Reliable and Energy-efficient Hybrid Screen Mirroring Multicast System

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ABSTRACT - *Data sharing in networks are now days a challenging one where the source is sending a video file to destination, major problem is interference. Once the router is set to search for a path takes too time for identifying a better path to transmit data. The performance is affected due to the time delay of searching path and the interference cause data loss or interruption of transmission. To solve this problem and provide multicast video streaming over Wi-Fi network, some research efforts have been devoted to overhearing and forward error correction (FEC)-based multicast transmission. In this method, the sender delivers the data to the target receiver using uncast transmission while the non-target receivers overhear the uncast transmission. Because the rate adaptation and MAC-layer retransmission are operated by the uncast transmission between the sender and the target receiver, high transmission rate can be achieved. Moreover, FEC schemes are employed to provide reliable data delivery to the non-target receivers who cannot utilize the MAC-layer retransmission. The proposed system not only shapes the screen mirroring traffic, but also determines the target sink device and Raptor encoding parameters such as the number of source symbols, symbol size, and code rate while considering the energy consumption and processing delay of the Raptor encoding and decoding processes.*

Index Terms— Screen content, Screen mirroring, Wi-Fi, Multicast, Systematic Raptor codes, Overhearing

1. INTRODUCTION

SCREEN mirroring technology enables a mobile device to duplicate its screen content in real-time onto a large display device, such as monitor, TV, and projector. This technology allows the mobile user to overcome the constraints of the small display unit in a mobile device. Furthermore, screen mirroring can be applicable to various applications, such as gallery sharing, presentations, mobile streaming, and mobile gaming . Because of its wide range of applications, state-of-the-art mobile devices typically offer screen mirroring functionality, and some commercial products are already available, e.g., AirPlay, Chromecast , MirrorOp , Splashtop, and Miracast .

In particular, Miracast, which is developed by the WiFi Alliance, aims to act like a wireless High Definition Multimedia Interface (HDMI) cable. In Miracast, the source device (i.e., the mobile device) encodes the screen content with H.264/AVC and transmits the compressed video data to the sink device (i.e., typically WiFi enabled receiver connected to a TV or display device) using Real-Time Streaming Protocol (RTSP) and WiFi Direct. Recently, the demand for screen content sharing among adjacent mobile devices has been increasing for conferences, lectures, etc. However, it is still challenging to provide screen mirroring for multiple adjacent devices because existing screen mirroring technologies support only one-to-one connection. To handle this problem, it is necessary to enable WiFi multicast for screen mirroring.

Unfortunately, there are several well-known problems in the WiFi multicast. One of the most serious problems is unreliable packet delivery caused by the absence of acknowledgment and packet A reliable and energy efficient hybrid screen mirroring multicast system for sharing high-quality screen content among adjacent mobile devices. In the proposed system, the overhearing based multicast scheme is employed to overcome well known problems of the WiFi multicast. To mitigate the video quality degradation caused by packet loss, the proposed system utilizes systematic Raptor codes as an FEC scheme and NACK-based retransmission scheme as an ARQ scheme for error correction. Raptor codes are a class of fountain codes and a block-based FEC scheme that provide systematic coding, flexibility, coding efficiency, and rate less codes. These characteristics are very useful for transmitting delay-sensitive data over error-prone wireless networks. The proposed system is designed to minimize energy consumption at the source device and sink devices while still providing a high quality screen mirroring service. To achieve this goal, an energy consumption model of a WiFi network interface is derived, and then simple but effective energy consumption and delay models for Raptor encoding and decoding processes are obtained. Based on the derived models, the proposed system is designed to shape the screen mirroring traffic based on the buffer occupancy of the sink device and determine the target sink device and Raptor encoding parameters to minimize the overall energy consumption.

Our main contributions are summarized below;

- Introduction of an energy consumption model of a WiFi network interface for the overhearing-based multicast scheme.
- Introduction of energy consumption and delay models for the SIMD-based Raptor encoding and decoding process.
- Design of a target sink device and code rate determining algorithm for the overhearing-based multicast environment by taking into account the wireless network conditions and the energy consumption of WiFi network interfaces.
- Adjustment of Raptor encoding parameters such as code rate, symbol size, number of source symbols, and number of Raptor encoding blocks on the fly by considering time-varying wireless networks and energy consumption of Raptor encoding and decoding processes.
- Implementation of the entire proposed system on Linux-based single board computers and examination of the proposed system in real wireless network environments

2. RELATED WORK

` So far, many research efforts have been devoted to screen mirroring compared the performance of state-of-the-art screen mirroring technologies. According to their measurements, there is no single winning screen mirroring technology, and there is some room for improvement through design considerations, such as rate adaptation mechanisms and error resilience tools. Furthermore, they implemented a rate adaptation mechanism for a screen mirroring platform presented practical screen sharing system in resource constrained environment. They developed a simple mechanism to transform inter-update temporal redundancy into intra-update spatial redundancy, and achieved good compression rates and high screen capture rates conducted a measurement study on the power consumption of Miracast. Using insights from the measurement, they proposed some energy efficient mechanisms such as adaptive video tail cutting, redundant codec operation bypass, and least congested channel selection. Ha et al. presented a frame filtering method that reduces the Miracast traffic load by analyzing the dynamism of screen content. Similarly, proposed an adaptive frame skipping method that analyzes the motion dynamics of screen content. However, it is still challenging to provide screen mirroring multicast because existing screen mirroring systems are limited to unicast transmission. To solve this problem, it is necessary to enable WiFi multicast for screen mirroring. To date, many research efforts have focused on providing multicast media delivery system over WiFi network proposed a leader-based multicast service (LBMS) to improve the reliability and efficiency of WiFi multicast.

Although the leader client of a multicast group can send feedback frames for retransmission request and rate adaptation, LBMS still cannot provide sufficient goodput for high-quality video multicast. To improve the goodput of a WiFi multicast, used the unicast transmission to deliver the IPTV stream to a target receiver, while non-target receivers overhear the unicast transmission. This WiFi multicast transmission method is called pseudo-broadcast.

Their analysis show that the pseudo-broadcast achieves high transmission rate with retransmission and rate adaptation for only one target receiver, and it cannot provide reliable packet delivery for non-target receivers.

One of the major concerns of screen mirroring multicast technology is the amount of energy needed by the mobile device to conduct multicast transmission over the wireless network. To date, many energy-efficient wireless networking technologies have been proposed to improve the energy efficiency of the network interface on a mobile device with limited battery capacity.

3. EXISTING SYSTEM

One of the major concerns of screen mirroring multicast technology is the amount of energy needed by the mobile device to conduct multicast transmission over the wireless network. To date, many energy-efficient wireless networking technologies have been pro-posed to improve the energy efficiency of the network interface on the device with limited battery capacity. It was shown that traffic shaping using a proxy server can save more energy than adjusting the mobile device sleep time. Presented an ES-treamer to provide energy-efficient multimedia streaming service. E-Streamer determines an optimal burst size and idle period length for a streaming client to allow the mo-bile device to reduce their energy consumption with seamless multimedia streaming. The existing routers takes too much of time to search a path for data transmission between source and destination. Performance is slow as well as interference occurred during each transmission.

4. PROPOSED SCREEN MIRRORING MULTICAST SYSTEM

The proposed system aims to provide a high-quality and energy-efficient screen mirroring multicast service among adjacent mobile devices over WiFi network. As mentioned earlier, systematic Raptor code and NACKbased retransmission scheme are adopted in the proposed system to recover lost packets over the error prone WiFi network. For energy saving at mobile devices, the proposed system shapes the screen mirroring traffic, and determines the target sink device and the Raptor encoding parameters based on the estimated energy consumption models of the WiFi network interface and Raptor encoding and decoding processes. The overall architecture of the proposed system is illustrated in Fig. 1.

The proposed system is de-signed to minimize energy consumption at the source device and sink devices while still providing a high-quality screen mirroring service. To achieve this goal, an energy consumption model of a Wi-Fi network interface is derived, and then simple but effective energy consumption and delay models for Raptor encoding and decoding processes are obtained. Introduction of an energy consumption model of a Wi-Fi network interface for the overhearing-based multicast scheme. Energy consumption and delays for encoding and decoding process.

Design of a target sink device and code rate determining algorithm for the overhearing-based multicast environment by taking into account the wireless network conditions and the energy consumption of Wi-Fi net-work interfaces. Implementation of the entire proposed system on Linux-based single board computers and examination of the proposed system in real wireless network environments. The system concentrates on this point and study the minimum number of infrastructure nodes that need to be added in order to maintain a specific property in the overlay routing. We develop a nontrivial approximation algorithm and prove its properties. We demonstrate the actual benefit one can gain from using our scheme in three practical scenarios, namely BGP routing, TCP improvement, and VoIP applications.

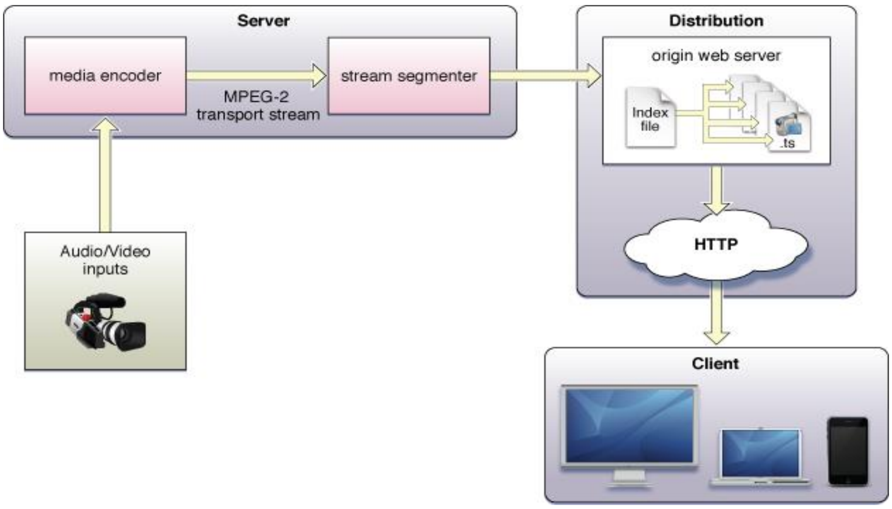

Fig. 1. Overall architecture of the proposed system.

In the sender side machine, initially user wants the ip address and port number of the target machine that is receiver side machine. Then in the sender side machine we are using two protocols, they are Video For Window (VFW) and Heuristic Distributed Protocol (HDP). In the receiver side machine also, initially the user wants the ip address and port number of the sender side machine. We use two rounds to find two paths together with spectrum allocation. In each round, the receiver broadcasts the path discovery message to its neighbors. Each intermediate node updates its currently best path and spectrum allocation to the receiver, and further broadcasts the update information. Once the sender has received the update messages, it selects a best path and spectrum allocation and replies to the receiver. HDP scans the data transferred from port.

Whenever any media streams have been transferred across the receiver application and sender application. HDP is adapted in both sender side as well as the receiver side. In both side it will report the information passed across the channel.

4.1 Energy Consumption Model and Delay Model

In this section, we propose an energy consumption model of the WiFi network interface and energy consumption models and delay models for Raptor encoding and decoding processes.

4.1.1 Energy Consumption Model for Wi-Fi Network Interface

The general energy consumption patterns of the Wi-Fi network interfaces at the source device and sink devices are presented in Fig. 3. Because the source device behaves like an AP, it periodically broadcasts beacon messages to the sink devices during the inactive state. The sink deviceses constantly listen to the wireless channel to overhear unicast transmission. When there is data to be received from the source device, the target sink device requests the data from the source device. Now, the source device transmits data using unicast transmission to the target device, and the non-target devices immediately overhear these data. After completing the data transmission, the source device and target sink device enter into the inactive state if there is no additional data for tail time.

4.1.2 Energy Consumption and Delay Model for Raptor Encoding/Decoding

Processes For Raptor encoding and decoding processes, the XOR operation is the most dominant process . Thus, the energy consumption for Raptor encoding and decoding processes can be predicted based on the amount of XORed bytes, which is calculated by multiplying the symbol size by the number of symbol-level XOR operations. In the proposed system, we implemented Raptor codes using a single instruction multiple data (SIMD) technology to improve the performance of the Raptor encoding and decoding processes. The SIMD is a wellknown parallel processing technology that enables the parallel processing of multiple data with a single instruction, e.g., matrix summation and multiplication. Since the performance of the Raptor codes in the proposed system is affected by the SIMD-based implementation, we derive the SIMD-based energy consumption and delay models. Hence, it is very difficult to find the typical coefficients of the energy models. But several device manufacturers provide the power profile to estimate the device energy consumption . If the power profile is offered by device manufacturer, then we can approximately calculate the coefficients of the energy models.

4.2 Parameter Determining Algorithm

In this section, we present the parameter determining algorithm to obtain a feasible solution. First, the target sink device and code rate determining algorithm is studied.

Then, the Raptor encoding parameter selection algorithm is described in detail. Target Sink Device and Code Rate Determining Algorithm We provide the determining algorithm for v and c. In the target sink device and code rate determining problem, when the target sink device is fixed, the solution candidates of c can be obtained by calculating the code rates which can achieve a successful Raptor decoding at a certain sink device. Thus, the optimal solution of v and c that minimizes the given cost function ( ) ,cor pktn vc can be easily obtained by conducting a full search among all possible candidates of c for all sink devices.

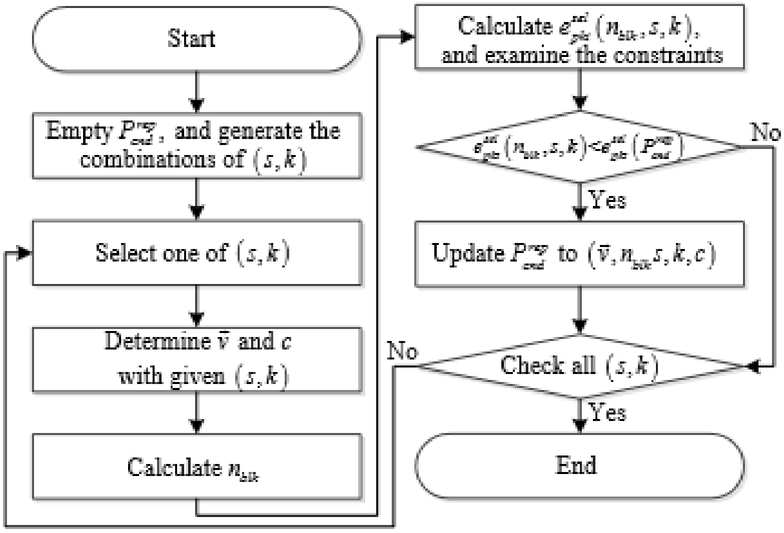

Fig. 2. Overall procedure of the parameter determining algorithm.

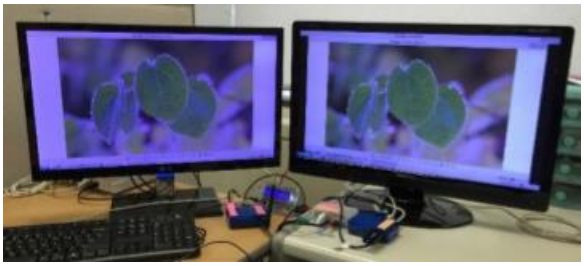

Fig. 3. Proposed system implemented on ODROID.

5. MODULES

Modules are units of code written in access basic language. We can write and use module to automate and customize the database in very sophisticated ways.

Thus they have four types,

- Sender
- Receiver
- Distributed Routing and Channel Allocation
- Heuristic Distributed Protocol

Sender

In the sender side machine, initially user wants the ip address and port number of the target machine that is receiver side machine. The sender can capable of storing the file in the local machine. Then in the sender side machine we are using two protocols, they are Video For Window (VFW) and Heuristic Distributed Protocol (HDP).

Receiver

In the receiver side machine also, initially the user wants the ip address and port number of the sender side machine. So now the communication is established between the sender side machine and receiver side machine.

Distributed Routing and Channel Allocation

We use two rounds to find two paths together with spectrum allocation. In each round, the receiver broadcasts the path discovery message to its neighbors. Each intermediate node updates its currently best path and spectrum allocation to the receiver, and further broadcasts the update information. Once the sender has received the update messages, it selects a best path and spectrum allocation and replies to the receiver.

Heuristic Distributed Protocol:

HDP scans the data transferred from port. Whenever any media streams have been transferred across the receiver application and sender application. It just track the data transferred from the sender application. HDP is adapted in both sender side as well as the receiver side. In both side it will report the information passed across the channel.

6. CONCLUSION

In this paper, we have proposed a reliable and energyefficient hybrid screen mirroring multicast system for sharing high-quality screen mirroring service among adjacent sink devices. In the proposed system, systematic Raptor codes and NACK-based retransmission are employed to reduce the video quality degradation over an error-prone WiFi network. The proposed system not only shapes the screen mirroring traffic, but also determines the target sink device and Raptor encoding parameters while considering the energy consumption of the source device and sink devices. The proposed system has been fully implemented in Linux-based single board computers, and tested over a real WiFi network. Experimental results show that the proposed system can provide energy savings of 39.05% compared to ACK-based multicast systems while providing the same level of video quality. Furthermore, the proposed system can provide high quality screen mirroring without noticeable video quality degradation compared to existing systems.

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