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Video Distribution With Energy Efficient Statistical QOS Provision Over Wireless Networks

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Abstract:

The resource allocation problem for general multi hop multicast network flows and derives the optimal solution that minimizes the total energy consumption while guaranteeing a statistical end-to- end delay bound on each network path. Existing approaches use negated signal-to-noise ratio as link weights on the complete network graph, finds the minimum spanning tree using those weights to maximize the sum rate, and performs optimal resource allocation on the flow corresponding to the obtained tree structure and maintains a set of dominant flows that are optimal for a potentially large percentage of channel states under a certain network topology and performs flow selection. We propose network flow based algorithm allocates resources in the I th iteration, until all resources are exhausted and the utility is maximized by minimizing the flow cost representing the negative values of 'data rate'. In contrast to maximum-utility resource allocation, the problem of minimum power subject to rate target that we consider does not admit a single-stage multi-commodity flow formulation. In the proposed NFBA, we maximize the 'potential power saving' on the flow instead of minimizing the cost, in a Ft adaptively. We analyze our proposed scheme in terms of complexity, power and cost.

1.Introduction

Cooperation among mobile devices in wireless networks has the potential to provide notable performance gains in terms of increasing the network throughput, extending the network coverage, decreasing the end-user communication cost, decreasing the energy consumption. In this work , we develop optimized flow selection and resource allocation schemes that can provide end-to-end statistical delay bounds and minimize energy consumption for video distribution over cooperative wireless networks. The network flow for video content distribution can be any sequential multihop multicast tree forming a directed acyclic graph that spans the network topology. We model the queuing behavior of the cooperative network according to the effective capacity link layer model. Based on this model, we formulate and solve the resource allocation problem to minimize the total energy consumption subject to end-to-end delay bounds on each network path. Moreover we have used two approximation algorithms to solve the flow selection problem which involves selecting the optimal flow in terms of minimizing energy consumption. We propose network flow based algorithm allocates resources in the I th iteration, until all resources are exhausted and the utility is maximized by minimizing the flow cost representing the negative values of 'data rate'. In contrast to maximum-utility resource allocation, the problem of minimum power subject to rate target that we consider does not admit a single-stage multi-commodity flow formulation. In the proposed NFBA, we maximize the potential power saving instead of minimizing the cost, in a Ft adaptively.

2.Related Work

2.1.Scalable Video Coding(SVC)

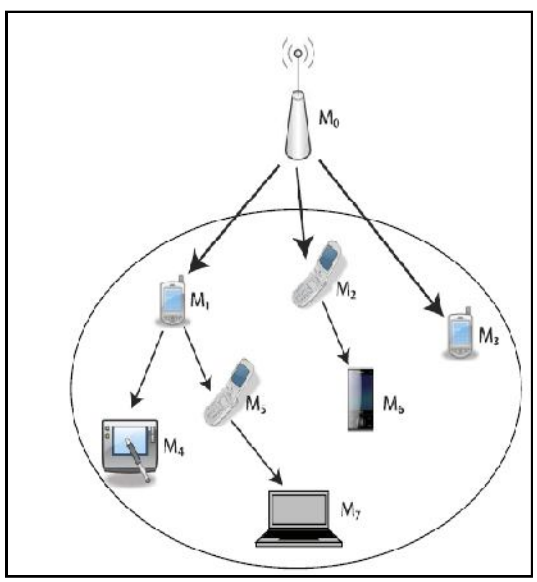
Scalable Video Coding(SVC) is a highly attractive solution to the problems posed by the characteristics of modern video transmission systems. The term "scalability" in this paper refers to the removal of parts of the video bit stream in order to adapt it to the various needs or preferences of end users as well as to varying terminal capabilities or network conditions. The term SVC is used interchangeably in this paper for both the concept of scalable video coding in general and for the particular new design that has been standardized as an extension of the H.264/AVC standard. The objective of the svc standardization has been to enable the encoding of a high-quality video bit stream that contains one or more subset bit streams that can themselves be decoded with a complexity and reconstruction quality similar to that achieved using the existing H.264/AVC design with the same quantity of data as in the subset bit stream.

2.2.Quality-Of-Service(QOS)

Quality-Of-Service(QOS) driven power and rate adaptation scheme for multichannel communication systems over wireless links in mobile networks. In particular, we use the multichannel communications to model the conceptual architectures for either diversity or multiplexing systems, which play a fundamental role in physical-layer evolutions of mobile wireless networks. By integrating information theory with the concept of effective capacity, our proposed scheme aims at maximizing the multi-channel systems throughput subject to a given delay QOS constraint. Under the framework of convex optimization, we develop the optimal adaptation algorithms. Our analyses for multichannel communications show that when the Qos constraint becomes loose , the optimal power-control policy converges to the well known water-filling scheme, Where the Shannon or ergodic capacity is achieved. On the other hand, when the Qos constraint gets stringent, the optimal policy converges to the scheme operating at a constant-rate(i.e.,zero-outage capacity),which by using only a limited number of subchannels, approaches to the Shannon capacity. This observation implies that unlike the single-channel communications, which to trade off the throughput for Qos provisioning, the multichannel communications can achieve both high throughput and stringent Qos at the same time. Furthermore, our results also demonstrates that for multiple-input-mutiple-output(MIMO) diversity and multiplexing systems, the superiority of MIMO infrastructure to enhance the Qos-guarantees is even more significant than that to improve the spectral-efficiency.

1.3.Cooperative Network Model

The proposed system model consists of a base station(BS),denoted by M0,and k MSs M1;_ _ _;MK which are capable of transmitting, receiving , or relaying a scalable video bitstream. The BS is responsible for distributing the same multi-layer video stream to the MSs over wireless fading channels. We define a flow as a tree of adjacent links that represents consecutive unicast /multicast transmission. We are given a set of N candidate flows where the nth flow is defined by a set of links Fn which form a directed acyclic tree(DAG). This network flow consists of four distinct paths leading to M4,M7,M6, and M3 and traversing all MSs. We define Pni as the set of nodes traversed by the ith path of the nth flow. For the first path in the given example network, Pn 1 = fM0;M1;M4g. we refer to pn as the number of paths in flow Fn. Thus,pn =4 for the fixed network flow n. The set of unicast/multicast receiver for MS Mk in the nth flow is denoted Mnk. For example, the set of multicast receivers for the BS transmission is Mn0=fM1;M2;M3g AND JmN0 J=3. Note that jMnk j=1 characterizes a unicast transmission by Mk. The video stream generated by the scalable video codec consists of L video layers. Each layer maintain a separate queue at each node and a specific QoS requirements according to its relevance in the decoding process. The time frame T is defined as the difference between the playback time of the two video frame rate. Within this duration T, the video frame contents corresponding to the L layers should be transmitted as per the construction of flow Fn to all K receivers to avoid playback buffer starvation. We treat each path of the multicast tree separately by allowing the content to be streamed simultaneously(in parallel) on different paths of the network flow. This is based on the assumption that channels are readily available for all MSs in the network. Note that the number of channels required is upper bounded by the number of paths in the network. For example, the 4-path network flow in Figure 1 requires only two channels to support the simultaneous transmission by M1 and M2. The number of paths is typically significantly lower than the network size K, and in realistic scenarios, the network size is much less than the number of available channels in the wireless technology utilized for the short range transmissions.

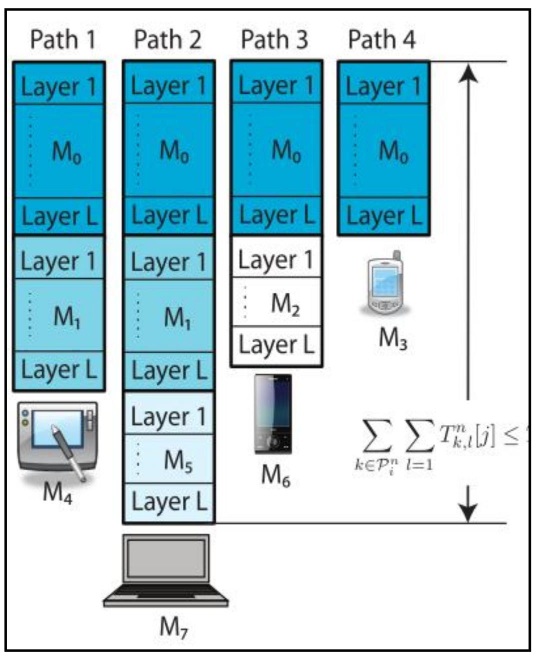


(a) Example network with a fixed network flow

Figure 1

2.Queuing Network Model For Multihop Layered Video Transmission

A separate queue is maintained for each video layer at each node. The arrival process at the BS is denoted Fa0;lgL l=1 and is determined by the scalable codec parameters and the video content. The behaviour of queue-length process in queue based process in queuing based communication networks is extensive. In an acyclic network, the queue length at time t of each queue can be bounded. The effective capacity channel model captures a generalized link-level capacity notion of the fading channel by characterizing wireless channels in term of functions that can be easily mapped to link-level QoS metrics, such as delay-bound violation probability. End-to-End Delay Bounds on Network Paths the arrival process Fa0;lgL l=1 at the BS has an average arrival rate l=E[A0;l=T] for each video layer l. the per layer arrival rate is determined by the parameters of the scalable codec and by the video content. Given this arrival process and the instantaneous SNRs, we are interested in adaptively configuring the service processes fC_{nk};lgL K l=1;k=0 such that the end-to-end delay bound are satisfied for every path. To model the end-to-end delay bound for each path in the network, we consider a fluid model of traffic such that the service at each node is cut-through.



(b) Time frame structure of the network flow

Figure 2

3.Resource Allocation And Flow Selection

Finding the globally optimal distribution strategy requires converting each of the Prufer sequences into a spanning tree and finding the minimal energy consumption using that tree structure, then choosing the tree that minimizes energy consumption among all candidates, and allocating resources accordingly. In this section, we propose two approximation algorithms to reduce the complexity involved in choosing the best flow for a given fading state. The objective of the proposed algorithms is to avoid searching through the exponential number of possible tree structures. The first algorithm uses negated SNRs as link weights on the complete network graph, and finds the minimum spanning tree using these weights. The second algorithm is based on selecting a set of dominant flows that are optimal for a large percentage of fading states for a given network topology.

3.1.Minimum Spanning Tree Flow Selection

To find a situation flow without using brute force, we should deal with network variables that are independent of the flow structure so that the flow choice is done independently and prior to resource allocation. The network variable that can be readily used is the instantaneous link SNR. For video frame j, given the fading state [j], fk;k0 [j]gK K k=0;k0=1, we construct the complete network graph with edge weights k;k0 [j] on the link between nodes Mk and Mk0. We then use Prim's algorithm to obtain the minimum spanning tree. The spanning tree is mapped to the corresponding directed acyclic graph representing the network flow, and wireless resource are allocated on the flow according to the convex problem in through to minimize total energy consumption. The chosen flow under this strategy maximizes the sum SNR over the network links, or equivalently the sum rate because the Shannon rate is a concave function of the SNR.

3.2.Dominant Set Flow Selection

The approximate algorithm is based on the observation that most of the network flows can only be optimal for a small percentage of the fading states corresponding to extreme instantaneous SNRs on the network links. For instance, if MS M1 lies between the BS and MS M2, it is very unlikely that the transmission to M1 through M2 is more energy-efficient than the transmission to M2 through M1. We thus attempt to reduce the number of candidates by taking into account the network flows that collectively correspond to a large percentage of the fading states. We refer to this set of network flow as the dominant set. Since we employ a block-fading model, the flows that are optimal in a percentage p of the fading states are also optimal in a percentage p of the video frames for an asymptotically large number of video frames. Thus, we can estimate the dominant set using an offline simulation of the brute force algorithm.

3.3.Resource Allocation

Distributed approach to implement the resource allocation process where we assume that each node knows only its own transmit rate Rk(), transmit power Pk;t, and its set of multicast nodes M_{nk}. Additionally , to avoid added complexity, node are only allowed to send feedback to their direct upstream node. Distributed fashion describes starting from the leaf nodes, each node Mk sums the component it receives from its downstream nodes, add and send the incremental value to its upstream node. The BS can linearly transform the received incremental information to obtain using knowledge of its multicast tree and transmit rate. On each path starting from the leaf node, each node Mk adds to the incremental value it receives and sends it to its upstream node until it reaches the BS which scales it by R0 performed at the BS with the knowledge of transmission rate for each path. so that each node computes its resource allocation and transmits accordingly. Each node knows the rate at which it receives from its upstream node Mk0 and its own transmit rate. In addition the receiver can easily finds the resource allocation of its upstream node by sensing the time it takes to receive all video layers. Thus, Mk allocates resources for its transmission according to optimal allocation of nodes.

4.Network-Flow-Based Algorithm(NFBA)

NFBA sequentially allocates First resource in the t^{th} iteration, until all resource are Exhausted. A graph-based solution framework and the utility is maximized by minimizing the flow cost representing the negative values of 'date rate'. In contrast to maximum-utility resource allocation, the problem of minimum power subject to rate target that we consider does not admit a single-stage multi-commodity flow formulation. In the proposed NFBA, we maximize the 'potential power saving'(profit) on the flow, instead of minimizing the cost, in a Ft adaptively. In NFBA, flow size Ft is a control parameter which influences performance. Finding the optimal set of Ft's, however, requires enormous number of comparisons for all possible work based on to adapt Ft on iteration-by iteration basis.

5.Performance Evaluation

Finally in this module the proposed approaches were illustrated and evaluated to compare the performance of all the approaches. We analyze our proposed scheme in terms complexity, power and cost. Based on the comparison ant the results from the experiments show the proposed approach works better than the other existing systems.

5.Conclusion

Thus, we propose a system with the cooperation among mobile devices in wireless networks has the potential to provide notable performance gain in terms of increasing the network throughput, extending the network coverage, decreasing the end-user communication cost, decreasing the energy consumption. In this proposed system we derived NFBA to maximize the ‘potential power saving on the flow, instead of minimizing the cost, in a Ft adaptively. Results demonstrate notable gains in energy consumption reduction close to the optimal solution for various network topologies.

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