CoCam: Real-time Photo Sharing Based on Opportunistic P2P Networking

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***Abstract*—We describe a mobile application for sharing user-authored photo content in realtime called CoCam. CoCam is a collaborative content sharing framework based on opportunistic P2P proximal networking. CoCam users who are located in the same physical space can automatically share the photos they create as well as receive photos from other users around them. Since CoCam is based on an opportunistic P2P network middleware, users are not required to know each other in advance. It is also not necessary for them to agree on the same service provider nor coordinate the network configuration, infrastructure and security settings. This middleware automatically discovers other peers and handles the organization of ad-hoc network connections. With CoCam, we demonstrate that users are able to share and enjoy shared photos and video streams without the effort of manual setup and cost associated with the 3G/4G network.**

I. Introduction

Web based services, such as Facebook[1] are very popular for sharing images and video clips after the event (post hoc). In parallel to the growth of content sharing services, smartphones and tablet devices have massively increased their penetration. With their smartphones, users are now capable of creating, consuming and sharing rich media, and are able to use such web services during the actual events. In most cases, in order to access the shared content users must use the same services and be connected on the social graph beforehand. Moreover, users may need to agree on hashtags or other tagging mechanisms in order to filter out shared content that is not relevant to the context of the shared event.

While smartphones with high-quality cameras are excellent for creating contents, transmitting such contents over the cellular infrastructure can be problematic. Sharing contents using web services though the mobile data network is associated with higher costs. It may also lead to bandwidth congestion and negatively affect the user experience. Todays cellular networks may be suitable for e-mail communication and web browsing, but may not be optimal for real-time content sharing.

Operating a mobile phone camera, creating rich media, sharing and consuming others shared media, all at the same time is a very complex multitasking challenge. Traditionally, these tasks are separated into different applications designed separately for creating, sharing, or consuming media. This complexity is overwhelming when requiring the users to perform network setup and configuration tasks.

Opportunistic networks[2] based on proximal radio are good candidates to address the limitations of content sharing between uncoordinated users who may not know each other or may not use the same services. Opportunistic networks can improve the user experience by using proximal wireless links with higher bandwidth instead of mobile data infrastructure. These networks can also reduce the cost associated with mobile data when sharing contents. Another advantage of such networks is the ability to eliminate the need of tagging for searching and filtering for relevant content, since the relevance can be inferred from the opportunistic context. Since opportunistic networks self organize around the shared context, users are not required to perform network configurations.

In contrast to the above limitations and following the opportunistic networks principles, we propose a prototype photo sharing application built on top of a framework called CoCam. CoCam enables smartphones to coordinate with each other and self-configure a proximal P2P network group on an ad-hoc opportunistic basis. It also enables users to distribute and share photos and video streams over the local network, without applying additional burden on the cellular infrastructure. CoCam eliminates complicated settings for joining and leaving the network. As a result, users can enjoy a familiar and simple point-and-shoot interfaces. Using this camera application, people are able to automatically share the images they create and receive shared images without the use of other applications dedicated for sharing and consuming shared content.

II. System Architecture

The CoCam framework mainly consists of four modules; a middleware for opportunistic P2P networking, a media sender/receiver, a front end user interface, and a backend server for managing the node groups. The network middleware senses the opportunistic context of the device, and controls the network configurations based on the grouping decision made by the server. The server keeps track of all the groups as well as the nodes, and handles the grouping decision. The media sender/receiver handles the transmission of contents over proximal radio, and the user interface provides a simple camera view for generating contents.

The opportunistic context of CoCam groups is defined by the geo-spacial factors (longitude, latitude, and fingerprints of fixed Wi-Fi access points) of a specific scene. The network middleware would sense the geo-spacial factors, and

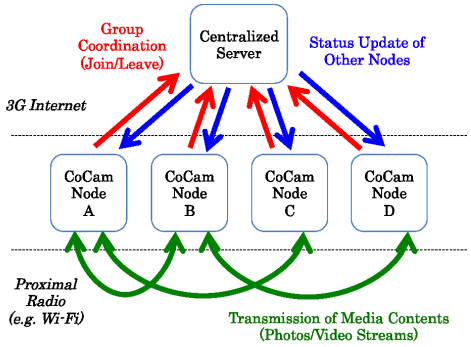

Fig. 1. Interaction Flow

Fig. 2. User Interface of CoCam

send them periodically to the server, which would decide the most relevant group to join. If the group already exists, CoCam would attempt to join in. Otherwise, it would create a new network. As for the network interface, CoCam uses the standard Wi-Fi channels. There are other solutions, such as Bluetooth or Wi-Fi Direct[3], but they are somewhat limited in terms of bandwidth, communication range, or penetration in the market. In order for CoCam to be used on off-the-shelf smartphones, it exploits the standard mobile access point feature for establishing local P2P networks. Upon initiating a new group, one of the nodes would become an AP node.

The role of the server is to increase the reliability. The server-client interaction of CoCam inherits the example of MOVi[4]. As shown in Figure 1, CoCam nodes would interact with the server individually though the conventional cellular infrastructure. While the actual content sharing is kept within the P2P links over proximal Wi-Fi. The interaction with the server enables peers to join the most relevant network group, and receive periodic updates on the latest status of other nodes. It also enables the groups to self-reconfigure the network upon corruption (e.g. loss of AP node) This architecture does not completely eliminate the reliance on the cellular infrastructure. However, given the fact that centralized group/node management would reduce the uncertainty of opportunistic networks, CoCam takes this design concept into practice.

For addressing the privacy issues upon sharing contents, CoCam features a function that enables the users to easily toggle between private mode and public mode, and take control of the contents to be shared. CoCam also features a function for changing groups, if the group is irrelevant to the user.

III. Prototype Application

The prototype application represents a typical utilization of CoCam for sharing photos with other peers within the same context. It is implemented as a standard Android application, and has a very simple user interface for shooting and sharing images, as well as joining, leaving, or changing CoCam groups. Figure 2 indicates the basic image of the interface with a camera preview shown on the background.

In order to examine how CoCam could enhance the user experience in public event scenarios, a series of user studies were conducted with this application, under a mock-up environment of a demo session within a technology conference. As a result, we were able to understand that there is a potential need for creating and sharing photos with others in real-time during such events. We also learned that this prototype application is suitable for addressing the that need, and it can improve the user experience by expanding the content coverage of the event without applying additional burden to the user.

Other example scenarios that can benefit from CoCam include sport events and live concerts. The spectators of a sport event may enjoy photos and video clips from multiple angles during the actual game. In live concerts, the audience in the back may enjoy up-front footages shared by people closer to the performer.

In this particular opportunity, we would like to showcase the prototype application on actual smartphones during the CCNC 2013 demo session, and demonstrate the concept of how people can easily record and share their experiences with others. As for the demo environment, a table with a power outlet would be more than enough.

IV. Conclusion

This paper describes a prototype application for sharing photos using the CoCam framework, enabling users to easily share photos in real-time over proximal networks created opportunistically. As for the next step, we hope to implement efficient algorithms or methods for increasing the scalability of mobile opportunistic networks. We are also looking into implementing methods that enables users to not only share, but also co-generate media together in real-time.

Acknowledgment

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