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Optimal bandwidth assignment for multiple description coded video

Naveen kumar, Jaishree Tripathi, Rachana Dubey Mr. Abhishek Srivastava

Institute of Technology & Management GIDA Gorakhpur U P

Abstract

In video streaming over multicast network,user bandwidth requirement is often heterogeneous possibly with orders of magnitude difference (say, from hundreds of kb/s for mobile devices to tens of mb/s for high-definition TV).Multiple descry ption coding (MDC) can be used to address this bandwidth heterogeneity issue. In MDC, the video source is encoded into multiple independent descriptions. A receiver, depending on its available bandwidth, joins different descriptions to meet their bandwidth requirements.An important but challenging problem for MDC video multicast is how to assign bandwidth to each description in order to maximize overall user satisfaction. In this paper,we investigate this issue by formulating it as an optimization problem, with the objective to maximize user bandwidth experience by taking into account then coding inefficiency due to MDC.

We prove that the optimization problem is NP-hard. However, if the description number is larger than or equal to a certain threshold(e.g., if the minimum and maximum bandwidth requirements are100 kb/s and 10 mb/s, respectively, such threshold is seven descriptions), there is an exact and simple solution to achieve maximum user satisfaction, i.e., meeting all the bandwidth requirements. For the case when the description number is smaller, we present an efficient heuristic called simulated annealing for MDC bandwidth assignment(SAMBA) to assign bandwidth to each description given the distribution of user bandwidth requiremen.We evaluate our algorithm using simulations. SAMBA achieves virtually the same optimal performance based on exhaustive search .By comparing with other assignment algorithms, SAMBA significantly improves user satisfaction. We also show that, if the coding efficiency decreases with the number of descriptions, there is an optimal description number to achieve maximal user satisfaction.

Index Terms—Multiple-description-coded video, optimal description bandwidth assignment, simulated annealing, streaming.

Introduction

In video streaming over multicast network, user bandwidth requirement is often heterogeneous possibly with orders of magnitude difference (say, from hundreds of kb/s for mobile devices to tens of Mb/s for high-definition TV). Multiple description coding (MDC) can be used to address this bandwidth heterogeneity issue. In MDC, the video source is encoded into multiple independent descriptions. A receiver, depending on its available bandwidth, joins different descriptions to meet their bandwidth requirements. An important but challenging problem for MDC video multicast is how to assign bandwidth to each description in order to maximize overall user satisfaction.

In this paper, we investigate this issue by formulating it as an optimization problem, with the objective to maximize user bandwidth experience by taking into account the encoding inefficiency due to MDC. We prove that the optimization problem is NP-hard. However, if the description number is larger than or equal to a certain threshold (e.g., if the minimum and maximum bandwidth requirements are 100 kb/s and 10 Mb/s, respectively, such threshold is seven descriptions), there is an exact and simple solution to achieve maximum user satisfaction, i.e., meeting all the bandwidth requirements. For the case when the description number is smaller, we present an efficient heuristic called simulated annealing for MDC bandwidth assignment (SAMBA) to assign bandwidth to each description given the distribution of user bandwidth requirement.

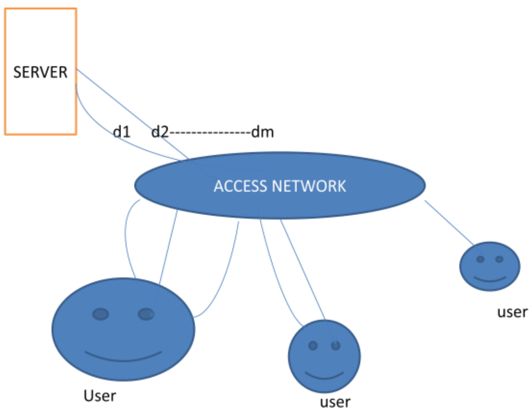

Fig.1.Video streaming using MDC to heterogeneous users.

Literature Survey

In literature survey we find some problems in i.e how we assign bandwidth for different heterog -eneous user. By the use of MDC we can solve this problem.

With the help of MDC we can make numerous application in video streaming field .Here we only focus on MDC on its error resilient techniques to ensure transmission robustness, and have not considered the assignment of description bandwidth to achieve system performance as investigated in this paper.

2. Existing System

With the penetration of broadband Internet access and advances in video compression techniques, there has been increasing interest in both stored and live video services. like YouTube and MSN Video have offered numerous on-demand video clips. Online live TV streaming with the use of IP multicast or peer-to-peer (P2P) technology have also been widely deployed (e.g., AT&T IPTV, PPLive, Coop Net, and Split Stream) . To stream video to a large group of users, meeting heterogeneous bandwidth requirements presents a challenging problem. Such bandwidth requirement may differ by orders of magnitude, from hundreds of kb/s for mobile devices to tens of Mb/s for high-definition TV.

In order to serve all the users, obviously it is neither efficient nor feasible for the server to transcode the stream to each of the user bandwidths. A simple approach is to encode the video into a number of streams of different bitrates, which users join to best match their bandwidth requirements. Given the wide range of bandwidth requirements and limited number of video streams, this approach is clearly not satisfactory, resulting in many receivers getting a stream substantially lower than their bandwidth requirements

3. Proposed System

1) A much better approach is to use multiple description coding (MDC), which encodes the video into multiple independent “descriptions” of different bandwidth. The descriptions can be arbitrarily combine to best match user’s bandwidth requirement. Such approach provides many more options of video bitrates to meet different user requirements, e.g., descriptions provide up to different video bitrates. A user chooses to receive a set of descriptions, where the sum of their bandwidth best matches the user bandwidth requirement. We illustrate in Fig. 1 video streaming using MDC to heterogeneous users.
2) the video is encoded into descriptions with bitrates . The users, depending on their access bandwidth, get the descriptions that best match their bandwidth requirements so as to maximize their video quality. In this paper, we study optimal bandwidth assignment for descriptions given heterogeneous

bandwidth requirements. We expect an optimal assignment because of the following: if description bandwidths are set too high, the low-bandwidth receivers may not benefit from them (as joining them may exceed their bandwidth), leading to low video quality. On the other hand, if description bandwidths are set too low, those high-bandwidth receivers may not be able to fulfill their bandwidth by joining them, leading again to low video quality. Therefore, we expect optimal description bandwidths to achieve the best overall video quality. The contributions of our work are as follows.

4. Literature Survey

In literature survey we find some problems in i.e how we assign bandwidth for different heterog -eneous user. By the use of MDC we can solve this problem.

With the help of MDC we can make numerous application in video streaming field .Here we only focus on MDC on its error resilient techniques to ensure transmission robustness, and have not considered the assignment of description bandwidth to achieve system performance as investigated in this paper.

5. Problem Formulation

Consider a video stream to be accessed by a large pool of users with heterogeneous bandwidth requirements. In Figure 2, we show the optimization being done at the server. The server encodes the stream into multiple descriptions, given the description number m, user bandwidth requirement cj and its importance (in term of a weight value wj). Users employ a greedy approach in joining the descriptions to maximize their video quality, i.e., they join the descriptions so that the total bandwidth best matches the bandwidth requirement without over flowing. The c user can use exhaustive search to and the best combination of descriptions, which is simple due to small search space. Denote the bandwidth of description i by di. Then d is m-dimensional vector (sorted in the increasing order) and represents a particular bandwidth assignment for the descriptions. The total joined video bandwidth vj is the sum of received description bandwidths. Clearly we need vj≤cj (5.1) ,

Let Kij 2 f0; 1g be a binary number with 1 indicating that user j chooses description i.

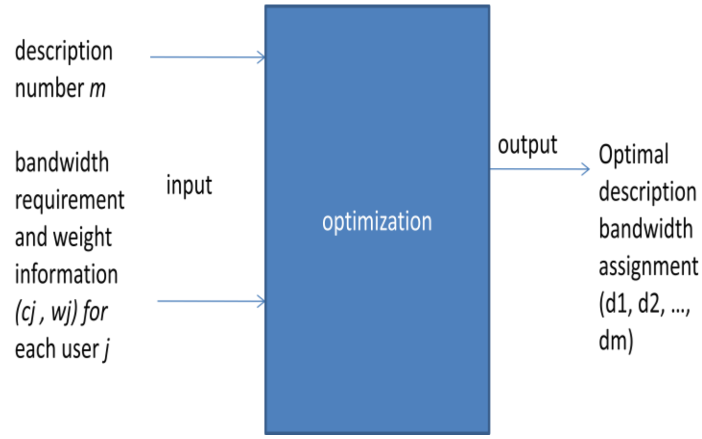

Fig.2. The optimization model for MDC bandwidth assignment.

We have
$Vj = \sum_{i=1}^{m}$ Kij dj: (5.1)

We consider that bandwidth is normalized to some unit (say, 50 kb/s), and hence cj and di are integral. The heterogeneity factor h is defined as the difference between maximum and minimum user bandwidth requirement, i.e.,

h = max j cj - min j cj + 1 : (5.2)

Define rj the bandwidth matching factor given by the ratio of vj and cj , i.e.,

$rj = vj/cj$: (5.3)

Define $a_m €(0,1)$: (5.4)as the coding efficiency factor given m descriptions, which decreases with m. We model user individual satisfaction as a monotonically increasing function f in terms of rj αm. The individual satisfaction of user j, is hence given by

$\mathrm{Sind}(\vec{d};\ cj) = f(\alpha_m r_j)$: (5.5)

Let n be the number of users in the network. The overall network satisfaction is hence given

$$s(\vec{d}) = \frac{\sum_{j=1}^{n} w_j \, s_{ind}\,(\vec{d}, Cj)}{\sum_{j=1}^{n} wj} : (5.6)$$

Our objective is then to and optimal bandwidth assignment d* so as to maximize Equation (3.6) subject to Equations (5.1), (5.2), (5.4) and (5.5), i.e., S*= S($\vec{d}$ *) =max $\vec{d}$ S($\vec{d}$) : (5.7)

The problem is NP-hard (shown in the Appendix, by finding a polynomial reduction from the subset sum problem).

6. Exact Solution

An exact solution for description number larger than a certain threshold; Our problem is in general NP-hard. However, when the number of descriptions is larger than or equal to a certain value (e.g., if the minimum and maximum bandwidth requirements are 100 kb/s and 10 Mb/s, respectively, such threshold is seven descriptions), we show that the problem can be solved exactly and efficiently Our solution takes only computational time to set description bandwidths with all user bandwidth requirements fully matched. In other words, maximum overall user satisfaction can be achieved in this case. An efficient heuristic for smaller description number; For the case where is lower than the threshold, we present an efficient heuristic called simulated annealing for MDC bandwidth assignment (SAMBA) to set the description bandwidths. SAMBA is shown to be efficient, and virtually matches the optimum based on exhaustive search. As compared with other simple assignment algorithms, our algorithm can achieve much higher user satisfaction. Using SAMBA, we further show that, if the coding efficiency decreases with the description number , there is an optimal to achieve maximum user satisfaction. Such is typically small (in the range of 3–5).

7. Work Done

COMPARISION BETWEEN SCHEAMS & PERFORMANCE METRIC

- SAMBA has been compared with
  - Exhaustive search
  - Uniform assignment
  - Linear assignment
  - Random assignment
- The metrics include
  - Overall satisfaction
  - Individual satisfactio

7. Conclusion

In this paper the use of Multiple Description Coding MDC is proposed to support heterogeneous terminals in future generation wireless networks such as envisioned in 4G. Based upon the capabilities of the various terminals, all the descriptors or only a subset of the descriptors can be used in the reception. This way the application can be kept unaware of the requirements of the individual terminals. The data flow should be split into large number of descriptors, in order to support a large number of heterogeneous terminals within the system. Terminals with advanced capabilities will use many descriptors, while the terminals with limited capabilities will utilize proportionally smaller subset of descriptors.

8. FUTURE WORK

1) How to do optimization over a horizon of several periods, taking into account the inter-dependence between the periods.
2) How to do optimal scheduling with scalable How video coding (such as layered video coding) or multiple description coding.

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