Video-on-Demand: State of Art

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ABSTRACT
Within last few years the information volumes transferred through network channels increased drastically. This is mainly connected with the increased demand on higher quality video information. However the end users mostly don't want to store demanded information on their computers, where the storage capacities are quite limited, but prefer downloading them on demand. Hence, methods of storing of huge information on the Network (for example, Cloud Computing [1]) as well as new approaches for fast transferring of large information portions from storage devices to end users (for example, Video-on-Demand [2]) are becoming increasingly important. This is the reason why the technological solutions in both mentioned above areas are of a great interest/demand worldwide. R&D activities in these two increasingly important areas somehow appeared out of interests of researchers in Armenia. Hence it is necessary to include non-systematic activities in these areas into the R&D programs of researchers in Armenia as soon as possible.

Keywords
Video on Demand, Pyramid Broadcasting, Hybrid PON+EOC, GPON, EPON, APON.

1. INTRODUCTION
Video on demand (VOD) [2] is a method of showcasing streaming videos. With VOD, the video is derived from a main server or network and viewed on a television or computer screen. VOD allows the user to order digitally transmitted movies, as well as to view training videos from the comfort of home. In addition, VOD can be used with videoconferencing, because videoconferencing usually consists of enhanced presentations featuring video clips. VOD can also be used to send and view video clips on mobile phones and other wireless gadgets.

With VOD, one can easily stream content by viewing the video as it is being downloaded. At the same time, the user can choose to wait to view the video until after it has been completely downloaded. To speed up the streaming capabilities of VOD, a greater network bandwidth may be required. Therefore, it is best to have a cable modem or Digital Subscriber Line (DSL) when using VOD services. These connections allow for a faster and more reliable connection, which results in a more effective response from the VOD server.

2. VOD SERVICES VIA PYRAMID BROADCASTING
A new way of giving VOD service on a metropolitan area is called pyramid broadcasting [3]. For gaining a radical improvement in bandwidth use and access time the most frequently requested movies on the network are multiplexed. It conquered through using storage at the receiving end.

There are known two kinds of VOD services: near video-on-demand (NVOD) service and true video-on-demand (TVOD) service [4]. An alternative solution to provide VOD services by providing NVOD for popular movies and TVOD for the less popular movies. Pyramid broadcasting can be used for NVOD, which provides all the control functions, except the fast forward function.

The fiber-optic networks with transmission speed of Gb/s already exist [3] and will be increased further in the nearest future. The consumption rate of a movie with MPEG compression is typically 1.5 Mbits/s. On such networks, when a VOD service is planned, the enormous difference between the available bandwidth of the network and the consumption rate of the movie can be exploited to achieve a significant reduction in the access time of the movies. This difference is exploited by multiplexing the movies on the channels in such a way that the clients can start consuming the movies early. This is achieved by breaking up each movie into segments of increasing size [3]. The smallest segment is broadcasted many times. The frequency of broadcasting a segment decreases with the increase in its size. The segments are broadcasted in such a way that, once the first segment has been received, the subsequent segments follow, so that the movie can be viewed continuously. While the first segment is being consumed, the second segment is collected. This method called pyramid broadcasting, results in a substantial improvement of the access time of the movies while assuring that clients can consume the movies continuously without interruptions. In this pipelining approach, the time to access the movie is the time to access the first segment, which achieved by using storage at the receiving end. Storage doesn't need to be main memory; it can be secondary storage such as tapes or disks.

In the future the companies that are going to provide VOD service have different ways of handling this problem. Pyramid broadcasting provides a much better access time than conventional broadcasting and as the available bandwidth increases, the improvement in access time is exponential instead of linear as in conventional broadcasting. The larger the bandwidth of the network is the better gain in the access time. As the access-time requirement decreases, the bandwidth in conventional broadcasting increases, too [3].

3. VOD SERVICES CARRIED BY HYBRID PON+EOC NETWORKING
An evolution method integrating the PON and EOC for providing high dedicated bandwidth for the metropolitan VOD services is proposed in [5]. In traditional unicast VOD systems, each customer is served by an individually allocated channel. Although these systems can respond to requests immediately, the server network bandwidth is rapidly depleted. As we know traditional unicast VOD systems require huge amounts of the server network's bandwidth, near-VOD systems using broadcast protocols have been proposed to reduce the bandwidth requirement. Fiber-to-the-Home (FTTH) networks have been recognized as an efficient solution to facilitate high

bandwidth, low-cost and fault-tolerant next-generation broadband access networks. Hence, the service providers are trying to provide triple play services over these networks, which have not been feasible so far due to the limited availability of bandwidth in the existing access network technologies such as digital subscriber lines (DSL). VOD services have become one of the most attractive services over FTTH networks, predicted to have the potential to change the way people watch and use television creating new markets with video rentals becoming a major part of telecommunications offerings.

FTTH is considered as the ultimate solution to provide triple-play service with a high quality of service [6]. Passive optical networking (PON) is cost-effective and favorable architectures for FTTH. On the other hand, to take advantage of COAX (Coaxial Cable) which has accessed into home, the Ethernet over COAX (EOC) is the attractive technology which has been applied into HFC (Hybrid Fiber-COAX) reconstruction. So the PON+EOC is the most appropriate solution which can provide broad bandwidth and sufficiently utilizes the existent coax. The structure of Ethernet/SCM PON is shown in Fig. 1

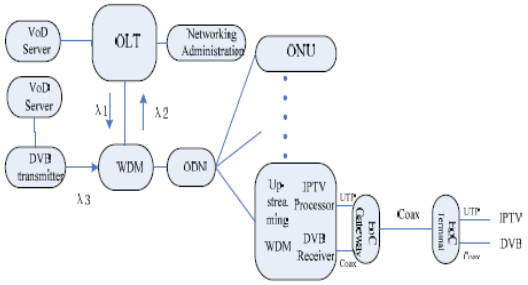


Fig.1. The structure of Hybrid PON+EOC

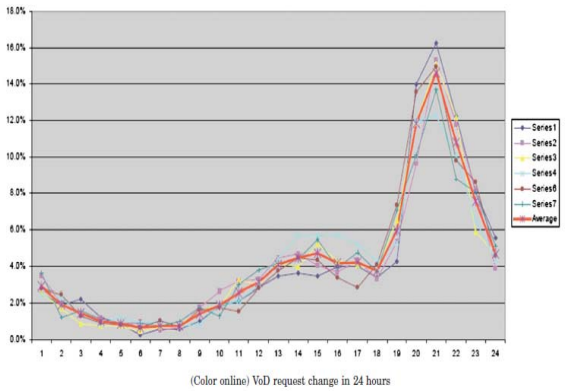
To the most popular programs, in order to save the bandwidth, the system uses the NVOD mechanism based on DVB protocol. To NVOD program, the system uses *M* channels to broadcasting it. This method is an evolution method that integrates the EPON and SCM-PON by WDM technology providing high dedicated bandwidth for the VOD services. Using DVB, protocol and SCMPON implement broadcasting NVOD service. DVB, IPTV protocols, and SCM-PON, EPON are all support the unicasting VOD service. By EOC technology one COAX can carry IPTV, DVB and up-streaming IP services.

The use of numerical analysis is the best separation of NVOD and VOD programs which rewards the best system property and the hybrid PON+EOC that can implement the metropolitan VOD services.

4. EFFICIENT VOD STREAMING FOR BROADBAND ACCESS NETWORKS

Fiber-to-the-X technologies such as 1 Gbps Ethernet passive optical networks (EPONs) and 2.488 Gbps PONs (GPONs) are being increasingly deployed in broadband access networks (BAN) [3]. VOD service, which is in the deployment stage, is a frontrunner in video services. To provide VOD service economically by reducing the costs to the service provider and user, quite a lot of research attention has been generated on efficient VOD network architectures and mechanisms, content delivery and content allocation. It is a very promising service as a revenue source, since VoD service has great potential to capture a significant fraction of the traditional $25 billion annual video rental market in the near future. Video streaming schemes include broadcasting, batching, patching, stream merging, and a hybrid approach, are well-known examples of efficient video-delivery mechanisms. Unlike unicast streaming, which provides a separate unicast video stream to each VOD request, these streaming schemes use multicast streaming and exploit user storage. Thus, they can save on video delivery cost by reducing the required network bandwidth while providing the same service quality to users. Previous researches mainly are focused on the improvement of the streaming scheme itself to save on network bandwidth, without considering other important factors.

To provide more efficient VOD streaming, three important factors should be considered: (1) an efficient streaming scheme for bandwidth savings, (2) optimal use of deployed network bandwidth, and (3) proactive use of user storage. Previous research activities tried to improve one of these three important aspects without considering other factors. These algorithms use a method that adaptively increases the streaming speed when the request rate is low and decreases the speed when the request rate is high by considering the patching scheme, video popularity and VOD request model to maximize the use of available network bandwidth [7]. However, if we also consider items (2) and (3), we can achieve more efficient VOD streaming strategies. The Fig. 1 shows that the VOD request rate pattern during a 24-hour period of a day, which has an analogous pattern every day. Interesting property is that the video request rate is low during most of the day except 7 pm to midnight, which means that the deployed network bandwidth is underutilized most of the day [7]. That is why if the underutilized time period's bandwidth is exploited further, but the busiest time period's bandwidth is less, the service provider can save on the expense for bandwidth provisioning by efficient bandwidth usage.



(Color online) VoD request change in 24 hours

Fig.2. VOD request change in 24 hours [7].

The results show that, when the available network bandwidth is reduced below the required level due to background traffic, the algorithm can considerably reduce the average user waiting time and the number of waiting requests.

5. VOD SERVICES IN NEXT GENERATION

Optical access networks have been developed significantly. VOD is an important service for many network operators that deploy and operate optical access networks. It is highly important to design next generation optical access networks that can guarantee high quality VOD service for end users [9].

Most existing optical access networks are based on passive optical network (PON) technologies, which are classified into Time Division Multiplexing (TDM)-based PON, including Wavelength Division Multiplexing *PON* (WDM PON), Gigabit *PON* (GPON) and Ethernet *PON* (EPON). Such PON architecture can now provide 10 Gb/s downstream bandwidth from the OLT to ONUs. Surely deployment of PONs gives huge advantage in high data rates, however we have to face a number of challenges while doing it [9]. And so one of the most important issues is how the network operators

can gain sufficient revenues and profits by providing services to the end users. Thus VOD is becoming more important.

For improvement of the quality-of-service of VOD has been studied intensively, however most of the existing techniques are developed to support internet-based video streaming, with one or more of the following objectives: (1) to reduce the load of the VOD server, (2) to reduce the playback delay of the viewers and (3) to relieve the pressure for high bandwidth requirement in the internet.

6. APON, EPON AND GPON

By promising high-speed Internet access at a reasonable price, PONs brings the vision of the fully digital home one step closer to becoming reality. There are a number of PON-based access network solutions available, the most important ones being broadband PON (BPON), generic framing PON (GPON), asynchronous transfer mode PON (APON), and Ethernet PON (EPON). Attempts have also been made to integrate solutions based on synchronous optical networking (SONET) with PON technology, but so far it has not been proved that this technology mix can be cost-effective and present any advantages over other schemes [10].

It is commonly believed that EPONs are far more efficient and cost-effective than APONs. However many unrealistic assumptions as to how efficient they really are, especially when comparing them with GPON systems. Numerous studies attribute EPON transmission overhead only to pure encapsulation overhead, forgetting about such vital components as interpacket gaps (IPG) or scheduling protocol components, resulting in very optimistic assumptions of the overall system capacity, especially in the up-stream direction.

GPON systems use a more complex framing procedure when compared with APONs, with downstream and upstream traffic featuring different encapsulation formats [10].

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