Peer-to-Peer Computing

P

Manuela Pereira
University of Beira Interior, Portugal

INTRODUCTION

The term peer-to-peer (P2P) was originally used to refer to network protocols where all the nodes had the same role and there were no nodes with specific responsibilities to act as the administrators or supervisors of a network (Ye, Makedon, & Ford, 2004). However, with the evolution of Internet as the dominant architecture for applications, contents, and services, applications and services have gradually migrated from the client-server paradigm to the edge services paradigm and now to the P2P computing paradigm. Therefore, nowadays, the term P2P refers to a class of systems and applications that use distributed resources to perform some function in a decentralized manner, where every participating node can act as both a client and a server (Ye et al., 2004).

This article provides an overview of P2P computing, being focused on the types of multimedia distribution services and cooperation models in P2P systems. These models are classified regarding the functionality, the degree of decentralization, and the degree of structure of the information system.

BACKGROUND

The P2P Working Group (http://www.peer-to-peerwg. org), a consortium for the development of P2P technology, defines P2P as the sharing of computer resources by direct exchange.

P2P systems have advantages regarding client-server systems, namely: (1) improved scalability and reliability since they avoid the dependency of centralized servers, which are often points of failure; (2) cheaper infrastructures due to direct communication among peers; and (3) easiness of resource aggregation in order to provide, for instance, massive processing power (Ye et al., 2004). However, P2P systems also have some drawbacks namely considerably more complex searching and node organization and security issues (Aberer, Punceva, Hauswirth, & Schmidt, 2002).

P2P networks have been deployed in several application areas, such as distributed grid computing (http://www. entropia.com), storage (Cohen, 2003), Web cache (Dabek, Kaashoek, Karger, Morris, & Stoica, 2001), and service directory (Iyer, Rowstron, & Druschel, 2002; Ratnasamy, Francis, Handley, Karp, & Shenker, 2001; Stoica, Morris,

Karger, Kaashoek, & Balakrishman, 2001). However, P2P systems were popularized due to the applications of file sharing: Many different P2P file sharing systems, such as Gnutella (http://www.gnutella.com), KaZaA (http://www. kazaa.com.), eDonkey (http://www.overnet.com), and Bit-Torrent (http://bitconjurer.org/bittorrent/) have recently experienced dramatic growth in popularity and are currently responsible for a large amount of the Internet traffic (Saroiu, Gummadi, & Gribble, 2002; SD-NAP, 2002). As a result of the increasing popularity, P2P file sharing systems became more complex in order to provide services to millions of users. The original centralized architecture of Napster (http://www. napster.com) has been replaced by unstructured decentralized systems such as Freenet (http://freenet.sourceforge.net) and Gnutella. A detailed performance evaluation of the main features of current unstructured P2P architectures may be found in Benevenuto, Ismael, and Almeida (2004). Due to scalability limitations of the unstructured P2P approaches, structured P2P systems have been developed to manage huge amounts of data in a scalable way in overlay networks. One type of structured P2P systems is Distributed Hash Tables (DHTs) (Rieche, Wehrle, Landsiedel, Gotz, & Petrak, 2004). Examples of these DHTs include Chord (Stoica et al., 2001), Content-Addressable Network (CAN) (Ratnasamy et al., 2001), DKS(N,k,f) (Alima, El-Ansary, Brand, & Haridi, 2003), or Pastry (Rowstron & Druschel, 2001).

MULTIMEDIA DISTRIBUTION SERVICES

The demand of delivering multimedia content over the Internet has become increasingly high for scientific, educational, entertainment, and commercial applications. However delivering streaming media content over best effort, packet-switched networks has to deal with high bit rates, delay, loss sensitivity, and heterogeneous client resources. The expensive growth of multimedia applications over the Internet lead to an increasing interest to provide low cost, efficient, and scalable multimedia distribution services. Recently, P2P systems have received a great amount of interest as a promising scalable and cost-effective solution for next-generation multimedia content distribution.

Multimedia distribution services may be classified into three categories (Xiang, Zhang, Zhu, Zhang, & Zhang, 2004) as follows:

1. **Centralized Multimedia Distribution:** A centralized multimedia server is deployed to support a client to access multimedia content across the Internet. In order to extend the storage and Input/Output capacity of the centralized server and to improve the service availability, server clustering or mirroring are often used. This strategy is widely used in traditional Web-based distribution services, although they are unable to reduce the network bottleneck problem, which has significant impacts on the performance of multimedia distribution. As reported by Kangasharju, Roberts, and Ross (2002), a centralized system is not suitable neither scalable for multimedia distribution services. The use of proxy caches (Xiang, Zhang, Zhu, & Zhong, 2001; Zhang, Wang, Du, & Su, 2000) can alleviate the bottleneck problem by caching popular contents from origin servers to proxy servers located at the edge of network. Clients receive the content from edge servers without consuming the network bandwidth. However, the cache policies that influence the effectiveness of proxy caching are suboptimal for streaming media since they were not developed with new video coders in mind. Moreover, proxy caching has scalability limitations for multimedia distribution services.

2. **Multimedia Distribution Based on Content Distribution Networks:** This technique is a server-oriented approach based on content distribution networks (CDNs) (also known as content delivery networks) platforms. The original server is replicated and placed locally or remotely in geographical or network spaces. CDN-based architectures have a limited performance for large-scale multimedia distribution services, since the capacity of the edge server is not large enough to support multimedia services, specially the streaming media service. Furthermore, the decision of the number and location of edge servers is a difficult problem, which has not yet been solved efficiently (Chen, Katz, & Kubiatowicz, 2002; Cohen, Katzir, & Raz, 2002; Qiu, Padmanabhan, & Voelker, 2001)

3. **P2P Networks:** In P2P networks, clients host contents in their local storage and distribute contents to other clients, allowing the sharing of data and resources by a large community at low cost and small network management. Furthermore, the availability of distribution services relies on the reliability of each peer, but peers may not guarantee service persistence. Some current P2P systems also have scalability limitations such as Napster, CenterSpan (http://www.centerspan.com), and Vtrails (http://www.vtrails.com), which are centralized. However, new P2P scalable frameworks have also been developed, and P2P-based multimedia distribution services have started to appear and are considered as the most scalable, efficient, and low-cost

solution for future multimedia applications and services. The next section is devoted to P2P systems.

P2P COMPUTING

Since there are about 70 different P2P applications, this section provides an overview of those P2P applications regarding their models of cooperation and how they may be classified according to the following criteria: functionality, degree of decentralization, and degree of structure of the information system.

Functional Classification

P2P systems may be classified from a functional point of view into three basic subcategories: (1) management and contents-sharing applications; (2) distributed processing and; (3) collaboration and communication (Benayoune & Lancieri, 2004). However, there are also platforms, such as JXTA (Gong, 2001), and Globus, that aim at facilitating the development of these applications by offering a set of common basic services such as the authentication or research and routing services. Table 1 summarizes this classification. The file-sharing applications are extremely popular on the Internet and have a large user base. Recent statistics show that the activities of these applications consume more than 60% of Internet service provider (ISP) traffic.

Degree of Decentralization

The Internet is nowadays largely based on the client-server paradigm but the use of central servers leads to a waste of

Table 1. Functional classification of P2P systems

Management and Contents Sharing Applications	Distributed Processing	Collaboration and Communication
Napster	Seti@Home	Groove,
Audiogalaxy, GNUtella	Genome@Home	NextPage,
KaZaA	Folding@Home	Kanari,
Grokster	Evolutionary@Home	Magi,
Morpheus	XPulsar@home	Jabber,
Blubster	Life Mapper	AIMster,
DirectConnect	ChessBrain	MSN,
BitTorrent	FightAIDS@Home	AOL Chat,
Freenet	Avaki	NetMeeting
Aimster	Jivalti	
IMesh	Axceleon	
EMule	Entropia	
eDonkey2000	GridSystems	
OpenNap (WinMX)		
LimeWire		
Shareaza		
XoLoX		
Chord		
Tapestry		
Pastry		
Tornado		
CAN		

Related Content

Change Process Drivers for E-Business
H. D. Richards, C. Makatsorsisand Y. S. Chang (2005). *Encyclopedia of Information Science and Technology, First Edition (pp. 397-403).*
www.irma-international.org/chapter/change-process-drivers-business/14269

Study on Green Construction Evaluation of Highway in Seasonal Frozen Zone
Zhenwu Shi, Zhaolin Li, Xianyu Tanand Shuxin Hua (2021). *Journal of Information Technology Research (pp. 70-86).*
www.irma-international.org/article/study-on-green-construction-evaluation-of-highway-in-seasonal-frozen-zone/279035

Dense Disparity Computing Method Based on Mesh Aggregation and Snake Optimization for Stereo Vision
Liu Shuangand Yu Shuchun (2020). *Journal of Information Technology Research (pp. 95-112).*
www.irma-international.org/article/dense-disparity-computing-method-based-on-mesh-aggregation-and-snake-optimization-for-stereo-vision/258835

Differences in Business Process Management Leadership and Deployment: Is There a Connection to Industry Affiliation?
Richard J. Goekeand Yvonne Lederer Antonucci (2013). *Information Resources Management Journal (pp. 43-63).*
www.irma-international.org/article/differences-business-process-management-leadership/76880

Computer Music Interface Evaluation
Dionysios Politis, Ioannis Stamelosand Dimitrios Margounakis (2009). *Encyclopedia of Information Science and Technology, Second Edition (pp. 654-660).*
www.irma-international.org/chapter/computer-music-interface-evaluation/13644