Measurement of Download and Play and Streaming IPTV Traffic

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ABSTRACT

Telecommunication service providers are eager for the benefits of IPTV services to penetrate into the lives of their broadband subscribers. A few multimedia delivery methods, such as multicast and P2P-style data bartering, are investigated in an attempt to reduce the network traffic at the backbone while preventing quality of experience degradation. While delivering fiber to households is still in its infancy in most parts of the world, the download and play delivery scheme has been deployed as an interim solution for video-on-demand service until full-scale multicast IPTV deployment in order to handle heterogeneous residential access networks. QoS-controlled streaming IPTV (e.g., multicast) is only available to customers with high-bandwidth broadband access. The research community has been heavily focused on how to reduce network load at the backbone and has overlooked the importance of traffic impact at the customer premises, which is very closely related to the quality of experience. This article provides a traffic impact analysis and a discussion of network-centric quality from the perspective of customers using real-world commercial traces in various user scenarios. We also present an overview of IPTV delivery schemes and user behavior models from previous measurement work. Finally, we illustrate a bandwidth demand estimation method for D&P scenarios.

INTRODUCTION

Telecommunication service providers (telcos) around the world are introducing IPTV service over residential broadband access networks, and competing against cable service providers and media corporations. IPTV is envisioned as a key player in the upcoming IP convergence networks and a new cash cow for telcos where they find a saturated market in terms of the number of broadband subscribers and residential penetration ratio. The research community and industry have overcome most of the technical issues of deploying IPTV service in existing or redesigned infrastructures. Diverse data delivery methods, such as multicast and peer-to-peer (P2P)-style bartering, are investigated in an attempt to reduce the network traffic at the backbone while preventing quality of experience (QoE) degradation. QoE is a measure of end-to-end performance at the service level from the user perspective. It is greatly influenced by network conditions and viewer behaviors, which are unpredictable in many ways. While delivering fiber to households is still in its infancy in most parts of the world, the download and play (D&P) delivery scheme [1] has been deployed by some telcos as an interim solution until full-scale multicast IPTV deployment in order to handle heterogeneous residential access networks.

Some previous studies have discussed the performance measurement results of multicast IPTV traffic at the backbone network and suggested that the results lay within the boundary of tolerable QoE [2, 3]. However, these observations were made from the perspective of service providers and at the level of the backbone network, disregarding the condition of access networks. The same thresholds for performance metrics may not hold in the customer premises, where performance (e.g., upload/download bandwidth) is diverse. Therefore, we need to investigate the performance of IPTV delivery schemes at the level of access networks as well.

This article provides network-centric quality measurement results and analyzes its impact using real-world commercial traces in various user scenarios. We have measured two commercial IPTV services' traffic in four different types of residential broadband access networks: asymmetrical digital subscriber line (ADSL), cable, fiber to the building (FTTB), and fiber to the home (FTTH). The available commercial IPTV service in our reach is a video-on-demand (VoD) service using a set-top box (STB) that relies on three separate transmission techniques: best effort streaming, QoS controlled streaming, and D&P. In this article we also present pros and cons of popular IPTV delivery schemes and user behavior models. A brief description of how these different delivery schemes are actually deployed in our experimental environment is also given. Finally, we present a bandwidth estimation method for the D&P scenario that follows a trail similar to FTP traffic.

The organization of the article is as follows. The next section presents related work on IPTV delivery schemes and user behavior models. We then explain our measurement environments and provide comparison analysis of IPTV traffic characteristics in diverse delivery schemes. Next, we present the bandwidth estimation method in a D&P-based IPTV network and simulation results. Concluding remarks and possible future work are given in the final section.

Related Work

Many researchers have proposed IPTV delivery architectures for some time. In this section we describe IPTV delivery schemes (multicast, peer-assisted, and D&P), and discuss pros and cons of each. A brief overview of IPTV user behavior models is also provided.

Delivery Schemes

The basis for IPTV network architecture is to bring QoS guaranteed video services to the end user at the lowest network cost (e.g., bandwidth) possible. Multicast, and many of its related protocols, is an obvious and favored choice by many telcos; however, it is still in an experimental stage prior to large-scale deployment in many places. Some researchers have considered the possibility of sharing the benefits of P2P file sharing and Internet personal broadcasting with commercial IPTV services. In addition, the D&P architecture is suggested to support the current needs for IPTV in best effort IP networks.

The modeling technique for multicast IPTV networks proposes optimal placements of the required equipment or changes in a cost-effective way [4]. It breaks down the problem domain into client, network provider, and service provider domains, and evaluates the service throughput of the modeling networks based on queuing analysis. For a network that is correctly designed, the estimated bandwidth demand for multicast IPTV networks was given in [1]. It indicates that the peak demand in a commercial break is almost twice the steady state for program viewing. Both of these studies made an assumption that the multimegabit-per-second video delivery rate is guaranteed at all times, which might not be the case in real-world scenarios.

Ma *et al.* [5] present the concept and techniques that can be used in multicast VoD (MVoD) services. While multicast is a remedy to reduce traffic at the backbone, MVoD addresses a few difficult challenges: bandwidth assurance, full VCR-like interactivity (e.g., forward and rewind), service latency optimization, and so on. Although many scheduling strategies for channels (e.g., optimal batching policy for popular contents) are available, the fairness of channel distribution and an immediate prompt to user requests might not be guaranteed in MVoD. These uncertainties set MVoD apart from true VoD services (TVoD) in the current state. In addition, the client heterogeneity in customer premises equipment (CPE) or access networks is addressed as an important issue where there are different transmission rates for users.

The piece exchange strategies (or bartering) between peers in live and VoD streaming are illustrated in Garbacki *et al.* [6]. A piece here refers to a data chunk of a video stream. They explored the efficiency of data bartering and found that a simple optimization of piece exchange policy, called biased random selection, could save a significant amount of VoD server bandwidth. Collaborative VoD protocols, controlling which chunk to pick next, play an important role and result in the benefit of server bandwidth savings.

Sentinelli *et al.* [7] provide an overview of P2P video streaming systems, tree-based and mesh-based. The data chunks between participants are transferred in a tree or mesh overlay network to cope with high peer churn rates and asymmetrical residential networks. While pursuing conventional TV performance, P2P streaming systems focus on optimizing the setup delay, playback delay, and playback continuity at a user tolerable level. In some cases it may be possible for the user to experience tens of seconds in delay before the service starts. The trade-off between delay tolerance by a user and the quality of service (QoS) of P2P streaming systems has been identified through simulation analysis. Manageable metrics such as chunk size, user bandwidth availability, and user buffer size are important in pursing the optimal delay tolerance in a large-scale deployment.

In contrast to the telcos' negative view of P2P services, the possibility of Internet service provider (ISP)-driven P2P IPTV has been addressed by Cha *et al.* [8]. The STB is participated as the source or peer for limited channel contents in order to minimize the network costs at the backbone. By analyzing viewing patterns in a real IPTV network, the authors claimed that locality-aware content storage by the STB could serve a significant amount of rewind requests for popular channels. However, the organizing of locality-aware peers and serving relatively unpopular channel requests in a cost-effective way are still unsolved.

D&P delivery is a form of progressive download in the Web server and client architecture. The user buffer in an STB is filled with a sufficient amount of streaming data prior to playing video. If the playback rate exceeds the download rate, playback is delayed until more data is downloaded to the buffer. Therefore, the initial service latency must be compromised in order to guarantee reliable streaming. Rather than the adaptive codec approach in a multicast environment, D&P is an alternative strategy to cope with heterogeneous end-user network conditions. Popular flash video services (e.g., YouTube) in the Internet are engaged in similar delivery architecture. In addition, D&P data delivery can provide an experience closest to TVoD while offering extra interactive functionalities, such as slow/fast forward and rewind [5]. The quality of content delivery network (CDN) organization in terms of file batching, scheduling, and optimal location is another crucial factor to achieve successful D&P service. However, unlike the previous architectures, no comprehensive study has presented the traffic details of D&P IPTV delivery.

Figure 1 illustrates the piece exchange patterns in multicast and peer-assisted streaming [6] scenarios, and D&P. The playback positions of

The basis for IPTV network architecture is to bring QoS guaranteed video services to the end user at the lowest network cost possible. Multicast, and many of its related protocols, is an obvious and favored choice by many telcos; however, it is still in an experimental stage prior to large-scale deployment in many places.

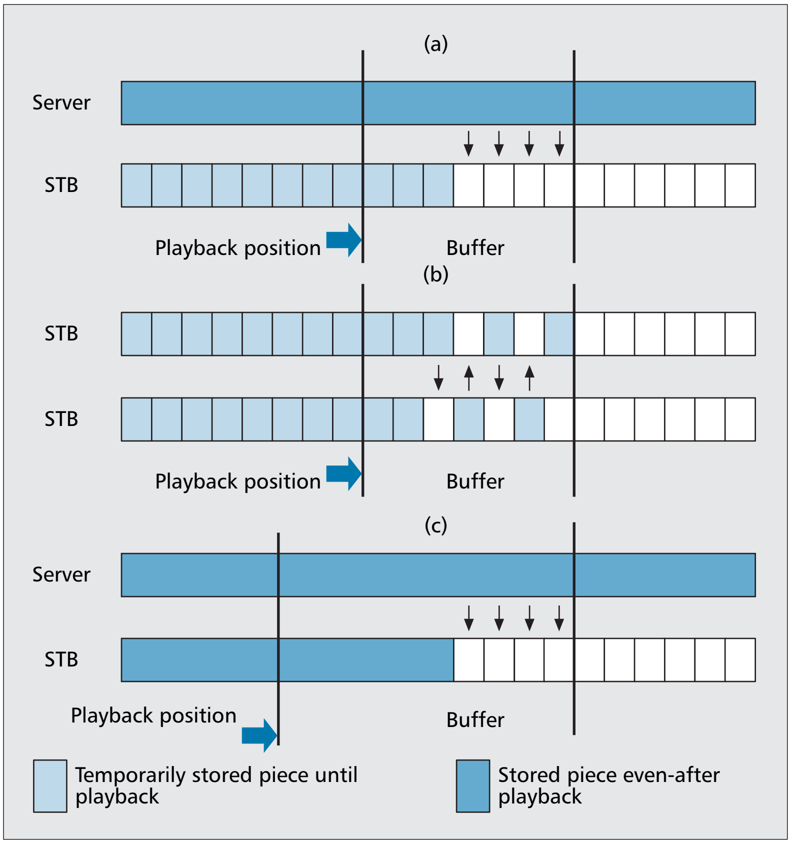

Figure 1. *Piece exchange patterns: a) multicast streaming; b) peer-assisted streaming; c) D&P.*

Figs. 1a and 1b are ahead of that in Fig. 1c, which infers that both streaming approaches can be more vulnerable to unfavorable and sudden changes in network conditions. Because the playback position of Fig.s 1a and 1b is near the download buffer in progress, there is less room to react to sudden changes in transmission bit ratio. On the other hand, Fig. 1c shows considerable initial service latency with delayed playback. The data blocks being exchanged in both streaming scenarios are removed from the buffer after the playback, while those in D&P are stored even after the playback. This enables extra interactive functionality (e.g., rewind and viewing from the left-off position) without reinitializing another download session in VoD service. The streaming solutions engage in memoryless data blocks.

User Behavior Models

The effectiveness of designed IPTV networks can be determined with an accurate model for user behavior. To obtain an accurate behavior model, a measurement analysis of real-world IPTV log and trace data is desirable. Models for channel popularity and user arrival/leave patterns can be explored using server logs or multicast messages (if multicast is being used). Network-centric metrics from packet trace analysis, such as session length, reflects user surfing behavior and corresponding traffic impact on the network.

Zipf-like distribution of user access to content in the Internet is commonly known [9]. Recent studies indicate that a similar modeling of user patterns in IPTV services can be found in the real trace analysis. Sripanidkulchai *et al.* [3] found that media (e.g., audio and video clips) popularity over the Internet follows a two-mode Zipf distribution by analyzing the request distribution in the CDN server logs where the most requested content is audio rather than video clips. A large scale of user log analysis in the commercial IPTV VoD in China [10] also shows a clear Zipf-like distribution in channel requests. In addition, the user arrival distribution is matched to a modified form of the Poisson distribution. For limited cases, it reveals a short flash crowd of sessions which represents frequent channel surfing and impatient viewers that could not stay on the same channel for long.

A first large-scale measurement of commercial multicast IPTV traces that has provided some insights into traffic behavior at the mini-backbone level was presented by Irma *et al.* [2]. Traffic characteristics, such as bit rate, inter-packet arrival time, jitter, packet loss, and reordering, were measured in sessions from the network provider's domain networks. One interesting observation was that there had been no packet loss in the backbone at the time of measurement. Based on the excellent quality in network performance metrics, the authors believe that multicast IPTV is mature enough for further deployment in their country.

A large-scale measurement study of P2P IPTV networks [11] presented user behavior where the logic behind it is similar to that of typical P2P overlay networks. Among their analysis categories, they showed a steady number of residing peers in popular channels and the presence of significant upload traffic from participating viewers. They claimed that there is a clear grouping of heavy and light traffic, video, and signaling packets, respectively. Interestingly, the quality of experience of P2P IPTV did not impact the network load heavily at the time of measurement.

Experiments

In this section we present our measurement environments and the network-centric characteristics of commercial IPTV services. Unlike the previous measurement studies, our measurement focuses on the network characteristics at the customer premises. We present the tolerable network characteristics of D&P at heterogeneous access networks and compare them with those of other streaming delivery schemes.

Measurement Environments

We have subscribed to the commercial IPTV services provided by the two biggest telcos in Korea, referred to as IPTV A and IPTV B in this context. The number of IPTV subscribers nation-wide is over 850,000 and 500,000, respectively. IPTV A service engages in D&P content delivery; the other offers an optional choice of streaming delivery. There are three different types of STBs available according to the content delivery type: D&P, streaming over a best effort backbone network, and streaming over a QoS-enabled backbone network. A single program content is allocated with an instance of a channel; consequently, both IPTV services offer roughly over 30,000 available channels. Due to government regulation, VoD service was only provided as of early 2008, although QoS-enabled streaming service is already technically ready for live multicast TV. We have collected the end user traces in combinations of these three types of STBs over four different residential broadband access networks in two different cities.

Figure 2 shows the IPTV deployment topology and available delivery schemes. QoS-enabled streaming service is available through a so-called premium backbone network built on multiprotocol label switching (MPLS)/differential services (DiffServ) code point (DSCP) technology. The contents are distributed from the head-end to the premium backbone network by multicast, and the rest of the path to the end user is carried by unicast. The premium backbone network is designed separate from the existing best effort IP backbone to provide better quality to high-priority subscribers in limited regional locations. For our experiment, QoS-enabled streaming for VoD service was only accessible via FTTH. D&P service is available in all four access networks via the best effort backbone network. The STBs for D&P service can be installed across the different locations regardless of access network types or even behind network address translation (NAT). Finally, for slightly lower-quality streaming service, best effort streaming over ADSL is provided in an early stage of IPTV introduction. This service is gradually replaced by either D&P or QoS-enabled streaming because there is simply no control over the quality issue.

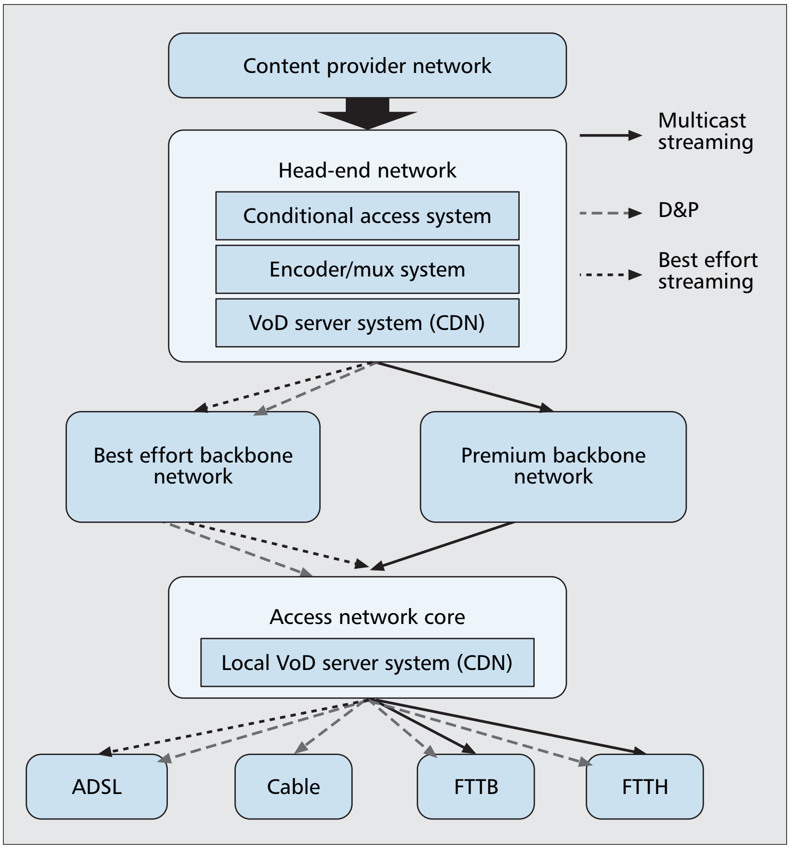

Figure 2. *IPTV deployment topology and available delivery schemes.*

Network-Centric Measurement Analysis at the Customer Premises

Packet traces were collected while watching an episode from a popular TV series, *CSI Miami*. We used a 100 Mb/s copper network tap (full-duplex) to intercept the packets in and out of the STB. A PC with two interfaces running tcpdump stored the first 96 bytes of the packet header. Most channel transmissions were established over TCP, except the QoS streaming solution, where UDP was used. No flashback or frame stoppage had been observed at the time of measurement. For the D&P service solution, we observed that the actual packet transmission was completed in early in the channel viewing period. In other words, the transmission time is not equal to the total running time of the content. Depending on the bandwidth of the subscribed access networks, the complete delivery time to the STB varied from 13 to 20 min for a 40-min episode. Our analysis included throughput, jitter, byte distribution, packets per second (PPS), and reordering measurements of each viewing session.

Figure 3 illustrates the traffic burst periods of each monitoring location. In Fig. 3a, the throughputs in FTTH and FTTB show an approximately 13-min traffic burst period where they generate 10~11 Mb/s constantly. The throughputs in cable and ADSL are two-thirds of the throughput achieved by FTTH. The maximum throughputs for D&P service via FTTH in Figs. 3a and 3b are 11 and 6 Mb/s, respectively. IPTV B shows the consistent maximum bound of throughput, 6 Mb/s, regardless of access network types; however, IPTV A shows significant changes in heterogeneous environments. The throughput achieved in D&P for IPTV B via ADSL also shows 6 Mb/s as in FTTH (this is omitted from the graph because its throughput pattern is an exact match with ADSL). We believe that a different strategy for VoD server configuration by the two IPTV providers results in such a difference. Furthermore, the service latency for both IPTV D&P is delayed by 10–20 s until 1 percent of the total video file size is delivered to the user buffer.

We observed rather steady-state traffic delivery in the streaming IPTV services. Figure 3b presents a comparison between D&P and streaming IPTV services via ADSL and FTTH. The D&P type completes its download with initial traffic bursts, while the streaming type shows relatively low yielding bandwidth through the entire running time. Because it delivers the content over a longer time period, the quality of streaming could be more overlapped with or vulnerable to other types of traffic bursts in the residential line, such as Web surfing, P2P file sharing, and VoIP. These two concrete patterns of traffic delivery should be considered thoroughly when planning bandwidth demand and analyzing the impact on the traffic mix.

Figure 3b shows that the QoS-enabled streaming traffic actually drops to a steady-state several minutes after the channel request. We observe that immediate traffic increase is followed by channel selection in most cases, which is very similar to the traditional Web request-reply model. However, the QoS-enabled streaming service initiates even more data transmission between channel requests. We believe this traffic burst is responsible for background data retrieval, like downloading commercials and program guide information.

At last, Fig. 3c presents the throughput variation of IPTV in a viable bit ratio situation. We placed a D&P STB of IPTV B via the residential cable network in San Jose, California, and tested the viewing of IPTV services from Korea over intercontinental

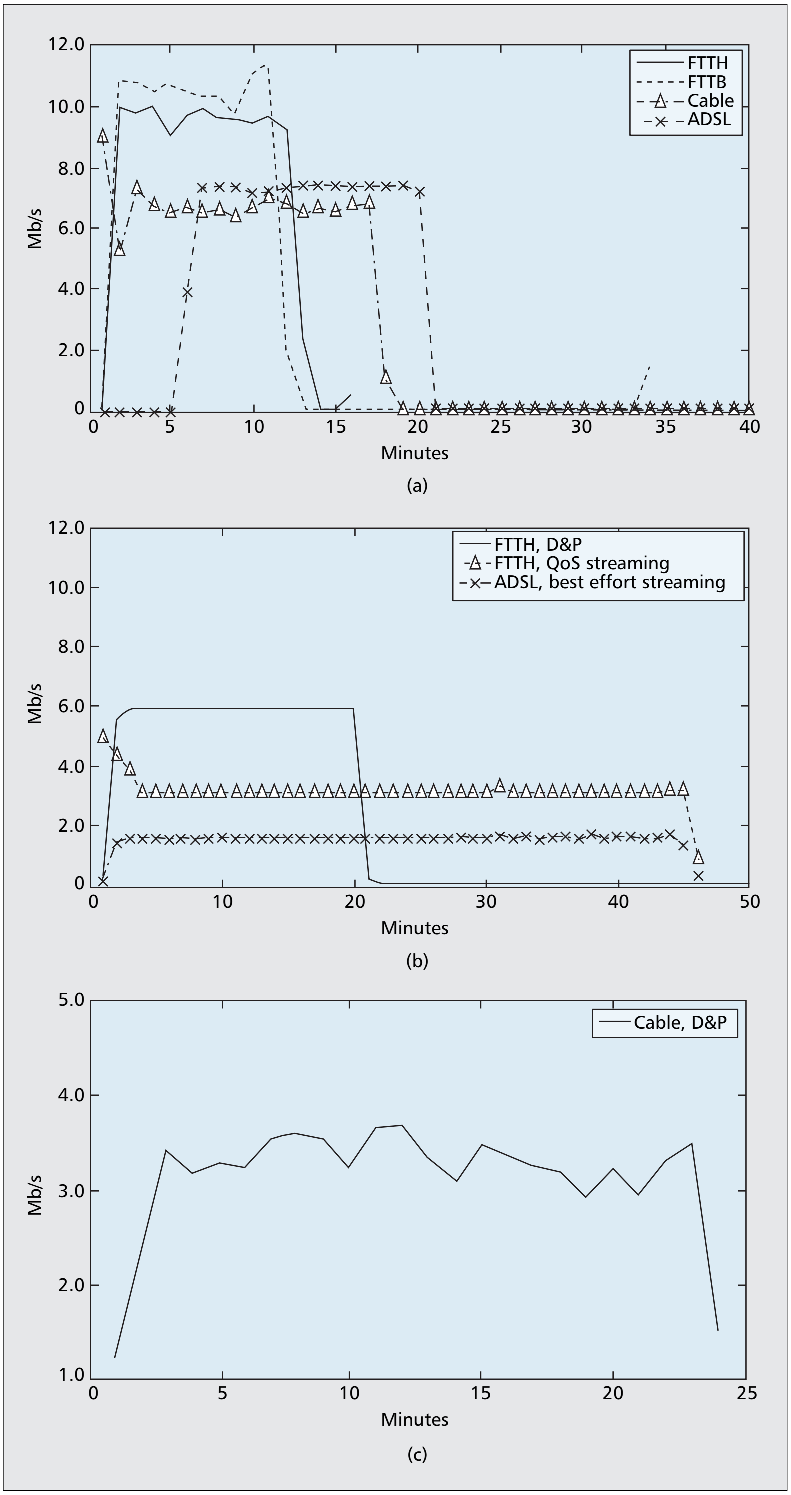

Figure 3. *Throughput via heterogeneous broadband access networks: a) IPTV A: D&P; b) IPTV B: D&P vs. two streaming types; c) IPTV B: D&P over intercontinental Internet links.*

Internet links. Maintaining the SD video quality was prioritized; thus, frequent pauses were inevitable due to slow filling of the video buffer. This is clearly the opposite of the phenomenon of low-quality streaming service where the video quality degrades to compensate and avoid frame stoppage.

Figure 4 illustrates the comparisons between two D&P and QoS-enabled streaming sessions in the following categories: packet byte distribution, jitter variation, and number of packets per second. The two distinct groups, up/download streaming and control packets, of packet size distribution were noticeable in the P2P IPTV traffic [11]. In Fig. 4b the QoS-enabled streaming traffic also follows a similar trail to P2P IPTV traffic where most of the packets reside in 1300- and 300-byte bins. Meanwhile, Fig. 4a indicates four distinct groups instead, which is close to typical Web traffic with heavy content download. Furthermore, the interpacket arrival time (jitter) stays at less than 10 ms, while the D&P reaches up to 90 ms and shows wider variation in the recorded values. Again, there was no QoE degradation at the time of measurement, so a less strict service level agreement (SLA) condition in terms of jitter is acceptable for D&P. Therefore, D&P can be provided to handle heterogeneous and uncontrolled access network environments.

Network-centric conditions cannot directly reflect the actual QoE. However, we can determine the tolerable ratios for performance-related measurement values. Irman *et al.* [2] indicated no packet reordering in the backbone and drew a conclusion that there would be no problem in QoE for IPTV users. We extend this view to cover the CPE as well. Table 1 shows the packet reordering counts in the monitored IPTV sessions by counting retransmission and out-of-order delivery packets accordingly. Despite packet reordering at the client domain, the video quality is not degraded, and these ratios are tolerable over TCP. IPTV over cable experiences a higher out-of-order ratio (9.9 percent) than the others. It has to go through an additional cable provider's network, while the others stay within the same ISP's network, which provides IPTV services as well. Furthermore, IPTV B shows almost no reordering occurrences even without relying on a premium network. We believe that optimal placement of local VoD servers is a key difference between the two IPTV services. It also infers that a very reliable and high-quality service is achievable through the D&P delivery scheme. Overall, the following observations are made to describe IPTV traffic characteristics:

- Unlike streaming, the transmission time for D&P does not coincide with the total viewing time.
- The tolerable boundary for jitter in multicast streaming is stricter than that in D&P.
- Packet reordering ratios at the customer premises do not correlate to the performance of broadband access networks.

Bandwidth Demand Estimation for D&P

Unlike streaming traffic, the traffic pattern of D&P does not reflect the actual user viewing time due to initial heavy data transfer rather

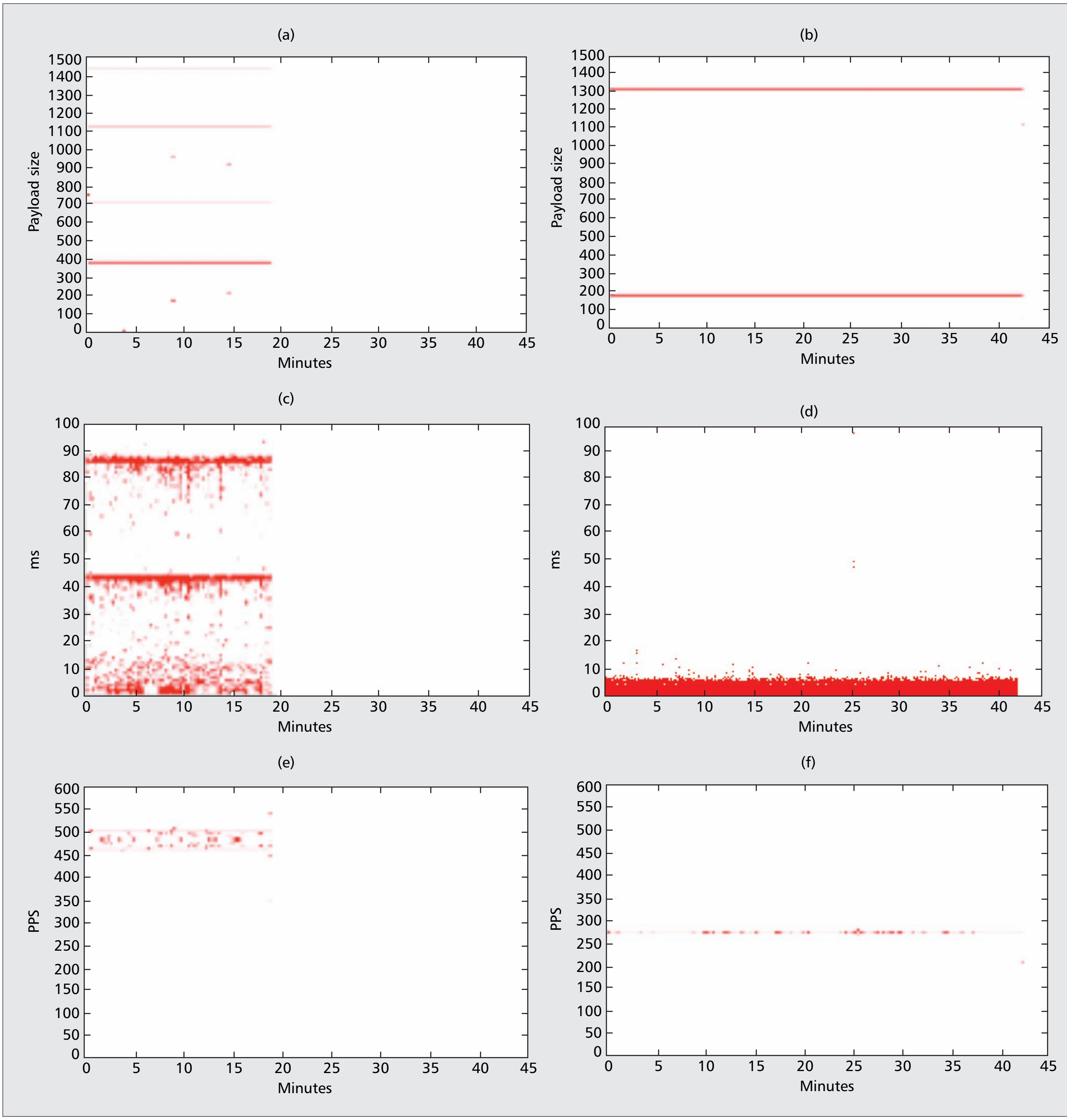

Figure 4. *Session measurement, D&P vs. QoS-enabled streaming: a), b) byte distribution; c), d) jitter variation; e), f) packets per second count.*

than steady continuous data transfer. D&P traffic can be modeled on the traditional diurnal traffic cycle of FTP, which consists of bursty and non-bursty traffic. FTP connection interarrivals are well modeled by a Poisson process, and the data transferred follows heavytailed distributions [12]. Based on previous observations, we have formulated the representation of bandwidth demand in IPTV D&P services.

Bandwidth Demand

The throughput rates in real IPTV networks are sampled according to the type of broadband access network. The sampled values in our measurement environments are 11, 10, 7, and 7 Mb/s for FTTH, FTTB, cable, and ADSL, respectively. $D_j(t)$ is a random variable that represents the bandwidth demand of a single STB (viewer j) at time t. It indicates whether the download of movie content is terminated after channel selection. If it indicates zero, the bandwidth is no longer required for viewing the remaining time on the channel because the content is already delivered to the STB. In our measurement results the file transfer is completed on average within half the channel running time after viewing starts. The bandwidth demand for VoD at time t, $Bv(t)$, is the band-

Transmission type			Retransmission	Out of order	Total received
IPTV A	D&P	ADSL	2289 (0.2%)	36,891(4.2%)	877,140
		Cable	381 (0.02%)	126,564 (9.9%)	1,277,063
		FTTB	2224 (0.2%)	34,939 (3.9%)	878,735
		FTTH	1604 (0.2%)	36,467 (4.1%)	885,760
IPTV B	D&P	ADSL	301 (0.05%)	422 (0.07%)	579,173
		FTTH	101 (0.01%)	168 (0.01%)	642,791
	Best effort streaming	ADSL	20 (0.003%)	0	573,273
	QoS streaming	FTTH	N/A	N/A	869,856

Table 1. *Packet reordering ratio (out-of-order and retransmission packets) during IPTV delivery.*

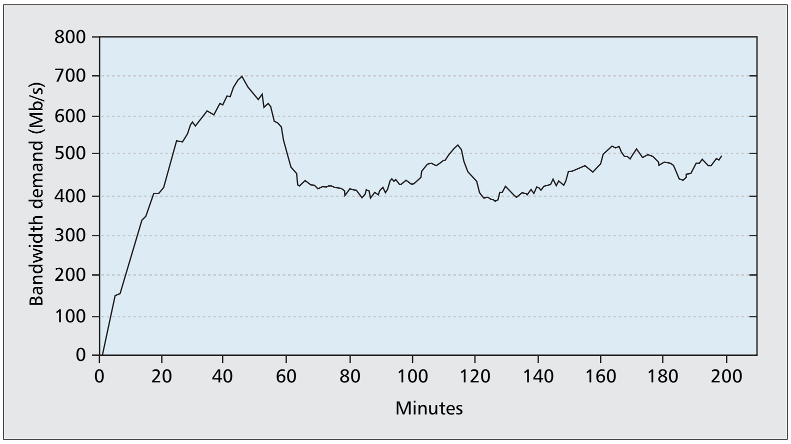

Figure 5. *Mean estimated bandwidth for D&P service.*

width estimation of all active viewers during the actual download period. $I_j(t)$ is an indicator function of whether the viewer stays in the same channel he/she originally chose at time t. Thus, $Bv(t)$ is defined by:

- j A single viewer j
- r_l Throughput rate between VoD server and client via media l where $l \in$ {ADSL, cable, FTTB, FTTH}
- T_{jk} Time viewer j started to download channel file size k
- t_{kl} Duration of downloading program file k by medium l
- C_{jk} Time viewer j stopped to play channel file size k (a new arrival of channel selection)
- h Active household STBs
- $Ij(t)$ Indicator function of t, which is 1 if viewer j is on at time t, otherwise 0.

$$Bv(t) = \sum_{j=1}^{h} Dj(t) \cdot Ij(t) \text{ where}$$

$$Dj(t) = \begin{cases} rl \text{ if } T_{jk} & \leq t \leq T + \tau_{kl} \\ 0 & \mathit{Otherwise} \end{cases} \quad \text{and } \tau_{jk} = \frac{c_{jk}}{r_l}$$

SIMULATION RESULT

We have simulated the bandwidth demand estimation model on dedicated links where the IPTV server farm supports 200 active viewers. To simplify the viewer behavior for IPTV VoD subscribers, we assume that every viewer stays in the channel of their choice until it terminates. The arrival of channel selection requests per unit time follows a Poisson distribution.

The targeted IPTV service in this article has a majority of channels with 1 h long content (1000-Mbyte file size at 34.1 percent occupancy with the Zipf channel popularity) because it mostly consists of reruns of popular TV dramas and shows that are around an hour long. Our assumption is made over SD quality encoding for now. In addition, the penetration ratios of the broadband access networks used in the simulation are 60, 10, 20, and 10 percent for ADSL, Cable, FTTB, and FTTH, respectively.

Based on the above conditions, we have taken the mean of multiple estimation simulations. Figure 5 shows the bandwidth demand over a 3 h period. The initial peak reaches up to 700 Mb/s, and then it gradually reduces to an average of 500 Mb/s. Reference [5] shows that an average of 1000 Mb/s is required for 200 active viewers in a multicast live TV environment. Although the assumptions in that research cannot be directly compared to our simulation, there may be a possible bandwidth gain from IPTV VoD service when it does not require a constant and fixed throughput rate in play (e.g., SD = 3.75 Mb/s, HD = 15 Mb/s).

CONCLUDING REMARKS

Various IPTV delivery schemes are suggested in order to offer reliable service with the lowest network cost possible. In this article an overview of IPTV delivery schemes and user behavior models is given, followed by real-world measurement studies. Then this article exploits the network-centric measurement results of commercial IPTV services, based on streaming and D&P delivery, from the customer premises perspective. The D&P architecture has some advantages over multicast streaming delivery. We conclude that D&P is an effective solution for IPTV deployment in the following ways:

- It is scalable and can deliver high-quality IPTV service even in existing best effort networks. No imminent upgrade to advanced backbone or access networks is necessary for the deployment of quality-assured service.
- It can tolerate relatively poor network performance conditions better than the streaming solutions to support heterogeneous access networks.
- In the case of VoD it allows viewers to have extra interactive functionalities (e.g., TVoD) without transmission redundancy in memoryless streaming solutions.
- The proposed bandwidth demand approach for D&P is simpler and more effective than previous IPTV traffic modeling work.

There is a trade-off between service latency and IPTV quality. Finding the optimum service latency for D&P is an important issue to satisfy the viewer's QoE. D&P delivery can also be applicable to live broadcast TV with reasonable playback delay (in seconds) when the broadcasting companies intentionally spares on some occasions (e.g., the Academy Awards show). In addition, FTP-like traffic behavior should be considered in traffic engineering. The planning and simulation strategies for IPTV in previous studies disregard the fact that high-bandwidth steady-state transmission would be difficult to achieve in a real-world network.

D&P is considered an interim solution until pure multicast and end-to-end QoS controlled networks are in service. While fiber delivery to households is still in its infancy, D&P has become a cost-effective choice for telcos. There is a high possibility that D&P is emerging as the only feasible solution without changing too much for the Internet. In future work we plan to analyze the impact of IPTV on existing traffic in the bundled service environment. Accurate traffic modeling and analysis techniques for bundled service traffic will be investigated.

Acknowledgments

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There is a high possibility that D&P is emerging as the only feasible solution without changing the Internet too much. For future work, we plan to analyze the impact of IPTV on the existing traffic in the bundled service environment.