

Multimedia Delivery Grid: A Novel Multimedia Delivery Scheme

ZhiHui Lv, Jian Yang, ShiYong Zhang, and YiPing Zhong

Department of Computer & Information Technology, Fudan University,
200433 Shanghai, China
{lzh, jianyang, szhang, ypzhang}@fudan.edu.cn

Abstract. Based on the analysis of some problems faced with traditional edge multimedia delivery technology such as CDN today, a novel grid-based multimedia delivery scheme, multimedia delivery grid, is introduced in this paper. We propose new hierarchy architecture and analyze the relationship of the elements in this architecture, and then discuss the dynamic delivery process. At last, from our research experiences and related survey, we illustrate the prospective research direction of this field.

1 Introduction

While consumption of multimedia information is steadily increasing, the usage of multimedia has not fully caught on because of the low quality of service (QoS), and the resulting poor user experience. As a developing trend, the arrival of broadband technology is solving the bandwidth limitation problem at the delivery edge of the network, but Internet backbones remain congested. To overcome this challenge of massive multimedia consuming, only installing more high-speed main pipes will not be enough; service providers need a more intelligent infrastructure layout to grow with this explosive market. Therefore, today's service providers are improving quality, bandwidth availability, profitability and service delivery levels allowing for more customers within the current infrastructure by using edge technologies, such as CDN, mirror sites, integrated caching to provide services. As a representative technique, Content Delivery Networks (CDN) is based on a large-scale distributed network of caching servers located closer to the edges of the Internet for efficient delivery of digital content including various forms of multimedia content. Moving content closer to the consumer results in greater network efficiency, improved QoS, and lower latency, while facilitating personalization of content through broadband content applications.

Although CDN is an effective means of multimedia information access and delivery, there are two main barriers to making CDN a more common service: cost and replication integrity. Deploying a CDN for publicly available content is expensive. The difficulty in maintaining replication integrity over a CDN is not because of inadequate corruption detection of single files, but the delay caused by the replication of very large files [1].

Furthermore, in order to more effectively address the requirements to access multimedia services from everywhere at anytime, recent research has focused on the development of new scalable, efficient, and flexible "next generation" middleware platforms [5]. These middleware platforms are intended to support the deployment of mainstream broadband applications including CDN and Video on Demand. One such next-generation middleware platform is the Grid computing system. A Grid is a virtual framework that allows resources across national and international boundaries to interoperate and share capacities in a controlled fashion to form scalable systems.

The integration between the grid technology and multimedia edge technology has produced a novel technology—multimedia delivery grid. The multimedia delivery grid is an extension of the computing grid mechanism to support the deployment of multimedia services to meet the ever-increasing demand for multimedia from users engaging in a wide range of activities such as scientific research, education, commerce, and entertainment. The multimedia delivery grid will provide various new services and sustain several enabling technologies to support multimedia [3]. Some of the new services include transparent user profile location and access supporting so that adaptive applications can be developed. A user in such an environment is not tied to a specific machine but rather is a machine independent entity that exists in the grid and can transparently carry its profile across the different platforms constituting the grid. Some of the enabling technologies that will be supported include: (1) Streaming Media, (2) Multicast, (3) QoS, (4) Co-allocation of Resources, and so on.

2 The Architecture of Multimedia Delivery Grid

In order to provide a pattern for establishing a Grid for delivering multimedia content to consumers, we propose the architecture of a three-tier hierarchy of few initial media sources (original content providers), metropolitan media centers and regional media centers acting as hierarchical carriers for popular multimedia content.

As Figure 1 showing, in this architecture, regional media centers are deployed in the network edge (at the inner end of the so-called "last mile"). The function of metropolitan media centers is to aggregate a number of neighbored regional media centers, for instance of a metropolitan area. Regional media centers are interconnected among each other according to their geographic neighborhoods. Consumer clients are connected to one associated regional media center from which they obtain media content. On request of a consumer, if the media content is available in the media center, the media content is directly provided from the regional media center to the consumer's home. If content is not present, the regional media center asks its neighbor or peer regional media centers for the content. If the content cannot be obtained from there, the regional media center asks its associated metropolitan media center. This procedure of asking peers before the higher-ordered element intends to avoid load at metropolitan media centers. Metropolitan media centers behave similarly as regional centers. If content cannot be obtained from peer metropolitan media centers, content is obtained from the original content provider at the top of the distribution hierarchy. Each media center has a certain capacity for storing content and maintains an index

about the stored content. It is assumed that content can be uniquely identified by index data (keys), as well as that the original content provider can be derived from a content inquiry description issued by consumers [4].

At the same time, delivery grid is highly scalable, because relay mechanism is used. It means that not only the peered media centers can relay and share contents each other, but also as each additional PC client also becomes a potential microserver and software node to provide content for other future neighbored or peered requestors of the content. Therefore, in the delivery grid, some of client desktop and laptop, armed with a piece of delivery agent, can act as microserver to distribute the received content to other neighbor requesters.

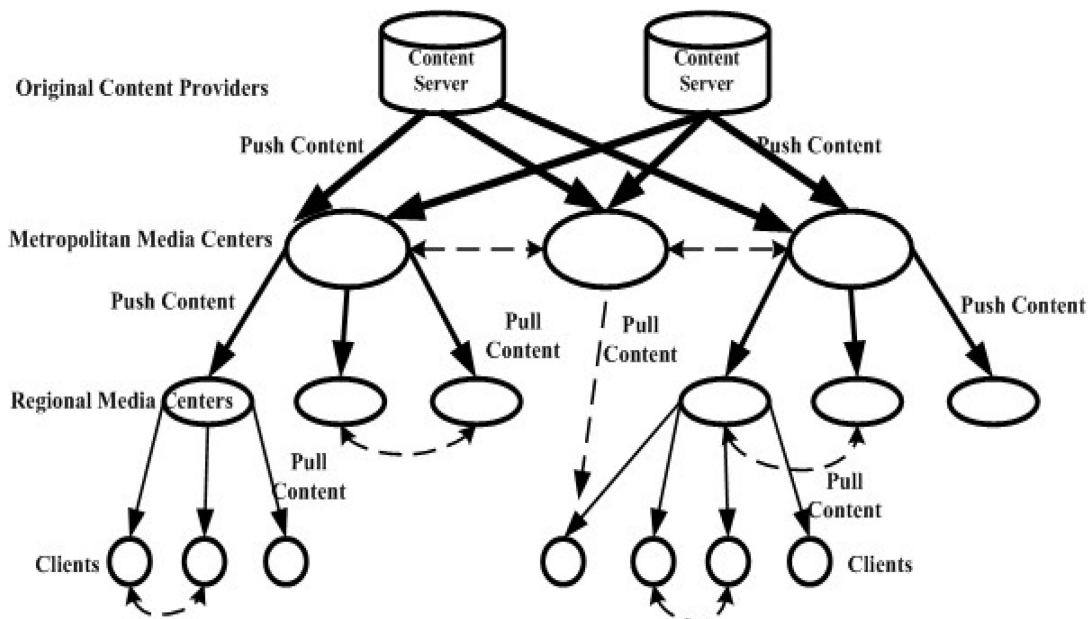


Fig. 1. Hierarchy Architecture of Multimedia Delivery Grid

3 The Delivery Process of Multimedia Delivery Grid

In our architecture, the delivery process is as following: Content owner publishes content to origin server through authorized publishing. Network Publisher applies content security settings using Network Protector and content metadata is communicated into the Directory Server. Published, secured content is propagated to Grid Servers (including metropolitan and regional media centers). When user requests the published content, he firstly logs on the Authorization Server and makes an access request. Then the authenticated user obtains the delivery ticket and requests a list of content sources to the Directory Server. Directory Server verifies requested content's validity; authenticate delivery ticket and responds with a list of optimal content sources. The requested client starts content retrieval process from optimal Grid Servers. Content downloaded successfully and verified against digital signature.

When another user on the Client Grid requests the published content from Directory Server, Directory Server recommends optimal Grid Delivery Servers and Client Grid

Nodes as content sources. The user makes requests to optimal Grid Servers and Client Grid Nodes. Requested content is Multi-Sourced from well-connected Client Grid Nodes and Grid Servers, resulting in high download performance, reliable delivery and reduction in bandwidth usage. The security protocols of the whole request and service flow comprise the typical transport layer security protocol-Security Socket Layer (SSL) and a novel XML-based Secure Distributed Delivery Protocol (SDDP). Login, authentication, authorization, and digital right management utilize SSL, while download request and content delivery employ the novel XML-based SDDP.

4 Conclusions and Future Work

Multimedia delivery grid further entering into global Internet will necessarily make grid technology closer to business field and obtain more enormous industry space. Nevertheless, the Internet use of delivery grid technology is in the research phase; researchers and developers must overcome many key technologies. Before deploying delivery grid on a worldwide scale, researchers have to carry on many experiments in grid test-bed with carefully controlled trials, continuously validating its scalability and evaluating its actual performance [2]. With the rapid development of multimedia communication and grid technology, multimedia delivery grid will necessarily have wide industrialization development prospects.

References

1. Zhihui L., Yiping Z., Shiyong Z., Jie W.: Study of Main Technology in Rich Media Grid Delivery. In the Proc. of ICCNMC'03, IEEE Computer Society Press, Oct 2003
2. Gartner Group Research Note.: Delivery grid Surfaces in Enterprise: A Tutorial, Jan 2003
3. Sujoy, B. (ed.): mmGrid: Distributed Resource Management Infrastructure for Multimedia Applications. In the Proc. of IPDPS'03, April 2003
4. Sven, G., Winfried, K., Carsten R.: Modeling and Simulation of Media-On-Demand Services -- Evaluating a Digital Media Grid Architecture. HP Laboratories Technical Report HPL-2002-192, July 2002
5. Muthucumaru M.: Main Topic- Part B: Next-Generation Middleware Platforms. Canadian Conference on Electrical & Computer Engineering 2002, CCECE'02, May 2002
6. Stefan, S., Krishna P. G., Richard J. D., Steven D. G., Henry M. L.: An Analysis of Internet Content Delivery Systems. In Proc. of OSDI '02, 2002
7. Bruce M.: Global Internet Content Delivery. In the Proc of IEEE CCGRID'01, 2001
8. Foster, I., Kesselman, C., Tuecke, S.: the Anatomy of the Grid: Enable Scalable Virtual Organizations. Int J. Supercomputer Applications, 2001