Gaming Platform for Running Games on Low-End Devices

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Abstract. Low cost networked consumer electronics (CE) are widely used. Various applications are offered, including IPTV, VoIP, VoD, PVR and games. At the same time the requirements of computer games by means of CPU and graphics performance are continuously growing. For pervasive gaming in various environments like at home, hotels, or internet cafes, it is beneficial to run games also on mobile devices and modest performance CE devices such as set top boxes. EU IST Games@Large project is developing a new cross-platform approach for distributed 3D gaming in local networks. It introduces novel system architecture and protocols used to transfer the game graphics data across the network to end devices. Simultaneous execution of video games on a central server and a novel streaming approach of the 3D graphics output to multiple end devices enable the access of games on low cost devices that natively lack the power of executing high-quality games.

Keywords: distributed gaming, graphics streaming, video streaming, gaming architecture.

1 Introduction

Future home is considered to be an always-on connected digital home with various appliances. Computer gaming and other entertainment equipment has been utilizing networked home infrastructure already for some time. Modern games have become highly realistic and their requirements for CPU processing power and graphics performance are increasing. At the same time users have adopted to use various low execution power end devices for which modern 3D computer games are too heavy.

The Games@Large project is developing a novel system for gaming both for homes and for enterprise environments, like hotels, internet cafés and elderly homes [1]. In the Games@Large system the key concepts are execution distribution, audio, video and graphic streaming and decoupling of input control commands. According to the Cloud Computing concept, games are executed in one or more servers and the game display and audio is captured and streamed to the end device, where the stream

P. Daras and O. Mayora (Eds.): UCMedia 2009, LNICST 40, pp. 259–262, 2010.

is rendered and the game is actually played. Game control is captured at the end device, streamed back to the server and injected to the game. In comparison to other currently emerging systems, the Games@Large framework explicitly addresses support of end devices with rigorously different characteristics, ranging from PCs with different operating systems over set-top boxes to simple handheld devices with small displays and low CPU power, with adaptive streaming techniques.

There is a number of commercial Gaming on Demand systems, overviewed in [2], that have been presented to the market. More recently, there have been some new announcements about the upcoming systems such as Playcast Media Systems, Gaikai's Streaming Worlds technology, Onlive and GameTree.tv from TransGaming Technologies. However, there is very little detailed technical information publicly available about the commercial systems.

This paper presents briefly the novel Games@Large architecture and its key functionalities. Finally we present system performance conclusions based on our laboratory tests.

2 Games@Large Framework

The Games@Large system consists of three major element classes: servers, end devices and access points. Games are played on the end devices and executed on the servers. Games run on the Local Processing Server (LPS), which utilizes also the Local Storage Server (LSS). In the home version, these logical entities will be located in the same physical computer. In an enterprise version, the server entities are distributed into several physical computers. End devices, like STBs or Enhanced Multimedia Extenders (EME), Enhanced Handheld Devices (EHD) and notebooks are connected to the server either with wireless or wired connection. The system exploits an adaptive streaming architecture and uses Quality of Service (QoS) functionalities to ensure good quality gaming to a variety of devices connected to the wireless network. The details of each component have been presented in earlier publications [1,2,3,4,5,6,7,8] so only a brief summary is given here.

The objective of the streaming architecture is to support various end devices with an efficient and high quality game experience, independent of software or hardware capabilities. To meet these demands a streaming architecture has been developed that is able to support two streaming strategies to display the game remotely: graphics and video streaming.

Graphics streaming is used for end devices with accelerated graphics support, like computers or set-top-boxes, typically having screens of higher resolution. Here the graphics commands from the game are captured on the server, transmitted across the network using a protocol developed in the project, and rendered locally on the end device. In this way, high image quality is achieved, since the scenes are always directly rendered for the desired screen.

Video streaming is used mainly for end devices without a GPU, like handheld devices, typically having screens of lower resolution. Here the graphical output is rendered on the game server and the frame-buffer is captured and transmitted encoded as H.264 video stream. In this approach the bit rates are in general much more predictable in comparison to graphics streaming. However, H.264 encoding on server side as well as decoding on end devices is computationally demanding.

Audio streaming sub-system has been developed to produce sounds and music of the games at the end device. Since computer games typically produce their audio samples in a block-oriented manner, the current state-of-the-art audio encoder, the High Efficiency Advanced Audio Coding version 2 (HE AAC-v2) is used. UDP based Real-time Transmission Protocol (RTP) and Real Time Control Protocol (RTCP) are used for the synchronization at the playback.

Different end devices typically provide several different input modalities. In the initial discovery phase performed by the UPnP device discovery, the end device sends its properties and capabilities. During the game play, the input from the controllers are captured either using interrupts or through polling. The captured commands are then transmitted to the server. At the server side the input commands are mapped to the appropriate game control and injected in real-time to the game running at the server.

To ensure smooth game play, decent Quality of Service (QoS) is required from the wireless home network. In order to meet the requirement of using low cost components, the choice for the wireless home network has been to use IEEE 802.11 based technologies, because of their dominant position in the market. Priority based QoS is supported using Wi-Fi Multimedia (WMM) extensions at the MAC-layer and UPnP QoS framework for QoS management.

3 Games@Large Performance Potential

Lab experiments have shown that the G@L system is capable of running video games of different genres and streaming them with a high quality to concurrently connected clients via a wireless / wired network, in particular exploiting a QoS solution, which improves systems performance also in the presence of competing traffic.

In the case of graphics streaming the quality of gaming experience is typically correlated with the game frame rate, which in the G@L system is proportional to the network throughput. Video games that use high data rates per frame require very high bandwidth and thus, are problematic to be deployed via current networks.

For the video streaming, experiments have shown that the encoding time at the server enables the handling of multiple parallel streams on a single server. Further enhancements are expected by exploiting more information on the scene structure obtained from the graphics board. The performance of H.264 allows for satisfying visual quality at bit rates of several hundreds of kilobits [7].

With regard to device performance, the server must have enough CPU power and memory to run the game natively. Additionally, the amount of video memory that a game requires when running natively, must be available in the system memory when running in the Games@Large environment (because the graphic objects are emulated by the streaming module in the system memory). The most important hardware requirement for the client device is the video adapter (for 3D streaming). It should have hardware acceleration capabilities to enable fast rendering of 3D scenes, otherwise only the video streaming can be used. As on the server, the graphic resources that the game stores in the video memory should be available in the system memory to enable manipulation prediction and caching. So memory requirements for the client should be 200-300 MB available to the client application for fairly heavy games [8].

Another issue for a game to be playable on low-end devices is that it has to be compatible with the device screen size (in particular concerning resolution) and controller capabilities (e.g., some games are difficult to control with a gamepad, a PDA keypad or a remote control for TV). Thus, our research argues for new generation mobile devices to have an increase in their Human-Computer Interaction capabilities in order to support more advanced interaction modalities also considering new networked interactive media applications [7].

4 Conclusions

Games@Large is implementing an innovative architecture, transparent to legacy game code, that allows distribution of a cross-platform gaming and entertainment on a variety of low-cost networked devices. Virtually extending the capabilities of such devices the Games@Large system is opening important opportunities for new services and experiences in a variety of fields and in particular for the entertainment in the home and other popular environments.

Acknowledgement

This work has been carried out in the IST Games@Large project (http://www.gamesatlarge.eu) [1], which is an Integrated Project under contract no IST038453 and is partially funded by the European Commission.

References

[1] Tzruya, Y., Shani, A., Bellotti, F., Jurgelionis, A.: Games@Large – a new platform for ubiquitous gaming. In: Proc. BBEurope, Geneva, Switzerland, December 11-14 (2006)
[2] Jurgelionis, A., et al.: Platform for Distributed 3D Gaming. International Journal of Computer Games Technology, Article ID 231863, 2009
[3] Eisert, P., Fechteler, P.: Remote rendering of computer games. In: SIGMAP 2007, Barcelona, Spain, July 28-31 (2007)
[4] Bouras, Poulopoulos, Sengounis, Tsogkas: Networking Aspects for Gaming Systems. In: ICIW 2008, Athens, Greece, June 8-13 (2008)
[5] Laulajainen, J.-P.: Implementing QoS Support in a Wireless Home Network. In: WCNC 2008, Las Vegas, USA, 31 March-3 April (2008)
[6] Eisert, P., Fechteler, P.: Low Delay Streaming of Computer Graphics. In: Proc. Intern. Conf. on Image Processing (ICIP), October 2008 (2008)
[7] Jurgelionis, A., et al.: Distributed video game streaming system for pervasive gaming. In: STreaming Day 2009, Genoa, September 21 (2009)
[8] Laikari, A., Fechteler, P., Eisert, P., Jurgelionis, A., Bellotti, F.: Games@Large Distributed Gaming System. In: 2009 NEM Summit, Saint-Malo, France, September 28-30 (2009)