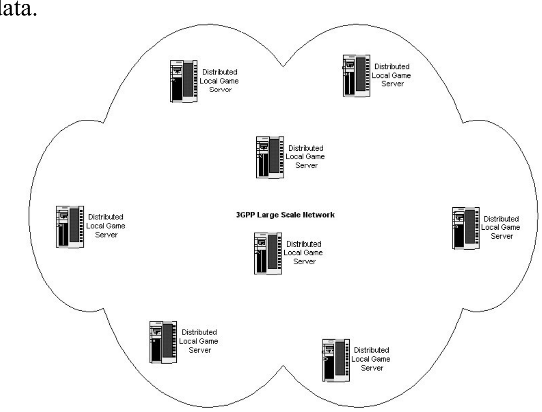

Fig. 2 – Large scale network level of the system

The system that will be targeted by the middleware will be composed of 3 levels: the back-office central level, depicted in Fig. 1, the large scale network level, depicted in general in Fig. 2, and the personal area network level, depicted in general in Fig. 3.

The back-office central will consist of one or more of a series of parallel servers and will serve as the main controlling station of the game administrator. The person responsible for starting, stopping and managing game performance and general maintenance tasks. This may be done for every specific game running on the system.

The large-scale network is the 3GPP network as it is being built by the specifications, where servers will be distributed according to some logic of spatial distribution and linkage of its location with specific geographic locations. These may be, in the extreme, the cells of the mobile communications network.

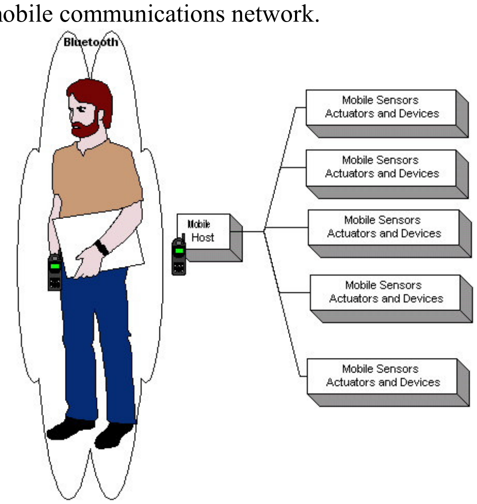

Fig. 3 - The personal area network level of the system

The personal area network level will consist of the network of pervasive devices dedicated to personal communications and to augmenting reality that the person carries with it. These may be sensors, actuators, and other devices that can communicate under Bluetooth or other means of communication. All those communicate to the mobile host, probably just a cell phone or specialized device connected to the large scale network, the 3GPP network. The player is so enabled to play games of augmented reality wherever it is.

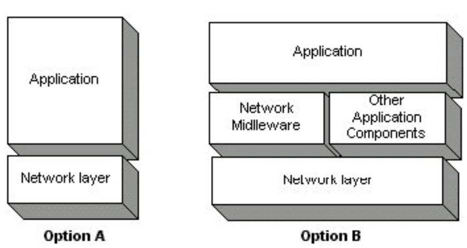

Fig. 4 - Opting for network middleware architecture

Targeting this architecture will allow the study, evaluation and proposal of mechanisms to deal with issues of scalability, multimedia data heterogeneity, data distribution and replication, consistency, security, geospatial location and orientation, mobility, quality of service, management of networks and services, discovery ,ad-hoc networking and dynamic configuration.

We can consider that building the augmented reality applications using the network middleware (option B of Fig. 4) is better that building them standalone (option A of Fig. 4). This is because with option B many game applications may then use the same application programming interface (API) to leverage network resources, giving it much faster service development and deployment.

The middleware produced will be build according to the characteristics of agile pervasive middleware [13], such as application – awareness, mobility, integration, interoperability, scalability, portability, adaptability, robustness and simplicity of evolution.

IV. The System

The system that will be built will be based on Java technology, and will make use of the Java Technology for the Wireless Industry related APIs, like the location API, the SIP API, the Bluetooth API and others, and will be designed to utilize a 3GPP network as the base mobile network for the system. The system will have three levels: The central level, the distributed server level and the personal area network level.

A. Central level

At the central level, there will be one server, which may be constituted by more than one parallel server, running in Java Standard Edition 1.4.2. There will also be database servers, which may or may not be integrated on the same server.

B. Distributed server level

At the distributed server level, there will be multiple distributed servers, linked to geographical coverage areas which in the extreme may even be linked to the cells of the mobile network, which will distribute the load off the main server.

These servers will run on Java Standard Edition 1.4.2 also. They will have integrated database servers running on same or different computers.

C. Personal area network level

At the personal area network level we will find the most diversified types of devices. The main device will probably be a cell phone or a specialized device for game playing.

The required characteristics for this device is that it must support the Java language , more specifically, Java Micro Edition, in its Connected Limited Device Configuration (CLDC) version 1.1, and the MIDP – Mobile Information Device Profile - version 2.0..

This central device must support also the Java Bluetooth API (JSR-82), the Java SIP (Session Initiation Protocol) API for J2ME (JSR-180) and the location API for J2ME (JSR-189).

Other devices that are needed on the personal area network level are input and output devices. These devices must also support at least Java (same version and configuration) and the Bluetooth API.

Output devices are essentially video and audio output devices. Video and audio output devices should also support, besides Java (CLDC 1.1) and Bluetooth for Java Micro edition (JSR-82), the Mobile 3D graphics API (JSR-184), and the Mobile Media API for J2ME (JSR-135).

As for input devices, in the real world environment, the user is often used to using one or both hands to perform a task. Therefore, the input devices used with wearable computers need to be designed with this requirement in mind. Appropriate input devices need to be utilized to allow the user to efficiently manipulate and interact with objects. For data entry or text input, body mounted keyboards, speech recognition software, or hand held keyboards are often used. Devices such as IBM's Intellipoint, trackballs, datagloves, etc., are used to take the place of a mouse to move a cursor to select options or to manipulate data. One of the main advantages of using a wearable computer is that it allows the option of hands free use.

Common factors in the design of input devices are that they all must be unobtrusive, accurate, and easy to use on the job.

In order for any digital system to have an awareness of and be able to react to events in its environment, it must be able to sense the environment.

This can be accomplished by incorporating sensors, or arrays of various sensors (sensor fusion) into the system. Sensors are devices that are able to take an analogue stimulus from the environment and convert it into electrical signals that can be interpreted by a digital device with a microprocessor.

For a sensor or array of sensors to be supported by the status transmission framework version 2.0, it must be accompanied by hardware that translates its electrical impulses to digital signals transmitted over Bluetooth communications over the personal area network to the central device.

Is the central device witch will coordinate all the augmented reality experience for the user, using all the multimedia capacities of the other devices and eventually, even own multimedia capacities of the central personal area network device.

The central personal area network device will communicate using the mobile network with the distributed or central servers to provide the required game receiving and transmitting services, and value added services.

Status Transmission Framework version 2.0 will integrate and optimize all these technologies with network level optimizations to achieve optimum middleware performance.

V. Conclusion and Future Work

In this paper we proposed a network middleware system that facilitates building large scale mobile and pervasive augmented reality game applications.

Besides the novelty of the system itself, we hope to contribute with new mechanisms on areas such as mobility, quality of service, security, management of networks and services, discovery, ad-hoc networking and dynamic configuration, geospatial location and orientation, scalability, consistency, multimedia data heterogeneity, data distribution and replication.

As for future work we hope to be able to create, test and optimize the middleware and with it contribute with a platform that solves the network needs of large scale mobile and pervasive augmented reality game applications.

Acknowledgment

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