LECTURE SERIES

Peer-to-Peer Networks 2

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The development of network resources changes the network computing models. P2P networks, a new type of network adopting peer-to-peer strategy for computing, have attracted worldwide attention. The P2P architecture is a type of distributed network in which all participants share their hardware resources and the shared resources can be directly accessed by peer nodes without going through any dedicated servers. The participants in a P2P network are both resource providers and resource consumers. This article on P2P networks is divided into two issues. In the previous issue, P2P architecture, network models and core search algorithms were introduced. The second part in this issue is analyzing the current P2P research and application situations, as well as the impacts of P2P on telecom operators and equipment vendors.

2 Typical Applications of P2P Networks

Resource sharing was one of the main motivations behind the birth and development of the Internet. And the demands on files exchange have directly led to the merging of P2P technology. The files exchange is the original P2P application and one of the most successful applications of P2P technology. Sharing software Napster for such an application makes people under the client/server model rediscover the impacts of the P2P concept on people's habit of using the network.

With people's more understanding of the P2P concept and the technical development, P2P technology, as a type of software architecture, may have various new application models besides the original files exchange, such as distributed storage, deep searching, distributed computing, personal instant messaging, and cooperative working. SETI@home is the most famous example of the new P2P applications. It is a scientific experiment that uses distributed computing in the Search for Extraterrestrial Intelligence (SETI). The SETI@home program is a special kind of screensaver. After downloading and running it, each volunteer can use the idle computing ability of his computer to analyze wireless electromagnetic wave data specially captured by the world's largest radio telescope Arecibo and send the computed results back. Moreover, P2P technology has shown many application prospects in mobile communication and intelligent networks after SUN extended its JXTA protocol to handheld terminals such as Personal Digital Assistant (PDA) and mobile phones and allowed resources sharing and files exchange by screening physical platforms.

Various types of P2P application software have been emerging endlessly on the Internet in recent years. P2P technology is being applied into military, business, government informationization, and communications. According to different applications, P2P can be divided into the following types:

(1) P2P networks that offer sharing of files and other contents, such as Napster, Gnutella, eDonkey, emule and BitTorrent

(2) Applications that use P2P computing and storage sharing capabilities, such as Xenoservers, SETI@home, Avaki, and Popular Power

(3) P2P based cooperative processing and service sharing platforms, such as JXTA, Magi, Groove, and NET My Service

(4) Applications for instant messaging, such as ICQ, OICQ, and Yahoo Messenger

(5) Implementations of secure P2P communications and information sharing, such as Skype, Crowds, and Onion Routing

(6) Implementations of P2P application-layer multicasting without the necessity of support of the network layer, avoiding the situation that multicast applications cannot be implemented since the network layer fails to support multicasting. Application-layer multicasting requires an overlap network between application nodes that join the multicasting. This network is scalable and capable of supporting error tolerance. The DHT-based finding mechanism just provides a good platform for the implementation of application-layer multicasting. Application examples include ttzai.com, QQ video, Shenzhen Bluewave network, and PPLive.

(7) Implementation of Internet Indirection Infrastructure. The concept of "Communication based on Convergence Points" is used in the Internet Indirection Infrastructure. It can make the Internet support multicasting, unicasting and mobility better. Each packet in the infrastructure is not directly sent to the destination node, but assigned with an identifier. Then the destination nodes receive corresponding packets

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according to their identifiers. In fact, the identifier shows the convergence point of a message. The destination node, through a trigger, tells the convergence point in advance about the identifier of the packet it is about to receive. Then when the convergence point receives the packet, it, according to the trigger, transfers the packet to the corresponding destination node. The Internet Indirection Infrastructure is actually an overlap network on the Internet, which requires support of the application-layer routing system of P2P networks.

3 Current Situations of P2P Network Research and Market

3.1 Current Situations of P2P Research of Chinese Academic Institutes

(1) Maze System of Peking University

Maze is a P2P computing based files sharing system developed by the Network Lab of Peking University. It integrates centralized control and P2P connection. Its structure is similar to that of Napster, and P2P computing and searching methods are similar to those of Gnutella. A computer, no matter connected to the intranet or to the exterior networks, can freely join or withdraw the Maze system by installing and running Maze client-end software. Each node in the system provides the files under its one or more directories for sharing, and enjoys the resources offered by other member nodes at the same time. Maze supports resource search based on key words and can obtain resources through friendly relationship.

(2) AnySee System of Huazhong University of Science and Technology

AnySee is a live video system developed by Huazhong University of Science and Technology. It uses the one-to-multiple service model, supports part Network Address Translation (NAT) and firewall bypassing, and improves the scalability of the live video system.

3.2 P2P Products Developed by Chinese Enterprises

(1) POCO Platform of Guangzhou POCO Co., Ltd.

POCO, the biggest P2P platform in China, is the third-generation P2P resources exchange platform with secure and flow-controlled decentralized servers. It is one of the few profitable P2P platforms worldwide. The current capacity of POCO is 26 million users, with the average online subscribers of 585 thousands and the peak online subscribers of 710 thousands. All POCO subscribers are broadband users.

(2) OP Platform of Shenzhen Deemstone Software Company

OP, also called Openext Media Desktop, is a content platform for network entertainment. It is the successor to Napster, and integrates Internet Explorer, Windows Media Player, RealOne Player, and ACDSee. With it, any music, movies, software, games, pictures, books, and all sorts of files can be found in the most direct way. It supports anytime online sharing of files. It claims to have storage of thousand millions of files, known as "hundred thousands of movies, millions of music files and ten millions of pictures".

(3) PPLive, Live Online TV Sharing Software Based on P2P

PPLive is sharing software for large-scale live video on the Internet. Using a network model, it effectively solves the problem of limited bandwidth and load of network Video on Demand (VoD) service. It fulfills more fluent play with more users, and greatly improves the whole service quality.

3.3 Applications of P2P Technology outside China

The P2P Working Group (P2PWG) and Global Grid Forum (GGF) are the main academic organizations focusing on research of P2P. The P2PWG and GGF have merged, and GGF is responsible for standardization of P2P and grid computing.

Sun, Microsoft, and Intel support more and have large investments in P2P computing.

Sun initiated its JXTA project based on Java technology. JXTA is an open P2P platform based on Java. Any individuals and organizations can join in the JXTA project. Therefore, it has attracted a large number of P2P R&D personnel. The JXTA based instant messaging software package has been released. JXTA defines a set of core services: authentication, resource finding, and management. As for security, JXTA allows to use encryption software package to encrypt data to ensure the privacy, the ability of authentication, and integrity of messages. Based on the core services, JXTA also defines various optional services, including content management, information searching and service management. Based on the core and optional services, users can develop diversified P2P applications on the JXTA platform.

Microsoft established the Pastry project group to take charge of R&D of P2P computing technology. Microsoft has released Pastry-based software package SimPastry/VisPastry. Rice University in Houston, USA, has also released its FreePastry software package.

Intel established the P2P working group for P2P research. The working group has actively cooperated with application developers to develop P2P application platforms. In 2002, Intel released the P2P Accelerator Kit and P2P secure Application Programming Interface (API) software package based on .Net infrastructure, which helps Microsoft .Net developers build P2P secure Web application programs quickly.

4 Impacts of P2P Applications

P2P applications will lead to the multi-player game in the telecom industry (telecom users, operators and equipment vendors), as well as between industries (such as the telecom industry and the broadcasting and TV industry). Therefore, the situations will become more complicated. This article only takes telecom operators and equipment

vendors as analysis objects for space limit, and will discuss the positive and negative influences of P2P applications based on the service and network layers.

4.1 Service Layer

(1) Instant Messaging Services

On one hand, the instant messaging services like QQ and Skype take certain telephoning traffic away from the International Direct Dialing (IDD) service, as well as from part of Domestic Direct Dialing (DDD) and local call services. On the other hand, more and more people make friends via QQ and Skype, and thus they promote people's communication, and make the total demands on communication rise. This is a positive impact on telecom services.

(2) Network TV

Network TV richens telecom services, and helps meet people's demands better. However, it has more rigid requirement on the QoS guarantee capability of the IP networks. Accordingly, the best-effort service model of IP networks is possible to step off the stage of history gradually.

(3) Entertainment Services

Entertainment services richen people's life. However, the problems of intellectual property rights and digital copyrights of entertainment services are serious. The game between industries is unavoidable, and policies of the government will play an important role.

(4) Privacy of Messages

On one hand, privacy of personal messages requires more protection. On the other hand, information monitoring and control is more difficult, and the network has become a hotbed of viruses and illegal trades.

(5) Service and Technology Competition

P2P applications aggravate the competition of different technologies inside the telecom industry, which may go against the protection of industrial investments. In addition, they improve the competence of telecom operators to enterprises from other industries, especially from the broadcasting and TV industry.

For avoiding the aforementioned negative impacts, simple increase of bandwidth doesn't work. It is necessary to fulfill the transformation from the access-time-oriented billing model to the differentiated services-oriented or business-oriented billing models, and make a revolution of existing networks on infrastructure and service support system.

4.2 Network Layer

(1) Network Bandwidth

P2P applications will promote operators to enlarge the network capacity, which not only does good for equipment vendors but also increases average consumable bandwidth per user. However, P2P applications occupy more and more bandwidth, therefore, networks will be congested and even become less robust if everyone uses P2P applications.

(2) Network Topology

On one hand, P2P applications have more requirements on traffic analysis, which makes network planning and optimization work more difficult. On the other hand, P2P applications may lead to improvement and evolution of network topology.

(3) Access Control Capability

P2P applications bring a challenge to the traditional "full-open" access control policies of the Internet. Moreover, they will help fulfill the change from full-open IP telecom networks to half-open ones. (Traditional open services will keep open, but new services may be more strictly controlled and the carriers may retain the right to charge them).

5 Conclusions

According to the process of network construction in China, the integration of P2P applications and the Internet may be divided into 3 phases.

(1) First Phase

At the beginning of evolution to broadband IP networks (referring to popular application of ADSL), abundant P2P applications are the important services for operators to attract customers to transfer from narrowband users to broadband users. At this phase, the main ingluence of P2P is positive.

(2) Second Phase

Now China has almost fulfilled network broadbandization. Assuming most services are in the P2P mode, demand of all the network users (the number is n) on network resources may increase from $O(n)$ to $O(n^2)$. (The possibility needs further verification.) At this phase, the increase speed of users' demand on resources $O(n^2)$ will greatly exceed that of network users $O(n)$. The negative impacts of P2P applications are emerging, such as occupation of network bandwidth and copyright problems. Thus, many issues such as DiffServ services and stricter access control policies are on the agenda, which will cause large-scale transformation of existing networks.

(3) Third Phase

With the implementation of intelligence policies (buniness-oriented or service-oriented billing policies) of network access control, the gaming between telecom service capabilities and requirements of customers will reach a new balance, and the "wave" made by P2P will end.

Challenge is opportunity. Everything always develops during the contradictions. P2P is a fresh wave, which will bring opportunities and challenges to telecom users, operators, equipment vendors, and other relevant industries.

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Biographies

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Roundup

ZTE Brings State–of–the–art Telecoms Industry Training to Indonesia

ZTE Corporation announced the opening of a new training establishment in Bandung, Indonesia. In partnership with nationally renowned telecom educational institution STT Telkom, ZTE has established the specialised national telecommunications training center as part of plans to make training in telecoms technologies accessible to both students and customers across Indonesia.

"The establishment of this training center will significantly enhance the telecoms exchange between ZTE and local industry players." said Mr. Cui, President of the Asian Pacific region for ZTE, "One of the core aims of the training centre is to foster talent in the region by promoting telecoms education across the Asia–Pacific through technology and management training for hundreds of students each year."

ZTE's initial investment of $1.5 million USD will focus on telecoms training for clients, ZTE staff and other colleges in the Asia–Pacific Region. In addition, the center will provide a forum for research and development.

The training courses will be divided into basic, intermediate and advanced levels according to the student's background. The training center will also provide customized training plans for customers with individual requirements.