REVIEW ARTICLE OPEN ACCESS

Flexible Broadcasting of Scalable Video Streams in Broadband Wireless System

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Abstract
This paper presents a novel cross-layer optimization framework to improve the quality of user experience (QOE) and energy efficiency of the heterogeneous wireless multimedia broadcast receivers. User grouping is based on the respective UE resolution capabilities and received SNR. A UE capability is determined by the BS at the time of service subscription, when the UE sends its type information, i.e., the number of layers it wants to receive. The UE periodically updated its channel condition to the BS through the uplink channel. This joint optimization is achieved by grouping the users based on their device capabilities and estimated channel conditions experienced by them and broadcasting adaptive content to these groups. The adaptive multimedia content is obtained by using scalable video coding (SVC) with optimal source encoding parameters resulted from an innovative cooperative game. Energy saving at user terminals results from using a layer-aware time slicing approach in the transmission stage. Time slicing approach allows discontinuous reception at the UEs, thereby facilitating the UE to turn-off the radio when not receiving data bursts and hence saving energy. A trade-off between energy saving and QOE is observed, and is incorporated in the definition of a utility function of the players in the formulated heterogeneous user composition and physical channel aware game. An adaptive modulation and coding scheme is also optimally incorporated in order to maximize the reception quality of the broadcast receivers, while maximizing the network broadcast capacity.

I. INTRODUCTION

Mobile computing is human–computer interaction by which a computer is expected to be transported during normal usage. Mobile computing involves mobile communication, mobile hardware, and mobile software. Communication issues include ad hoc and infrastructure networks as well as communication properties, protocols, data formats and concrete technologies. Hardware includes mobile devices or device components. Mobile software deals with the characteristics and requirements of mobile applications.

Multimedia broadcasting or data casting refers to the use of the existing broadcast infrastructure to transport digital information to a variety of devices (not just PCs). While the existing infrastructure of broadcast radio and television uses analog transmissions, digital signals can be transmitted on subcarriers or sub channels. Also, both the radio and television industries have begun a transition to digital transmissions. Multimedia broadcasting will be developed in three basic dimensions. First, data casting supports the transport of multiple data types. This means that more than the traditional real-time, linear, and prescheduled forms of audio and video programming will be available. Broadcast programming will become richer and more involving by expanding its creative palette to encompass different data types and leveraging the processing power of intelligent receivers and PCs on the client side. Second, while some of this data will be related to the main channel programming (i.e., conventional radio and television programming), other data wholly unrelated to conventional programming will be transported. And third, broadcast applications will interoperate seamlessly with other non-broadcast client-server applications. Hoping to capitalize on the presumed demand for more bandwidth to the home, both cable and telephone companies actively plotted fiber optic build-outs in their distribution plant. This would have supported broadband capacity to and from the home. Given the market turn away from video-on-demand products (at least for the moment) and towards the Internet, a new economic picture emerges. There is no particular reason to optimize a network for symmetric performance (as with a fiber optics build-out), when upstream and downstream bandwidth can be allocated more efficiently with existing infrastructures. Indeed, the telephone industry's promising answer to repurposing much of their existing copper plant is a rejuvenating technology known as asymmetric digital subscriber line (ADSL). This technology supports a minimum configuration of a downstream data rate of at least 1.544 Mbps per second (e.g., equivalent to a T-1 rate), and an upstream data rate of 16 kbps.

Television broadcasters could transmit data such as HTML pages, Java applets, and virtual Reality Modeling Language (VRML), streaming audio and video or binary file transfers in their broadcast signals for capture and display by smart TV receivers, PCs, personal digital assistants, or network computers. Consumers could select from this data stream only that which is interesting to them. Further, they could activate agents or filters to grab and store particular resources of interest to them. This data could be accessed later, at their convenience, rather than having to grab it and display it in real time from the data stream being currently broadcast. This model so far assumes a one-way data stream. One interesting thing about this scenario is that from a technical viewpoint it is one-way. However, given the choice and control, it appears to be interactive to the client. This adds value. Another interesting thing is that since the telecommunications technology supporting this service is one-way, it can be available to remote and mobile users. There is no need to be tethered to any kind of wire to enjoy the benefits of this implementation of Internet service. A second model is that the client could have his or her Web browser connected to an Internet Service Provider (ISP) with the appropriate enabling technology to permit a multimedia connection to the Internet. In this scenario, the user is sitting at home surfing the Web. The person goes to a Web site where there are lots video objects. Until now, the Internet connection has been supported by a dial-up connection. When the person clicks on a 5-minute video news clip, the session software notes that this is a 3-Mbyte file and instead of pushing it through the 28.8 kbps phone connection, shunts it to a local broadcast station which loads it into the data broadcast queue.

II. LITERATURE SURVEY

G. Faria, J. Henriksson et al.[1], proposed a brief review of the new Digital Video Broadcasting—Handheld (DVB-H) standard. This is based on the earlier standard DVB-T, which is used for terrestrial digitalTV broadcasting. The new extension brings features that make it possible to receive digital video broadcast type services in handheld, mobile terminals. The paper discusses the key technologyelements—4K mode and in-depth interleavers, time slicing and additional forward error correction—in some detail. It also gives extensive range of performance results based on laboratory measurements and real field tests. Finally it presents viewpoints relevant for DVB-H network design and system use in general. The new DVB-H standard, while in no way changing thecurrent digital TV business models for fixed reception, couldprovide new business possibilities for a variety of playersfrom broadcast and cellular operators to chip and equipmentmanufacturers. The standard has exhibited proven performance in the laboratory and field tests where the additional error correction and virtual interleaver have shown their efficiency.The power saving given by time slicing makes digital broadcast reception in handheld terminals practical reality. The new system has been well received by various operators, both broadcast and telecom. Several pilot networks are running in various parts of the world and commercialization in the form of chips and user terminals takes place by several manufactures.

M. Hefeedaet al. [2],proposed the scalable video broadcasting problem in mobile TV broadcast networks, where each TV channel is encoded into a scalable video stream with multiple layers, and several TV channels are concurrently broadcast over a shared air medium to many mobile devices with heterogeneous resources. Our goal is to encapsulate and broadcast video streams encoded in scalable manner to enable heterogeneous mobile devices to render the most appropriate video sub streams while achieving high energy saving and low channel switching delay. The appropriate streams depend on the device capability and the target energy consumption level.We propose two new broadcast schemes, which are flexible in the sense that they allow diverse bit rates among layers of the same stream. Such flexibility enables videos to be optimally encoded in terms of coding efficiency, and allows the coded video streams to be better matched with the capability of mobile devices. We analyze the performance of the proposed broadcast schemes. In addition, we have implemented the proposed schemes in a real mobile TV test bed to show their practicality and efficiency. Our extensive experiments confirm that the proposed schemes enable energy saving differentiation: between 75 and 95 percent were observed.

III. PROPOSED SYSTEM

3.1 PROPOSED METHOD

A single-cell broadcast scenario is considered. Multimedia content delivery is done from the BS and managed jointly with a connected media server. The wireless user equipments (UEs) have varying display resolution and battery capabilities. Based on the users characteristics in the celland their SNRs, the media server suitably encodes the source content in H.264/SVC standard of DVB-H. The broadcast over the physical channel is OFDM-based. AUE, depending on its current status, may choose to receive all or part of the broadcast content (layers) by exploiting the time sliced transmission feature of DVB-H. Fig. 1 illustrates a representative system, where L layers and T user types are considered. For example, L = 14 in the standard ‘Harbor’ video sequence.

3.1.1 DVB-H SYSTEM FRAMEWORK

The proposed overall system architecture is illustrated in Fig. 2. The server encapsulates the SVC encoded data in real-time transport protocol (RTP) format to IP packets and sends them to the BS. The BS comprises of the IP encapsulate, DVB-H modulator, and the radio transmitter.IP encapsulate puts the IP packets into multiprotocol encapsulation (MPE) frames and forms MPE-FEC for burst transmission as per the time slicing scheme. The DVB-H modulator employs an adaptive MCS selection for the layered video content and sends it to the radio transmitter for broadcast. The SVC encoding and MPE-FEC framing operations are inter-dependent and jointly optimized based on some underlying parameters (user, channel, and layer information). The optimized video encoding parameters are obtained through a game theoretic approach and stored in a central database. The UE and channel aware user grouping is discussed in, and SVC parameter optimization game. The UE informs its capabilities while subscribing to the broadcast service and also time-to-time updates its signal strength to the BS. It also has a power manager that helps to take advantage of the time slicing scheme and save energybased on its remaining power.

3.1.2 PERFORMANCE MODELING AND OPTIMIZATION

The video quality Q(q, t) is a parametric function that best approximates the Mean Opinion Score (MOS). MOS is a subjective measure that indicates the user QoE level. MOS to ’excellent’ quality, 4 is ’good’, 3 is fair, 2 is ’poor’, and 1 is ’bad’. The parameters for the quality model are
specific to a video based on its inherent features. The quality parametric model in is specified with video specific parameters λ and g. For a given spatial resolution, Q(q, t) is a function of the quantization parameter QP and frame rate t, as follows:

$$Q(q,t) = Q_{max} \cdot Q_{t_c}(t) \cdot Q_q(q), \quad \text{with}$$
$$Q_{t_c}(t) = \frac{1 - e^{(-\lambda \cdot t/t_{max})}}{1 - e^{-\lambda}},$$
$$Q_q(q) = \frac{e^{(-g \cdot q/q_{min})}}{e^{-g}}, \text{ and } q = 2^{(QP-4)/6}.$$

$Q_{max}$is the maximum quality of the received video at the UE when it is encoded at minimum quantization level $q_{max}$and at the highest frame rate t_{max}. To normalize, we consider $Q_{max}$to be 100%. To comprehensively study the video quality in the proposed system framework, we consider three representative video sequences: ‘Harbor’, ‘Town’, ‘Tree’, which cover a wide spatial and temporal perceptual information space . In particular, the ‘Harbor’ video represents a sequence with sharp edges (high spatial variations) but having a relatively slow motion (low temporal variations), ‘Town’ has high spatial and temporal variations, whereas ‘Tree’ has low spatial and temporal variations in first half and high spatial and high temporal changes in the later half. Similar in all these video sequences. Also, the plots indicate that the quality is a concave function of QP.

3.1.3 ENERGY SAVING VERSUS QUALITY TRADE-OFF

The energy saving is a function of rate allocation to the layers. We now consider the scalability factors as parameters in the rate allocation at the source encoding stage. A function of the quantization level q, frame rate t, and spatial resolution s. The parameters θ, a andd, here are video specific.

$$R_c(q,t,s) = R_{max} \cdot R_{t_c}(t) \cdot R_q(q) \cdot R_s(s), \quad \text{with}$$
$$R_{t_c}(t) = \frac{1 - e^{(-\theta \cdot t/t_{max})}}{1 - e^{-\theta}}, \quad R_q(q) = e^{a \cdot (1-q)/q_{min}},$$
$$\text{and} \quad R_s(s) = \left(\frac{s}{s_{max}}\right)^d, \; d < 1.$$

Here, $R_{max}$is the maximum bit rate of the video sequence with minimum quantization level q_{min}, maximum frame rate t_{max}, and maximum spatial resolution s_{max}. By using these rate parametric model equations for energy saving analysis.

3.1.4 ENERGY SAVING AND QUALITY OPTIMIZATION GAME

Based on the energy saving and quality trade-off that depends on the quantization level q, we now formulate a cooperative game to obtain the optimal video encoding parameters. However it does not provide an insight to the encoding optimality for broadcast when there are different user class in different proportions. Here, we address this optimization aspect. This optimization game jointly accounts for the users of different classes as well as the fraction of users in each class. The game is defined below:

Players: Class c comprising of a set of users who can be served up to l = c layers, where $1 \le c \le l^{(\tau)}$, τ = 1, 2, 3. (Recall that, c is dynamic, computed at the BS, depending on the UE type τ and their individual SNRs.)

Strategy: Quantization level q used by the SVC encoder for encoding the source video. Optimum q determines the rate distribution (i.e. the minimum bit rate) rlfor the different layers l of the SVC content, that satisfy the users’ ES and quality requirements.

Utility: For class c the utility is defined as: uc= $(ESc(q, t))^{\alpha c} \cdot (Qc(q, t))^{\beta c}$, where αc, βc are the parametersfor a particular class of users based on their emphasis onenergy saving or quality, with αc+βc = 1. The higher the αcvalue is, the higher is the emphasis on energy saving by theusers in that class. On the other hand, the higher the value of βc is, the more will be the emphasis on receiving higher quality video. Here, for class c, energy saving ESc(q, t) is and the quality value Qc(q, t) .

3.2 MODULE DESCRIPTION

1. User grouping
2. Time slicing at data-link level transmission
3. Adaptive MCS allocation to the SVC layer
4. Video Quality Measure

3.2.1. User grouping:

User grouping is based on the respective UE resolution capabilities and received SNR. A UE capability is determined by the BS at the time of service subscription, when the UE sends its type information, i.e., the number of layers it wants to receive. The UE periodically updated its channel condition to the BS through the uplink channel.

3.2.2. Time slicing at data-link level transmission

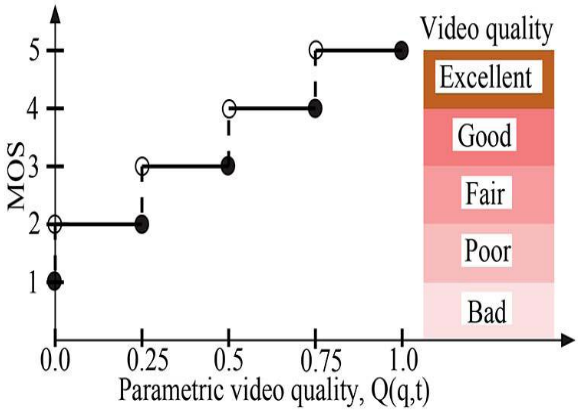
T ime slicing approach allows discontinuous reception at the UEs, thereby facilitating the UE to turn-off the radio when not receiving data bursts and hence saving energy. In time slicing-based layered broadcast, the UEs know apriority the specific layer constituted in a MPE-FEC frame (burst). As shown in Fig. 4, each layer corresponds to a different burst within the recurring window. This allows a UE to safely skip the bursts containing the layers that are irrelevant to it, and thereby save energy.

3.2.3. Adaptive MCS allocation to the SVC layer

In our approach, besides user-and channel aware SVC rate optimization at the application layer and time slicing at the link layer, at the physical layer adaptive MCS is applied which is optimized for enhanced energy efficiency and network capacity. This adaptation is a function of the heterogeneous users composition in a cell and the dynamic physical channel rate constraint. Physical channel dynamics is accounted in a slow (shadow fading) scale to avoid high bandwidth overhead of frequent channel state feedback and computation of coding and MCS optimizations at the BS as well as the video server.

3.2.4. Video Quality Measure

The quality of reception performance of the different competitive strategies, we define a video reception quality measure.



It is a performance metric that indicates the QoE of the broadcast users in a given heterogeneous users distribution. Being a weighted average, it also indicates the proportion of total number of users that are served with a specified video quality level.

IV. CONCLUSION

This paper presents a novel cross-layer optimization framework to improve both user QoE levels and energy efficiency of wireless multimedia broadcast receivers with varying display and energy constraints. This solution combines user composition-aware source c oding rate (SVC) optimization, optimum time slicing for layer coded transmission, and a cross-layer adaptive modulation and coding scheme (MCS). The joint optimization is achieved by grouping the users based on their device capabilities and estimated channel conditions experienced by them and broadcasting adaptive content to these groups. The optimization is a game theoretic approach which performs energy saving versus reception quality trade-off, and obtains optimum video encoding rates of the different users. This optimization is a function of the proportion of users in a cell with different capabilities, which in turn determines the time slicing proportions for different video content layers for maximized energy saving of low-end users, while maximizing the quality of reception of the high-end users. The optimized layered coding rate, coupled with the receiver groups' SNRs, adaptation of the MCS for transmission of different layers, ensure higher number of users are served while also improving users' average reception quality. Thorough testing has shown how the proposed optimization solution supports better performance for multimedia broadcast over wireless in comparison with the existing techniques.

REFERENCES

[1] Google, "*The new multi-screen world: Understanding crossplatform consumer behavior*," Aug. 2012.

[2] Cisco, "*Cisco visual networking index: Global mobile data traffic forecast update, 2013–2018*," Feb. 2014.

[3] K. Rao, Z. S. Bojkovic, and D. A. Milovanoic, *Multimedia Communication Systems: Techniques*, Standards, Networks, 1st ed.Upper Saddle River, NJ, USA: Prentice Hall, 2002.

[4] S. Sesia, I. Toufik, and M. Baker, LTE UMTS Long Term Evolution, from Theory to Practice. Chichester, U.K.: Wiley, 2009.

[5] G. Faria, J. Henriksson, E. Stare, and P. Talmola, "*DVB-H: Digital broadcast services to handheld devices*," Proc. IEEE, vol. 94, no. 1, pp. 194–209, Jan. 2006.

[6] Digital Video Broadcasting (DVB); Framing Structure, Channel Coding and Modulation for Digital Terrestrial Television, ETSI EN Std. 300744, 2009.

[7] Digital Video Broadcasting (DVB); DVB-H Transmission System for Handheld Terminals, ETSI EN Std. 302 304, 2011.

[8] Amendment 5: Enhancements for Higher Throughput, IEEE Std.802.11n, Oct. 2009.

[9] C.-H. Hsu and M. M. Hefeeda, "*Flexible broadcasting of scalable video streams to heterogeneous mobile devices*," IEEE Trans.Mobile Comput., vol. 10, no. 3, pp. 406–418, Mar. 2011.

[10] T. E. Shabrawy and S. Wahed, "*Adaptive modulation and coding for broadcast DVB-H systems,"* in Proc. IEEE PIMRC, Tokyo,Japan, Sep. 2009, pp. 1292–1296.