

# Progress of Internet Video Technology

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## Abstract:

In China, currently there are more than 100 million videos being watched everyday on the Internet. There are three kinds of Internet videos: video sharing, Video on Demand (VoD), and Peer-to-Peer (P2P) streaming media. Video sharing is based on browser/server mode, severing user generated content. VoD is based on client/server mode and needs to be paid for. P2P streaming media is based on P2P mode service for hot content. To address P2P traffic optimization and content regulation, China National Information Technology Standardization Technical Committee sets up P2P working group to make relevant standards.

In recent years, Internet video services have developed rapidly in China and more than 100 million Internet videos are viewed each day. Along with the fast growth of Web 2.0 and new network media, the User Generated Contents (UGC)s "mushroom" on the Internet. These contents are of a huge number, but most of them are only viewed several times. The new media contents will be characterized by Long Tail and compliant with Zipf's law and Pareto distributions.

Zipf's law postulates a power law relation between the frequency of selection and the rank order of the option, expressed mathematically by Equation (1) (i.e. Zipf equation).

$$P = KR^{Z-1} \quad (1)$$

Where  $P$  is the frequency of selection,  $R$  is the rank order,  $Z$  is the Zipf exponent and  $K$  is a constant.

In video rentals,  $Z$  is about 0.27; for Amazon.com Book sales,  $Z$  is about 0.13; for Youtube,  $Z$  is about 0.44, and for common website usage,  $Z$  is about 0.15. It can be seen that the  $Z$  exponent for video websites (e.g. Youtube) is often higher than those for other websites, and the long tail is bigger.

The existing Internet video streaming media fall into three kinds: video sharing,

Video on Demand (VoD) and Peer-to-Peer (P2P) streaming media. The video sharing website is based on client (browser)/server mode, serving the UGCs with long tail. The VoD website takes client/server mode and its services need to be paid for. The P2P streaming media website adopts P2P mode, mainly serving popular contents.

The reason why the video sharing website uses browser/server mode is to meet the requirement of long tail contents. But for popular contents, the browser/server mode shows up its limitation. Therefore, a technology should be developed to automatically transfer this mode into P2P mode when a video is viewed by many users<sup>[1-3]</sup>.

## 1 Video Sharing and Blog

In 2006, Chinese video sharing websites emerged. At that time, the contents were mainly videos produced by Internet users, funny videos and foreign short clippings, and there were few pirated videos and erotic films. In 2007, along with rapid development of these websites, a large number of pirated videos and offensive videos were uploaded to the Internet and made the main part of video sharing websites. On the one hand, the limited bandwidth of

these websites requires their contents to be highly compressed, so the frame quality is not very good; on the other, the contents are easy and convenient to be viewed because only a browser rather than a special client is necessary. At present, many users would first browse the contents on these websites. If they find some interesting contents, they would download high-definition version of these contents via P2P mode for future viewing.

Most of existing Chinese video sharing websites adopt browser/server mode and the contents on them are mainly in Flash format. In 2007, supported by investments from Venture Capital (VC), major video sharing websites configured many servers in the Data Center of the China Internet (DCCI). Their contents accounted for over 65% of the total Internet videos viewed by Internet users, about 25% are VoD contents and the rest 10% are from P2P streaming media websites. Besides, the degree of video sharing market concentration is relatively high. The monthly reach rate of tudou.com, youku.com, 56.com or ku6.com exceeds 25% and their penetration rate of target Internet users exceeds 25%. From Table 1 we can see the monthly reach rate of video sharing websites is only half

▼ Table 1. Performance index comparison between portal and video sharing websites in the first quarter of 2008

	Monthly Reach Rate (%)	Time Spent per Visitor per Month (s)	Visit Frequency per Visitor per Month (Times)	Page Views per Visitor per Month (Page)
Top 4 Portal Websites	72.0%	12570.3	20.6	214.4
Top 4 Video Sharing Websites	31.3%	5995.4	6.0	24.9
Youtu.com	36.2%	10387.2	8.4	38.1
Tudou.com	34.2%	7185.8	6.4	26.8

Note: The websites are ranked by their monthly reach rates, and all indexes are averages of the first 3 months.

of portal websites, but some video sharing websites' time spent per visitor per month is almost the same as that of portal websites. Hence, video sharing websites have an important place among Internet applications.

At present, all portal websites provide their own video services, called blog. Blog technology is similar to video sharing and its contents include those collected, edited and relayed by the portal websites themselves.

The contents on video sharing websites are free of charge, and they are not monitored as strictly as those on VoD websites. Consequently, this kind of websites achieved great development in 2007 and threatened the status of VoD websites. But these websites are unlikely to maintain sustainable development until such issues as profit-making model and copyright protection are addressed. The advantage of video sharing websites is UGCs. In 2008, the UGCs of video sharing websites played an important role in reporting snow storm in South China, protesting the distorted report of western media on the Tibetan riot and supporting Beijing Olympic Games.

## 2 Video on Demand

Chinese first VoD website was launched in 2000. With the popularization of broadband services, China Telecom established a VoD platform called Internet Star Space. In 2004, the introduction of distribution business model in Internet Star Space's monthly package services urged all VoD websites to transfer, one after another, into video providers of telecom operators and get their parts of revenue from the operators. In 2006, there are three major VoD websites in China, namely joy.cn, juznet.com and 51tv.net. Other VoD

websites include jeboo.com, imhb.cn, v.21cn.com, xintv.com, v.ifeng.com, and comup.net.cn. These VoD service providers only provide local services and configure their servers on the telecom operators' network. The users access VoD website via telecom operators' websites, such as Internet Star Space, to enjoy VoD services; while the telecom operators charge certain fees for these services or share profits with service providers.

VoD websites take client/server mode. Due to Input/Output (I/O) bottleneck, a server can not support many users. Moreover, the VoD websites mainly deliver local services. But the service providers often have mature distribution models and strictly follow the principle of payment for viewing. As a result, their current flows are often healthy and most of them keep close cooperation with telecom operators. They are strategic partners of telecom operators.

## 3 P2P Download and Streaming Media

### 3.1 P2P Download

P2P file sharing and downloading is the most effective way to distribute videos on the Internet. The introduction of BitTorrent (BT) and eDonkey (ED) pushes P2P applications to a climax. As no login account is required, the users' resources can be more widely broadcast and shared via Web than ever. At that time, BT unions and ED unions emerged one after another, and the number of their users grew rapidly, too. The P2P sharing and downloading service promoted and popularized P2P applications in a very short time.

Later, Chinese mainstream download

engine websites, such as xunlei.com and flashget.com, introduce the same services. Flashget begins to support BT protocol and eMule protocol since V1.81; while Xunlei introduces Version 5, which is a BT version. In addition to supporting Dynamic Hash Table (DHT) and Universal Plug and Play (UPnP) standards, the above two software increase their download speeds and reduce resource occupation. They become the main software in the domestic market of P2P video download and distribution. Other download software also begins to integrate P2P protocols. For instance, Toutu integrates such download protocols as BT, eMule and Hypertext Transfer Protocol (HTTP), enabling the users to download videos quickly and easily, with simple settings. On the other hand, P2P software (e.g. BitComet) begins to support common HTTP/File Transfer Protocol (FTP) download method and they claim they can increase download speed with BT technology. All download tools are trying to be the almighty software that is integrated with HTTP, FTP, BT and eMule. The download websites integrated with P2P function, such as xunlei.com and flashget.com, dominate P2P video downloading market in China.

Another development trend of P2P download is to integrate download function with VoD services, for instance, Panpan VoD services developed on xunlei.com website.

### 3.2 P2P Streaming Media

The principle of most P2P video streaming media software is similar to that of BT download, where DHT algorithm is used to connect intelligent nodes for P2P transmission. Such software system can play videos smoothly and reliably. Moreover, it has



the following features:

- The bigger number of the access nodes, the better the play quality is resulted;
- The quit of any individual node has no impact on the overall performance;
- The data are buffered into the memory;
- It supports multi-point download;
- It can dynamically find the near point; and
- It supports several streaming media formats, such as Windows Media Video (WMV), Moving Picture Experts Group (MPEG)-4, and Advanced Systems Format (ASF).

The existing public access modes, such as Asymmetric Digital Subscriber Line (ADSL) and Cable Modem (CM), are asymmetric. Their uplink bandwidth is much less than the downlink one. As a result, the uplink bandwidth becomes a main factor to restrict the development of P2P streaming media. Besides, P2P services bring about a sharp increase of traffic in backbones and occupy lots of bandwidths, thus affecting other Internet services. For the above two problems, one solution is to develop firewall penetration technology, which not only enables the users within the network to enjoy P2P services, but also makes full use of the rich uplink bandwidth resources of these users. Another solution is to configure cache memory locally to make up for the deficiency of uplink bandwidth. Currently, many P2P Internet TV operators establish their own layered network architectures, like P2P Content Delivery Network (CDN), trying to limit the local traffic. In this way, they increase the speed and reduce the delay, thus improving the performance.

Based on P2P streaming media technology, P2P Internet TV has been rapidly developed and continuously improved since it was first introduced 3 years ago. Existing P2P Internet TV can play at a rate of 700 kb/s (1 Mb/s in case of ADSL). At such a rate, the video quality can be the same as Digital Video Disc (DVD) and the buffer time can be reduced to several seconds.

The main advantages of P2P streaming media technology are its live broadcast and global reachability. The P2P live streaming system performs quite well in live reporting the launching of

▼ Table 2. Comparison of three video formats

	AVI	RMVB	FLV
Resolution	(640–800) × (272–500)	(640–800) × (272–500)	320 × 240
Frame Rate	24–30 F/S	24–30 F/S	20 F/S
File Size	700 MB	200–400 MB	20–200 MB
Size/Minute	14 Mb/minute	4–5 Mb/minute	1.5–2 Mb/minute
Download Method	P2P	P2P	Browser/Server
Dependence on User	High	Very High	Average
Flash/MP4 Applicability	Medium	Very High	Average
AVI: Audio Video Interleave FLV: Flash Video RMVB: RealMedia Variable Bitrate			

spaceship Shenzhou 6 (2005), the Seventeenth National Congress of the Communist Party of China (2007), and 2008 Beijing Olympic Games.

## 4 Video Coding

Currently, there is a wide variety of formats for video and streaming media on the Internet. Among them, the most commonly used three formats are Flash Video (FLV), RealMedia Variable Bitrate (RMVB) and Audio Video Interleave (AVI).

FLV is a new video format designed for Web video application. It adopts browser/server mode and takes advantage of Flash Player which is widely used in the web pages to integrate videos into Flash animation. The website visitors can watch FLV videos via Flash Player. The videos in FLV format can not only be played at a high rate, but also protect their copyright. Meanwhile, they do not require any extra video plug-in, which facilitates video sharing. Consequently, FLV has become one of the most popular online video formats in 2–3 years, and has been widely used by many famous websites, including YouTube, tudou.com, Google, Baidu, sina.com, qq.com, mop.com, and Yahoo!.

AVI was first introduced by Microsoft in 1992. An AVI file stores motion images and audio data in an interleaving way and it is independent of hardware. The main parameters of an AVI file involve three aspects: video, audio and compression. Due to its openness feature, AVI format is supported by lots of coding research organizations. In return, the diversified coding technologies enable AVI to be improved continuously.

After MPEG is introduced, AVI files are often compressed with MPEG4 codecs (DivX5 and Xvid, for example), letting their video quality and size be better controlled. A high quality DVD film is often 4–5 GB, while the AVI file is only 650–700 MB after encoded with DivX or XviD, which is only 1/8 of the DVD file in size but which images are almost of the same quality as DVD. This makes AVI format one of the most favorite formats of film fans.

RMVB is a video format developed by RealNetworks. Real 9.0, one of the RMVB versions, is very popular in current Internet markets. About 80%–90% of downloaded videos are in this format. The earlier RM formats (e.g. Real 8.0) adopted fixed bit rate coding method, which can only provide a video quality equivalent to Video Compact Disc (VCD) at the rate of 450 kb/s. They were often used to produce VCD videos. RMVB lowers the bit rate in case of static (or quasi-static) images, and increases the rate in case of dynamic images. In this way, the image quality is greatly improved. Compressed with RMVB, not only can the image quality equivalent to DVD be delivered at a rate of 450 kb/s, but also the file size can be dramatically slimmed. For example, one DVD film of about 4GB can be compressed into a RMVB file of 300–450 MB. Moreover, the subtitles in RMVB files are embedded and convenient for use.

Table 2 summarizes the three video formats.

## 5 P2P Video Distribution Environment and P2P Standardization

At present, different P2P applications are

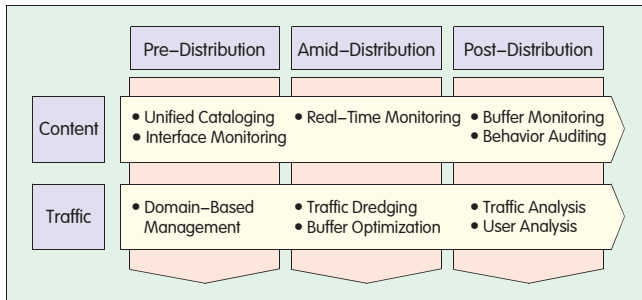


Figure 1.  
P2P optimization and management technology.

delivered with their own software. As no unified standard is applicable, these applications are independent of each other. Meanwhile, P2P videos are perplexed with two problems. First, P2P streams make a large part of backbone capacity so they have affected other Internet services. Sometimes, they are even blocked by the operators. Second, without effective supervision measures, pirated and offensive contents flood on the Internet, placing P2P videos into an embarrassing situation of force-out. Therefore, to keep healthy development of P2P video distribution, the two major problems have to be solved: traffic control and content regulation.

In 2007, P2P Cash and P2P CDN technologies, which are for P2P downloading, developed rapidly. The CDN products of NetEast Technologies and other companies were deployed by some telecom and broadcasting and TV operators. These products have performed quite well in dredging the traffic and reducing the load of backbone. As a result, the telecom operators and some data centers are considering upgrading old CDN into P2P CDN.

The optimization and control of P2P traffic requires related standards to be worked out first. In March 2008, China National Information Technology Standardization Technical Committee (NITS) decided to establish P2P standard working group, whose mission is to develop P2P standards to solve the two problems: traffic optimization and content regulation.

In terms of technology, two levels (traffic and content) and three stages of Internet content distribution (pre-distribution, amid-distribution and post-distribution) have to be addressed in P2P traffic optimization and control, as shown in Figure 1.

Accordingly, the standards in Figure 2 may be involved.

NITS plans to cooperate with network operators, P2P application providers, content providers and Internet associations to promote the implementation of P2P standards by way of self-discipline. With standards and self-discipline, it is expected to reconcile existing conflicts in the industry chain and change the vicious circle into a virtuous one, thus creating a multi-win environment and promoting quick development of Chinese Internet application technologies. It is also expected to lay foundations in both technologies and standards for better management and utility of Internet by government departments.

Current technical schemes for P2P optimization are based on Domain Detecting Protocol (DDP). DDP requires the cooperation between P2P device manufacturers and network operators. It not only allows P2P traffic to be dredged according to the autonomous domains divided by the operator without changing the old P2P protocol, but also enables traffic optimization device, such as cache, to be installed for better user experience. The DDP-based technical scheme can be extended to monitor P2P

contents on the Internet.

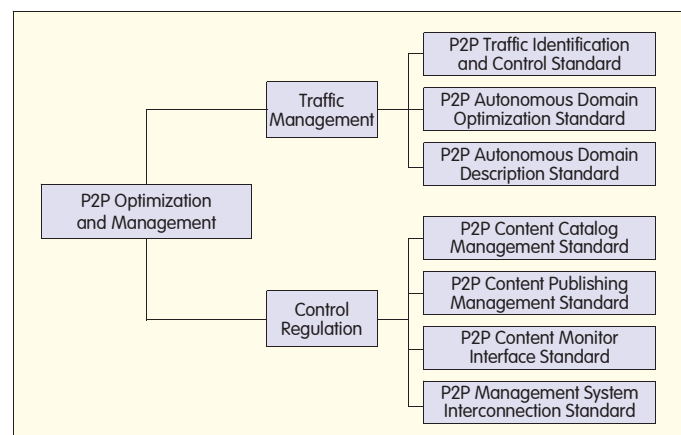
As a P2P management protocol supporting autonomous domain discovery and optimization and having simple protocol flow, DDP is just added to existing P2P protocol without changing it. Owing to an open system framework, it can be automatically discovered and it supports plug-and-play. Moreover, a set of standardized management interfaces enables the protocol to manage the traffic and contents by content, user or region. DDP is also a globalized Internet standard, supporting cross-domain networking and interconnection as well as optimization and management of the entire network.

As shown in Figure 3, a DDP system is made up of two parts: P2P Redirector (PPR) and P2P Cache (PPC). The PPR is deployed in the autonomous domain of the operator and its functions are: to maintain the topology information of the domain where it is, to guide P2P clients in the domain for optimal interconnection and to manage the PPC in the domain via standardized interfaces and protocols. The PPC is also deployed in the autonomous domain of the operator, performing proxy or cache function of P2P protocols under the guidance of PPR.

With a layered structure, DDP can realize hierarchical traffic management of the entire network, as illustrated in Figure 4.

Internationally, the standardization of P2P optimization and management is mainly undertaken by the P4P working group of Distributed Computing Industry Association (DCIA). The mission of this working group is to work jointly and cooperatively with leading Internet

Figure 2. P2P standards.





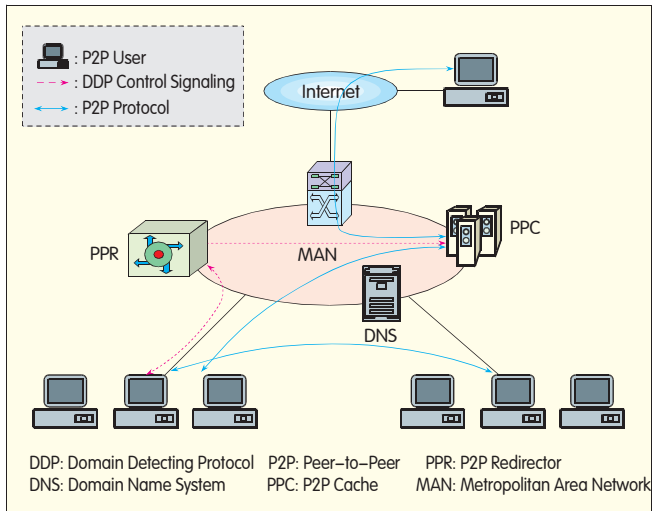


Figure 3.  
DDP-based  
single-domain P2P traffic  
management.

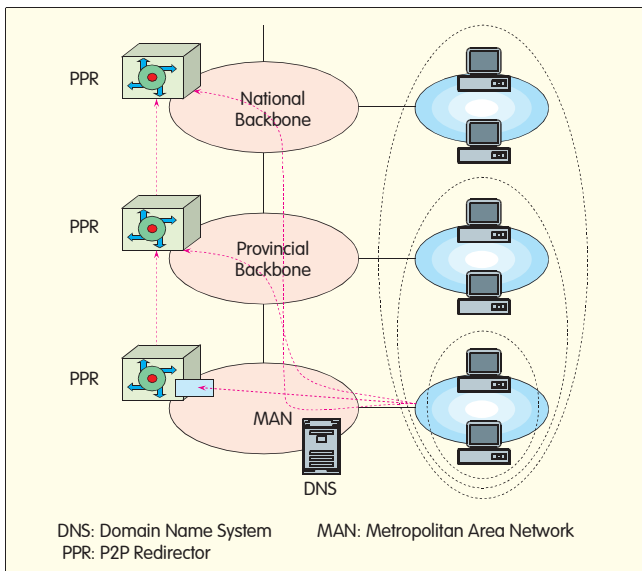


Figure 4.  
DDP-based global P2P  
traffic management.

Service Providers (ISPs) and P2P software distributors to optimize P2P traffic.

## 6 Internet Video Regulation and Copyright

Since 2007, Chinese government has strengthened Internet video content regulation. For this purpose, the State Administration of Radio, Film and Television (SARFT) and the Ministry of Information Industry (MII) jointly issued No.56 Decree "Regulations on Administration of Internet Audio-Video Programs and Services" at the end of 2007. According to this decree, a license is required for providing Internet video services. If any website or operator spreads offensive or pirated contents,

they will be not granted a license or their license will be revoked. No doubt, this decree has deterrent effect on the websites and operators. So far, 247 licenses have been issued. Except TV stations and media websites, some private websites are issued with licenses.

Internet video regulation mainly involves two aspects: copyright and offensive contents. For such services as online VoD, video sharing and P2P live broadcast and video on demand, the contents are explicitly published by the website, so their sources can be easily traced and their regulation is quite simple.

The case with P2P downloading is different. There is not a download center and the sources of downloaded contents cannot be traced. For example, such

websites as BT and xunlei only provide search engine and they do not provide any content. At present, the contents downloaded via BT can be detected by opening the data packet, which makes content monitoring possible. If related P2P standards are made to unify the catalog format, the contents in P2P streams can be easily monitored and P2P traffic can be dredged and controlled. Therefore, the work of P2P standard working group is quite important in standardizing P2P software and their operation, improving Internet content regulation as well as purifying Internet environment.

## 7 Conclusion

The rapid growth of various Web 2.0 and Internet video services pushes new (network) media into a fast track of development. Currently, the leading TV stations in China are quickening up their evolution to new media. The broadcasting of 2008 Beijing Olympic Games with the new media has undoubtedly brought China's Internet video services a new round of rapid development.

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### Biography

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